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1 Introduction

1.1 Where does this specification fit?

This specification defines a big part of the web platform, in lots of detail. Its place in the web platform specification stack relative to other specifications can be best summed up as follows:

CSS   SVG   MathML   Service Workers

CSP   PNG   AV1

HTTP   TLS   DOM   Unicode   Web IDL
MIME   URL   XML   JavaScript   Encoding

1.2 Is this HTML5?

This section is non-normative.

In short: Yes.

In more length: the term "HTML5" is widely used as a buzzword to refer to modern web technologies, many of which (though by no
means all) are developed at the WHATWG. This document is one such; others are available from the WHATWG Standards overview.

1.3 Background

This section is non-normative.

HTML is the World Wide Web's core markup language. Originally, HTML was primarily designed as a language for semantically describing scientific documents. Its general design, however, has enabled it to be adapted, over the subsequent years, to describe a number of other types of documents and even applications.

1.4 Audience

This section is non-normative.

This specification is intended for authors of documents and scripts that use the features defined in this specification, implementers of tools that operate on pages that use the features defined in this specification, and individuals wishing to establish the correctness of documents or implementations with respect to the requirements of this specification.

This document is probably not suited to readers who do not already have at least a passing familiarity with web technologies, as in places it sacrifices clarity for precision, and brevity for completeness. More approachable tutorials and authoring guides can provide a gentler introduction to the topic.

In particular, familiarity with the basics of DOM is necessary for a complete understanding of some of the more technical parts of this specification. An understanding of Web IDL, HTTP, XML, Unicode, character encodings, JavaScript, and CSS will also be helpful in places but is not essential.

1.5 Scope

This section is non-normative.

This specification is limited to providing a semantic-level markup language and associated semantic-level scripting APIs for authoring accessible pages on the web ranging from static documents to dynamic applications.

The scope of this specification does not include providing mechanisms for media-specific customization of presentation (although default rendering rules for web browsers are included at the end of this specification, and several mechanisms for hooking into CSS are provided as part of the language).

The scope of this specification is not to describe an entire operating system. In particular, hardware configuration software, image manipulation tools, and applications that users would be expected to use with high-end workstations on a daily basis are out of scope. In terms of applications, this specification is targeted specifically to applications that would be expected to be used by users on an occasional basis, or regularly but from disparate locations, with low CPU requirements. Examples of such applications include online purchasing systems, searching systems, games (especially multiplayer online games), public telephone books or address books, communications software (email clients, instant messaging clients, discussion software), document editing software, etc.

1.6 History

This section is non-normative.

For its first five years (1990-1995), HTML went through a number of revisions and experienced a number of extensions, primarily hosted first at CERN, and then at the IETF.

With the creation of the W3C, HTML's development changed venue again. A first abortive attempt at extending HTML in 1995 known as HTML 3.0 then made way to a more pragmatic approach known as HTML 3.2, which was completed in 1997. HTML4 quickly followed
later that same year.

The following year, the W3C membership decided to stop evolving HTML and instead begin work on an XML-based equivalent, called XHTML. This effort started with a reformulation of HTML4 in XML, known as XHTML 1.0, which added no new features except the new serialization, and which was completed in 2000. After XHTML 1.0, the W3C's focus turned to making it easier for other working groups to extend XHTML, under the banner of XHTML Modularization. In parallel with this, the W3C also worked on a new language that was not compatible with the earlier HTML and XHTML languages, calling it XHTML2.

Around the time that HTML's evolution was stopped in 1998, parts of the API for HTML developed by browser vendors were specified and published under the name DOM Level 1 (in 1998) and DOM Level 2 Core and DOM Level 2 HTML (starting in 2000 and culminating in 2003). These efforts then petered out, with some DOM Level 3 specifications published in 2004 but the working group being closed before all the Level 3 drafts were completed.

In 2003, the publication of XForms, a technology which was positioned as the next generation of web forms, sparked a renewed interest in evolving HTML itself, rather than finding replacements for it. This interest was borne from the realization that XML's deployment as a web technology was limited to entirely new technologies (like RSS and later Atom), rather than as a replacement for existing deployed technologies (like HTML).

A proof of concept to show that it was possible to extend HTML4's forms to provide many of the features that XForms 1.0 introduced, without requiring browsers to implement rendering engines that were incompatible with existing HTML web pages, was the first result of this renewed interest. At this early stage, while the draft was already publicly available, and input was already being solicited from all sources, the specification was only under Opera Software's copyright.

The idea that HTML's evolution should be reopened was tested at a W3C workshop in 2004, where some of the principles that underlie the HTML5 work (described below), as well as the aforementioned early draft proposal covering just forms-related features, were presented to the W3C jointly by Mozilla and Opera. The proposal was rejected on the grounds that the proposal conflicted with the previously chosen direction for the web's evolution; the W3C staff and membership voted to continue developing XML-based replacements instead.

Shortly thereafter, Apple, Mozilla, and Opera jointly announced their intent to continue working on the effort under the umbrella of a new venue called the WHATWG. A public mailing list was created, and the draft was moved to the WHATWG site. The copyright was subsequently amended to be jointly owned by all three vendors, and to allow reuse of the specification.

The WHATWG was based on several core principles, in particular that technologies need to be backwards compatible, that specifications and implementations need to match even if this means changing the specification rather than the implementations, and that specifications need to be detailed enough that implementations can achieve complete interoperability without reverse-engineering each other.

The latter requirement in particular required that the scope of the HTML5 specification include what had previously been specified in three separate documents: HTML4, XHTML1, and DOM2 HTML. It also meant including significantly more detail than had previously been considered the norm.

In 2006, the W3C indicated an interest to participate in the development of HTML5 after all, and in 2007 formed a working group chartered to work with the WHATWG on the development of the HTML5 specification. Apple, Mozilla, and Opera allowed the W3C to publish the specification under the W3C copyright, while keeping a version with the less restrictive license on the WHATWG site.

For a number of years, both groups then worked together. In 2011, however, the groups came to the conclusion that they had different goals: the W3C wanted to publish a "finished" version of "HTML5", while the WHATWG wanted to continue working on a Living Standard for HTML, continuously maintaining the specification rather than freezing it in a state with known problems, and adding new features as needed to evolve the platform.

In 2019, the WHATWG and W3C signed an agreement to collaborate on a single version of HTML going forward: this document.

### 1.7 Design notes

This section is non-normative.

It must be admitted that many aspects of HTML appear at first glance to be nonsensical and inconsistent.

HTML, its supporting DOM APIs, as well as many of its supporting technologies, have been developed over a period of several decades by a wide array of people with different priorities who, in many cases, did not know of each other's existence.
Features have thus arisen from many sources, and have not always been designed in especially consistent ways. Furthermore, because of the unique characteristics of the web, implementation bugs have often become de-facto, and now de-jure, standards, as content is often unintentionally written in ways that rely on them before they can be fixed.

Despite all this, efforts have been made to adhere to certain design goals. These are described in the next few subsections.

### 1.7.1 Serializability of script execution

**This section is non-normative.**

To avoid exposing web authors to the complexities of multithreading, the HTML and DOM APIs are designed such that no script can ever detect the simultaneous execution of other scripts. Even with workers, the intent is that the behavior of implementations can be thought of as completely serializing the execution of all scripts in all globals.

The exception to this general design principle is the JavaScript `SharedArrayBuffer` class. Using `SharedArrayBuffer` objects, it can in fact be observed that scripts in other agents are executing simultaneously. Furthermore, due to the JavaScript memory model, there are situations which not only are un-representable via serialized script execution, but also un-representable via serialized statement execution among those scripts.

### 1.7.2 Compliance with other specifications

**This section is non-normative.**

This specification interacts with and relies on a wide variety of other specifications. In certain circumstances, unfortunately, conflicting needs have led to this specification violating the requirements of these other specifications. Whenever this has occurred, the transgressions have each been noted as a "willful violation", and the reason for the violation has been noted.

### 1.7.3 Extensibility

**This section is non-normative.**

HTML has a wide array of extensibility mechanisms that can be used for adding semantics in a safe manner:

- Authors can use the `class` attribute to extend elements, effectively creating their own elements, while using the most applicable existing "real" HTML element, so that browsers and other tools that don't know of the extension can still support it somewhat well. This is the tack used by microformats, for example.

- Authors can include data for inline client-side scripts or server-side site-wide scripts to process using the `data-*` attributes. These are guaranteed to never be touched by browsers, and allow scripts to include data on HTML elements that scripts can then look for and process.

- Authors can use the `<meta name=``content``>` mechanism to include page-wide metadata.

- Authors can use the `rel` mechanism to annotate links with specific meanings by registering extensions to the predefined set of link types. This is also used by microformats.

- Authors can embed raw data using the `<script type=``>` mechanism with a custom type, for further handling by inline or server-side scripts.

- Authors can extend APIs using the JavaScript prototyping mechanism. This is widely used by script libraries, for instance.

- Authors can use the microdata feature (the `itemscope``` and `itemprop`` attributes) to embed nested name-value pairs of data to be shared with other applications and sites.

- Authors can define, share, and use custom elements to extend the vocabulary of HTML. The requirements of valid custom element names ensure forward compatibility (since no elements will be added to HTML, SVG, or MathML with hyphen-containing local names in the future).
1.8 HTML vs XML syntax

This section is non-normative.

This specification defines an abstract language for describing documents and applications, and some APIs for interacting with in-memory representations of resources that use this language.

The in-memory representation is known as "DOM HTML", or "the DOM" for short.

There are various concrete syntaxes that can be used to transmit resources that use this abstract language, two of which are defined in this specification.

The first such concrete syntax is the HTML syntax. This is the format suggested for most authors. It is compatible with most legacy web browsers. If a document is transmitted with the `text/html` MIME type, then it will be processed as an HTML document by web browsers. This specification defines the latest HTML syntax, known simply as "HTML".

The second concrete syntax is XML. When a document is transmitted with an `XML` MIME type, such as `application/xhtml+xml`, then it is treated as an XML document by web browsers, to be parsed by an XML processor. Authors are reminded that the processing for XML and HTML differs; in particular, even minor syntax errors will prevent a document labeled as XML from being rendered fully, whereas they would be ignored in the HTML syntax.

Note

The XML syntax for HTML was formerly referred to as "XHTML", but this specification does not use that term (among other reasons, because no such term is used for the HTML syntaxes of MathML and SVG).

The DOM, the HTML syntax, and the XML syntax cannot all represent the same content. For example, namespaces cannot be represented using the HTML syntax, but they are supported in the DOM and in the XML syntax. Similarly, documents that use the `noscript` feature can be represented using the HTML syntax, but cannot be represented with the DOM or in the XML syntax. Comments that contain the string "--->" can only be represented in the DOM, not in the HTML and XML syntaxes.

1.9 Structure of this specification

This section is non-normative.

This specification is divided into the following major sections:

Introduction

Non-normative materials providing a context for the HTML standard.

Common Infrastructure

The conformance classes, algorithms, definitions, and the common underpinnings of the rest of the specification.

Semantics, structure, and APIs of HTML documents

Documents are built from elements. These elements form a tree using the DOM. This section defines the features of this DOM, as well as introducing the features common to all elements, and the concepts used in defining elements.

The elements of HTML

Each element has a predefined meaning, which is explained in this section. Rules for authors on how to use the element, along with user agent requirements for how to handle each element, are also given. This includes large signature features of HTML such as video playback and subtitles, form controls and form submission, and a 2D graphics API known as the HTML canvas.

Microdata

This specification introduces a mechanism for adding machine-readable annotations to documents, so that tools can extract trees of name-value pairs from the document. This section describes this mechanism and some algorithms that can be used to convert HTML documents into other formats. This section also defines some sample Microdata vocabularies for contact information, calendar events, and licensing works.

User interaction

HTML documents can provide a number of mechanisms for users to interact with and modify content, which are described in this section, such as how focus works, and drag-and-drop.
HTML documents do not exist in a vacuum — this section defines many of the features that affect environments that deal with multiple pages, such as web browsers.

This section introduces basic features for scripting of applications in HTML.

This section defines an API for background threads in JavaScript.

This section defines infrastructure for APIs that need to run JavaScript separately from the main JavaScript execution environment.

This section describes some mechanisms that applications written in HTML can use to communicate with other applications from different domains running on the same client. It also introduces a server-push event stream mechanism known as Server Sent Events or EventSource, and a two-way full-duplex socket protocol for scripts known as Web Sockets.

This section defines a client-side storage mechanism based on name-value pairs.

All of these features would be for naught if they couldn't be represented in a serialized form and sent to other people, and so these sections define the syntaxes of HTML and XML, along with rules for how to parse content using those syntaxes.

This section defines the default rendering rules for web browsers.

There are also some appendices, listing obsolete features and IANA considerations, and several indices.

1.9.1 How to read this specification

This specification should be read like all other specifications. First, it should be read cover-to-cover, multiple times. Then, it should be read backwards at least once. Then it should be read by picking random sections from the contents list and following all the cross-references.

As described in the conformance requirements section below, this specification describes conformance criteria for a variety of conformance classes. In particular, there are conformance requirements that apply to producers, for example authors and the documents they create, and there are conformance requirements that apply to consumers, for example web browsers. They can be distinguished by what they are requiring: a requirement on a producer states what is allowed, while a requirement on a consumer states how software is to act.

Requirements on producers have no bearing whatsoever on consumers.

For example, "the foo attribute's value must be a valid integer" is a requirement on producers, as it lays out the allowed values; in contrast, the requirement "the foo attribute's value must be parsed using the rules for parsing integers" is a requirement on consumers, as it describes how to process the content.

Continuing the above example, a requirement stating that a particular attribute's value is constrained to being a valid integer emphatically does not imply anything about the requirements on consumers. It might be that the consumers are in fact required to treat the attribute as an opaque string, completely unaffected by whether the value conforms to the requirements or not. It might be (as in the previous example) that the consumers are required to parse the value using specific rules that define how invalid (non-numeric in this case) values are to be processed.
1.9.2 Typographic conventions

This is a definition, requirement, or explanation.

Note
This is a note.

Example
This is an example.

This is an open issue.

⚠ Warning!
This is a warning.

IDL
[Exposed=Window]
interface Example {
  // this is an IDL definition
};

For web developers (non-normative)
variable = object.method([optionalArgument])
This is a note to authors describing the usage of an interface.

CSS
/* this is a CSS fragment */

The defining instance of a term is marked up like this. Uses of that term are marked up like this or like this.

The defining instance of an element, attribute, or API is marked up like this. References to that element, attribute, or API are marked up like this.

Other code fragments are marked up like this.

Variables are marked up like this.

In an algorithm, steps in synchronous sections are marked with ⌛.

In some cases, requirements are given in the form of lists with conditions and corresponding requirements. In such cases, the requirements that apply to a condition are always the first set of requirements that follow the condition, even in the case of there being multiple sets of conditions for those requirements. Such cases are presented as follows:

← This is a condition
← This is another condition
  This is the requirement that applies to the conditions above.
← This is a third condition
  This is the requirement that applies to the third condition.

1.10 A quick introduction to HTML

This section is non-normative.

A basic HTML document looks like this:

```html
<!DOCTYPE html>
```
HTML documents consist of a tree of elements and text. Each element is denoted in the source by a start tag, such as "<body>", and an end tag, such as "</body>". (Certain start tags and end tags can in certain cases be omitted and are implied by other tags.)

Tags have to be nested such that elements are all completely within each other, without overlapping:

```
<p>This is <em>very</em> wrong!</p>
<p>This <em>is</em> correct.</p>
```

This specification defines a set of elements that can be used in HTML, along with rules about the ways in which the elements can be nested.

Elements can have attributes, which control how the elements work. In the example below, there is a hyperlink, formed using the `a` element and its `href` attribute:

```
<a href="demo.html">simple</a>
```

Attributes are placed inside the start tag, and consist of a name and a value, separated by an "=" character. The attribute value can remain unquoted if it doesn't contain ASCII whitespace or any of "',`<>". Otherwise, it has to be quoted using either single or double quotes. The value, along with the "=" character, can be omitted altogether if the value is the empty string.

```
<!-- empty attributes -->
<input name="address" disabled>
<input name="address" disabled=""/>

<!-- attributes with a value -->
<input name="address" maxlength="200">
<input name="address" maxlength='200'>
<input name="address" maxlength="200">
```

HTML user agents (e.g., web browsers) then parse this markup, turning it into a DOM (Document Object Model) tree. A DOM tree is an in-memory representation of a document.

DOM trees contain several kinds of nodes, in particular a `DocumentType` node, `Element` nodes, `Text` nodes, `Comment` nodes, and in some cases `ProcessingInstruction` nodes.

The markup snippet at the top of this section would be turned into the following DOM tree:

```
<!DOCTYPE html>
<html lang="en">
<head>
  <title>Sample page</title>
</head>
<body>
  <h1>Sample page</h1>
  <p>This is a <a href="demo.html">simple</a> sample.</p>
  <!-- this is a comment -->
</body>
</html>
```
The document element of this tree is the `html` element, which is the element always found in that position in HTML documents. It contains two elements, `head` and `body`, as well as a Text node between them.

There are many more Text nodes in the DOM tree than one would initially expect, because the source contains a number of spaces (represented here by "␣") and line breaks ("⏎") that all end up as Text nodes in the DOM. However, for historical reasons not all of the spaces and line breaks in the original markup appear in the DOM. In particular, all the whitespace before `head` start tag ends up being dropped silently, and all the whitespace after the `body` end tag ends up placed at the end of the `body`.

The `head` element contains a `title` element, which itself contains a Text node with the text "Sample page". Similarly, the `body` element contains an `h1` element, a `p` element, and a comment.

This DOM tree can be manipulated from scripts in the page. Scripts (typically in JavaScript) are small programs that can be embedded using the `script` element or using event handler content attributes. For example, here is a form with a script that sets the value of the form's `output` element to say "Hello World":

```html
<form name="main">
  Result: <output name="result"></output>
  <script>
    document.forms.main.elements.result.value = 'Hello World';
  </script>
</form>
```

Each element in the DOM tree is represented by an object, and these objects have APIs so that they can be manipulated. For instance, a link (e.g. the `a` element in the tree above) can have its "href" attribute changed in several ways:

```javascript
var a = document.links[0]; // obtain the first link in the document
a.href = 'sample.html'; // change the destination URL of the link
a.protocol = 'https'; // change just the scheme part of the URL
a.setAttribute('href', 'https://example.com/'); // change the content attribute directly
```

Since DOM trees are used as the way to represent HTML documents when they are processed and presented by implementations (especially interactive implementations like web browsers), this specification is mostly phrased in terms of DOM trees, instead of the markup described above.

HTML documents represent a media-independent description of interactive content. HTML documents might be rendered to a screen, or through a speech synthesizer, or on a braille display. To influence exactly how such rendering takes place, authors can use a styling language such as CSS.

In the following example, the page has been made yellow-on-blue using CSS.

```html
<!DOCTYPE html>
<html lang="en">
<head>
  <title>Sample styled page</title>
  <style>
    body { background: navy; color: yellow; }
  </style>
</head>
```
For more details on how to use HTML, authors are encouraged to consult tutorials and guides. Some of the examples included in this specification might also be of use, but the novice author is cautioned that this specification, by necessity, defines the language with a level of detail that might be difficult to understand at first.

### 1.10.1 Writing secure applications with HTML

This section is non-normative.

When HTML is used to create interactive sites, care needs to be taken to avoid introducing vulnerabilities through which attackers can compromise the integrity of the site itself or of the site's users.

A comprehensive study of this matter is beyond the scope of this document, and authors are strongly encouraged to study the matter in more detail. However, this section attempts to provide a quick introduction to some common pitfalls in HTML application development.

The security model of the web is based on the concept of "origins", and correspondingly many of the potential attacks on the web involve cross-origin actions. [ORIGIN][1460]

#### Not validating user input

**Cross-site scripting (XSS)**

**SQL injection**

When accepting untrusted input, e.g. user-generated content such as text comments, values in URL parameters, messages from third-party sites, etc, it is imperative that the data be validated before use, and properly escaped when displayed. Failing to do this can allow a hostile user to perform a variety of attacks, ranging from the potentially benign, such as providing bogus user information like a negative age, to the serious, such as running scripts every time a user looks at a page that includes the information, potentially propagating the attack in the process, to the catastrophic, such as deleting all data in the server.

When writing filters to validate user input, it is imperative that filters always be safelist-based, allowing known-safe constructs and disallowing all other input. Blocklist-based filters that disallow known-bad inputs and allow everything else are not secure, as not everything that is bad is yet known (for example, because it might be invented in the future).

**Example**

For example, suppose a page looked at its URL's query string to determine what to display, and the site then redirected the user to that page to display a message, as in:

```html
<ul>
  <li><a href="message.cgi?say=Hello">Say Hello</a></li>
  <li><a href="message.cgi?say=Welcome">Say Welcome</a></li>
  <li><a href="message.cgi?say=Kittens">Say Kittens</a></li>
</ul>
```

If the message was just displayed to the user without escaping, a hostile attacker could then craft a URL that contained a script element:

```
https://example.com/message.cgi?say=%3Cscript%3Ealert%28%27Oh%20no%21%27%29%3C/script%3E
```

If the attacker then convinced a victim user to visit this page, a script of the attacker's choosing would run on the page. Such a script could do any number of hostile actions, limited only by what the site offers: if the site is an e-commerce shop, for instance, such a script could cause the user to unknowingly make arbitrarily many unwanted purchases.

This is called a cross-site scripting attack.

There are many constructs that can be used to try to trick a site into executing code. Here are some that authors are encouraged to consider when writing safelist filters:
When allowing harmless-seeming elements like `<img>`, it is important to safelist any provided attributes as well. If one allowed all attributes then an attacker could, for instance, use the `onload` attribute to run arbitrary script.

When allowing URLs to be provided (e.g. for links), the scheme of each URL also needs to be explicitly safelisted, as there are many schemes that can be abused. The most prominent example is `javascript:`

Allowing a `base` element to be inserted means any `script` elements in the page with relative links can be hijacked, and similarly that any form submissions can get redirected to a hostile site.

### Cross-site request forgery (CSRF)

If a site allows a user to make form submissions with user-specific side-effects, for example posting messages on a forum under the user's name, making purchases, or applying for a passport, it is important to verify that the request was made by the user intentionally, rather than by another site tricking the user into making the request unknowingly.

This problem exists because HTML forms can be submitted to other origins.

Sites can prevent such attacks by populating forms with user-specific hidden tokens, or by checking `Origin` headers on all requests.

### Clickjacking

A page that provides users with an interface to perform actions that the user might not wish to perform needs to be designed so as to avoid the possibility that users can be tricked into activating the interface.

One way that a user could be so tricked is if a hostile site places the victim site in a small `iframe` and then convinces the user to click, for instance by having the user play a reaction game. Once the user is playing the game, the hostile site can quickly position the iframe under the mouse cursor just as the user is about to click, thus tricking the user into clicking the victim site's interface.

To avoid this, sites that do not expect to be used in frames are encouraged to only enable their interface if they detect that they are not in a frame (e.g. by comparing the `window` object to the value of the `top` attribute).

### 1.10.2 Common pitfalls to avoid when using the scripting APIs

This section is non-normative.

Scripts in HTML have "run-to-completion" semantics, meaning that the browser will generally run the script uninterrupted before doing anything else, such as firing further events or continuing to parse the document.

On the other hand, parsing of HTML files happens incrementally, meaning that the parser can pause at any point to let scripts run. This is generally a good thing, but it does mean that authors need to be careful to avoid hooking event handlers after the events could have possibly fired.

There are two techniques for doing this reliably: use event handler content attributes, or create the element and add the event handlers in the same script. The latter is safe because, as mentioned earlier, scripts are run to completion before further events can fire.

**Example**

One way this could manifest itself is with `<img>` elements and the `load` event. The event could fire as soon as the element has been parsed, especially if the image has already been cached (which is common).

Here, the author uses the `onload` handler on an `img` element to catch the `load` event:

```html
<img src="games.png" alt="Games" onload="gamesLogoHasLoaded(event)"/>
```

If the element is being added by script, then so long as the event handlers are added in the same script, the event will still not be missed:

```javascript
var img = new Image();
img.src = 'games.png';
```
Authors are encouraged to make use of conformance checkers (also known as validators) to catch common mistakes. The WHATWG maintains a list of such tools at: https://whatwg.org/validator/

1.10.3 How to catch mistakes when writing HTML: validators and conformance checkers

This section is non-normative.

Authors are encouraged to make use of conformance checkers (also known as validators) to catch common mistakes. The WHATWG maintains a list of such tools at: https://whatwg.org/validator/

1.11 Conformance requirements for authors

This section is non-normative.

Unlike previous versions of the HTML specification, this specification defines in some detail the required processing for invalid documents as well as valid documents.

However, even though the processing of invalid content is in most cases well-defined, conformance requirements for documents are still important: in practice, interoperability (the situation in which all implementations process particular content in a reliable and identical or equivalent way) is not the only goal of document conformance requirements. This section details some of the more common reasons for still distinguishing between a conforming document and one with errors.

1.11.1 Presentational markup

This section is non-normative.

The majority of presentational features from previous versions of HTML are no longer allowed. Presentational markup in general has been found to have a number of problems:

The use of presentational elements leads to poorer accessibility

While it is possible to use presentational markup in a way that provides users of assistive technologies (ATs) with an acceptable experience (e.g. using ARIA), doing so is significantly more difficult than doing so when using semantically-appropriate markup. Furthermore, even using such techniques doesn't help make pages accessible for non-AT non-graphical users, such as users of text-mode browsers.

Using media-independent markup, on the other hand, provides an easy way for documents to be authored in such a way that they work for more users (e.g. users of text browsers).

Higher cost of maintenance

It is significantly easier to maintain a site written in such a way that the markup is style-independent. For example, changing the

```html
img.alt = 'Games';
img.onload = gamesLogoHasLoaded;
// img.addEventListener('load', gamesLogoHasLoaded, false); // would work also
</script>
```

However, if the author first created the `img` element and then in a separate script added the event listeners, there's a chance that the `load` event would be fired in between, leading it to be missed:

```html
<!-- Do not use this style, it has a race condition! -->
<img id="games" src="games.png" alt="Games">
<!-- the 'load' event might fire here while the parser is taking a break, in which case you will not see it! -->
<script>
  var img = document.getElementById('games');
  img.onload = gamesLogoHasLoaded; // might never fire!
</script>
```
color of a site that uses `<font color="">` throughout requires changes across the entire site, whereas a similar change to a site based on CSS can be done by changing a single file.

**Larger document sizes**

Presentational markup tends to be much more redundant, and thus results in larger document sizes.

For those reasons, presentational markup has been removed from HTML in this version. This change should not come as a surprise; HTML4 deprecated presentational markup many years ago and provided a mode (HTML4 Transitional) to help authors move away from presentational markup; later, XHTML 1.1 went further and obsoleted those features altogether.

The only remaining presentational markup features in HTML are the `style` attribute and the `style` element. Use of the `style` attribute is somewhat discouraged in production environments, but it can be useful for rapid prototyping (where its rules can be directly moved into a separate style sheet later) and for providing specific styles in unusual cases where a separate style sheet would be inconvenient. Similarly, the `style` element can be useful in syndication or for page-specific styles, but in general an external style sheet is likely to be more convenient when the styles apply to multiple pages.

It is also worth noting that some elements that were previously presentational have been redefined in this specification to be media-independent: `<b>`, `<i>`, `<hr>`, `<s>`, `<small>`, and `<u>`.

### 1.11.2 Syntax errors

*This section is non-normative.*

The syntax of HTML is constrained to avoid a wide variety of problems.

#### Unintuitive error-handling behavior

Certain invalid syntax constructs, when parsed, result in DOM trees that are highly unintuitive.

**Example**

For example, the following markup fragment results in a DOM with an `<hr>` element that is an earlier sibling of the corresponding `<table>` element:

```
<table><hr>...
```

#### Errors with optional error recovery

To allow user agents to be used in controlled environments without having to implement the more bizarre and convoluted error handling rules, user agents are permitted to fail whenever encountering a `parse error`.

#### Errors where the error-handling behavior is not compatible with streaming user agents

Some error-handling behavior, such as the behavior for the `<table><hr>...` example mentioned above, are incompatible with streaming user agents (user agents that process HTML files in one pass, without storing state). To avoid interoperability problems with such user agents, any syntax resulting in such behavior is considered invalid.

#### Errors that can result in infoset coercion

When a user agent based on XML is connected to an HTML parser, it is possible that certain invariants that XML enforces, such as element or attribute names never contain multiple colons, will be violated by an HTML file. Handling this can require that the parser coerce the HTML DOM into an XML-compatible infoset. Most syntax constructs that require such handling are considered invalid. (Comments containing two consecutive hyphens, or ending with a hyphen, are exceptions that are allowed in the HTML syntax.)

#### Errors that result in disproportionately poor performance

Certain syntax constructs can result in disproportionately poor performance. To discourage the use of such constructs, they are typically made non-conforming.

**Example**

For example, the following markup results in poor performance, since all the unclosed `<i>` elements have to be reconstructed in each paragraph, resulting in progressively more elements in each paragraph:

```
<p><i>She dreamt.</i>
```
Errors involving fragile syntax constructs

There are syntax constructs that, for historical reasons, are relatively fragile. To help reduce the number of users who accidentally run into such problems, they are made non-conforming.

Example

For example, the parsing of certain named character references in attributes happens even with the closing semicolon being omitted. It is safe to include an ampersand followed by letters that do not form a named character reference, but if the letters are changed to a string that does form a named character reference, they will be interpreted as that character instead.

In this fragment, the attribute's value is "?bill&ted":

```html
<a href="?bill&ted">Bill and Ted</a>
```

In the following fragment, however, the attribute's value is actually "?art&copy", not the intended "?art&copy", because even without the final semicolon, "&copy" is handled the same as "&copy;" and thus gets interpreted as "c":

```html
<a href="?art&copy">Art and Copy</a>
```

To avoid this problem, all named character references are required to end with a semicolon, and uses of named character references without a semicolon are flagged as errors.

Thus, the correct way to express the above cases is as follows:

```html
<a href="?bill&ted">Bill and Ted</a> <!-- &ted is ok, since it's not a named character reference -->
```

```html
<a href="?art&copy">Art and Copy</a> <!-- the & has to be escaped, since &copy is a named character reference -->
```

Errors involving known interoperability problems in legacy user agents

Certain syntax constructs are known to cause especially subtle or serious problems in legacy user agents, and are therefore marked as non-conforming to help authors avoid them.

Example
For example, this is why the U+0060 GRAVE ACCENT character (´) is not allowed in unquoted attributes. In certain legacy user agents, it is sometimes treated as a quote character.

**Example**

Another example of this is the DOCTYPE, which is required to trigger no-quirks mode, because the behavior of legacy user agents in quirks mode is often largely undocumented.

### Errors that risk exposing authors to security attacks

Certain restrictions exist purely to avoid known security problems.

**Example**

For example, the restriction on using UTF-7 exists purely to avoid authors falling prey to a known cross-site-scripting attack using UTF-7. [UTF7](#) [p.39]

### Cases where the author's intent is unclear

Markup where the author's intent is very unclear is often made non-conforming. Correcting these errors early makes later maintenance easier.

**Example**

For example, it is unclear whether the author intended the following to be an h1 heading or an h2 heading:

```
<h1>Contact details</h1>
```

### Cases that are likely to be typos

When a user makes a simple typo, it is helpful if the error can be caught early, as this can save the author a lot of debugging time. This specification therefore usually considers it an error to use element names, attribute names, and so forth, that do not match the names defined in this specification.

**Example**

For example, if the author typed `<capton>` instead of `<caption>`, this would be flagged as an error and the author could correct the typo immediately.

### Errors that could interfere with new syntax in the future

In order to allow the language syntax to be extended in the future, certain otherwise harmless features are disallowed.

**Example**

For example, "attributes" in end tags are ignored currently, but they are invalid, in case a future change to the language makes use of that syntax feature without conflicting with already-deployed (and valid!) content.

Some authors find it helpful to be in the practice of always quoting all attributes and always including all optional tags, preferring the consistency derived from such custom over the minor benefits of terseness afforded by making use of the flexibility of the HTML syntax. To aid such authors, conformance checkers can provide modes of operation wherein such conventions are enforced.

### 1.11.3 Restrictions on content models and on attribute values

This section is non-normative.

Beyond the syntax of the language, this specification also places restrictions on how elements and attributes can be specified. These restrictions are present for similar reasons:

**Errors involving content with dubious semantics**

To avoid misuse of elements with defined meanings, content models are defined that restrict how elements can be nested when such nestings would be of dubious value.
Errors that involve a conflict in expressed semantics

Similarly, to draw the author’s attention to mistakes in the use of elements, clear contradictions in the semantics expressed are also considered conformance errors.

Example

In the fragments below, for example, the semantics are nonsensical: a separator cannot simultaneously be a cell, nor can a radio button be a progress bar.

```html
<hr role="cell">
<input type=radio role=progressbar>
```

Cases where the default styles are likely to lead to confusion

Certain elements have default styles or behaviors that make certain combinations likely to lead to confusion. Where these have equivalent alternatives without this problem, the confusing combinations are disallowed.

Example

Another example is the restrictions on the content models of the `ul` element, which only allows `li` element children. Lists by definition consist just of zero or more list items, so if a `ul` element contains something other than an `li` element, it’s not clear what was meant.

Errors that indicate a likely misunderstanding of the specification

Sometimes, something is disallowed because allowing it would likely cause author confusion.

Example

For example, setting the `disabled` attribute to the value "false" is disallowed, because despite the appearance of meaning that the element is enabled, it in fact means that the element is disabled (what matters for implementations is the presence of the attribute, not its value).

Errors involving limits that have been imposed merely to simplify the language

Some conformance errors simplify the language that authors need to learn.

Example

For example, the `area` element’s `shape` attribute, despite accepting both `circ` and `circle` values in practice as synonyms, disallows the use of the `circ` value, so as to simplify tutorials and other learning aids. There would be no benefit to allowing both, but it would cause extra confusion when teaching the language.

Errors that involve peculiarities of the parser

Certain elements are parsed in somewhat eccentric ways (typically for historical reasons), and their content model restrictions are intended to avoid exposing the author to these issues.
Errors that would likely result in scripts failing in hard-to-debug ways
Some errors are intended to help prevent script problems that would be hard to debug.

Example
For example, a `<form>` element isn't allowed inside phrasing content, because when parsed as HTML, a `<form>` element's start tag will imply a `p` element's end tag. Thus, the following markup results in two paragraphs, not one:

```
<p>Welcome. <form><label>Name:</label> <input></form>
```

It is parsed exactly like the following:

```
<p>Welcome. </p><form><label>Name:</label> <input></form>
```

Errors that waste authoring time
Some constructs are disallowed because historically they have been the cause of a lot of wasted authoring time, and by encouraging authors to avoid making them, authors can save time in future efforts.

Example
This is why, for instance, it is non-conforming to have two `<id>` attributes with the same value. Duplicate IDs lead to the wrong element being selected, with sometimes disastrous effects whose cause is hard to determine.

Errors that involve areas that affect authors migrating between the HTML and XML syntaxes
Some authors like to write files that can be interpreted as both XML and HTML with similar results. Though this practice is discouraged in general due to the myriad of subtle complications involved (especially when involving scripting, styling, or any kind of automated serialization), this specification has a few restrictions intended to at least somewhat mitigate the difficulties. This makes it easier for authors to use this as a transitionary step when migrating between the HTML and XML syntaxes.

Example
For example, there are somewhat complicated rules surrounding the `<lang>` and `<xml:lang>` attributes intended to keep the two synchronized.

Example
Another example would be the restrictions on the values of `<xmlns>` attributes in the HTML serialization, which are intended to ensure that elements in conforming documents end up in the same namespaces whether processed as HTML or XML.

Errors that involve areas reserved for future expansion
As with the restrictions on the syntax intended to allow for new syntax in future revisions of the language, some restrictions on the content models of elements and values of attributes are intended to allow for future expansion of the HTML vocabulary.

Example
For example, limiting the values of the `<target>` attribute that start with an U+005F LOW LINE character (_) to only specific predefined values allows new predefined values to be introduced at a future time without conflicting with author-defined values.

Errors that indicate a mis-use of other specifications
Certain restrictions are intended to support the restrictions made by other specifications.

Example
For example, requiring that attributes that take media query lists use only `valid` media query lists reinforces the importance of following the conformance rules of that specification.
1.12 Suggested reading

This section is non-normative.

The following documents might be of interest to readers of this specification.

**Character Model for the World Wide Web 1.0: Fundamentals [CHARMOD]**

This Architectural Specification provides authors of specifications, software developers, and content developers with a common reference for interoperable text manipulation on the World Wide Web, building on the Universal Character Set, defined jointly by the Unicode Standard and ISO/IEC 10646. Topics addressed include use of the terms 'character', 'encoding' and 'string', a reference processing model, choice and identification of character encodings, character escaping, and string indexing.

**Unicode Security Considerations [UTR36]**

Because Unicode contains such a large number of characters and incorporates the varied writing systems of the world, incorrect usage can expose programs or systems to possible security attacks. This is especially important as more and more products are internationalized. This document describes some of the security considerations that programmers, system analysts, standards developers, and users should take into account, and provides specific recommendations to reduce the risk of problems.

**Web Content Accessibility Guidelines (WCAG)**

Web Content Accessibility Guidelines (WCAG) covers a wide range of recommendations for making web content more accessible. Following these guidelines will make content accessible to a wider range of people with disabilities, including blindness and low vision, deafness and hearing loss, learning disabilities, cognitive limitations, limited movement, speech disabilities, photosensitivity and combinations of these. Following these guidelines will also often make your web content more usable to users in general.

**Authoring Tool Accessibility Guidelines (ATAG) 2.0 [ATAG]**

This specification provides guidelines for designing web content authoring tools that are more accessible for people with disabilities. An authoring tool that conforms to these guidelines will promote accessibility by providing an accessible user interface to authors with disabilities as well as by enabling, supporting, and promoting the production of accessible web content by all authors.

**User Agent Accessibility Guidelines (UAAG) 2.0 [UAAG]**

This document provides guidelines for designing user agents that lower barriers to web accessibility for people with disabilities. User agents include browsers and other types of software that retrieve and render web content. A user agent that conforms to these guidelines will promote accessibility through its own user interface and through other internal facilities, including its ability to communicate with other technologies (especially assistive technologies). Furthermore, all users, not just users with disabilities, should find conforming user agents to be more usable.
2 Common infrastructure

This specification depends on Infra. [INFRA]

2.1 Terminology

This specification refers to both HTML and XML attributes and IDL attributes, often in the same context. When it is not clear which is being referred to, they are referred to as content attributes for HTML and XML attributes, and IDL attributes for those defined on IDL interfaces. Similarly, the term "properties" is used for both JavaScript object properties and CSS properties. When these are ambiguous they are qualified as object properties and CSS properties respectively.

Generally, when the specification states that a feature applies to the HTML syntax or the XML syntax, it also includes the other. When a feature specifically only applies to one of the two languages, it is called out by explicitly stating that it does not apply to the other format, as in "for HTML, ... (this does not apply to XML).

This specification uses the term document to refer to any use of HTML, ranging from short static documents to long essays or reports with rich multimedia, as well as to fully-fledged interactive applications. The term is used to refer both to Document objects and their descendant DOM trees, and to serialized byte streams using the HTML syntax or the XML syntax, depending on context.

In the context of the DOM structures, the terms HTML document and XML document are used as defined in DOM, and refer specifically to two different modes that Document objects can find themselves in. [DOM] (Such uses are always hyperlinked to their definition.)

In the context of byte streams, the term HTML document refers to resources labeled as text/html, and the term XML document refers to resources labeled with an XML MIME type.

For simplicity, terms such as shown, displayed, and visible might sometimes be used when referring to the way a document is rendered to the user. These terms are not meant to imply a visual medium; they must be considered to apply to other media in equivalent ways.

2.1.1 Parallelism

To run steps in parallel means those steps are to be run, one after another, at the same time as other logic in the standard (e.g., at the same time as the event loop). This standard does not define the precise mechanism by which this is achieved, be it time-sharing cooperative multitasking, fibers, threads, processes, using different hyperthreads, cores, CPUs, machines, etc. By contrast, an operation that is to run immediately must interrupt the currently running task, run itself, and then resume the previously running task.

To avoid race conditions between different in parallel algorithms that operate on the same data, a parallel queue can be used.

A parallel queue represents a queue of algorithm steps that must be run in series.

A parallel queue has an algorithm queue (a queue), initially empty.

To enqueue steps to a parallel queue, enqueue the algorithm steps to the parallel queue's algorithm queue.

To start a new parallel queue, run the following steps:

1. Let parallelQueue be a new parallel queue.
2. Run the following steps in parallel:
1. While true:
   1. Let steps be the result of dequeueing from parallelQueue's [algorithm queue][p43].
   2. If steps is not nothing, then run steps.
   3. Assert: running steps did not throw an exception, as steps running in parallel[p43] are not allowed to throw.

   **Note**
   Implementations are not expected to implement this as a continuously running loop. Algorithms in standards are to be easy to understand and are not necessarily great for battery life or performance.

3. Return parallelQueue.

   **Note**
   Steps running in parallel[p43] can themselves run other steps in in parallel[p43]. E.g., inside a parallel queue[p43] it can be useful to run a series of steps in parallel with the queue.

**Example**

Imagine a standard defined nameList (a list), along with a method to add a name to nameList, unless nameList already contains name, in which case it rejects.

The following solution suffers from race conditions:

1. Let p be a new promise.
2. Run the following steps in parallel[p43]:
   1. If nameList contains name, reject p with a TypeError and abort these steps.
   2. Do some potentially lengthy work.
   3. Append name to nameList.
   4. Resolve p with undefined.

Two invocations of the above could run simultaneously, meaning name isn't in nameList during step 2.1, but it might be added before step 2.3 runs, meaning name ends up in nameList twice.

Parallel queues solve this. The standard would let nameListQueue be the result of starting a new parallel queue[p43], then:

1. Let p be a new promise.
2. Enqueue the following steps[p43] to nameListQueue:
   1. If nameList contains name, reject p with a TypeError and abort these steps.
   2. Do some potentially lengthy work.
   3. Append name to nameList.
   4. Resolve p with undefined.

The steps would now queue and the race is avoided.

**2.1.2 Resources**

The specification uses the term supported when referring to whether a user agent has an implementation capable of decoding the semantics of an external resource. A format or type is said to be supported if the implementation can process an external resource of that format or type without critical aspects of the resource being ignored. Whether a specific resource is supported can depend on
what features of the resource's format are in use.

**Example**

For example, a PNG image would be considered to be in a supported format if its pixel data could be decoded and rendered, even if, unbeknownst to the implementation, the image also contained animation data.

**Example**

An MPEG-4 video file would not be considered to be in a supported format if the compression format used was not supported, even if the implementation could determine the dimensions of the movie from the file's metadata.

What some specifications, in particular the HTTP specifications, refer to as a representation is referred to in this specification as a resource. [HTTP][p1458]

A resource's critical subresources are those that the resource needs to have available to be correctly processed. Which resources are considered critical or not is defined by the specification that defines the resource's format.

For CSS style sheets, we tentatively define here that their critical subresources are other style sheets imported via @import rules, including those indirectly imported by other imported style sheets.

![This definition is not fully interoperable; furthermore, some user agents seem to count resources like background images or web fonts as critical subresources. Ideally, the CSS Working Group would define this; see w3c/csswg-drafts issue #1088 to track progress on that front.]

### 2.1.3 XML compatibility §p45

To ease migration from HTML to XML, user agents conforming to this specification will place elements in HTML in the [http://www.w3.org/1999/xhtml](http://www.w3.org/1999/xhtml) namespace, at least for the purposes of the DOM and CSS. The term "HTML elements" refers to any element in that namespace, even in XML documents.

Except where otherwise stated, all elements defined or mentioned in this specification are in the HTML namespace ("http://www.w3.org/1999/xhtml"), and all attributes defined or mentioned in this specification have no namespace.

The term *element type* is used to refer to the set of elements that have a given local name and namespace. For example, button elements are elements with the element type button, meaning they have the local name "button" and (implicitly as defined above) the HTML namespace.

Attribute names are said to be XML-compatible if they match the Name production defined in XML and they contain no U+003A COLON characters (:). [XML][p1464]

### 2.1.4 DOM trees §p45

When it is stated that some element or attribute is ignored, or treated as some other value, or handled as if it was something else, this refers only to the processing of the node after it is in the DOM. A user agent must not mutate the DOM in such situations.

A content attribute is said to change value only if its new value is different than its previous value; setting an attribute to a value it already has does not change it.

The term *empty*, when used for an attribute value, Text node, or string, means that the length of the text is zero (i.e., not even containing controls or U+0020 SPACE).

An HTML element can have specific HTML element insertion steps defined for the element's local name. Similarly, an HTML element can have specific HTML element removing steps defined for the element's local name.

The insertion steps for the HTML Standard, given insertedNode, are defined as the following:

1. If insertedNode is an element whose namespace is the HTML namespace, and this standard defines HTML element insertion steps for insertedNode's local name, then run the corresponding HTML element insertion steps given insertedNode.
2. If `insertedNode` is a form-associated element or the ancestor of a form-associated element, then:
   1. If the form-associated element's parser inserted flag is set, then return.
   2. Reset the form owner of the form-associated element.
3. If `insertedNode` is an Element that is not on the stack of open elements of an HTML parser, then process internal resource links given `insertedNode`'s node document.

The removing steps for the HTML Standard, given `removedNode` and `oldParent`, are defined as the following:
1. Let `document` be `removedNode`'s node document.
2. If `document`'s focused area is `removedNode`, then set `document`'s focused area to `document`'s viewport, and set `document`'s relevant global object's navigation API's focus changed during ongoing navigation to false.

   **Note**
   This does not perform the unfocusing steps, focusing steps, or focus update steps, and thus no blur or change events are fired.

3. If `removedNode` is an element whose namespace is the HTML namespace, and this standard defines HTML element removing steps for `removedNode`'s local name, then run the corresponding HTML element removing steps given `removedNode` and `oldParent`.
4. If `removedNode` is a form-associated element or the ancestor of a form-associated element, then:
   1. If the form-associated element has a form owner and the form-associated element and its form owner are no longer in the same tree, then reset the form owner of the form-associated element.
5. If `removedNode`'s popover attribute is not in the no popover state, then run the hide popover algorithm given `removedNode`, false, false, and false.

A node is inserted into a document when the insertion steps are invoked with it as the argument and it is now in a document tree. Analogously, a node is removed from a document when the removing steps are invoked with it as the argument and it is now no longer in a document tree.

A node becomes connected when the insertion steps are invoked with it as the argument and it is now connected. Analogously, a node becomes disconnected when the removing steps are invoked with it as the argument and it is now no longer connected.

A node is browsing-context connected when it is connected and its shadow-including root's browsing context is non-null. A node becomes browsing-context connected when the insertion steps are invoked with it as the argument and it is now browsing-context connected. A node becomes browsing-context disconnected either when the removing steps are invoked with it as the argument and it is now no longer browsing-context connected, or when its shadow-including root's browsing context becomes null.

### 2.1.5 Scripting

The construction "a Foo object", where Foo is actually an interface, is sometimes used instead of the more accurate "an object implementing the interface Foo".

An IDL attribute is said to be getting when its value is being retrieved (e.g. by author script), and is said to be setting when a new value is assigned to it.

If a DOM object is said to be live, then the attributes and methods on that object must operate on the actual underlying data, not a snapshot of the data.

### 2.1.6 Plugins

The term plugin refers to an implementation-defined set of content handlers used by the user agent that can take part in the user agent's rendering of a Document object, but that neither act as child navigables of the Document nor introduce any Node objects to the Document's DOM.
Typically such content handlers are provided by third parties, though a user agent can also designate built-in content handlers as plugins.

A user agent must not consider the types `text/plain` and `application/octet-stream` as having a registered plugin.

**Example**

One example of a plugin would be a PDF viewer that is instantiated in a navigable when the user navigates to a PDF file. This would count as a plugin regardless of whether the party that implemented the PDF viewer component was the same as that which implemented the user agent itself. However, a PDF viewer application that launches separate from the user agent (as opposed to using the same interface) is not a plugin by this definition.

**Note**

This specification does not define a mechanism for interacting with plugins, as it is expected to be user-agent- and platform-specific. Some UAs might opt to support a plugin mechanism such as the Netscape Plugin API; others might use remote content converters or have built-in support for certain types. Indeed, this specification doesn’t require user agents to support plugins at all. [NPAPI]

**Warning!**

Browsers should take extreme care when interacting with external content intended for plugins. When third-party software is run with the same privileges as the user agent itself, vulnerabilities in the third-party software become as dangerous as those in the user agent.

Since different users having different sets of plugins provides a tracking vector that increases the chances of users being uniquely identified, user agents are encouraged to support the exact same set of plugins for each user.

2.1.7 Character encodings

A character encoding, or just encoding where that is not ambiguous, is a defined way to convert between byte streams and Unicode strings, as defined in Encoding. An encoding has an encoding name and one or more encoding labels, referred to as the encoding’s name and labels in the Encoding standard. [ENCODING]

2.1.8 Conformance classes

This specification describes the conformance criteria for user agents (relevant to implementers) and documents (relevant to authors and authoring tool implementers).

Conforming documents are those that comply with all the conformance criteria for documents. For readability, some of these conformance requirements are phrased as conformance requirements on authors; such requirements are implicitly requirements on documents: by definition, all documents are assumed to have had an author. (In some cases, that author may itself be a user agent — such user agents are subject to additional rules, as explained below.)

**Example**

For example, if a requirement states that “authors must not use the foo bar element”, it would imply that documents are not allowed to contain elements named foo bar.

**Note**

There is no implied relationship between document conformance requirements and implementation conformance requirements. User agents are not free to handle non-conformant documents as they please; the processing model described in this specification applies to implementations regardless of the conformity of the input documents.

User agents fall into several (overlapping) categories with different conformance requirements.

Web browsers and other interactive user agents

Web browsers that support the XML syntax must process elements and attributes from the HTML namespace found in XML documents as described in this specification, so that users can interact with them, unless the semantics of those elements have
been overridden by other specifications.

**Example**

A conforming web browser would, upon finding a `script` element in an XML document, execute the script contained in that element. However, if the element is found within a transformation expressed in XSLT (assuming the user agent also supports XSLT), then the processor would instead treat the `script` element as an opaque element that forms part of the transform.

Web browsers that support the HTML syntax must process documents labeled with an HTML MIME type as described in this specification, so that users can interact with them.

User agents that support scripting must also be conforming implementations of the IDL fragments in this specification, as described in Web IDL. [WEBIDL]

**Note**

Unless explicitly stated, specifications that override the semantics of HTML elements do not override the requirements on DOM objects representing those elements. For example, the `script` element in the example above would still implement the `HTMLScriptElement` interface.

**Non-interactive presentation user agents**

User agents that process HTML and XML documents purely to render non-interactive versions of them must comply to the same conformance criteria as web browsers, except that they are exempt from requirements regarding user interaction.

**Note**

Typical examples of non-interactive presentation user agents are printers (static UAs) and overhead displays (dynamic UAs). It is expected that most static non-interactive presentation user agents will also opt to lack scripting support.

**Example**

A non-interactive but dynamic presentation UA would still execute scripts, allowing forms to be dynamically submitted, and so forth. However, since the concept of “focus” is irrelevant when the user cannot interact with the document, the UA would not need to support any of the focus-related DOM APIs.

**Visual user agents that support the suggested default rendering**

User agents, whether interactive or not, may be designated (possibly as a user option) as supporting the suggested default rendering defined by this specification.

This is not required. In particular, even user agents that do implement the suggested default rendering are encouraged to offer settings that override this default to improve the experience for the user, e.g. changing the color contrast, using different focus styles, or otherwise making the experience more accessible and usable to the user.

User agents that are designated as supporting the suggested default rendering must, while so designated, implement the rules the Rendering section defines as the behavior that user agents are expected to implement.

**User agents with no scripting support**

Implementations that do not support scripting (or which have their scripting features disabled entirely) are exempt from supporting the events and DOM interfaces mentioned in this specification. For the parts of this specification that are defined in terms of an events model or in terms of the DOM, such user agents must still act as if events and the DOM were supported.

**Note**

Scripting can form an integral part of an application. Web browsers that do not support scripting, or that have scripting disabled, might be unable to fully convey the author's intent.

**Conformance checkers**

Conformance checkers must verify that a document conforms to the applicable conformance criteria described in this specification. Automated conformance checkers are exempt from detecting errors that require interpretation of the author's intent (for example, while a document is non-conforming if the content of a `blockquote` element is not a quote, conformance checkers running without the input of human judgement do not have to check that `blockquote` elements only contain quoted material).

Conformance checkers must check that the input document conforms when parsed without a browsing context (meaning that no scripts are run, and that the parser's scripting flag is disabled), and should also check that the input document conforms when
parsed with a browsing context in which scripts execute, and that the scripts never cause non-conforming states to occur other than transiently during script execution itself. (This is only a "SHOULD" and not a "MUST" requirement because it has been proven to be impossible. [COMPUTABLE]

The term "HTML validator" can be used to refer to a conformance checker that itself conforms to the applicable requirements of this specification.

**Note**

XML DTDs cannot express all the conformance requirements of this specification. Therefore, a validating XML processor and a DTD cannot constitute a conformance checker. Also, since neither of the two authoring formats defined in this specification are applications of SGML, a validating SGML system cannot constitute a conformance checker either.

To put it another way, there are three types of conformance criteria:

1. Criteria that can be expressed in a DTD.
2. Criteria that cannot be expressed by a DTD, but can still be checked by a machine.
3. Criteria that can only be checked by a human.

A conformance checker must check for the first two. A simple DTD-based validator only checks for the first class of errors and is therefore not a conforming conformance checker according to this specification.

**Data mining tools**

Applications and tools that process HTML and XML documents for reasons other than to either render the documents or check them for conformance should act in accordance with the semantics of the documents that they process.

**Example**

A tool that generates document outlines but increases the nesting level for each paragraph and does not increase the nesting level for headings would not be conforming.

**Authoring tools and markup generators**

Authoring tools and markup generators must generate conforming documents. Conformance criteria that apply to authors also apply to authoring tools, where appropriate.

Authoring tools are exempt from the strict requirements of using elements only for their specified purpose, but only to the extent that authoring tools are not yet able to determine author intent. However, authoring tools must not automatically misuse elements or encourage their users to do so.

**Example**

For example, it is not conforming to use an address element for arbitrary contact information; that element can only be used for marking up contact information for its nearest article or body element ancestor. However, since an authoring tool is likely unable to determine the difference, an authoring tool is exempt from that requirement. This does not mean, though, that authoring tools can use address elements for any block of italics text (for instance); it just means that the authoring tool doesn't have to verify that when the user uses a tool for inserting contact information for an article element, that the user really is doing that and not inserting something else instead.

**Note**

In terms of conformance checking, an editor has to output documents that conform to the same extent that a conformance checker will verify.

When an authoring tool is used to edit a non-conforming document, it may preserve the conformance errors in sections of the document that were not edited during the editing session (i.e. an editing tool is allowed to round-trip erroneous content). However, an authoring tool must not claim that the output is conformant if errors have been so preserved.

Authoring tools are expected to come in two broad varieties: tools that work from structure or semantic data, and tools that work on a What-You-See-Is-What-You-Get media-specific editing basis (WYSIWYG).

The former is the preferred mechanism for tools that author HTML, since the structure in the source information can be used to make informed choices regarding which HTML elements and attributes are most appropriate.
However, WYSIWYG tools are legitimate. WYSIWYG tools should use elements they know are appropriate, and should not use elements that they do not know to be appropriate. This might in certain extreme cases mean limiting the use of flow elements to just a few elements, like `div`, `p`, `b`, `i`, and `span` and making liberal use of the `style` attribute.

All authoring tools, whether WYSIWYG or not, should make a best effort attempt at enabling users to create well-structured, semantically rich, media-independent content.

For compatibility with existing content and prior specifications, this specification describes two authoring formats: one based on XML, and one using a custom format inspired by SGML (referred to as the HTML syntax). Implementations must support at least one of these two formats, although supporting both is encouraged.

Some conformance requirements are phrased as requirements on elements, attributes, methods or objects. Such requirements fall into two categories: those describing content model restrictions, and those describing implementation behavior. Those in the former category are requirements on documents and authoring tools. Those in the second category are requirements on user agents. Similarly, some conformance requirements are phrased as requirements on authors; such requirements are to be interpreted as conformance requirements on the documents that authors produce. (In other words, this specification does not distinguish between conformance criteria on authors and conformance criteria on documents.)

2.1.9 Dependencies

This specification relies on several other underlying specifications.

**Infra**

The following terms are defined in *Infra*: [INFRA]

- The general iteration terms `while`, `continue`, and `break`.
- `Assert`.
- `implementation-defined`.
- `tracking vector`.
- `code point` and its synonym `character`.
- `surrogate`.
- `scalar value`.
- `tuple`.
- `noncharacter`.
- `string`, `code unit`, `code unit prefix`, `code unit less than`, `starts with`, `ends with`, `length`, and `code point length`.
- The string equality operations `is` and `identical to`.
- `scalar value string`.
- `convert`.
- `ASCII string`.
- `ASCII tab or newline`.
- `ASCII whitespace`.
- `control`.
- `ASCII digit`.
- `ASCII upper hex digit`.
- `ASCII lower hex digit`.
- `ASCII hex digit`.
- `ASCII upper alpha`.
- `ASCII lower alpha`.
- `ASCII alpha`.
- `ASCII alphanumerics`.
- `isomorphic decode`.
- `isomorphic encode`.
- `ASCII lowercase`.
- `ASCII uppercase`.
- `ASCII case-insensitive`.
- `strip newlines`.
- `normalize newlines`.
- `strip leading and trailing ASCII whitespace`.
- `strip and collapse ASCII whitespace`.
- `split a string on ASCII whitespace`.
- `split a string on commas`.
- `collect a sequence of code points` and its associated position variable.
- `skip ASCII whitespace`.
- The ordered map data structure and the associated definitions for `key`, `value`, `empty`, `entry`, `exists`, `get the value of an entry`, `setting the value of an entry`, `removing an entry`, `clear`, `getting the keys`, `getting the values`, `setting the values`, `sorting in descending order`, `size`, and `iterate`.
- The list data structure and the associated definitions for `append`, `extend`, `prepend`, `replace`, `remove`, `empty`, `contains`, `size`, `indices`, `is empty`, `item`, `iterate`, and `clone sort in ascending order sort in descending order`.
- The stack data structure and the associated definitions for `push` and `pop`.
- The queue data structure and the associated definitions for `enqueue` and `dequeue`.
- The ordered set data structure and the associated definition for `append` and `union`.
- The struct specification type and the associated definition for `item`.
- The byte sequence data structure.
• The forgiving-base64 encode and forgiving-base64 decode algorithms
• exclusive range
• parse a JSON string to an Infra value
• HTML namespace
• MathML namespace
• SVG namespace
• XLink namespace
• XML namespace
• XMLNS namespace

Unicode and Encoding
The Unicode character set is used to represent textual data, and Encoding defines requirements around character encodings. [UNICODE]¹⁴⁶²

Note
This specification introduces terminology¹⁴⁶⁷ based on the terms defined in those specifications, as described earlier.

The following terms are used as defined in Encoding: [ENCODING]¹⁴⁵⁸

• Getting an encoding
• Get an output encoding
• The generic decode algorithm which takes a byte stream and an encoding and returns a character stream
• The UTF-8 decode algorithm which takes a byte stream and returns a character stream, additionally stripping one leading UTF-8 Byte Order Mark (BOM), if any
• The UTF-8 decode without BOM algorithm which is identical to UTF-8 decode except that it does not strip one leading UTF-8 Byte Order Mark (BOM)
• The encode algorithm which takes a character stream and an encoding and returns a byte stream
• The UTF-8 encode algorithm which takes a character stream and returns a byte stream
• The BOM sniff algorithm which takes a byte stream and returns an encoding or null.

XML and related specifications
Implementations that support the XML syntax for HTML must support some version of XML, as well as its corresponding namespaces specification, because that syntax uses an XML serialization with namespaces. [XML]¹⁴⁶⁴ [XMLNS]¹⁴⁶⁴

Data mining tools and other user agents that perform operations on content without running scripts, evaluating CSS or XPath expressions, or otherwise exposing the resulting DOM to arbitrary content, may “support namespaces” by just asserting that their DOM node analogues are in certain namespaces, without actually exposing the namespace strings.

Note
In the HTML syntax, namespace prefixes and namespace declarations do not have the same effect as in XML. For instance, the colon has no special meaning in HTML element names.

The attribute with the name space in the XML namespace is defined by Extensible Markup Language (XML). [XML]¹⁴⁶⁴

The Name production is defined in XML. [XML]¹⁴⁶⁴

This specification also references the <?xml-stylesheet?> processing instruction, defined in Associating Style Sheets with XML documents. [XMLSSPI]¹⁴⁶⁴

This specification also non-normatively mentions the XSLTProcessor interface and its transformToFragment() and transformToDocument() methods. [XSLTP]¹⁴⁶⁴

URLs
The following terms are defined in URL: [URL]¹⁴⁶²

• host
• public suffix
• domain
• IP address
• URL
• Origin of URLs
• Absolute URL
• Relative URL
• registrable domain
• The URL parser
• The basic URL parser and its url and state override arguments, as well as these parser states:
  ◦ scheme start state
  ◦ host state
  ◦ hostname state
- port state
- path start state
- query state
- fragment state

- URL record, as well as its individual components:
  - scheme
  - username
  - password
  - host
  - port
  - path
  - query
  - fragment
  - blob URL entry

- valid URL string
  - The cannot have a username/password/port concept
  - The opaque path concept
  - URL serializer and its exclude fragment argument
  - URL path serializer
  - The host parser
  - The host serializer
  - Host equals
  - URL equals and its exclude fragments argument
  - serialize an integer
  - Default encode set
  - component percent-encode set
  - UTF-8 percent-encode
  - percent-decode
  - set the username
  - set the password
  - The application/x-www-form-urlencoded format
  - The application/x-www-form-urlencoded serializer
  - is special

A number of schemes and protocols are referenced by this specification also:

- The about: scheme [ABOUT][p1455]
- The blob: scheme [FILEAPI][p1458]
- The data: scheme [RFC2397][p1461]
- The http: scheme [HTTP][p1458]
- The https: scheme [HTTP][p1458]
- The mailto: scheme [MAILTO][p1459]
- The sms: scheme [SMS][p1462]
- The urn: scheme [URN][p1463]

Media fragment syntax is defined in Media Fragments URI. [MEDIAFRAG][p1459]

HTTP and related specifications
The following terms are defined in the HTTP specifications: [HTTP][p1458]

- 'Accept' header
- 'Accept-Language' header
- 'Cache-Control' header
- 'Content-Disposition' header
- 'Content-Language' header
- 'Content-Range' header
- 'Last-Modified' header
- 'Range' header
- 'Referer' header

The following terms are defined in HTTP State Management Mechanism: [COOKIES][p1446]

- cookie-string
- receives a set-cookie-string
- 'Cookie' header

The following term is defined in Web Linking: [WEBLINK][p1463]

- 'Link' header
- Parsing a 'Link' field value

The following terms are defined in Structured Field Values for HTTP: [STRUCTURED-FIELDS][p1462]

- structured header
- boolean
- token
- parameters

The following terms are defined in MIME Sniffing: [MIMESNIFF][p1460]
• MIME type
• MIME type essence
• valid MIME type string
• valid MIME type string with no parameters
• HTML MIME type
• JavaScript MIME type and JavaScript MIME type essence match
• JSON MIME type
• XML MIME type
• image MIME type
• audio or video MIME type
• font MIME type
• parse a MIME type
• is MIME type supported by the user agent?

Fetch

The following terms are defined in Fetch: [FETCH]1458

• ABNF
• about:blank
• An HTTP(S) scheme
• A URL which is local
• A local scheme
• A fetch scheme
• CORS protocol
default `User-Agent` value
• extract a MIME type
• legacy extract an encoding
• fetch
• fetch controller
• process the next manual redirect
• ok status
• navigation request
• network error
• aborted network error
• `Origin` header
• `Cross-Origin-Resource-Policy` header
• getting a structured field value
• header list
• set
• get, decode, and split
• abort
cross-origin resource policy check
• the RequestCredentials enumeration
• the RequestDestination enumeration
• the `fetch()` method
• report timing
• serialize a response URL for reporting
• safely extracting a body
• incrementally reading a body
• processResponseConsumeBody
• processResponseEndOfBody
• processResponse
• useParallelQueue
• processEarlyHintsResponse
• connection pool
• obtain a connection
determine the network partition key
• extract full timing info
• as a body
• response body info
• resolve an origin
• response and its associated:
  • type
  • URL
  • URL list
  • status
  • header list
  • body
  • body info
  • internal response
  • location URL
  • timing info
  • service worker timing info
  • has-cross-origin-redirects
  • timing allow passed
  • extract content-range values
• request and its associated:
  • URL
  • method
  • header list
  • body
  • client
The following terms are defined in Referrer Policy: [REFERRERPOLICY][1461]

- **referrer policy**
  - The `Referrer-Policy` HTTP header
  - The parse a referrer policy from a `Referrer-Policy` header algorithm
  - The "no-referrer", "no-referrer-when-downgrade", "origin-when-cross-origin", and "unsafe-url" referrer policies
  - The default referrer policy

The following terms are defined in Mixed Content: [MIX][1460]

- **a priori authenticated URL**

The following terms are defined in Subresource Integrity: [SRI][1462]

- **parse integrity metadata**
  - the requirements of the integrity attribute
  - get the strongest metadata from set

**Paint Timing**

The following terms are defined in Paint Timing: [PAINTTIMING][1460]

- **mark paint timing**

**Navigation Timing**

The following terms are defined in Navigation Timing: [NAVIGATIONTIMING][1460]

- **create the navigation timing entry**
  - queue the navigation timing entry
  - NavigationTimingType and its "navigate", "reload", and "back forward" values.

**Resource Timing**

The following terms are defined in Resource Timing: [RESOURCETIMING][1461]

- **Mark resource timing**

**Performance Timeline**

The following terms are defined in Performance Timeline: [PERFORMANCECETIMELINE][1460]

- **PerformanceEntry** and its name, entryType, startTime, and duration attributes.
  - Queue a performance entry
Long Animation Frames

The following terms are defined in Long Animation Frames: [LONGANIMATIONFRAMES]

- record task start time
- record task end time
- record rendering time
- record classic script creation time
- record classic script execution start time
- record module script execution start time
- Record pause duration
- record timing info for timer handler
- record timing info for microtask checkpoint

Long Tasks

The following terms are defined in Long Tasks: [LONGTASKS]

- report long tasks

Web IDL

The IDL fragments in this specification must be interpreted as required for conforming IDL fragments, as described in Web IDL. [WEBIDL]

The following terms are defined in Web IDL:

- this
- extended attribute
- named constructor
- constructor operation
- overridden constructor steps
- internally create a new object implementing the interface
- array index property name
- supports indexed properties
- supported property indices
- determine the value of an indexed property
- set the value of an existing indexed property
- set the value of a new indexed property
- support named properties
- supported property names
- determine the value of a named property
- set the value of an existing named property
- set the value of a new named property
- delete an existing named property
- perform a security check
- platform object
- legacy platform object
- primary interface
- interface object
- named properties object
- include
- inherit
- interface prototype object
- implements
- [[Realm]] field of a platform object
- [[GetOwnProperty]] internal method of a named properties object
- callback context
- frozen array and creating a frozen array
- create a new object implementing the interface
- callback this value
- converting between Web IDL types and JS types
- invoking and constructing callback functions
- overload resolution algorithm
- exposed
- a promise resolved with
- a promise rejected with
- wait for all
- upon rejection
- upon fulfillment
- mark as handled
- [Global]
- [LegacyFactoryFunction]
- [LegacyLenientThis]
- [LegacyNullToEmptyString]
- [LegacyOverrideBuiltIns]
- LegacyPlatformObjectGetOwnProperty
- [LegacyTreatNonObjectAsNull]
- [LegacyUnenumerableNamedProperties]
- [LegacyUnforgeable]
- set entries
Web IDL also defines the following types that are used in Web IDL fragments in this specification:

- ArrayBuffer
- ArrayBufferView
- boolean
- DOMString
- double
- enumeration
- Function
- long
- object
- Promise
- Uint8ClampedArray
- unrestricted double
- unsigned long
- USVString
- VoidFunction

The term `throw` in this specification is used as defined in Web IDL. The `DOMException` type and the following exception names are defined by Web IDL and used by this specification:

- "IndexSizeError"
- "HierarchyRequestError"
- "InvalidCharacterError"
- "NoModificationAllowedError"
- "NotFoundError"
- "NotSupportedError"
- "InvalidStateError"
- "SyntaxError"
- "InvalidAccessError"
- "SecurityError"
- "NetworkError"
- "AbortError"
- "DataCloneError"
- "EncodingError"
- "NotAllowedError"

When this specification requires a user agent to create a `Date` object representing a particular time (which could be the special value Not-a-Number), the milliseconds component of that time, if any, must be truncated to an integer, and the time value of the newly created `Date` object must represent the resulting truncated time.

### Example

For instance, given the time 23045 millionths of a second after 01:00 UTC on January 1st 2000, i.e. the time 2000-01-01T00:00:00.023045Z, then the `Date` object created representing that time would represent the same time as that created representing the time 2000-01-01T00:00:00.023Z, 45 millionths earlier. If the given time is NaN, then the result is a `Date` object that represents a time value NaN (indicating that the object does not represent a specific instant of time).

### JavaScript

Some parts of the language described by this specification only support JavaScript as the underlying scripting language. [JAVASCRIPT](#1459)

### Note

*The term "JavaScript" is used to refer to ECMA-262, rather than the official term ECMAScript, since the term JavaScript is more widely known.*

The following terms are defined in the JavaScript specification and used in this specification:

- active function object
- agent and agent cluster
- automatic semicolon insertion
- candidate execution
- The current realm
- early error
- forward progress
- invariants of the essential internal methods
- JavaScript execution context
- JavaScript execution context stack
- realm
- JobCallback Record
- NewTarget
- running JavaScript execution context
- surrounding agent
- abstract closure
- immutable prototype exotic object
- Well-Known Symbols, including @@hasInstance, @@isConcatSpreadable, @@toPrimitive, and @@toStringTag
- Well-Known Intrinsic Objects, including %Array.prototype%, %Error.prototype%, %EvalError.prototype%, %Function.prototype%, %JSON.parse%, %Object.prototype%, %Object.prototype.valueOf%, %RangeError.prototype%, %ReferenceError.prototype%, %SyntaxError.prototype%, %TypeError.prototype%, and %URIError.prototype%

- The Module production
- The Pattern production
- The Script production
- The Type notation
- The Completion Record specification type
- The List and Record specification types
- The Property Descriptor specification type
- The Script Record specification type
- The Cyclic Module Record specification type
- The Source Text Module Record specification type and its Evaluate, Link and LoadRequestedModules methods
- The ArrayCreate abstract operation
- The Call abstract operation
- The ClearKeptObjects abstract operation
- The CleanupFinalizationRegistry abstract operation
- The Construct abstract operation
- The CopyDataBlockBytes abstract operation
- The CreateBuiltInFunction abstract operation
- The CreateByteDataBlock abstract operation
- The CreateDataProperty abstract operation
- The DefinePropertyOrThrow abstract operation
- The DetachArrayBuffer abstract operation
- The EnumerableOwnProperties abstract operation
- The FinishLoadingImportedModule abstract operation
- The OrdinaryFunctionCreate abstract operation
- The Get abstract operation
- The GetActiveScriptOrModule abstract operation
- The GetFunctionRealm abstract operation
- The HasOwnProperty abstract operation
- The HostCallJobCallback abstract operation
- The HostEnqueueFinalizationRegistryCleanupJob abstract operation
- The HostEnqueueGenericJob abstract operation
- The HostEnqueuePromiseJob abstract operation
- The HostEnqueueTimeoutJob abstract operation
- The HostEnsureCanAddPrivateElement abstract operation
- The HostEnsureCanCompileStrings abstract operation
- The HostLoadImportedModule abstract operation
- The HostMakeJobCallback abstract operation
- The HostPromiseRejectionTracker abstract operation
- The InitializeHostDefinedRealm abstract operation
- The IsAccessorDescriptor abstract operation
- The IsCallable abstract operation
- The IsConstructor abstract operation
- The IsDataDescriptor abstract operation
- The IsDetachedBuffer abstract operation
- The IsSharedArrayBuffer abstract operation
- The NewObjectEnvironment abstract operation
- The NormalCompletion abstract operation
- The OrdinaryGetPropertyOf abstract operation
- The OrdinarySetPrototypeOf abstract operation
- The OrdinaryIsExtensible abstract operation
- The OrdinaryPreventExtensions abstract operation
- The OrdinaryGetOwnProperty abstract operation
- The OrdinaryDefineOwnProperty abstract operation
- The OrdinaryGet abstract operation
- The OrdinarySet abstract operation
- The OrdinaryDelete abstract operation
- The OrdinaryOwnPropertyKeys abstract operation
- The OrdinaryObjectCreate abstract operation
- The ParseModule abstract operation
- The ParseScript abstract operation
- The NewPromiseReactionJob abstract operation
- The NewPromiseResolveThenableJob abstract operation
- The RegExpBuiltInExec abstract operation
- The RegExpCreate abstract operation
- The RegExp jobs abstract operation
- The SameValue abstract operation
- The ScriptEvaluation abstract operation
- The SetImmutablePrototype abstract operation
- The ToBoolean abstract operation
- The ToString abstract operation
- The ToUint32 abstract operation
- The TypedArrayCreate abstract operation
- The IsLooselyEqual abstract operation
- The IsStrictlyEqual abstract operation
- The Atomics object
Users agents that support JavaScript must also implement **ECMAScript Internationalization API**. \[JSINTL\]¹⁴⁵⁹

User agents that support JavaScript must also implement the **Import Attributes** proposal. The following terms are defined there, and used in this specification: \[JSIMPORTATTRIBUTES\]¹⁴⁵⁹

- The **ModuleRequest Record** specification type
- The **HostGetSupportedImportAttributes** abstract operation

User agents that support JavaScript must also implement the **JSON modules** proposal. The following terms are defined there, and used in this specification: \[JSJSONMODULES\]¹⁴⁵⁹

- The **CreateDefaultExportSyntheticModule** abstract operation
- The **SetSyntheticModuleExport** abstract operation
- The **Synthetic Module Record** specification type
- The **ParseJSONModule** abstract operation

User agents that support JavaScript must also implement the **Resizable ArrayBuffer and growable SharedArrayBuffer** proposal. The following terms are defined there, and used in this specification: \[JSRESIZABLEBUFFERS\]¹⁴⁵⁹

- The ** isArrayBufferViewOutOfBounds** abstract operation

**WebAssembly**

The following term is defined in **WebAssembly JavaScript Interface**: \[WASMJS\]¹⁴⁶³

- **WebAssembly.Module**

**DOM**

The Document Object Model (DOM) is a representation — a model — of a document and its content. The DOM is not just an API; the conformance criteria of HTML implementations are defined, in this specification, in terms of operations on the DOM. \[DOM\]¹⁴⁵⁸

Implementations must support DOM and the events defined in UI Events, because this specification is defined in terms of the DOM, and some of the features are defined as extensions to the DOM interfaces. \[DOM\]¹⁴⁵⁸ \[UIEVENTS\]¹⁴⁶²

In particular, the following features are defined in **DOM**: \[DOM\]¹⁴⁵⁸

- **Attr** interface
- **CharacterData** interface
- **Comment** interface
- **DOMImplementation** interface
- **Document** interface and its **doctype** attribute
- **DocumentOrShadowRoot** interface
- **DocumentFragment** interface
- **DocumentType** interface
- **ChildNode** interface
- **Element** interface
- **attachShadow()** method.
- An element's **shadow root**
- A **shadow root's** **mode**
- A **shadow root's** **declarative** member
- The **attach a shadow root** algorithm
- The **retargeting algorithm**
- **Node** interface
- **NodeList** interface
- **ProcessingInstruction** interface
- **ShadowRoot** interface
- **Text** interface
- **Range** interface
- **node document** concept
- **document type** concept
- **host** concept
- The **shadow root** concept, and its **delegates focus, available to element internals, clonable, and serializable**.
- The **shadow host** concept
- **HTMLCollection** interface, its **length** attribute, and its **item() and namedItem()** methods
- The terms **collection** and **represented by the collection**
- **DOMTokenList** interface, and its **value** attribute and **supports** operation
- **createElement()** method
- **createDocument()** method
- **createElement()** method
- **createElementNS()** method
- **getElementById()** method
- **getElementsByTagName()** method
- **appendChild()** method
- **cloneNode()** method
- **importNode()** method
- **preventDefault()** method
- **id** attribute
- **setAttribute()** method
- **id** attribute
- The **tree**, **shadow tree**, and **node tree** concepts
- The **tree order** and **shadow-including tree order** concepts
- The **element** concept
- The **child** concept
- The **root** and **shadow-including root** concepts
- The **inclusive ancestor**, **descendant**, **shadow-including ancestor**, **shadow-including descendant**, **shadow-including inclusive descendant**, and **shadow-including inclusive ancestor** concepts
- The **first child**, **next sibling**, **previous sibling**, and **parent** concepts
- The **parent element** concept
- The **document element** concept
- The **in a document tree, in a document** (legacy), and **connected** concepts
- The **slot** concept, and its **name** and **assigned nodes**
- The **assigned slot** concept
- The **slot assignment** concept
- The **slottable** concept
- The **assign slottables for a tree** algorithm
- The **slotchange** event
- The **inclusive descendant** concept
- The **find flattened slottables** algorithm
- The **manual slot assignment** concept
- The **assign a slot** algorithm
- The **pre-insert**, **insert**, **append**, **replace**, **replace all**, **string replace all**, **remove**, and **adopt** algorithms for nodes
- The **descendant** concept
- The **insertion steps, removing steps, adopting steps**, and **children changed steps** hooks for elements
- The **change**, **append**, **remove**, **replace**, **get an attribute by namespace and local name**, **set value**, and **remove an attribute by namespace and local name** algorithms for attributes
- The **attribute change steps** hook for attributes
- The **value** concept for attributes
- The **attribute list** concept
- The **data** of a **CharacterData** node and its **replace data** algorithm
- The **child text content** of a node
- The **descendant text content** of a node
- The **name**, **public ID**, and **system ID** of a doctype
- **Event** interface
- **Event and derived interfaces constructor behavior**
- **EventTarget** interface
- The **activation behavior** hook
- The **legacy-pre-activation behavior** hook
- The **legacy-cancelled-activation behavior** hook
- The **create an event** algorithm
- The **fire an event** algorithm
- The **canceled flag**
- The **dispatch flag**
- The **dispatch** algorithm
- **EventInit** dictionary type
- **type** attribute
- An event's **target**
- **currentTarget** attribute
- **bubbles** attribute
- **cancelable** attribute
- **composed** attribute
- **composed flag**
- **isTrusted** attribute
- **initEvent()** method
- **add an event listener**
- **addEventListener()** method
- The **remove an event listener** and **remove all event listeners** algorithms
- **EventListener** callback interface
- The **type** of an event
- An **event listener** and its **type** and **callback**
- The **encoding** (herein the **character encoding**), **mode**, **allow declarative shadow roots**, and **content type** of a **Document**
- The distinction between **XML documents** and **HTML documents**
The terms **quirks mode**, **limited-quirks mode**, and **no-quirks mode**
The algorithm to **clone** a **Node**, and the concept of **cloning steps** used by that algorithm
The concept of **base URL change steps** and the definition of what happens when an element is **affected by a base URL change**
The concept of an element's **unique identifier (ID)**
The concept of an element's **classes**
The term **supported tokens**
The concept of a **DOM range**, and the terms **start node**, **start**, **end**, and **boundary point** as applied to ranges.
The **create an element** algorithm
The **element interface** concept
The concepts of **custom element state**, and of **defined** and **custom** elements
An element's **namespace**, **namespace prefix**, **local name**, **custom element definition**, and **is value**
**MutationObserver** interface and its **mutation observers** in general
**AbortController** and its **signal**
**AbortSignal**
**aborted**
**signal abort**
**add**
The **get an attribute by name** algorithm

The following features are defined in **UI Events**: [UIEVENTS]¹⁴⁶²

- The **MouseEvent** interface
- The **MouseEvent** interface's **relatedTarget** attribute
- **MouseEventInit** dictionary type
- The **FocusEvent** interface
- The **FocusEvent** interface's **relatedTarget** attribute
- The **UIEvent** interface
- The **UIEvent** interface's **view** attribute
- **auxClick** event
- **beforeinput** event
- **click** event
- **contextmenu** event
- **dblclick** event
- **input** event
- **mousedown** event
- **mouseup** event
- **mousemove** event
- **mouseout** event
- **mouseover** event
- **mouseup** event
- **wheel** event
- **keydown** event
- **keypress** event
- **keyup** event

The following features are defined in **Touch Events**: [TOUCH]¹⁴⁶²

- **Touch** interface
- **Touch point** concept
- **touchend** event

The following features are defined in **Pointer Events**: [POINTEREVENTS]¹⁴⁶³

- The **PointerEvent** interface
- The **PointerEvent** interface's **pointerType** attribute
- **fire a pointer event**
- **pointerdown** event
- **pointerup** event
- **pointercancel** event

The following events are defined in **Clipboard API and events**: [CLIPBOARD-APIS]¹⁴⁵⁵

- **copy** event
- **cut** event
- **paste** event

This specification sometimes uses the term **name** to refer to the event's **type**: as in, "an event named **click**" or "if the event name is **keypress**". The terms "name" and "type" for events are synonymous.

The following features are defined in **DOM Parsing and Serialization**: [DOMPARSING]¹⁴⁵⁸

- **XML serialization**

The following features are defined in **Selection API**: [SELECTION]¹⁴⁶²

- **selection**
- Selection
The following features are defined in Fullscreen API: [FULLSCREEN]

- `requestFullscreen()`
- `fullscreenchange`
- `run the fullscreen steps`
- `fully exit fullscreen`
- `fullscreen element`
- `fullscreen flag`

High Resolution Time provides the `current high resolution time`, the `relative high resolution time`, the `unsafe shared current time`, the `shared monotonic clock`, the `unsafe moment`, the `duration from`, the `coarsen time` algorithm, and the `DOMHighResTimeStamp` typedef. [HRT]

File API

This specification uses the following features defined in File API: [FILEAPI]

- The `Blob` interface and its `type` attribute
- The `File` interface and its `name` and `lastModified` attributes
- The `FileList` interface
- The concept of a `Blob`'s `snapshot state`
- The concept of `read errors`
- `Blob URL Store`
- `Blob URL entry` and its `object` and `environment`

Indexed Database API

This specification uses `cleanup Indexed Database transactions` defined by Indexed Database API. [INDEXEDDB]

Media Source Extensions

The following terms are defined in Media Source Extensions: [MEDIASOURCE]

- `MediaSource` interface
- `detaching from a media element`

Media Capture and Streams

The following terms are defined in Media Capture and Streams: [MEDIASTREAM]

- `MediaStream` interface

Reporting

The following terms are defined in Reporting: [REPORTING]

- `Queue a report`
- `report type`
- `visible to ReportingObservers`

XMLHttpRequest

The following features and terms are defined in XMLHttpRequest: [XHR]

- The `XMLHttpRequest` interface, and its `responseXML` attribute
- The `ProgressEvent` interface, and its `lengthComputable`, `loaded`, and `total` attributes
- The `FormData` interface, and its associated `entry list`

Battery Status

The following features are defined in Battery Status API: [BATTERY]

- `getBattery()` method

Media Queries

Implementations must support Media Queries. The `<media-condition>` feature is defined therein. [MQ]

CSS modules

While support for CSS as a whole is not required of implementations of this specification (though it is encouraged, at least for web browsers), some features are defined in terms of specific CSS requirements.

When this specification requires that something be parsed according to a particular CSS grammar, the relevant algorithm in CSS Syntax must be followed, including error handling rules. [CSSSYNTAX]
The following terms and features are defined in Cascading Style Sheets (CSS): [CSS]\(^{1456}\)

- viewport
- line box
- out-of-flow
- in-flow
- collapsing margins
- containing block
- inline box
- block box
  - The ‘top’, ‘bottom’, ‘left’, and ‘right’ properties
  - The ‘float’ property
  - The ‘clear’ property
  - The ‘width’ property
  - The ‘height’ property
  - The ‘min-width’ property
  - The ‘min-height’ property
  - The ‘max-width’ property
  - The ‘max-height’ property
  - The ‘line-height’ property
  - The ‘vertical-align’ property
  - The ‘content’ property
  - The ‘inline-block’ value of the ‘display’ property
  - The ‘visibility’ property

The basic version of the ‘display’ property is defined in CSS, and the property is extended by other CSS modules. [CSS]\(^{1456}\) [CSSRUBY]\(^{1457}\) [CSSTABLE]\(^{1457}\).

The following terms and features are defined in CSS Box Model: [CSSBOX]\(^{1456}\)

- content area
- content box
- border box
- margin box
- border edge
- margin edge
  - The ‘margin-top’, ‘margin-bottom’, ‘margin-left’, and ‘margin-right’ properties
  - The ‘padding-top’, ‘padding-bottom’, ‘padding-left’, and ‘padding-right’ properties

The following features are defined in CSS Logical Properties: [CSSLOGICAL]\(^{1457}\)


The following terms and features are defined in CSS Color: [CSSCOLOR]\(^{1456}\)

- named color
- color
  - The ‘color’ property
- currentcolor
  - opaque black
- transparent black

Example

For example, user agents are required to close all open constructs upon finding the end of a style sheet unexpectedly. Thus, when parsing the string "rgb(0,0,0" (with a missing close-parenthesis) for a color value, the close parenthesis is implied by this error handling rule, and a value is obtained (the color ‘black’). However, the similar construct "rgb(0,0," (with both a missing parenthesis and a missing "blue" value) cannot be parsed, as closing the open construct does not result in a viable value.
• 'srgb' color space
• 'display-p3' color space
• 'relative-colorimetric' rendering intent
• parse a CSS <color> value

The following terms are defined in CSS Images: [CSSIMAGES]

• default object size
• concrete object size
• natural dimensions
• natural height
• natural width
• The 'image-orientation' property
• 'conic-gradient'
• The 'object-fit' property

The term paint source is used as defined in CSS Images Level 4 to define the interaction of certain HTML elements with the CSS 'element()' function. [CSSIMAGES4]

The following features are defined in CSS Backgrounds and Borders: [CSSBG]

• The 'background-color', 'background-image', 'background-repeat', 'background-attachment', 'background-position', 'background-clip', 'background-origin', and 'background-size' properties
• The 'border-radius', 'border-top-left-radius', 'border-top-right-radius', 'border-bottom-right-radius', 'border-bottom-left-radius' properties
• The 'border-image-source', 'border-image-slice', 'border-image-width', 'border-image-outset', and 'border-image-repeat' properties

CSS Backgrounds and Borders also defines the following border properties: [CSSBG]

<table>
<thead>
<tr>
<th>Width</th>
<th>Top</th>
<th>Bottom</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>border-top-width</td>
<td>border-bottom-width</td>
<td>border-left-width</td>
<td>border-right-width</td>
<td></td>
</tr>
</tbody>
</table>

The following features are defined in CSS Box Alignment: [CSSALIGN]

• The 'align-content' property
• The 'align-items' property
• The 'align-self' property
• The 'justify-self' property
• The 'justify-content' property
• The 'justify-items' property

The following terms and features are defined in CSS Display: [CSSDISPLAY]

• outer display type
• inner display type
• block-level
• block container
• formatting context
• block formatting context
• inline formatting context
• replaced element
• CSS box

The following features are defined in CSS Flexible Box Layout: [CSSFLEXBOX]

• The 'flex-direction' property
• The 'flex-wrap' property

The following terms and features are defined in CSS Fonts: [CSSFONTS]

• first available font
• The 'font-family' property
• The 'font-weight' property
• The 'font-size' property
• The 'font' property
• The 'font-kerning' property
• The 'font-stretch' property
• The 'font-variant-caps' property
• The 'small-caps' value
• The 'all-small-caps' value
• The 'petite-caps' value
• The 'all-petite-caps' value
• The 'unicase' value
• The 'titling-caps' value
• The 'ultra-condensed' value
• The 'extra-condensed' value
• The 'condensed' value
• The 'semi-condensed' value
• The 'semi-expanded' value
• The 'expanded' value
• The 'extra-expanded' value
• The 'ultra-expanded' value

The following features are defined in CSS Grid Layout: [CSSGRID]  
• The 'grid-auto-columns' property
• The 'grid-auto-flow' property
• The 'grid-auto-rows' property
• The 'grid-column-gap' property
• The 'grid-row-gap' property
• The 'grid-template-areas' property
• The 'grid-template-columns' property
• The 'grid-template-rows' property

The following terms are defined in CSS Inline Layout: [CSSINLINE]  
• alphabetic baseline
• ascent metric
• descent metric
• hanging baseline
• ideographic-under baseline

The following terms and features are defined in CSS Box Sizing: [CSSSIZING]  
• fit-content inline size
• 'aspect-ratio' property
• intrinsic size

The following features are defined in CSS Lists and Counters: [CSSLISTS]  
• list item
• The 'counter-reset' property
• The 'counter-set' property
• The 'list-style-type' property

The following features are defined in CSS Overflow: [CSSOVERFLOW]  
• The 'overflow' property and its 'hidden' value
• The 'text-overflow' property
• The term scroll container

The following terms and features are defined in CSS Positioned Layout: [CSSPOSITION]  
• absolutely-positioned
• The 'position' property and its 'static' value
• The top layer (an ordered set)
• add an element to the top layer
• request an element to be removed from the top layer
• remove an element from the top layer immediately
• process top layer removals

The following features are defined in CSS Multi-column Layout: [CSSMULTICOL]  
• The 'column-count' property
• The 'column-fill' property
• The 'column-gap' property
• The 'column-rule' property
• The 'column-width' property

The 'ruby-base' value of the 'display' property is defined in CSS Ruby Layout: [CSSRUBY]  

The following features are defined in CSS Table: [CSSTABLE]  
• The 'border-spacing' property
• The 'border-collapse' property
• The 'table-cell', 'table-row', 'table-caption', and 'table' values of the 'display' property

The following features are defined in CSS Text: [CSSTEXT]  
• The 'text-transform' property
• The 'white-space' property
• The 'text-align' property
• The ‘letter-spacing’ property
• The ‘word-spacing’ property

The following features are defined in CSS Writing Modes: [CSSWM]\[p1457

• The ‘direction’ property
• The ‘unicode-bidi’ property
• The ‘writing-mode’ property
• The block flow direction, block axis, inline axis, block size, inline size, block-start, block-end, inline-start, inline-end, line-left, and line-right concepts

The following features are defined in CSS Basic User Interface: [CSSUI]\[p1457

• The ‘outline’ property
• The ‘cursor’ property
• The ‘appearance’ property, its <compat-auto> non-terminal value type, its ‘textfield’ value, and its ‘menulist-button’ value.
• The ‘field-sizing’ property, and its ‘content’ value.
• The concept widget
• The concept native appearance
• The concept primitive appearance
• The concept element with default preferred size
• The non-devolvable widget and devolvable widget classification, and the related devolved widget state.
• The ‘pointer-events’ property
• The ‘user-select’ property

The algorithm to update animations and send events is defined in Web Animations. [WEBANIMATIONS]\[p1463

Implementations that support scripting must support the CSS Object Model. The following features and terms are defined in the CSSOM specifications: [CSSOM][p1457, [CSSOMVIEW][p1457

• Screen interface
• LinkStyle interface
• CSSStyleDeclaration interface
• style IDL attribute
• cssText attribute of CSSStyleDeclaration
• StyleSheet interface
• CSSStyleSheet interface
• create a CSS style sheet
• remove a CSS style sheet
• associated CSS style sheet
• create a constructed CSSStyleSheet
• synchronously replace the rules of a CSSStyleSheet
• disable a CSS style sheet
• CSS style sheets and their properties:
  • type
  • location
  • parent CSS style sheet
  • owner node
  • owner CSS rule
  • media
  • title
  • alternate flag
  • disabled flag
  • CSS rules
  • origin-clean flag
• CSS style sheet set
• CSS style sheet set name
• preferred CSS style sheet set name
• change the preferred CSS style sheet set name
• Serializing a CSS value
• run the resize steps
• run the scroll steps
• evaluate media queries and report changes
• Scroll a target into view
• Scroll to the beginning of the document
• The resize event
• The scroll event
• The scrollend event
• set up browsing context features

The following features and terms are defined in CSS Syntax: [CSSSYNTAX]\[p1457

• conformant style sheet
• parse a list of component values
• parse a comma-separated list of component values
• component value
• environment encoding
• <whitespace-token>
The following terms are defined in Selectors: [SELECTORS]

- type selector
- attribute selector
- pseudo-class
- :focus-visible pseudo-class
- indicate focus
- pseudo-element

The following features are defined in CSS Values and Units: [CSSVALUES]

- <length>
  - The 'em' unit
  - The 'ex' unit
  - The 'vw' unit
  - The 'vm' unit
  - The 'px' unit
  - The 'pt' unit
  - The 'attr()' function
  - The math functions

The following features are defined in CSS View Transitions: [CSSVIEWTRANSITIONS]

- perform pending transition operations
- rendering suppression for view transitions
- activate view transition
- ViewTransition
- view transition page visibility change steps
- resolving inbound cross-document view-transition
- setting up a cross-document view-transition
- can navigation trigger a cross-document view-transition?

The term **style attribute** is defined in CSS Style Attributes. [CSSATTR]

The following terms are defined in the CSS Cascading and Inheritance: [CSSCASCADE]

- cascaded value
- specified value
- computed value
- used value
- cascade origin
- Author Origin
- User Origin
- User Agent Origin
- Animation Origin
- Transition Origin
- initial value

The CanvasRenderingContext2D object's use of fonts depends on the features described in the CSS Fonts and Font Loading specifications, including in particular FontFace objects and the font source concept. [CSSFONTS] [CSSFONTLOAD]

The following interfaces and terms are defined in Geometry Interfaces: [GEOMETRY]

- DOMMatrix interface, and associated m11 element, m12 element, m21 element, m22 element, m41 element, and m42 element
- DOMMatrix2DInit and DOMMatrixInit dictionaries
- The create a DOMMatrix from a dictionary and create a DOMMatrix from a 2D dictionary algorithms for DOMMatrix2DInit or DOMMatrixInit
- The DOMPointInit dictionary, and associated x and y members
- Matrix multiplication

The following terms are defined in the CSS Scoping: [CSSSCOPING]

- flat tree

The following terms and features are defined in CSS Color Adjustment: [CSSCOLORADJUST]

- 'color-scheme'
- page's supported color-schemes

The following term is defined in CSS Pseudo-Elements: [CSSPSEUDO]

- '::file-selector-button'

The following terms are defined in CSS Containment: [CSSCONTAIN]

- skips its contents
- relevant to the user
• proximity to the viewport
• layout containment
• 'content-visibility' property
• 'auto' value for 'content-visibility'

Intersection Observer
The following term is defined in Intersection Observer: [INTERSECTIONOBSERVER]

• run the update intersection observations steps
• IntersectionObserver
• IntersectionObserverInit
• observe
• unobserve
• isIntersecting
• target

Resize Observer
The following terms are defined in Resize Observer: [RESIZEOBSERVER]

• gather active resize observations at depth
• has active resize observations
• has skipped resize observations
• broadcast active resize observations
• deliver resize loop error

WebGL
The following interfaces are defined in the WebGL specifications: [WEBGL]

• WebGLRenderingContext interface
• WebGL2RenderingContext interface
• WebGLContextAttributes dictionary

WebGPU
The following interfaces are defined in WebGPU: [WEBGPU]

• GPUCanvasContext interface

WebVTT
Implementations may support WebVTT as a text track format for subtitles, captions, metadata, etc., for media resources. [WEBVTT]

The following terms, used in this specification, are defined in WebVTT:

• WebVTT file
• WebVTT file using cue text
• WebVTT file using only nested cues
• WebVTT parser
• The rules for updating the display of WebVTT text tracks
• The WebVTT text track cue writing direction
• VTT Cue interface

ARIA
The role attribute is defined in Accessible Rich Internet Applications (ARIA), as are the following roles: [ARIA]

• button
• presentation

In addition, the following aria-* content attributes are defined in ARIA: [ARIA]

• aria-checked
• aria-describedby
• aria-disabled
• aria-label

Finally, the following terms are defined ARIA: [ARIA]

• role
• accessible name
• The ARIAMixin interface, with its associated ARIAMixin getter steps and ARIAMixin setter steps

Content Security Policy
The following terms are defined in Content Security Policy: [CSP]

• Content Security Policy
• disposition
• directive set
• Content Security Policy directive
• CSP list
• The Content Security Policy syntax
• enforce the policy
• The parse a serialized Content Security Policy algorithm
• The Run CSP initialization for a Document algorithm
• The Run CSP initialization for a global object algorithm
• The Should element's inline behavior be blocked by Content Security Policy? algorithm
• The Should navigation request of type be blocked by Content Security Policy? algorithm
• The Should navigation response to navigation request of type in target be blocked by Content Security Policy? algorithm
• The report-uri directive
• The EnsureCSPDoesNotBlockStringCompilation abstract operation
• The Is base allowed for Document? algorithm
• The frame-ancestors directive
• The sandbox directive
• The contains a header-delivered Content Security Policy property.
• The Parse a response's Content Security Policies algorithm.
• SecurityPolicyViolationEvent interface
• The securitypolicyviolation event

Service Workers
The following terms are defined in Service Workers: [SW]\textsuperscript{1462}

• active worker
• client message queue
• control
• handle fetch
• match service worker registration
• service worker
• service worker client
• ServiceWorker interface
• ServiceWorkerContainer interface
• ServiceWorkerGlobalScope interface

Secure Contexts
The following algorithms are defined in Secure Contexts: [SECURE-CONTEXTS]\textsuperscript{1462}

• Is url potentially trustworthy?

Permissions Policy
The following terms are defined in Permissions Policy: [PERMISSIONSPOLICY]\textsuperscript{1460}

• permissions policy
• policy-controlled feature
• container policy
• serialized permissions policy
• default allowlist
• The creating a permissions policy algorithm
• The creating a permissions policy from a response algorithm
• The is feature enabled by policy for origin algorithm
• The process permissions policy attributes algorithm

Payment Request API
The following feature is defined in Payment Request API: [PAYMENTREQUEST]\textsuperscript{1460}

• PaymentRequest interface

MathML
While support for MathML as a whole is not required by this specification (though it is encouraged, at least for web browsers), certain features depend upon small parts of MathML being implemented. [MATHML]\textsuperscript{1469}

The following features are defined in Mathematical Markup Language (MathML):

• MathML annotation-xml element
• MathML math element
• MathML merror element
• MathML mi element
• MathML mn element
• MathML mo element
• MathML ms element
• MathML mtext element

SVG
While support for SVG as a whole is not required by this specification (though it is encouraged, at least for web browsers), certain
features depend upon parts of SVG being implemented.

User agents that implement SVG must implement the SVG 2 specification, and not any earlier revisions.

The following features are defined in the SVG 2 specification: [SVG][p1462]

- `<SVGElement>` interface
- `<SVGImageElement>` interface
- `<SVGScriptElement>` interface
- `<SVGSVGElement>` interface
- `<SVG a>` element
- `<SVG desc>` element
- `<SVG foreignObject>` element
- `<SVG image>` element
- `<SVG script>` element
- `<SVG svg>` element
- `<SVG title>` element
- `<SVG use>` element
- `<SVG text-rendering>` property

**Filter Effects**

The following features are defined in Filter Effects: [FILTERS][p1458]

- `<filter-value-list>`

**Compositing**

The following features are defined in Compositing and Blending: [COMPOSITE][p1465]

- `<blend-mode>`
- `<composite-mode>`
- `<source-over>`
- `<copy>`

**Cooperative Scheduling of Background Tasks**

The following features are defined in Cooperative Scheduling of Background Tasks: [REQUESTIDLECALLBACK][p1461]

- `requestIdleCallback()`
- `start an idle period algorithm`

**Screen Orientation**

The following terms are defined in Screen Orientation: [SCREENORIENTATION][p1462]

- `<screen orientation change steps>`

**Storage**

The following terms are defined in Storage: [STORAGE][p1462]

- `<obtain a local storage bottle map>`
- `<obtain a session storage bottle map>`
- `<obtain a storage key for non-storage purposes>`
- `<storage key equal>`
- `<storage proxy map>`
- `<legacy-clone a traversable storage shed>`

**Web App Manifest**

The following features are defined in Web App Manifest: [MANIFEST][p1459]

- `<application manifest>`
- `<installed web application>`
- `<process the manifest>`

**WebCodecs**

The following features are defined in WebCodecs: [WEBCODECS][p1463]

- `<VideoFrame>` interface.
- `[display width]`
- `[display height]`

**WebDriver**

The following terms are defined in WebDriver: [WEBDRIVER][p1463]

- `<extension command>`
- `<remote end steps>`
- `<WebDriver error>`
• WebDriver error code
• invalid argument
• getting a property
• success
• WebDriver's security considerations
• current browsing context

WebDriver BiDi
The following terms are defined in WebDriver BiDi: [WEBDRIVERBIDI]\(^{[1463]}\)

• WebDriver BiDi navigation status
  • navigation status id
  • navigation status status
  • navigation status pending
  • navigation status canceled
  • navigation status complete
  • navigation status url
  • WebDriver BiDi navigation started
  • WebDriver BiDi navigation aborted
  • WebDriver BiDi navigation failed
  • WebDriver BiDi download started
  • WebDriver BiDi fragment navigated
  • WebDriver BiDi DOM content loaded
  • WebDriver BiDi load complete
  • WebDriver BiDi user prompt closed
  • WebDriver BiDi user prompt opened

Web Cryptography API
The following terms are defined in Web Cryptography API: [WEBCRYPTO]\(^{[1463]}\)

• generating a random UUID

WebSockets
The following terms are defined in WebSockets: [WEBSOCKETS]\(^{[1463]}\)

• WebSocket
• make disappear

WebTransport
The following terms are defined in WebTransport: [WEBTRANSPORT]\(^{[1463]}\)

• WebTransport
• context cleanup steps

Web Authentication: An API for accessing Public Key Credentials
The following terms are defined in Web Authentication: An API for accessing Public Key Credentials: [WEBAUTHN]\(^{[1463]}\)

• public key credential

Credential Management
The following terms are defined in Credential Management: [CREDMAN]\(^{[1456]}\)

• conditional mediation
• credential
• navigator.credentials.get()

Console
The following terms are defined in Console: [CONSOLE]\(^{[1455]}\)

• report a warning to the console

Web Locks API
The following terms are defined in Web Locks API: [WEBLOCKS]\(^{[1463]}\)

• locks
• lock requests

Trusted Types
This specification uses the following features defined in Trusted Types: [TRUSTED-TYPES]\(^{[1462]}\)

• HTMLString
• ScriptURLString
• TrustedHTML
data
• TrustedScript
This specification does not require support of any particular network protocol, style sheet language, scripting language, or any of the DOM specifications beyond those required in the list above. However, the language described by this specification is biased towards CSS as the styling language, JavaScript as the scripting language, and HTTP as the network protocol, and several features assume that those languages and protocols are in use.

A user agent that implements the HTTP protocol must implement HTTP State Management Mechanism (Cookies) as well. [HTTP][p1458] [COOKIES][p1456]

Note

This specification might have certain additional requirements on character encodings, image formats, audio formats, and video formats in the respective sections.

2.1.10 Extensibility §p71

Vendor-specific proprietary user agent extensions to this specification are strongly discouraged. Documents must not use such extensions, as doing so reduces interoperability and fragments the user base, allowing only users of specific user agents to access the content in question.

All extensions must be defined so that the use of extensions neither contradicts nor causes the non-conformance of functionality defined in the specification.

Example

For example, while strongly discouraged from doing so, an implementation could add a new IDL attribute "typeTime" to a control that returned the time it took the user to select the current value of a control (say). On the other hand, defining a new control that appears in a form's elements array would be in violation of the above requirement, as it would violate the definition of elements given in this specification.

When vendor-neutral extensions to this specification are needed, either this specification can be updated accordingly, or an extension specification can be written that overrides the requirements in this specification. When someone applying this specification to their activities decides that they will recognize the requirements of such an extension specification, it becomes an applicable specification for the purposes of conformance requirements in this specification.

Example

Someone could write a specification that defines any arbitrary byte stream as conforming, and then claim that their random junk is conforming. However, that does not mean that their random junk actually is conforming for everyone's purposes: if someone else decides that that specification does not apply to their work, then they can quite legitimately say that the aforementioned random junk is just that, junk, and not conforming at all. As far as conformance goes, what matters in a particular community is what that community agrees is applicable.

User agents must treat elements and attributes that they do not understand as semantically neutral; leaving them in the DOM (for DOM processors), and styling them according to CSS (for CSS processors), but not inferring any meaning from them.

When support for a feature is disabled (e.g. as an emergency measure to mitigate a security problem, or to aid in development, or for performance reasons), user agents must act as if they had no support for the feature whatsoever, and as if the feature was not mentioned in this specification. For example, if a particular feature is accessed via an attribute in a Web IDL interface, the attribute itself would be omitted from the objects that implement that interface — leaving the attribute on the object but making it return null or throw an exception is insufficient.

2.1.11 Interactions with XPath and XSLT §p71

Implementations of XPath 1.0 that operate on HTML documents parsed or created in the manners described in this specification (e.g. as part of the document.evaluate() API) must act as if the following edit was applied to the XPath 1.0 specification.
First, remove this paragraph:

A QName in the node test is expanded into an expanded-name using the namespace declarations from the expression context.
This is the same way expansion is done for element type names in start and end-tags except that the default namespace declared with xmlns is not used: if the QName does not have a prefix, then the namespace URI is null (this is the same way attribute names are expanded). It is an error if the QName has a prefix for which there is no namespace declaration in the expression context.

Then, insert in its place the following:

A QName in the node test is expanded into an expanded-name using the namespace declarations from the expression context. If the QName has a prefix, then there must be a namespace declaration for this prefix in the expression context, and the corresponding namespace URI is the one that is associated with this prefix. It is an error if the QName has a prefix for which there is no namespace declaration in the expression context.

If the QName has no prefix and the principal node type of the axis is element, then the default element namespace is used. Otherwise, if the QName has no prefix, the namespace URI is null. The default element namespace is a member of the context for the XPath expression. The value of the default element namespace when executing an XPath expression through the DOM3 XPath API is determined in the following way:

1. If the context node is from an HTML DOM, the default element namespace is "http://www.w3.org/1999/xhtml".
2. Otherwise, the default element namespace URI is null.

Note
This is equivalent to adding the default element namespace feature of XPath 2.0 to XPath 1.0, and using the HTML namespace as the default element namespace for HTML documents. It is motivated by the desire to have implementations be compatible with legacy HTML content while still supporting the changes that this specification introduces to HTML regarding the namespace used for HTML elements, and by the desire to use XPath 1.0 rather than XPath 2.0.

XSLT 1.0 processors outputting to a DOM when the output method is "html" (either explicitly or via the defaulting rule in XSLT 1.0) are affected as follows:

If the transformation program outputs an element in no namespace, the processor must, prior to constructing the corresponding DOM element node, change the namespace of the element to the HTML namespace, ASCII-lowercase the element's local name, and ASCII-lowercase the names of any non-namespaced attributes on the element.

Note
This change is a willful violation of the XPath 1.0 specification, motivated by desire to have implementations be compatible with legacy content while still supporting the changes that this specification introduces to HTML regarding which namespace is used for HTML elements. [XPATH10]

Note
This requirement is a willful violation of the XSLT 1.0 specification, required because this specification changes the namespaces and case-sensitivity rules of HTML in a manner that would otherwise be incompatible with DOM-based XSLT transformations. (Processors that serialize the output are unaffected.) [XSLT10]

This specification does not specify precisely how XSLT processing interacts with the HTML parser infrastructure (for example, whether an XSLT processor acts as if it puts any elements into a stack of open elements). However, XSLT processors must stop parsing if they successfully complete, and must update the current document readiness first to "interactive" and then to "complete" if they are aborted.

This specification does not specify how XSLT interacts with the navigation algorithm, how it fits in with the event loop, nor how error pages are to be handled (e.g. whether XSLT errors are to replace an incremental XSLT output, or are rendered inline, etc.).

Note
There are also additional non-normative comments regarding the interaction of XSLT and HTML in the script element section and of XSLT, XPath, and HTML in the template element section.
2.2 Policy-controlled features

This document defines the following policy-controlled features:

- "autoplay", which has a default allowlist of 'self'.
- "cross-origin-isolated", which has a default allowlist of 'self'.

2.3 Common microsyntaxes

There are various places in HTML that accept particular data types, such as dates or numbers. This section describes what the conformance criteria for content in those formats is, and how to parse them.

Note

Implementers are strongly urged to carefully examine any third-party libraries they might consider using to implement the parsing of syntaxes described below. For example, date libraries are likely to implement error handling behavior that differs from what is required in this specification, since error-handling behavior is often not defined in specifications that describe date syntaxes similar to those used in this specification, and thus implementations tend to vary greatly in how they handle errors.

2.3.1 Common parser idioms

Some of the micro-parsers described below follow the pattern of having an input variable that holds the string being parsed, and having a position variable pointing at the next character to parse in input.

2.3.2 Boolean attributes

A number of attributes are boolean attributes. The presence of a boolean attribute on an element represents the true value, and the absence of the attribute represents the false value.

If the attribute is present, its value must either be the empty string or a value that is an ASCII case-insensitive match for the attribute's canonical name, with no leading or trailing whitespace.

Note

The values "true" and "false" are not allowed on boolean attributes. To represent a false value, the attribute has to be omitted altogether.

Example

Here is an example of a checkbox that is checked and disabled. The checked and disabled attributes are the boolean attributes.

```html
<label><input type=checkbox checked name=cheese disabled> Cheese</label>
```

This could be equivalently written as this:

```html
<label><input type=checkbox checked=checked name=cheese disabled=disabled> Cheese</label>
```

You can also mix styles; the following is still equivalent:

```html
<label><input type='checkbox' checked name=cheese disabled=> Cheese</label>
```
2.3.3 Keywords and enumerated attributes

Some attributes, called enumerated attributes, take on a finite set of states. The state for such an attribute is derived by combining the attribute's value, a set of keyword/state mappings given in the specification of each attribute, and two possible special states that can also be given in the specification of the attribute. These special states are the invalid value default and the missing value default.

Note

Multiple keywords can map to the same state.

Note

The empty string can be a valid keyword. Note that the missing value default applies only when the attribute is missing, not when it is present with an empty string value.

To determine the state of an attribute, use the following steps:

1. If the attribute is not specified:
   1. If the attribute has a missing value default state defined, then return that missing value default state.
   2. Otherwise, return no state.

2. If the attribute's value is an ASCII case-insensitive match for one of the keywords defined for the attribute, then return the state represented by that keyword.

3. If the attribute has an invalid value default state defined, then return that invalid value default state.

4. Return no state.

For authoring conformance purposes, if an enumerated attribute is specified, the attribute's value must be an ASCII case-insensitive match for one of the conforming keywords for that attribute, with no leading or trailing whitespace.

For reflection purposes, states which have any keywords mapping to them are said to have a canonical keyword. This is determined as follows:

- If there is only one keyword mapping to the given state, then it is that keyword.
- If there is only one conforming keyword mapping to the given state, then it is that conforming keyword.
- Otherwise, the canonical keyword for the state will be explicitly given in the specification for the attribute.

2.3.4 Numbers

2.3.4.1 Signed integers

A string is a valid integer if it consists of one or more ASCII digits, optionally prefixed with a U+002D HYPHEN-MINUS character (-).

A valid integer without a U+002D HYPHEN-MINUS (-) prefix represents the number that is represented in base ten by that string of digits. A valid integer with a U+002D HYPHEN-MINUS (-) prefix represents the number represented in base ten by the string of digits that follows the U+002D HYPHEN-MINUS, subtracted from zero.

The rules for parsing integers are as given in the following algorithm. When invoked, the steps must be followed in the order given, aborting at the first step that returns a value. This algorithm will return either an integer or an error.

1. Let input be the string being parsed.
2. Let position be a pointer into input, initially pointing at the start of the string.
3. Let sign have the value "positive".
4. Skip ASCII whitespace within input given position.
5. If position is past the end of input, return an error.
6. If the character indicated by position (the first character) is a U+002D HYPHEN-MINUS character (-):
   1. Let sign be "negative".
   2. Advance position to the next character.
   3. If position is past the end of input, return an error.

Otherwise, if the character indicated by position (the first character) is a U+002B PLUS SIGN character (+):
   1. Advance position to the next character. (The "+" is ignored, but it is not conforming.)
   2. If position is past the end of input, return an error.

7. If the character indicated by position is not an ASCII digit, then return an error.

8. Collect a sequence of code points that are ASCII digits from input given position, and interpret the resulting sequence as a base-ten integer. Let value be that integer.

9. If sign is "positive", return value, otherwise return the result of subtracting value from zero.

2.3.4.2 Non-negative integers

A string is a valid non-negative integer if it consists of one or more ASCII digits.

A valid non-negative integer represents the number that is represented in base ten by that string of digits.

The rules for parsing non-negative integers are as given in the following algorithm. When invoked, the steps must be followed in the order given, aborting at the first step that returns a value. This algorithm will return either zero, a positive integer, or an error.

   1. Let input be the string being parsed.
   2. Let value be the result of parsing input using the rules for parsing integers.
   3. If value is an error, return an error.
   4. If value is less than zero, return an error.
   5. Return value.

2.3.4.3 Floating-point numbers

A string is a valid floating-point number if it consists of:

   1. Optionally, a U+002D HYPHEN-MINUS character (-).
   2. One or both of the following, in the given order:
      1. A series of one or more ASCII digits.
      2. Both of the following, in the given order:
         1. A single U+002E FULL STOP character (.).
         2. A series of one or more ASCII digits.
   3. Optionally:
      1. Either a U+0065 LATIN SMALL LETTER E character (e) or a U+0045 LATIN CAPITAL LETTER E character (E).
      2. Optionally, a U+002D HYPHEN-MINUS character (-) or U+002B PLUS SIGN character (+).
      3. A series of one or more ASCII digits.

A valid floating-point number represents the number obtained by multiplying the significand by ten raised to the power of the exponent, where the significand is the first number, interpreted as base ten (including the decimal point and the number after the decimal point, if any, and interpreting the significand as a negative number if the whole string starts with a U+002D HYPHEN-MINUS
character (-) and the number is not zero), and where the exponent is the number after the E, if any (interpreted as a negative number if there is a U+002D HYPHEN-MINUS character (-) between the E and the number and the number is not zero, or else ignoring a U+002B PLUS SIGN character (+) between the E and the number if there is one). If there is no E, then the exponent is treated as zero.

The Infinity and Not-a-Number (NaN) values are not valid floating-point numbers.

The valid floating-point number concept is typically only used to restrict what is allowed for authors, while the user agent requirements use the rules for parsing floating-point number values below (e.g., the max attribute of the progress element). However, in some cases the user agent requirements include checking if a string is a valid floating-point number (e.g., the value sanitization algorithm for the Number state of the input element, or the parse a srcset attribute algorithm).

The best representation of the number as a floating-point number is the string obtained from running ToString(n). The abstract operation ToString is not uniquely determined. When there are multiple possible strings that could be obtained from ToString for a particular value, the user agent must always return the same string for that value (though it may differ from the value used by other user agents).

The rules for parsing floating-point number values are as given in the following algorithm. This algorithm must be aborted at the first step that returns something. This algorithm will return either a number or an error.

1. Let input be the string being parsed.
2. Let position be a pointer into input, initially pointing at the start of the string.
3. Let value have the value 1.
4. Let divisor have the value 1.
5. Let exponent have the value 1.
6. Skip ASCII whitespace within input given position.
7. If position is past the end of input, return an error.
8. If the character indicated by position is a U+002D HYPHEN-MINUS character (-):
   1. Change value and divisor to −1.
   2. Advance position to the next character.
   3. If position is past the end of input, return an error.
   Otherwise, if the character indicated by position (the first character) is a U+002B PLUS SIGN character (+):
      1. Advance position to the next character. (The "+" is ignored, but it is not conforming.)
      2. If position is past the end of input, return an error.
9. If the character indicated by position is a U+002E FULL STOP (.), and that is not the last character in input, and the character after the character indicated by position is an ASCII digit, then set value to zero and jump to the step labeled fraction.
10. If the character indicated by position is not an ASCII digit, then return an error.
11. Collect a sequence of code points that are ASCII digits from input given position, and interpret the resulting sequence as a base-ten integer. Multiply value by that integer.
12. If position is past the end of input, jump to the step labeled conversion.
13. Fraction: If the character indicated by position is a U+002E FULL STOP (.), run these substeps:
   1. Advance position to the next character.
   2. If position is past the end of input, or if the character indicated by position is not an ASCII digit, U+0065 LATIN SMALL LETTER E (e), or U+0045 LATIN CAPITAL LETTER E (E), then jump to the step labeled conversion.
   3. If the character indicated by position is a U+0065 LATIN SMALL LETTER E character (e) or a U+0045 LATIN CAPITAL LETTER E character (E), skip the remainder of these substeps.

5. Add the value of the character indicated by position, interpreted as a base-ten digit (0..9) and divided by divisor, to value.

6. Advance position to the next character.

7. If position is past the end of input, then jump to the step labeled conversion.

8. If the character indicated by position is an ASCII digit, jump back to the step labeled fraction loop in these substeps.

14. If the character indicated by position is U+0065 (e) or a U+0045 (E), then:
   1. Advance position to the next character.
   2. If position is past the end of input, then jump to the step labeled conversion.
   3. If the character indicated by position is a U+002D HYPHEN-MINUS character (-):
      1. Change exponent to −1.
      2. Advance position to the next character.
      3. If position is past the end of input, then jump to the step labeled conversion.
   Otherwise, if the character indicated by position is a U+002B PLUS SIGN character (+):
      1. Advance position to the next character.
      2. If position is past the end of input, then jump to the step labeled conversion.
   4. If the character indicated by position is not an ASCII digit, then jump to the step labeled conversion.
   5. Collect a sequence of code points that are ASCII digits from input given position, and interpret the resulting sequence as a base-ten integer. Multiply exponent by that integer.
   6. Multiply value by ten raised to the exponentth power.

15. *Conversion*: Let S be the set of finite IEEE 754 double-precision floating-point values except −0, but with two special values added: 2^{1024} and −2^{1024}.

16. Let rounded-value be the number in S that is closest to value, selecting the number with an even significand if there are two equally close values. (The two special values 2^{1024} and −2^{1024} are considered to have even significands for this purpose.)

17. If rounded-value is 2^{1024} or −2^{1024}, return an error.

18. Return rounded-value.

### 2.3.4.4 Percentages and lengths

The rules for parsing dimension values are as given in the following algorithm. When invoked, the steps must be followed in the order given, aborting at the first step that returns a value. This algorithm will return either a number greater than or equal to 0.0, or failure; if a number is returned, then it is further categorized as either a percentage or a length.

1. Let input be the string being parsed.
2. Let position be a position variable for input, initially pointing at the start of input.
3. Skip ASCII whitespace within input given position.
4. If position is past the end of input or the code point at position within input is not an ASCII digit, then return failure.
5. Collect a sequence of code points that are ASCII digits from input given position, and interpret the resulting sequence as a base-ten integer. Let value be that number.
6. If position is past the end of input, then return value as a length.
7. If the code point at position within input is U+002E (.), then:
1. Advance position by 1.

2. If position is past the end of input or the code point at position within input is not an ASCII digit, then return the current dimension value²⁷ with value, input, and position.

3. Let divisor have the value 1.

4. While true:
   1. Multiply divisor by ten.
   2. Add the value of the code point at position within input, interpreted as a base-ten digit (0..9) and divided by divisor, to value.
   3. Advance position by 1.
   4. If position is past the end of input, then return value as a length.
   5. If the code point at position within input is not an ASCII digit, then break.

8. Return the current dimension value²⁷ with value, input, and position.

The current dimension value, given value, input, and position, is determined as follows:

1. If position is past the end of input, then return value as a length.

2. If the code point at position within input is U+0025 (%), then return value as a percentage.

3. Return value as a length.

2.3.4.5 Nonzero percentages and lengths ²⁷

The rules for parsing nonzero dimension values are as given in the following algorithm. When invoked, the steps must be followed in the order given, aborting at the first step that returns a value. This algorithm will return either a number greater than 0.0, or an error; if a number is returned, then it is further categorized as either a percentage or a length.

1. Let input be the string being parsed.
2. Let value be the result of parsing input using the rules for parsing dimension values²⁷.
3. If value is an error, return an error.
4. If value is zero, return an error.
5. If value is a percentage, return value as a percentage.
6. Return value as a length.

2.3.4.6 Lists of floating-point numbers ²⁷

A valid list of floating-point numbers is a number of valid floating-point numbers²⁷ separated by U+002C COMMA characters, with no other characters (e.g. no ASCII whitespace). In addition, there might be restrictions on the number of floating-point numbers that can be given, or on the range of values allowed.

The rules for parsing a list of floating-point numbers are as follows:

1. Let input be the string being parsed.
2. Let position be a pointer into input, initially pointing at the start of the string.
3. Let numbers be an initially empty list of floating-point numbers. This list will be the result of this algorithm.
4. Collect a sequence of code points that are ASCII whitespace, U+002C COMMA, or U+003B SEMICOLON characters from input given position. This skips past any leading delimiters.
5. While position is not past the end of input:
1. Collect a sequence of code points that are not ASCII whitespace, U+002C COMMA, U+003B SEMICOLON, ASCII digits, U+002E FULL STOP, or U+002D HYPHEN-MINUS characters from input given position. This skips past leading garbage.

2. Collect a sequence of code points that are not ASCII whitespace, U+002C COMMA, or U+003B SEMICOLON characters from input given position, and let unparsed number be the result.

3. Let number be the result of parsing unparsed number using the rules for parsing floating-point number values.\(^\text{676}\)

4. If number is an error, set number to zero.

5. Append number to numbers.

6. Collect a sequence of code points that are ASCII whitespace, U+002C COMMA, or U+003B SEMICOLON characters from input given position. This skips past the delimiter.

6. Return numbers.

2.3.4.7 Lists of dimensions \(^\text{679}\)

The rules for parsing a list of dimensions are as follows. These rules return a list of zero or more pairs consisting of a number and a unit, the unit being one of percentage, relative, and absolute.

1. Let raw input be the string being parsed.

2. If the last character in raw input is a U+002C COMMA character (,), then remove that character from raw input.

3. Split the string raw input on commas. Let raw tokens be the resulting list of tokens.

4. Let result be an empty list of number/unit pairs.

5. For each token in raw tokens, run the following substeps:

   1. Let input be the token.

   2. Let position be a pointer into input, initially pointing at the start of the string.

   3. Let value be the number 0.

   4. Let unit be absolute.

   5. If position is past the end of input, set unit to relative and jump to the last substep.

   6. If the character at position is an ASCII digit, collect a sequence of code points that are ASCII digits from input given position, interpret the resulting sequence as an integer in base ten, and increment value by that integer.

   7. If the character at position is U+002E (.), then:

      1. Collect a sequence of code points consisting of ASCII whitespace and ASCII digits from input given position. Let s be the resulting sequence.

      2. Remove all ASCII whitespace in s.

      3. If s is not the empty string, then:

         1. Let length be the number of characters in s (after the spaces were removed).

         2. Let fraction be the result of interpreting s as a base-ten integer, and then dividing that number by \(10^{\text{length}}\).

         3. Increment value by fraction.

     8. Skip ASCII whitespace within input given position.

   9. If the character at position is a U+0025 PERCENT SIGN character (%), then set unit to percentage.

   Otherwise, if the character at position is a U+002A ASTERISK character (*), then set unit to relative.

10. Add an entry to result consisting of the number given by value and the unit given by unit.
6. Return the list \texttt{result}.

### 2.3.5 Dates and times

In the algorithms below, the number of days in month \emph{month} of year \emph{year} is: 31 if \emph{month} is 1, 3, 5, 7, 8, 10, or 12; 30 if \emph{month} is 4, 6, 9, or 11; 29 if \emph{month} is 2 and \emph{year} is a number divisible by 400, or if \emph{year} is a number divisible by 4 but not by 100; and 28 otherwise. This takes into account leap years in the Gregorian calendar. [GREGORIAN]^{1458}

When \texttt{ASCII digits} are used in the date and time syntaxes defined in this section, they express numbers in base ten.

**Note**

While the formats described here are intended to be subsets of the corresponding ISO8601 formats, this specification defines parsing rules in much more detail than ISO8601. Implementers are therefore encouraged to carefully examine any date parsing libraries before using them to implement the parsing rules described below; ISO8601 libraries might not parse dates and times in exactly the same manner. [ISO8601]^{1459}

Where this specification refers to the proleptic Gregorian calendar, it means the modern Gregorian calendar, extrapolated backwards to year 1. A date in the proleptic Gregorian calendar, sometimes explicitly referred to as a proleptic-Gregorian date, is one that is described using that calendar even if that calendar was not in use at the time (or place) in question. [GREGORIAN]^{1458}

**Note**

The use of the Gregorian calendar as the wire format in this specification is an arbitrary choice resulting from the cultural biases of those involved in the decision. See also the section discussing date, time, and number formats in forms (for authors), implementation notes regarding localization of form controls, and the time element.

#### 2.3.5.1 Months

A \emph{month} consists of a specific proleptic-Gregorian date with no time-zone information and no date information beyond a year and a month. [GREGORIAN]^{1458}

A string is a valid \texttt{month string} representing a year \emph{year} and month \emph{month} if it consists of the following components in the given order:

1. Four or more \texttt{ASCII digits}, representing \emph{year}, where \emph{year} > 0
2. A U+002D HYPHEN-MINUS character (-)
3. Two \texttt{ASCII digits}, representing the month \emph{month}, in the range 1 ≤ \emph{month} ≤ 12

The rules to parse a \texttt{month string} are as follows. This will return either a year and month, or nothing. If at any point the algorithm says that it “fails”, this means that it is aborted at that point and returns nothing.

1. Let \texttt{input} be the string being parsed.
2. Let \texttt{position} be a pointer into \texttt{input}, initially pointing at the start of the string.
3. Parse a \texttt{month component} to obtain \emph{year} and \emph{month}. If this returns nothing, then fail.
4. If \texttt{position} is not beyond the end of \texttt{input}, then fail.
5. Return \emph{year} and \emph{month}.

The rules to parse a \texttt{month component}, given an \texttt{input} string and a \texttt{position}, are as follows. This will return either a year and a month, or nothing. If at any point the algorithm says that it “fails”, this means that it is aborted at that point and returns nothing.

1. Collect a sequence of code points that are \texttt{ASCII digits} from \texttt{input} given \texttt{position}. If the collected sequence is not at least four characters long, then fail. Otherwise, interpret the resulting sequence as a base-ten integer. Let that number be the \emph{year}.
2. If \emph{year} is not a number greater than zero, then fail.
3. If \texttt{position} is beyond the end of \texttt{input} or if the character at \texttt{position} is not a U+002D HYPHEN-MINUS character, then fail.
Otherwise, move position forwards one character.

4. Collect a sequence of code points that are ASCII digits from input given position. If the collected sequence is not exactly two characters long, then fail. Otherwise, interpret the resulting sequence as a base-ten integer. Let that number be the month.

5. If month is not a number in the range $1 \leq \text{month} \leq 12$, then fail.

6. Return year and month.

2.3.5.2 Dates \[^{81}\]

A date consists of a specific proleptic-Gregorian date\[^{680}\] with no time-zone information, consisting of a year, a month, and a day. [GREGORIAN]\[^{646}\]

A string is a valid date string representing a year year, month month, and day day if it consists of the following components in the given order:

1. A valid month string\[^{680}\], representing year and month
2. A U+002D HYPHEN-MINUS character (-)
3. Two ASCII digits, representing day, in the range $1 \leq \text{day} \leq \text{maxday}$ where maxday is the number of days in the month month and year year\[^{680}\]

The rules to parse a date string are as follows. This will return either a date, or nothing. If at any point the algorithm says that it "fails", this means that it is aborted at that point and returns nothing.

1. Let input be the string being parsed.
2. Let position be a pointer into input, initially pointing at the start of the string.
3. Parse a date component\[^{81}\] to obtain year, month, and day. If this returns nothing, then fail.
4. If position is not beyond the end of input, then fail.
5. Let date be the date with year year, month month, and day day.
6. Return date.

The rules to parse a date component, given an input string and a position, are as follows. This will return either a year, a month, and a day, or nothing. If at any point the algorithm says that it "fails", this means that it is aborted at that point and returns nothing.

1. Parse a month component\[^{81}\] to obtain year and month. If this returns nothing, then fail.
2. Let maxday be the number of days in month month of year year\[^{680}\].
3. If position is beyond the end of input or if the character at position is not a U+002D HYPHEN-MINUS character, then fail. Otherwise, move position forwards one character.
4. Collect a sequence of code points that are ASCII digits from input given position. If the collected sequence is not exactly two characters long, then fail. Otherwise, interpret the resulting sequence as a base-ten integer. Let that number be the day.
5. If day is not a number in the range $1 \leq \text{day} \leq \text{maxday}$, then fail.
6. Return year, month, and day.

2.3.5.3 Yearless dates \[^{81}\]

A yearless date consists of a Gregorian month and a day within that month, but with no associated year. [GREGORIAN]\[^{646}\]

A string is a valid yearless date string representing a month month and a day day if it consists of the following components in the given order:

1. Optionally, two U+002D HYPHEN-MINUS characters (-)
2. Two ASCII digits, representing the month month, in the range 1 ≤ month ≤ 12

3. A U+002D HYPHEN-MINUS character (-)

4. Two ASCII digits, representing day, in the range 1 ≤ day ≤ maxday where maxday is the number of days in the month month and any arbitrary leap year (e.g. 4 or 2000)

Note
In other words, if the month is "02", meaning February, then the day can be 29, as if the year was a leap year.

The rules to parse a yearless date string are as follows. This will return either a month and a day, or nothing. If at any point the algorithm says that it "fails", this means that it is aborted at that point and returns nothing.

1. Let input be the string being parsed.
2. Let position be a pointer into input, initially pointing at the start of the string.
3. Parse a yearless date component to obtain month and day. If this returns nothing, then fail.
4. If position is not beyond the end of input, then fail.
5. Return month and day.

The rules to parse a yearless date component, given an input string and a position, are as follows. This will return either a month and a day, or nothing. If at any point the algorithm says that it "fails", this means that it is aborted at that point and returns nothing.

1. Collect a sequence of code points that are U+002D HYPHEN-MINUS characters (-) from input given position. If the collected sequence is not exactly zero or two characters long, then fail.
2. Collect a sequence of code points that are ASCII digits from input given position. If the collected sequence is not exactly two characters long, then fail. Otherwise, interpret the resulting sequence as a base-ten integer. Let that number be the month.
3. If month is not a number in the range 1 ≤ month ≤ 12, then fail.
4. Let maxday be the number of days in month of any arbitrary leap year (e.g. 4 or 2000).
5. If position is beyond the end of input or if the character at position is not a U+002D HYPHEN-MINUS character, then fail. Otherwise, move position forwards one character.
6. Collect a sequence of code points that are ASCII digits from input given position. If the collected sequence is not exactly two characters long, then fail. Otherwise, interpret the resulting sequence as a base-ten integer. Let that number be the day.
7. If day is not a number in the range 1 ≤ day ≤ maxday, then fail.
8. Return month and day.

2.3.5.4 Times

A time consists of a specific time with no time-zone information, consisting of an hour, a minute, a second, and a fraction of a second.

A string is a valid time string representing an hour hour, a minute minute, and a second second if it consists of the following components in the given order:

1. Two ASCII digits, representing hour, in the range 0 ≤ hour ≤ 23
2. A U+003A COLON character (:) (§p82)
3. Two ASCII digits, representing minute, in the range 0 ≤ minute ≤ 59
4. If second is nonzero, or optionally if second is zero:
   1. A U+003A COLON character (:) (§p82)
   2. Two ASCII digits, representing the integer part of second, in the range 0 ≤ s ≤ 59
   3. If second is not an integer, or optionally if second is an integer:
      1. A U+002E FULL STOP character (.) (§p82)
      2. One, two, or three ASCII digits, representing the fractional part of second
The rules to parse a time string are as follows. This will return either a time, or nothing. If at any point the algorithm says that it “fails”, this means that it is aborted at that point and returns nothing.

1. Let input be the string being parsed.
2. Let position be a pointer into input, initially pointing at the start of the string.
3. Parse a time component to obtain hour, minute, and second. If this returns nothing, then fail.
4. If position is not beyond the end of input, then fail.
5. Let time be the time with hour hour, minute minute, and second second.
6. Return time.

The rules to parse a time component, given an input string and a position, are as follows. This will return either an hour, a minute, and a second, or nothing. If at any point the algorithm says that it “fails”, this means that it is aborted at that point and returns nothing.

1. Collect a sequence of code points that are ASCII digits from input given position. If the collected sequence is not exactly two characters long, then fail. Otherwise, interpret the resulting sequence as a base-ten integer. Let that number be the hour.
2. If hour is not a number in the range \(0 \leq \text{hour} \leq 23\), then fail.
3. If position is beyond the end of input or if the character at position is not a U+003A COLON character, then fail. Otherwise, move position forwards one character.
4. Collect a sequence of code points that are ASCII digits from input given position. If the collected sequence is not exactly two characters long, then fail. Otherwise, interpret the resulting sequence as a base-ten integer. Let that number be the minute.
5. If minute is not a number in the range \(0 \leq \text{minute} \leq 59\), then fail.
6. Let second be 0.
7. If position is not beyond the end of input and the character at position is U+003A (:), then:
   1. Advance position to the next character in input.
   2. If position is beyond the end of input, or at the last character in input, or if the next two characters in input starting at position are not both ASCII digits, then fail.
   3. Collect a sequence of code points that are either ASCII digits or U+002E FULL STOP characters from input given position. If the collected sequence is three characters long, or if it is longer than three characters long and the third character is not a U+002E FULL STOP character, or if it has more than one U+002E FULL STOP character, then fail. Otherwise, interpret the resulting sequence as a base-ten number (possibly with a fractional part). Set second to that number.
   4. If second is not a number in the range \(0 \leq \text{second} < 60\), then fail.
8. Return hour, minute, and second.

### 2.3.5.5 Local dates and times

A local date and time consists of a specific proleptic-Gregorian date, consisting of a year, a month, and a day, and a time, consisting of an hour, a minute, a second, and a fraction of a second, but expressed without a time zone.

A string is a valid local date and time string representing a date and time if it consists of the following components in the given order:

1. A valid date string representing the date
2. A U+0054 LATIN CAPITAL LETTER T character (T) or a U+0020 SPACE character
3. A valid time string representing the time
A string is a valid normalized local date and time string representing a date and time if it consists of the following components in the given order:

1. A valid date string\(^{[81]}\) representing the date
2. A U+0054 LATIN CAPITAL LETTER T character (T)
3. A valid time string\(^{[82]}\) representing the time, expressed as the shortest possible string for the given time (e.g. omitting the seconds component entirely if the given time is zero seconds past the minute)

The rules to parse a local date and time string are as follows. This will return either a date and time, or nothing. If at any point the algorithm says that it “fails”, this means that it is aborted at that point and returns nothing.

1. Let input be the string being parsed.
2. Let position be a pointer into input, initially pointing at the start of the string.
3. Parse a date component\(^{[81]}\) to obtain year, month, and day. If this returns nothing, then fail.
4. If position is beyond the end of input or if the character at position is neither a U+0054 LATIN CAPITAL LETTER T character (T) nor a U+0020 SPACE character, then fail. Otherwise, move position forwards one character.
5. Parse a time component\(^{[83]}\) to obtain hour, minute, and second. If this returns nothing, then fail.
6. If position is not beyond the end of input, then fail.
7. Let date be the date with year year, month month, and day day.
8. Let time be the time with hour hour, minute minute, and second second.
9. Return date and time.

2.3.5.6 Time zones \(^{[84]}\)

A time-zone offset consists of a signed number of hours and minutes.

A string is a valid time-zone offset string representing a time-zone offset if it consists of either:

- A U+005A LATIN CAPITAL LETTER Z character (Z), allowed only if the time zone is UTC
- Or, the following components, in the given order:
  1. Either a U+002B PLUS SIGN character (+) or, if the time-zone offset is not zero, a U+002D HYPHEN-MINUS character (-), representing the sign of the time-zone offset
  2. Two ASCII digits, representing the hours component hour of the time-zone offset, in the range 0 ≤ hour ≤ 23
  3. Optionally, a U+003A COLON character (:)
  4. Two ASCII digits, representing the minutes component minute of the time-zone offset, in the range 0 ≤ minute ≤ 59

Note

This format allows for time-zone offsets from -23:59 to +23:59. Right now, in practice, the range of offsets of actual time zones is -12:00 to +14:00, and the minutes component of offsets of actual time zones is always either 00, 30, or 45. There is no guarantee that this will remain so forever, however, since time zones are used as political footballs and are thus subject to very whimsical policy decisions.

Note

See also the usage notes and examples in the global date and time\(^{[85]}\) section below for details on using time-zone offsets with historical times that predate the formation of formal time zones.

The rules to parse a time-zone offset string are as follows. This will return either a time-zone offset, or nothing. If at any point the algorithm says that it “fails”, this means that it is aborted at that point and returns nothing.

1. Let input be the string being parsed.
2. Let position be a pointer into input, initially pointing at the start of the string.
3. Parse a time-zone offset component to obtain timezonehours and timezoneminutes. If this returns nothing, then fail.
4. If position is not beyond the end of input, then fail.
5. Return the time-zone offset that is timezonehours hours and timezoneminutes minutes from UTC.

The rules to parse a time-zone offset component, given an input string and a position, are as follows. This will return either time-zone hours and time-zone minutes, or nothing. If at any point the algorithm says that it "fails", this means that it is aborted at that point and returns nothing.

1. If the character at position is a U+005A LATIN CAPITAL LETTER Z character (Z), then:
   1. Let timezonehours be 0.
   2. Let timezoneminutes be 0.
   3. Advance position to the next character in input.

Otherwise, if the character at position is either a U+002B PLUS SIGN (+) or a U+002D HYPHEN-MINUS (-), then:

1. If the character at position is a U+002B PLUS SIGN (+), let sign be "positive". Otherwise, it's a U+002D HYPHEN-MINUS (-); let sign be "negative".
2. Advance position to the next character in input.
3. Collect a sequence of code points that are ASCII digits from input given position. Let s be the collected sequence.
4. If s is exactly two characters long, then:
   1. Interpret s as a base-ten integer. Let that number be the timezonehours.
   2. If position is beyond the end of input or if the character at position is not a U+003A COLON character, then fail. Otherwise, move position forwards one character.
   3. Collect a sequence of code points that are ASCII digits from input given position. If the collected sequence is not exactly two characters long, then fail. Otherwise, interpret the resulting sequence as a base-ten integer. Let that number be the timezoneminutes.

If s is exactly four characters long, then:

1. Interpret the first two characters of s as a base-ten integer. Let that number be the timezonehours.
2. Interpret the last two characters of s as a base-ten integer. Let that number be the timezoneminutes.

Otherwise, fail.

5. If timezonehours is not a number in the range 0 ≤ timezonehours ≤ 23, then fail.
6. If sign is "negative", then negate timezonehours.
7. If timezoneminutes is not a number in the range 0 ≤ timezoneminutes ≤ 59, then fail.
8. If sign is "negative", then negate timezoneminutes.

Otherwise, fail.

2. Return timezonehours and timezoneminutes.

2.3.5.7 Global dates and times

A global date and time consists of a specific proleptic-Gregorian date, consisting of a year, a month, and a day, and a time, consisting of an hour, a minute, a second, and a fraction of a second, expressed with a time-zone offset, consisting of a signed number of hours and minutes.

A string is a valid global date and time string representing a date, time, and a time-zone offset if it consists of the following components in the given order:
1. A valid date string\(^ {a1}\) representing the date
2. A U+0054 LATIN CAPITAL LETTER T character (T) or a U+0020 SPACE character
3. A valid time string\(^ {a2}\) representing the time
4. A valid time-zone offset string\(^ {a3}\) representing the time-zone offset

Times in dates before the formation of UTC in the mid-twentieth century must be expressed and interpreted in terms of UT1 (contemporary Earth solar time at the 0° longitude), not UTC (the approximation of UT1 that ticks in SI seconds). Time before the formation of time zones must be expressed and interpreted as UT1 times with explicit time zones that approximate the contemporary difference between the appropriate local time and the time observed at the location of Greenwich, London.

### Example

The following are some examples of dates written as valid global date and time strings\(^ {a4}\).

"0037-12-13 00:00Z"
- Midnight in areas using London time on the birthday of Nero (the Roman Emperor). See below for further discussion on which date this actually corresponds to.

"1979-10-14T12:00:00.001-04:00"
- One millisecond after noon on October 14th 1979, in the time zone in use on the east coast of the USA during daylight saving time.

"8592-01-01T02:09+02:09"
- Midnight UTC on the 1st of January, 8592. The time zone associated with that time is two hours and nine minutes ahead of UTC, which is not currently a real time zone, but is nonetheless allowed.

Several things are notable about these dates:

- Years with fewer than four digits have to be zero-padded. The date "37-12-13" would not be a valid date.
- If the "T" is replaced by a space, it must be a single space character. The string "2001-12-21 12:00Z" (with two spaces between the components) would not be parsed successfully.
- To unambiguously identify a moment in time prior to the introduction of the Gregorian calendar (insofar as moments in time before the formation of UTC can be unambiguously identified), the date has to be first converted to the Gregorian calendar from the calendar in use at the time (e.g. from the Julian calendar). The date of Nero's birth is the 15th of December 37, in the Julian Calendar, which is the 13th of December 37 in the proleptic Gregorian calendar\(^ {a5}\).
- The time and time-zone offset components are not optional.
- Dates before the year one can't be represented as a datetime in this version of HTML.
- Times of specific events in ancient times are, at best, approximations, since time was not well coordinated or measured until relatively recent decades.
- Time-zone offsets differ based on daylight saving time.

The rules to parse a global date and time string are as follows. This will return either a time in UTC, with associated time-zone offset information for round-tripping or display purposes, or nothing. If at any point the algorithm says that it "fails", this means that it is aborted at that point and returns nothing.

1. Let input be the string being parsed.
2. Let position be a pointer into input, initially pointing at the start of the string.
3. **Parse a date component**\(^ {a6}\) to obtain year, month, and day. If this returns nothing, then fail.
4. If position is beyond the end of input or if the character at position is neither a U+0054 LATIN CAPITAL LETTER T character (T) nor a U+0020 SPACE character, then fail. Otherwise, move position forwards one character.
5. **Parse a time component**\(^ {a7}\) to obtain hour, minute, and second. If this returns nothing, then fail.
6. If position is beyond the end of input, then fail.
7. **Parse a time-zone offset component**\(^ {a8}\) to obtain timezonehours and timezone minutes. If this returns nothing, then fail.
8. If position is not beyond the end of input, then fail.

9. Let time be the moment in time at year year, month month, day day, hours hour, minute minute, second second, subtracting timezonehours hours and timezoneminutes minutes. That moment in time is a moment in the UTC time zone.

10. Let timezone be timezonehours hours and timezoneminutes minutes from UTC.

11. Return time and timezone.

2.3.5.8 Weeks

A week consists of a week-year number and a week number representing a seven-day period starting on a Monday. Each week-year in this calendaring system has either 52 or 53 such seven-day periods, as defined below. The seven-day period starting on the Gregorian date Monday December 29th 1969 (1969-12-29) is defined as week number 1 in week-year 1970. Consecutive weeks are numbered sequentially. The week before the number 1 week in a week-year is the last week in the previous week-year, and vice versa. [GREGORIAN]

A week-year with a number year has 53 weeks if it corresponds to either a year year in the proleptic Gregorian calendar that has a Thursday as its first day (January 1st), or a year year in the proleptic Gregorian calendar that has a Wednesday as its first day (January 1st) and where year is a number divisible by 400, or a number divisible by 4 but not by 100. All other week-years have 52 weeks.

The week number of the last day of a week-year with 53 weeks is 53; the week number of the last day of a week-year with 52 weeks is 52.

Note
The week-year number of a particular day can be different than the number of the year that contains that day in the proleptic Gregorian calendar. The first week in a week-year y is the week that contains the first Thursday of the Gregorian year y.

Note
For modern purposes, a week as defined here is equivalent to ISO weeks as defined in ISO 8601. [ISO8601]

A string is a valid week string representing a week-year year and week if it consists of the following components in the given order:

1. Four or more ASCII digits, representing year, where year > 0
2. A U+002D HYPHEN-MINUS character (-)
3. A U+0057 LATIN CAPITAL LETTER W character (W)
4. Two ASCII digits, representing the week, in the range 1 ≤ week ≤ maxweek, where maxweek is the week number of the last day of week-year year

The rules to parse a week string are as follows. This will return either a week-year number and week number, or nothing. If at any point the algorithm says that it "fails", this means that it is aborted at that point and returns nothing.

1. Let input be the string being parsed.
2. Let position be a pointer into input, initially pointing at the start of the string.
3. Collect a sequence of code points that are ASCII digits from input given position. If the collected sequence is not at least four characters long, then fail. Otherwise, interpret the resulting sequence as a base-ten integer. Let that number be the year.
4. If year is not a number greater than zero, then fail.
5. If position is beyond the end of input or if the character at position is not a U+002D HYPHEN-MINUS character, then fail. Otherwise, move position forwards one character.
6. If position is beyond the end of input or if the character at position is not a U+0057 LATIN CAPITAL LETTER W character, then fail. Otherwise, move position forwards one character.
7. Collect a sequence of code points that are ASCII digits from input given position. If the collected sequence is not exactly two characters long, then fail. Otherwise, interpret the resulting sequence as a base-ten integer. Let that number be the week.
8. Let maxweek be the week number of the last day of year.

9. If week is not a number in the range \(1 \leq \text{week} \leq \text{maxweek}\), then fail.

10. If position is not beyond the end of input, then fail.

11. Return the week-year number \(\text{year}\) and the week number \(\text{week}\).

2.3.5.9 Durations

A duration consists of a number of seconds.

Note

Since months and seconds are not comparable (a month is not a precise number of seconds, but is instead a period whose exact length depends on the precise day from which it is measured) a duration as defined in this specification cannot include months (or years, which are equivalent to twelve months). Only durations that describe a specific number of seconds can be described.

A string is a valid duration string representing a duration \(t\) if it consists of either of the following:

- A literal U+0050 LATIN CAPITAL LETTER P character followed by one or more of the following subcomponents, in the order given, where the number of days, hours, minutes, and seconds corresponds to the same number of seconds as in \(t\):
  1. One or more ASCII digits followed by a U+0044 LATIN CAPITAL LETTER D character, representing a number of days.
  2. A U+0054 LATIN CAPITAL LETTER T character followed by one or more of the following subcomponents, in the order given:
     1. One or more ASCII digits followed by a U+0048 LATIN CAPITAL LETTER H character, representing a number of hours.
     2. One or more ASCII digits followed by a U+004D LATIN CAPITAL LETTER M character, representing a number of minutes.
     3. The following components:
        1. One or more ASCII digits, representing a number of seconds.
        2. Optionally, a U+002E FULL STOP character (.) followed by one, two, or three ASCII digits, representing a fraction of a second.
        3. A U+0053 LATIN CAPITAL LETTER S character.

Note

This, as with a number of other date- and time-related microsyntaxes defined in this specification, is based on one of the formats defined in ISO 8601. [ISO8601]

- One or more duration time components, each with a different duration time component scale, in any order; the sum of the represented seconds being equal to the number of seconds in \(t\).

A duration time component is a string consisting of the following components:

1. Zero or more ASCII whitespace.
2. One or more ASCII digits, representing a number of time units, scaled by the duration time component scale specified (see below) to represent a number of seconds.
3. If the duration time component scale specified is 1 (i.e. the units are seconds), then, optionally, a U+002E FULL STOP character (.) followed by one, two, or three ASCII digits, representing a fraction of a second.
4. Zero or more ASCII whitespace.
5. One of the following characters, representing the duration time component scale of the time unit used in the numeric part of the duration time component:
The rules to parse a duration string are as follows. This will return either a duration or nothing. If at any point the algorithm says that it “fails”, this means that it is aborted at that point and returns nothing.

1. Let input be the string being parsed.
2. Let position be a pointer into input, initially pointing at the start of the string.
3. Let months, seconds, and component count all be zero.
4. Let M-disambiguator be minutes.

5. Skip ASCII whitespace within input given position.
6. If position is past the end of input, then fail.
7. If the character in input pointed to by position is a U+0050 LATIN CAPITAL LETTER P character, then advance position to the next character, set M-disambiguator to months, and skip ASCII whitespace within input given position.
8. While true:

   1. Let units be undefined. It will be assigned one of the following values: years, months, weeks, days, hours, minutes, and seconds.
   2. Let next character be undefined. It is used to process characters from the input.
   3. If position is past the end of input, then break.
   4. If the character in input pointed to by position is a U+0054 LATIN CAPITAL LETTER T character, then advance position to the next character, set M-disambiguator to minutes, skip ASCII whitespace within input given position, and continue.
   5. Set next character to the character in input pointed to by position.
   6. If next character is a U+002E FULL STOP character (.), then let N equal zero. (Do not advance position. That is taken care of below.)
Otherwise, if next character is an ASCII digit, then collect a sequence of code points that are ASCII digits from input given position, interpret the resulting sequence as a base-ten integer, and let $N$ be that number.

Otherwise next character is not part of a number; fail.

7. If position is past the end of input, then fail.

8. Set next character to the character in input pointed to by position, and this time advance position to the next character. (If next character was a U+002E FULL STOP character (.) before, it will still be that character this time.)

9. If next character is U+002E (.), then:
   1. Collect a sequence of code points that are ASCII digits from input given position. Let $s$ be the resulting sequence.
   2. If $s$ is the empty string, then fail.
   3. Let length be the number of characters in $s$.
   4. Let fraction be the result of interpreting $s$ as a base-ten integer, and then dividing that number by $10^{\text{length}}$.
   5. Increment $N$ by fraction.
   6. Skip ASCII whitespace within input given position.
   7. If position is past the end of input, then fail.
   8. Set next character to the character in input pointed to by position, and advance position to the next character.
   9. If next character is neither a U+0053 LATIN CAPITAL LETTER S character nor a U+0073 LATIN SMALL LETTER S character, then fail.

   Otherwise:
   1. If next character is ASCII whitespace, then skip ASCII whitespace within input given position, set next character to the character in input pointed to by position, and advance position to the next character.
   2. If next character is a U+0059 LATIN CAPITAL LETTER Y character, or a U+0079 LATIN SMALL LETTER Y character, set units to years and set M-disambiguator to months.
      
      If next character is a U+004D LATIN CAPITAL LETTER M character or a U+006D LATIN SMALL LETTER M character, and M-disambiguator is months, then set units to months.
      
      If next character is a U+0057 LATIN CAPITAL LETTER W character or a U+0077 LATIN SMALL LETTER W character, set units to weeks and set M-disambiguator to minutes.
      
      If next character is a U+0044 LATIN CAPITAL LETTER D character or a U+0064 LATIN SMALL LETTER D character, set units to days and set M-disambiguator to minutes.
      
      If next character is a U+0048 LATIN CAPITAL LETTER H character or a U+0068 LATIN SMALL LETTER H character, set units to hours and set M-disambiguator to minutes.
      
      If next character is a U+004D LATIN CAPITAL LETTER M character or a U+006D LATIN SMALL LETTER M character, and M-disambiguator is minutes, then set units to minutes.
      
      If next character is a U+0053 LATIN CAPITAL LETTER S character or a U+0073 LATIN SMALL LETTER S character, set units to seconds and set M-disambiguator to minutes.
      
      Otherwise, if next character is none of the above characters, then fail.

10. Increment component count.

11. Let multiplier be 1.

12. If units is years, multiply multiplier by 12 and set units to months.

13. If units is months, add the product of $N$ and multiplier to months.
Otherwise:

1. If units is weeks, multiply multiplier by 7 and set units to days.
2. If units is days, multiply multiplier by 24 and set units to hours.
3. If units is hours, multiply multiplier by 60 and set units to minutes.
4. If units is minutes, multiply multiplier by 60 and set units to seconds.
5. Forcibly, units is now seconds. Add the product of N and multiplier to seconds.

14. Skip ASCII whitespace within input given position.

9. If component count is zero, fail.

10. If months is not zero, fail.

11. Return the duration consisting of seconds seconds.

2.3.5.10 Vaguer moments in time

A string is a valid date string with optional time if it is also one of the following:

- A valid date string
- A valid global date and time string

The rules to parse a date or time string are as follows. The algorithm will return either a date, a time, a global date and time, or nothing. If at any point the algorithm says that it “fails”, this means that it is aborted at that point and returns nothing.

1. Let input be the string being parsed.
2. Let position be a pointer into input, initially pointing at the start of the string.
3. Set start position to the same position as position.
4. Set the date present and time present flags to true.
5. Parse a date component to obtain year, month, and day. If this fails, then set the date present flag to false.
6. If date present is true, and position is not beyond the end of input, and the character at position is either a U+0054 LATIN CAPITAL LETTER T character (T) or a U+0020 SPACE character, then advance position to the next character in input.
   Otherwise, if date present is true, and either position is beyond the end of input or the character at position is neither a U+0054 LATIN CAPITAL LETTER T character (T) nor a U+0020 SPACE character, then set time present to false.
   Otherwise, if date present is false, let position back to the same position as start position.
7. If the time present flag is true, then parse a time component to obtain hour, minute, and second. If this returns nothing, then fail.
8. If the date present and time present flags are both true, but position is beyond the end of input, then fail.
9. If the date present and time present flags are both true, parse a time-zone offset component to obtain timezonehours and timeminutes. If this returns nothing, then fail.
10. If position is not beyond the end of input, then fail.
11. If the date present flag is true and the time present flag is false, then let date be the date with year year, month month, and day day, and return date.
   Otherwise, if the time present flag is true and the date present flag is false, then let time be the time with hour hour, minute minute, and second second, and return time.
   Otherwise, let time be the moment in time at year year, month month, day day, hours hour, minute minute, second second, subtracting timezonehours hours and timeminutes minutes, that moment in time being a moment in the UTC time zone; let timezone be timezonehours hours and timeminutes minutes from UTC; and return time and timezone.
2.3.6 Colors

A **simple color** consists of three 8-bit numbers in the range 0 to 255, inclusive, representing the red, green, and blue components of the color respectively, in the 'srgb' color space.

A string is a **valid simple color** if it is exactly seven characters long, and the first character is a U+0023 NUMBER SIGN character (#), and the remaining six characters are all ASCII hex digits, with the first two digits representing the red component, the middle two digits representing the green component, and the last two digits representing the blue component, in hexadecimal.

A string is a **valid lowercase simple color** if it is a **valid simple color** and doesn't use any characters in the range U+0041 LATIN CAPITAL LETTER A to U+0046 LATIN CAPITAL LETTER F.

The **rules for parsing simple color values** are as given in the following algorithm. When invoked, the steps must be followed in the order given, aborting at the first step that returns a value. This algorithm will return either a **simple color** or an error.

1. Let *input* be the string being parsed.
2. If *input* is not exactly seven characters long, then return an error.
3. If the first character in *input* is not a U+0023 NUMBER SIGN character (#), then return an error.
4. If the last six characters of *input* are not all ASCII hex digits, then return an error.
5. Let *result* be a **simple color**.
6. Interpret the second and third characters as a hexadecimal number and let the result be the red component of *result*.
7. Interpret the fourth and fifth characters as a hexadecimal number and let the result be the green component of *result*.
8. Interpret the sixth and seventh characters as a hexadecimal number and let the result be the blue component of *result*.
9. Return *result*.

The **rules for serializing simple color values** given a **simple color** are as given in the following algorithm:

1. Let *result* be a string consisting of a single U+0023 NUMBER SIGN character (#).
2. Convert the red, green, and blue components in turn to two-digit hexadecimal numbers using ASCII lower hex digits, zero-padding if necessary, and append these numbers to *result*, in the order red, green, blue.
3. Return *result*, which will be a **valid lowercase simple color**.

Some obsolete legacy attributes parse colors in a more complicated manner, using the **rules for parsing a legacy color value**, which are given in the following algorithm. When invoked, the steps must be followed in the order given, aborting at the first step that returns a value. This algorithm will return either a **simple color** or an error.

1. Let *input* be the string being parsed.
2. If *input* is the empty string, then return an error.
3. Strip leading and trailing ASCII whitespace from *input*.
4. If *input* is an ASCII case-insensitive match for the string "transparent", then return an error.
5. If *input* is an ASCII case-insensitive match for one of the named colors, then return the **simple color** corresponding to that keyword. [CSSCOLOR]

6. If *input*’s code point length is four, and the first character in *input* is U+0023 (#), and the last three characters of *input* are all ASCII hex digits, then:
   1. Let *result* be a **simple color**.
   2. Interpret the second character of *input* as a hexadecimal digit; let the red component of *result* be the resulting number multiplied by 17.

---

**Note**

**CSS2 System Colors** are not recognized.

---

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3. Interpret the third character of input as a hexadecimal digit; let the green component of result be the resulting number multiplied by 17.

4. Interpret the fourth character of input as a hexadecimal digit; let the blue component of result be the resulting number multiplied by 17.

5. Return result.

7. Replace any code points greater than U+FFFF in input (i.e., any characters that are not in the basic multilingual plane) with the two-character string "00".

8. If input's code point length is greater than 128, truncate input, leaving only the first 128 characters.

9. If the first character in input is a U+0023 NUMBER SIGN character (#), remove it.

10. Replace any character in input that is not an ASCII hex digit with the character U+0030 DIGIT ZERO (0).

11. While input's code point length is zero or not a multiple of three, append a U+0030 DIGIT ZERO (0) character to input.

12. Split input into three strings of equal code point length, to obtain three components. Let length be the code point length that all of those components have (one third the code point length of input).

13. If length is greater than 8, then remove the leading length-8 characters in each component, and let length be 8.

14. While length is greater than two and the first character in each component is a U+0030 DIGIT ZERO (0) character, remove that character and reduce length by one.

15. If length is still greater than two, truncate each component, leaving only the first two characters in each.

16. Let result be a simple color.

17. Interpret the first component as a hexadecimal number; let the red component of result be the resulting number.

18. Interpret the second component as a hexadecimal number; let the green component of result be the resulting number.

19. Interpret the third component as a hexadecimal number; let the blue component of result be the resulting number.

20. Return result.

Note
The 2D graphics context has a separate color syntax that also handles opacity.

2.3.7 Space-separated tokens
A set of space-separated tokens is a string containing zero or more words (known as tokens) separated by one or more ASCII whitespace, where words consist of any string of one or more characters, none of which are ASCII whitespace.

A string containing a set of space-separated tokens may have leading or trailing ASCII whitespace.

An unordered set of unique space-separated tokens is a set of space-separated tokens where none of the tokens are duplicated.

An ordered set of unique space-separated tokens is a set of space-separated tokens where none of the tokens are duplicated but where the order of the tokens is meaningful.

Sets of space-separated tokens sometimes have a defined set of allowed values. When a set of allowed values is defined, the tokens must all be from that list of allowed values; other values are non-conforming. If no such set of allowed values is provided, then all values are conforming.

Note
How tokens in a set of space-separated tokens are to be compared (e.g. case-sensitively or not) is defined on a per-set basis.
2.3.8 Comma-separated tokens

A set of comma-separated tokens is a string containing zero or more tokens each separated from the next by a single U+002C COMMA character (,), where tokens consist of any string of zero or more characters, neither beginning nor ending with ASCII whitespace, nor containing any U+002C COMMA characters (,), and optionally surrounded by ASCII whitespace.

Example

For instance, the string "a,b,,d" consists of four tokens: "a", "b", the empty string, and "d". Leading and trailing whitespace around each token doesn't count as part of the token, and the empty string can be a token.

Sets of comma-separated tokens sometimes have further restrictions on what consists a valid token. When such restrictions are defined, the tokens must all fit within those restrictions; other values are non-conforming. If no such restrictions are specified, then all values are conforming.

2.3.9 References

A valid hash-name reference to an element of type type is a string consisting of a U+0023 NUMBER SIGN character (#) followed by a string which exactly matches the value of the name attribute of an element with type type in the same tree.

The rules for parsing a hash-name reference to an element of type type, given a context node scope, are as follows:

1. If the string being parsed does not contain a U+0023 NUMBER SIGN character, or if the first such character in the string is the last character in the string, then return null.
2. Let s be the string from the character immediately after the first U+0023 NUMBER SIGN character in the string being parsed up to the end of that string.
3. Return the first element of type type in scope's tree, in tree order, that has an id or name attribute whose value is s, or null if there is no such element.

Note

Although id attributes are accounted for when parsing, they are not used in determining whether a value is a valid hash-name reference. That is, a hash-name reference that refers to an element based on id is a conformance error (unless that element also has a name attribute with the same value).

2.3.10 Media queries

A string is a valid media query list if it matches the <media-query-list> production of Media Queries. [MQ]

A string matches the environment of the user if it is the empty string, a string consisting of only ASCII whitespace, or is a media query list that matches the user's environment according to the definitions given in Media Queries. [MQ]

2.3.11 Unique internal values

A unique internal value is a value that is serializable, comparable by value, and never exposed to script.

To create a new unique internal value, return a unique internal value that has never previously been returned by this algorithm.

2.4 URLs

2.4.1 Terminology

A string is a valid non-empty URL if it is a valid URL string but it is not the empty string.
A string is a **valid URL potentially surrounded by spaces** if, after stripping leading and trailing ASCII whitespace from it, it is a **valid URL string**.

A string is a **valid non-empty URL potentially surrounded by spaces** if, after stripping leading and trailing ASCII whitespace from it, it is a **valid non-empty URL**.

This specification defines the URL **about:legacy-compat** as a reserved, though unresolvable, **about:** URL, for use in **DOCTYPE**s in HTML documents when needed for compatibility with XML tools. [ABOUT]

This specification defines the URL **about:html-kind** as a reserved, though unresolvable, **about:** URL, that is used as an identifier for kinds of media tracks. [ABOUT]

This specification defines the URL **about:srcdoc** as a reserved, though unresolvable, **about:** URL, that is used as the **URL** of iframe srcdoc documents. [ABOUT]

The **fallback base URL** of a Document object `document` is the **URL record** obtained by running these steps:

1. If `document` is an iframe srcdoc document, then:
   1. Assert: `document`’s **about base URL** is non-null.
   2. Return `document`’s **about base URL**.
2. If `document`’s **URL** matches about:blank and `document`’s **about base URL** is non-null, then return `document`’s **about base URL**.
3. Return `document`’s **URL**.

The **document base URL** of a Document object `document` is the **URL record** obtained by running these steps:

1. If there is no `base` element that has an **href** attribute in the Document, then return the Document’s **fallback base URL**.
2. Otherwise, return the **frozen base URL** of the first `base` element in the Document that has an **href** attribute, in tree order.

A **URL matches about:blank** if its scheme is "about", its path contains a single string "blank", its username and password are the empty string, and its host is null.

**Note**

*Such a URL’s query and fragment can be non-null. For example, the **URL record** created by parsing "about:blank?foo#bar" matches **about:blank**.*

A **URL matches about:srcdoc** if its scheme is "about", its path contains a single string "srcdoc", its query is null, its username and password are the empty string, and its host is null.

**Note**

*The reason that **matches about:srcdoc** ensures that the URL’s query is null is because it is not possible to create an iframe srcdoc document whose **URL** has a non-null query, unlike Document’s whose **URL** matches **about:blank**. In other words, the set of all URLs that match **about:srcdoc** only vary in their fragment.*

### 2.4.2 Parsing URLs

Parsing a URL is the process of taking a string and obtaining the **URL record** that it represents. While this process is defined in **URL**, the HTML standard defines several wrappers to abstract base URLs and encodings. [URL]

**Note**

*Most new APIs are to use **parse a URL**. Older APIs and HTML elements might have reason to use **encoding-parse a URL**. When a custom base URL is needed or no base URL is desired, the **URL parser** can of course be used directly as well.*
To parse a URL, given a string `url`, relative to a `Document` object or `environment settings object` environment, run these steps. They return failure or a URL.

1. Let `baseURL` be environment's `base URL`, if environment is a `Document` object; otherwise environment's API base URL.
2. Return the result of applying the `URL parser` to `url`, with `baseURL`.

To encoding-parse a URL, given a string `url`, relative to a `Document` object or `environment settings object` environment, run these steps. They return failure or a URL.

1. Let `encoding` be UTF-8.
2. If environment is a `Document` object, then set `encoding` to environment's character encoding.
3. Otherwise, if environment's `relevant global object` is a `Window` object, set `encoding` to environment's relevant global object's associated `Document` object's character encoding.
4. Let `baseURL` be environment's `base URL`, if environment is a `Document` object; otherwise environment's API base URL.
5. Return the result of applying the `URL parser` to `url`, with `baseURL` and `encoding`.

To encoding-parse-and-serialize a URL, given a string `url`, relative to a `Document` object or `environment settings object` environment, run these steps. They return failure or a string.

1. Let `url` be the result of encoding-parsing a URL given `url`, relative to environment.
2. If `url` is failure, then return failure.
3. Return the result of applying the `URL serializer` to `url`.

2.4.3 Dynamic changes to base URLs

When a document's `document base URL` changes, all elements in that document are affected by a base URL change.

The following are base URL change steps, which run when an element is affected by a base URL change (as defined by DOM):

↪ If the element creates a hyperlink

If the URL identified by the hyperlink is being shown to the user, or if any data derived from that URL is affecting the display, then the `href` attribute's value should be reparsed, relative to the element's `node document` and the UI updated appropriately.

Example

For example, the CSS :link/:visited pseudo-classes might have been affected.

If the hyperlink has a `ping` attribute and its URL(s) are being shown to the user, then the `ping` attribute's tokens should be reparsed, relative to the element's `node document` and the UI updated appropriately.

↪ If the element is a `q`, `blockquote`, `ins`, or `del` element with a `cite` attribute

If the URL identified by the `cite` attribute is being shown to the user, or if any data derived from that URL is affecting the display, then the `cite` attribute's value should be reparsed, relative to the element's `node document` and the UI updated appropriately.

↪ Otherwise

The element is not directly affected.

Example

For instance, changing the base URL doesn't affect the image displayed by `img` elements, although subsequent accesses of the `src` IDL attribute from script will return a new `absolute URL` that might no longer correspond to the image being shown.
### 2.5 Fetching resources

#### 2.5.1 Terminology

A response whose type is "basic", "cors", or "default" is CORS-same-origin.

A response whose type is "opaque" or "opaqueredirect" is CORS-cross-origin.

A response's unsafe response is its internal response if it has one, and the response itself otherwise.

To create a potential-CORS request, given a url, destination, corsAttributeState, and an optional same-origin fallback flag, run these steps:

1. Let mode be "no-cors" if corsAttributeState is No CORS, and "cors" otherwise.
2. If same-origin fallback flag is set and mode is "no-cors", set mode to "same-origin".
3. Let credentialsMode be "include".
4. If corsAttributeState is Anonymous, set credentialsMode to "same-origin".
5. Let request be a new request whose URL is url, destination is destination, mode is mode, credentials mode is credentialsMode, and whose use-URL-credentials flag is set.

The Content-Type metadata of a resource must be obtained and interpreted in a manner consistent with the requirements of MIME Sniffing.

The computed MIME type of a resource must be found in a manner consistent with the requirements given in MIME Sniffing. The rules for sniffing images specifically, the rules for distinguishing if a resource is text or binary, and the rules for sniffing audio and video specifically are also defined in MIME Sniffing. These rules return a MIME type as their result.

⚠️ Warning! It is imperative that the rules in MIME Sniffing be followed exactly. When a user agent uses different heuristics for content type detection than the server expects, security problems can occur. For more details, see MIME Sniffing.

#### 2.5.2 Determining the type of a resource

The algorithm for extracting a character encoding from a meta element, given a string s, is as follows. It either returns a character encoding or nothing.

1. Let position be a pointer into s, initially pointing at the start of the string.
2. Loop: Find the first seven characters in s after position that are an ASCII case-insensitive match for the word "charset". If no such match is found, return nothing.
3. Skip any ASCII whitespace that immediately follow the word "charset" (there might not be any).
4. If the next character is not a U+003D EQUALS SIGN (=), then move position to point just before that next character, and jump back to the step labeled loop.
5. Skip any ASCII whitespace that immediately follow the equals sign (there might not be any).
6. Process the next character as follows:

   - If it is a U+0022 QUOTATION MARK character ("), and there is a later U+0022 QUOTATION MARK character
If it is a U+0027 APOSTROPHE character (') and there is a later U+0027 APOSTROPHE character (') in \( s \)

- Return the result of getting an encoding from the substring that is between this character and the next earliest occurrence of this character.

- If it is an unmatched U+0022 QUOTATION MARK character ("")
- If it is an unmatched U+0027 APOSTROPHE character (')
- If there is no next character
  - Return nothing.

- Otherwise
  - Return the result of getting an encoding from the substring that consists of this character up to but not including the first ASCII whitespace or U+003B SEMICOLON character (;), or the end of \( s \), whichever comes first.

### Note

This algorithm is distinct from those in the HTTP specifications (for example, HTTP doesn't allow the use of single quotes and requires supporting a backslash-escape mechanism that is not supported by this algorithm). While the algorithm is used in contexts that, historically, were related to HTTP, the syntax as supported by implementations diverged some time ago. [HTTP](https://developer.mozilla.org/en-US/docs/Web/HTTP)

### 2.5.4 CORS settings attributes

A CORS settings attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>anonymous</td>
<td>Anonymous</td>
<td>Requests for the element will have their mode set to &quot;cors&quot; and their credentials mode set to &quot;same-origin&quot;.</td>
</tr>
<tr>
<td>(the empty string)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>use-credentials</td>
<td>Use Credentials</td>
<td>Requests for the element will have their mode set to &quot;cors&quot; and their credentials mode set to &quot;include&quot;.</td>
</tr>
</tbody>
</table>

The attribute's missing value default is the No CORS state, and its invalid value default is the Anonymous state. For the purposes of reflection, the canonical keyword for the Anonymous state is the anonymous keyword.

The majority of fetches governed by CORS settings attributes will be done via the create a potential-CORS request algorithm.

For more modern features, where the request's mode is always "cors", certain CORS settings attributes have been repurposed to have a slightly different meaning, wherein they only impact the request's credentials mode. To perform this translation, we define the CORS settings attribute credentials mode for a given CORS settings attribute to be determined by switching on the attribute's state:

- No CORS
- Anonymous
  - "same-origin"
- Use Credentials
  - "include"

### 2.5.5 Referrer policy attributes

A referrer policy attribute is an enumerated attribute. Each referrer policy, including the empty string, is a keyword for this attribute, mapping to a state of the same name.

The attribute's missing value default and invalid value default are both the empty string state.

The impact of these states on the processing model of various fetches is defined in more detail throughout this specification, in Fetch, and in Referrer Policy. [FETCH](https://developer.mozilla.org/en-US/docs/Web/API/Fetch_API) [REFERRERPOLICY](https://developer.mozilla.org/en-US/docs/Web/API/Referrer_Policy_API)
Several signals can contribute to which processing model is used for a given fetch: a referrer policy attribute[^98] is only one of them. In general, the order in which these signals are processed are:

1. First, the presence of a `noreferrer`[^322] link type;
2. Then, the value of a `referrer policy attribute`[^99];
3. Then, the presence of any `meta`[^186] element with `name`[^187] attribute set to `referrer`[^189].
4. Finally, the `Referrer-Policy` HTTP header.

### 2.5.6 Nonce attributes[^99]

A **nonce** content attribute represents a cryptographic nonce ("number used once") which can be used by Content Security Policy to determine whether or not a given fetch will be allowed to proceed. The value is text. [CSP][^31456]

Elements that have a `nonce`[^99] content attribute ensure that the cryptographic nonce is only exposed to script (and not to side-channels like CSS attribute selectors) by taking the value from the content attribute, moving it into an internal slot named `[[CryptographicNonce]]`, exposing it to script via the `HTMLOrSVGElement`[^141] interface mixin, and setting the content attribute to the empty string. Unless otherwise specified, the slot's value is the empty string.

For web developers (non-normative)

```javascript
function element.nonce() {
  return element.[[CryptographicNonce]];
}
```

The `nonce` IDL attribute must, on getting, return the value of this element's `[[CryptographicNonce]][^99]; and on setting, set this element's `[[CryptographicNonce]][^99]` to the given value.

#### Note

Note how the setter for the `nonce`[^99] IDL attribute does not update the corresponding content attribute. This, as well as the below setting of the `nonce`[^99] content attribute to the empty string when an element becomes browsing-context connected[^146], is meant to prevent exfiltration of the nonce value through mechanisms that can easily read content attributes, such as selectors. Learn more in issue #2369, where this behavior was introduced.

The following attribute change steps are used for the `nonce`[^99] content attribute:

1. If `element` does not include `HTMLOrSVGElement[^141]`, then return.
2. If `localName` is not `nonce`[^99] or `namespace` is not null, then return.
3. If `value` is null, then set `element`'s `[[CryptographicNonce]][^99]` to the empty string.
4. Otherwise, set `element`'s `[[CryptographicNonce]][^99]` to `value`.

Whenever an element including `HTMLOrSVGElement[^141] becomes browsing-context connected[^146]`, the user agent must execute the following steps on the element:

1. Let `CSP list be element`'s `shadow-including root`'s `policy container[^129]`'s `CSP list[^99]`.
2. If `CSP list contains a header-delivered Content Security Policy`, and `element` has a `nonce`[^99] content attribute `attr` whose value is not the empty string, then:
   1. Let `nonce be element`'s `[[CryptographicNonce]][^99].`
   2. Set an attribute value for `element` using `nonce[^99]` and the empty string.
3. Set element's `[[CryptographicNonce]]` to nonce.

Note
If element's `[[CryptographicNonce]]` were not restored it would be the empty string at this point.

The cloning steps for elements that include `HTMLOrSVGElement` must set the `[[CryptographicNonce]]` slot on the copy to the value of the slot on the element being cloned.

### 2.5.7 Lazy loading attributes

A lazy loading attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>lazy</td>
<td>Lazy</td>
<td>Used to defer fetching a resource until some conditions are met.</td>
</tr>
<tr>
<td>eager</td>
<td>Eager</td>
<td>Used to fetch a resource immediately; the default state.</td>
</tr>
</tbody>
</table>

The attribute directs the user agent to fetch a resource immediately or to defer fetching until some conditions associated with the element are met, according to the attribute's current state.

The attribute's `missing value default` and `invalid value default` are both the `Eager` state.

The `will lazy load element steps`, given an element element, are as follows:

1. If scripting is disabled for `element`, then return false.

Note
This is an anti-tracking measure, because if a user agent supported lazy loading when scripting is disabled, it would still be possible for a site to track a user's approximate scroll position throughout a session, by strategically placing images in a page's markup such that a server can track how many images are requested and when.

2. If element's `lazy loading attribute` is in the `Lazy` state, then return true.

3. Return false.

Each `img` and `iframe` element has associated lazy load resumption steps, initially null.

Note
For `img` and `iframe` elements that `will lazy load`, these steps are run from the `lazy load intersection observer`'s callback or when their `lazy loading attribute` is set to the `Eager` state. This causes the element to continue loading.

Each `Document` has a lazy load intersection observer, initially set to null but can be set to an `IntersectionObserver` instance.

To start intersection-observing a lazy loading element `element`, run these steps:

1. Let `doc` be element's `node document`.

2. If `doc's lazy load intersection observer` is null, set it to a new `IntersectionObserver` instance, initialized as follows:

The intention is to use the original value of the `IntersectionObserver` constructor. However, we're forced to use the JavaScript-exposed constructor in this specification, until `Intersection Observer` exposes low-level hooks for use in specifications. See bug `w3c/IntersectionObserver#464` which tracks this. [INTERSECTIONOBSERVER]

   ◦ The `callback` is these steps, with arguments `entries` and `observer`:

   1. For each `entry` in `entries` using a method of iteration which does not trigger developer-modifiable array accessor or iteration hooks:

      1. Let `resumptionSteps` be null.

      2. If `entry`, `isIntersecting` is true, then set `resumptionSteps` to `entry`, `target`'s lazy load.
3. If `resumptionSteps` is null, then return.

4. Stop intersection-observing a lazy loading element for `entry`. 

5. Set `entry`'s `lazy load resumption steps` to null.

6. Invoke `resumptionSteps`.

The intention is to use the original value of the `isIntersecting` and `target` getters. See [w3c/IntersectionObserver#464](#). 

- The `options` is an `IntersectionObserverInit` dictionary with the following dictionary members: `{ "scrollMargin" → `lazy load scroll margin` }

Note

This allows for fetching the image during scrolling, when it does not yet — but is about to — intersect the viewport.

The `lazy load scroll margin` suggestions imply dynamic changes to the value, but the IntersectionObserver API does not support changing the scroll margin. See issue [w3c/IntersectionObserver#428](#).

3. Call `doc`'s `lazy load intersection observer`'s `observe` method with `element` as the argument.

The intention is to use the original value of the `observe` method. See [w3c/IntersectionObserver#464](#).

To stop intersection-observing a lazy loading element `element`, run these steps:

1. Let `doc` be `element`'s `node document`.

2. Assert: `doc`'s `lazy load intersection observer` is not null.

3. Call `doc`'s `lazy load intersection observer` unobserve method with `element` as the argument.

The intention is to use the original value of the `unobserve` method. See [w3c/IntersectionObserver#464](#).

The `lazy load scroll margin` is an implementation-defined value, but with the following suggestions to consider:

- Set a minimum value that most often results in the resources being loaded before they intersect the viewport under normal usage patterns for the given device.
- The typical scrolling speed: increase the value for devices with faster typical scrolling speeds.
- The current scrolling speed or momentum: the UA can attempt to predict where the scrolling will likely stop, and adjust the value accordingly.
- The network quality: increase the value for slow or high-latency connections.
- User preferences can influence the value.

Note

It is important for privacy that the `lazy load scroll margin` not leak additional information. For example, the typical scrolling speed on the current device could be imprecise so as to not introduce a new fingerprinting vector.

2.5.8 Blocking attributes

A blocking attribute explicitly indicates that certain operations should be blocked on the fetching of an external resource. The
operations that can be blocked are represented by **possible blocking tokens**, which are strings listed by the following table:

<table>
<thead>
<tr>
<th>Possible blocking token</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;render&quot;</td>
<td>The element is potentially render-blocking.</td>
</tr>
</tbody>
</table>

Note

In the future, there might be more possible blocking tokens.

A **blocking attribute** must have a value that is an unordered set of unique space-separated tokens, each of which are possible blocking tokens. The **supported tokens** of a blocking attribute are the possible blocking tokens. Any element can have at most one blocking attribute.

The blocking tokens set for an element \(el\) are the result of the following steps:

1. Let \(value\) be the value of \(el\)'s blocking attribute, or the empty string if no such attribute exists.
2. Set \(value\) to \(value\), converted to ASCII lowercase.
3. Let \(rawTokens\) be the result of splitting \(value\) on ASCII whitespace.
4. Return a set containing the elements of \(rawTokens\) that are possible blocking tokens.

An element is potentially render-blocking if its blocking tokens set contains "render", or if it is implicitly potentially render-blocking, which will be defined at the individual elements. By default, an element is not implicitly potentially render-blocking.

2.5.9 Fetch priority attributes

A **fetch priority attribute** is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>high</td>
<td>high</td>
<td>Signals a high-priority fetch relative to other resources with the same destination.</td>
</tr>
<tr>
<td>low</td>
<td>low</td>
<td>Signals a low-priority fetch relative to other resources with the same destination.</td>
</tr>
<tr>
<td>auto</td>
<td>auto</td>
<td>Signals automatic determination of fetch priority relative to other resources with the same destination.</td>
</tr>
</tbody>
</table>

The attribute's missing value default and invalid value default are both the auto state.

2.6 Common DOM interfaces

2.6.1 Reflecting content attributes in IDL attributes

The building blocks for reflecting are as follows:

- A **reflected target** is an element or `ElementInternals` object. It is typically clear from context and typically identical to the interface of the reflected IDL attribute. It is always identical to that interface when it is an `ElementInternals` object.

- A **reflected IDL attribute** is an attribute interface member.

- A **reflected content attribute name** is a string. When the reflected target is an element, it represents the local name of a content attribute whose namespace is null. When the reflected target is an `ElementInternals` object, it represents a key of the reflected target's target element's internal content attribute map.

A **reflected IDL attribute** can be defined to reflect a reflected content attribute name of a reflected target. In general this means that the IDL attribute getter returns the current value of the content attribute, and the setter changes the value of the content attribute to the given value.

If the reflected target is an element, then the reflected IDL attribute can additionally declare to support `ElementInternals`. This means that the `ElementInternals` interface also has a reflected IDL attribute, with the same identifier, and that reflected...
IDL attribute\(^{102}\) reflects\(^{102}\) the same reflected content attribute name\(^{102}\).

**Example**

The fooBar IDL attribute must reflect\(^{102}\) the foobar content attribute and support ElementInternals\(^{102}\).

**Reflected targets\(^{102}\)** have these associated algorithms:

- **get the element**: takes no arguments; returns an element.
- **get the content attribute**: takes no arguments; returns null or a string.
- **set the content attribute**: takes a string value; returns nothing.
- **delete the content attribute**: takes no arguments; returns nothing.

For a reflected target\(^{102}\) that is an element element, these are defined as follows:

**get the element**\(^{103}\)

1. Return element.

**get the content attribute**\(^{103}\)

1. Let attribute be the result of running get an attribute by namespace and local name given null, the reflected content attribute name\(^{102}\), and element.
2. If attribute is null, then return null.
3. Return attribute's value.

**set the content attribute**\(^{103}\) with a string value

1. Set an attribute value given element, the reflected content attribute name\(^{102}\), and value.

**delete the content attribute**\(^{103}\)

1. Remove an attribute by namespace and local name given null, the reflected content attribute name\(^{102}\), and element.

For a reflected target\(^{102}\) that is an ElementInternals\(^{766}\) object elementInternals, they are defined as follows:

**get the element**\(^{103}\)

1. Return elementInternals's target element\(^{766}\).

**get the content attribute**\(^{103}\)

1. If elementInternals's target element\(^{766}\)'s internal content attribute map\(^{769}\) [the reflected content attribute name\(^{102}\)] does not exist, then return null.
2. Return elementInternals's target element\(^{766}\)'s internal content attribute map\(^{769}\) [the reflected content attribute name\(^{102}\)].

**set the content attribute**\(^{103}\) with a string value

1. Set elementInternals's target element\(^{766}\)'s internal content attribute map\(^{769}\) [the reflected content attribute name\(^{102}\)] to value.

**delete the content attribute**\(^{103}\)

1. Remove elementInternals's target element\(^{766}\)'s internal content attribute map\(^{769}\) [the reflected content attribute name\(^{102}\)].

**Note**

This results in somewhat redundant data structures for ElementInternals\(^{766}\) objects as their target element\(^{766}\)'s internal content attribute map\(^{769}\) cannot be directly manipulated and as such reflection is only happening in a single direction. This approach was nevertheless chosen to make it less error-prone to define IDL attributes that are shared between reflected targets\(^{102}\) and benefit from common API semantics.

IDL attributes of type DOMString or DOMString\(^{224}\) that reflect\(^{102}\) enumerated\(^{224}\) content attributes can be limited to only known values. Per the processing models below, those will cause the getters for such IDL attributes to only return keywords for those enumerated attributes, or the empty string or null.
If a reflected IDL attribute has the type `DOMString`:

- The getter steps are:
  1. Let `element` be the result of running `this`'s `get the element`.
  2. Let `contentAttributeValue` be the result of running `this`'s `get the content attribute`.
  3. Let `attributeDefinition` be the attribute definition of `element`'s content attribute whose namespace is null and local name is the reflected content attribute name.
  4. If `attributeDefinition` indicates it is an enumerated attribute and the reflected IDL attribute is defined to be limited to only known values:
     1. If `contentAttributeValue` does not correspond to any state of `attributeDefinition` (e.g., it is null and there is no missing value default), or that it is in a state of `attributeDefinition` with no associated keyword value, then return the empty string.
     2. Return the canonical keyword for the state of `attributeDefinition` that `contentAttributeValue` corresponds to.
  5. If `contentAttributeValue` is null, then return the empty string.
  6. Return `contentAttributeValue`.

- The setter steps are to run `this`'s `set the content attribute` with the given value.

If a reflected IDL attribute has the type `DOMString`:

- The getter steps are:
  1. Let `element` be the result of running `this`'s `get the element`.
  2. Let `contentAttributeValue` be the result of running `this`'s `get the content attribute`.
  3. Let `attributeDefinition` be the attribute definition of `element`'s content attribute whose namespace is null and local name is the reflected content attribute name.
  4. Assert: `attributeDefinition` indicates it is an enumerated attribute.
  5. Assert: the reflected IDL attribute is limited to only known values.
  6. Assert: `contentAttributeValue` corresponds to a state of `attributeDefinition`.
  7. If `contentAttributeValue` corresponds to a state of `attributeDefinition` with no associated keyword value, then return null.
  8. Return the canonical keyword for the state of `attributeDefinition` that `contentAttributeValue` corresponds to.

- The setter steps are:
  1. If the given value is null, then run `this`'s `delete the content attribute`.
  2. Otherwise, run `this`'s `set the content attribute` with the given value.

If a reflected IDL attribute has the type `USVString`:

- The getter steps are:
  1. Let `element` be the result of running `this`'s `get the element`.
  2. Let `contentAttributeValue` be the result of running `this`'s `get the content attribute`.
  3. Let `attributeDefinition` be the attribute definition of `element`'s content attribute whose namespace is null and local name is the reflected content attribute name.
  4. Assert: `attributeDefinition` indicates it contains a URL:
     1. If `contentAttributeValue` is null, then return the empty string.
     2. Let `urlString` be the result of encoding-parsing-and-serializing a URL given `contentAttributeValue`,
relative to element's node document.

3. If urlString is not failure, then return urlString.

5. Return contentAttributeValue, converted to a scalar value string.

• The setter steps are to run this's set the content attribute with the given value.

If a reflected IDL attribute has the type boolean:

• The getter steps are:
  1. Let contentAttributeValue be the result of running this's get the content attribute.
  2. If contentAttributeValue is null, then return false.
  3. Return true.

• The setter steps are:
  1. If the given value is false, then run this's delete the content attribute.
  2. If the given value is true, then run this's set the content attribute with the empty string.

• The getter steps are:
  1. Let contentAttributeValue be the result of running this's get the content attribute.
  2. If contentAttributeValue is null, then return false.
  3. Return true.

• The setter steps are:
  1. If the given value is false, then run this's delete the content attribute.
  2. If the given value is true, then run this's set the content attribute with the empty string.

If a reflected IDL attribute has the type long, optionally limited to only non-negative numbers and optionally with a default value defaultValue:

• The getter steps are:
  1. Let contentAttributeValue be the result of running this's get the content attribute.
  2. If contentAttributeValue is not null:
     1. Let parsedValue be the result of integer parsing contentAttributeValue if the reflected IDL attribute is not limited to only non-negative numbers; otherwise the result of non-negative integer parsing contentAttributeValue.
     2. If parsedValue is not an error and is within the long range, then return parsedValue.
  3. If the reflected IDL attribute has a default value, then return defaultValue.
  4. If the reflected IDL attribute is limited to only non-negative numbers, then return –1.
  5. Return 0.

• The setter steps are:
  1. If the reflected IDL attribute is limited to only non-negative numbers and the given value is negative, then throw an "IndexSizeError" DOMException.
  2. Run this's set the content attribute with the given value converted to the shortest possible string representing the number as a valid integer.

If a reflected IDL attribute has the type unsigned long, optionally limited to only positive numbers, limited to only positive numbers with fallback, or clamped to the range [clampedMin, clampedMax], and optionally with a default value defaultValue:

• The getter steps are:
  1. Let contentAttributeValue be the result of running this's get the content attribute.
  2. Let minimum be 0.
  3. If the reflected IDL attribute is limited to only positive numbers or limited to only positive numbers with fallback, then set minimum to 1.
  4. If the reflected IDL attribute is clamped to the range, then set minimum to clampedMin.
5. Let maximum be 2147483647 if the reflected IDL attribute\textsuperscript{p102} is not clamped to the range\textsuperscript{p105}; otherwise clampedMax.

6. If contentAttributeValue is not null:
   1. Let parsedValue be the result of non-negative integer parsing\textsuperscript{p75} contentAttributeValue.
   2. If parsedValue is not an error and is in the range minimum to maximum, inclusive, then return parsedValue.
   3. If parsedValue is not an error and the reflected IDL attribute\textsuperscript{p102} is clamped to the range\textsuperscript{p105}:
      1. If parsedValue is less than minimum, then return minimum.
      2. Return maximum.

7. If the reflected IDL attribute\textsuperscript{p102} has a default value\textsuperscript{p105}, then return defaultValue.

8. Return minimum.

\textbullet The setter steps are:
   1. If the reflected IDL attribute\textsuperscript{p102} is limited to only positive numbers\textsuperscript{p105} and the given value is 0, then throw an "IndexSizeError" DOMException.
   2. Let minimum be 0.
   3. If the reflected IDL attribute\textsuperscript{p102} is limited to only positive numbers\textsuperscript{p105} or limited to only positive numbers with fallback\textsuperscript{p105}, then set minimum to 1.
   4. Let newValue be minimum.
   5. If the reflected IDL attribute\textsuperscript{p102} has a default value\textsuperscript{p105}, then set newValue to defaultValue.
   6. If the given value is in the range minimum to 2147483647, inclusive, then set newValue to it.
   7. Run this's set the content attribute\textsuperscript{p103} with newValue converted to the shortest possible string representing the number as a valid non-negative integer\textsuperscript{p75}.

**Note**

Clamped to the range\textsuperscript{p105} has no effect on the setter steps.

If a reflected IDL attribute\textsuperscript{p102} has the type double, optionally limited to only positive numbers\textsuperscript{p105} and optionally with a default value\textsuperscript{p105} defaultValue:

\textbullet The getter steps are:
   1. Let contentAttributeValue be the result of running this's get the content attribute\textsuperscript{p103}.
   2. If contentAttributeValue is not null:
      1. Let parsedValue be the result of floating-point number parsing\textsuperscript{p76} contentAttributeValue.
      2. If parsedValue is not an error and is greater than 0, then return parsedValue.
      3. If parsedValue is not an error and the reflected IDL attribute\textsuperscript{p102} is not limited to only positive numbers\textsuperscript{p105}, then return parsedValue.
   3. If the reflected IDL attribute\textsuperscript{p102} has a default value\textsuperscript{p105}, then return defaultValue.
   4. Return 0.

\textbullet The setter steps are:
   1. If the reflected IDL attribute\textsuperscript{p102} is limited to only positive numbers\textsuperscript{p105} and the given value is not greater than 0, then return.
   2. Run this's set the content attribute\textsuperscript{p103} with the given value, converted to the best representation of the number as a floating-point number\textsuperscript{p76}.
If a reflected IDL attribute\textsuperscript{102} has the type \texttt{DOMTokenList}, then its getter steps are to return a \texttt{DOMTokenList} object whose associated element is \texttt{this} and associated attribute's local name is the \textit{reflected content attribute name}\textsuperscript{102}. Specification authors cannot use \texttt{support ElementInternals}\textsuperscript{102} for IDL attributes of this type.

If a reflected IDL attribute\textsuperscript{102} has the type \texttt{T?}, where \texttt{T} is either \texttt{Element} or an interface that inherits from \texttt{Element}, then with \texttt{attr} being the \textit{reflected content attribute name}\textsuperscript{102}:

- Its \texttt{reflected target}\textsuperscript{102} has an \textbf{explicitly set \texttt{attr}-element}, which is a weak reference to an element or null. It is initially null.
- Its \texttt{reflected target}\textsuperscript{102} \texttt{reflectedTarget} has a \textbf{get the \texttt{attr}-associated element} algorithm, that runs these steps:
  1. Let \texttt{element} be the result of running \texttt{reflectedTarget}'s \texttt{get the element}\textsuperscript{103}.
  2. Let \texttt{contentAttributeValue} be the result of running \texttt{reflectedTarget}'s \texttt{get the content attribute}\textsuperscript{103}.
  3. If \texttt{reflectedTarget}'s \texttt{explicitly set \texttt{attr}-element}\textsuperscript{107} is not null:
     - If \texttt{reflectedTarget}'s \texttt{explicitly set \texttt{attr}-element}\textsuperscript{107} is a descendant of any of \texttt{element}'s \textit{shadow-including ancestors}, then return \texttt{reflectedTarget}'s \texttt{explicitly set \texttt{attr}-element}\textsuperscript{107}.
     - Return null.
  4. Otherwise, if \texttt{contentAttributeValue} is not null, return the first element \texttt{candidate}, in \textit{tree order}, that meets the following criteria:
     - \texttt{candidate}'s \texttt{root} is the same as \texttt{element}'s \texttt{root};
     - \texttt{candidate}'s \texttt{ID} is \texttt{contentAttributeValue};and
     - \texttt{candidate} \texttt{implements} \texttt{T}.
     If no such element exists, then return null.
  5. Return null.
- The getter steps are to return the result of running \texttt{this}'s \texttt{get the \texttt{attr}-associated element}\textsuperscript{107}.
- The setter steps are:
  1. If the given value is null, then:
     1. Set \texttt{this}'s \texttt{explicitly set \texttt{attr}-element}\textsuperscript{107} to null.
     2. Run \texttt{this}'s \texttt{delete the content attribute}\textsuperscript{103}.
     3. Return.
  2. Run \texttt{this}'s \texttt{set the content attribute}\textsuperscript{103} with the empty string.
  3. Set \texttt{this}'s \texttt{explicitly set \texttt{attr}-element}\textsuperscript{107} to a weak reference to the given value.
- For element \texttt{reflected targets}\textsuperscript{102} only: the following \textbf{attribute change steps}, given \texttt{element}, \texttt{localName}, \texttt{oldValue}, \texttt{value}, and \texttt{namespace}, are used to synchronize between the content attribute and the IDL attribute:
  1. If \texttt{localName} is not \texttt{attr} or \texttt{namespace} is not null, then return.
  2. Set \texttt{element}'s \texttt{explicitly set \texttt{attr}-element}\textsuperscript{107} to null.

\textbf{Note} \textit{Reflected IDL attributes}\textsuperscript{102} of this type are strongly encouraged to have their identifier end in \"Element\" for consistency.

If a reflected IDL attribute\textsuperscript{102} has the type \texttt{FrozenArray<T>?}, where \texttt{T} is either \texttt{Element} or an interface that inherits from \texttt{Element}, then with \texttt{attr} being the \textit{reflected content attribute name}\textsuperscript{102}:

- Its \texttt{reflected target}\textsuperscript{102} has an \textbf{explicitly set \texttt{attr}-elements}, which is either a \texttt{list} of weak references to elements or null. It is initially null.
• Its reflected target\(^{102}\) has a **cached attr-associated elements**, which is a **list** of elements. It is initially « ».

• Its reflected target\(^{102}\) has a **cached attr-associated elements object**, which is a FrozenArray\(<T>\). It is initially null.

• Its reflected target\(^{102}\) reflectedTarget has a get the attr-associated elements algorithm, which runs these steps:

  1. Let elements be an empty **list**.
  2. Let element be the result of running reflectedTarget's get the element\(^{103}\).
  3. If reflectedTarget's explicitly set attr-elements\(^{107}\) is not null:
     1. **For each** attrElement in reflectedTarget's explicitly set attr-elements\(^{107}\):
        1. If attrElement is not a descendant of any of element's shadow-including ancestors, then **continue**.
        2. Append attrElement to elements.
  4. Otherwise:
     1. Let contentAttributeValue be the result of running reflectedTarget's get the content attribute\(^{103}\).
     2. If contentAttributeValue is null, then return null.
     3. Let tokens be contentAttributeValue, split on ASCII whitespace.
     4. **For each** id of tokens:
        1. Let candidate be the first element, in tree order, that meets the following criteria:
           - candidate's root is the same as element's root;
           - candidate's ID is id; and
           - candidate implements T.
        If no such element exists, then **continue**.
        2. Append candidate to elements.
  5. Return elements.

• The getter steps are:

  1. Let elements be the result of running this's get the attr-associated elements\(^{108}\).
  2. If the contents of elements is equal to the contents of this's cached attr-associated elements object\(^{108}\), then return this's cached attr-associated elements object\(^{108}\).
  3. Let elementsAsFrozenArray be elements, converted to a FrozenArray\(<T>\).
  4. Set this's cached attr-associated elements\(^{108}\) to elements.
  5. Set this's cached attr-associated elements object\(^{108}\) to elementsAsFrozenArray.
  6. Return elementsAsFrozenArray.

**Note**

This extra caching layer is necessary to preserve the invariant that element.reflectedElements === element.reflectedElements.

• The setter steps are:

  1. If the given value is null:
     1. Set this's explicitly set attr-elements\(^{107}\) to null.
     2. Run this's delete the content attribute\(^{103}\).
     3. Return.
2. Run this’s set the content attribute \[p103\] with the empty string.
3. Let elements be an empty \[list\].
4. For each element in the given value:
   1. Append a weak reference to element to elements.
5. Set this’s explicitly set attr-elements \[p107\] to elements.
   • For element reflected targets \[p102\] only: the following attribute change steps, given element, localName, oldValue, value, and namespace, are used to synchronize between the content attribute and the IDL attribute:
     1. If localName is not attr or namespace is not null, then return.
     2. Set element’s explicitly set attr-elements \[p107\] to null.

Note

Reflected IDL attributes \[p102\] of this type are strongly encouraged to have their identifier end in “Elements” for consistency.

2.6.2 Using reflect in specifications \[p10\]

Reflection \[p102\] is primarily about improving web developer ergonomics by giving them typed access to content attributes through reflected IDL attributes \[p102\]. The ultimate source of truth, which the web platform builds upon, is the content attributes themselves. That is, specification authors must not use the reflected IDL attribute \[p102\] getter or setter steps, but instead must use the content attribute presence and value. (Or an abstraction on top, such as the state of an enumerated attribute \[p10\].)

Two important exceptions to this are reflected IDL attributes \[p102\] whose type is one of the following:
   • \(T?\), where \(T\) is either Element or an interface that inherits from Element
   • FrozenArray<\(T\)?>, where \(T\) is either Element or an interface that inherits from Element

For those, specification authors must use the reflected target \[p102\]’s get the attr-associated element \[p107\] and get the attr-associated elements \[p108\], respectively. The content attribute presence and value must not be used as they cannot be fully synchronized with the reflected IDL attribute \[p102\].

A reflected target \[p102\]’s explicitly set attr-element \[p107\], explicitly set attr-elements \[p107\], cached attr-associated elements \[p108\], and cached attr-associated elements object \[p108\] are to be treated as internal implementation details and not to be built upon.

2.6.3 Collections \[p110\]

The HTMLFormControlsCollection \[p111\] and HTMLOptionsCollection \[p113\] interfaces are collections derived from the HTMLCollection interface. The HTMLAllCollection \[p110\] interface is a collection, but is not so derived.

2.6.3.1 The HTMLAllCollection \[p110\] interface \[p110\]

The HTMLAllCollection \[p110\] interface is used for the legacy document.all \[p1423\] attribute. It operates similarly to HTMLCollection; the main differences are that it allows a staggering variety of different (ab)uses of its methods to all end up returning something, and that it can be called as a function as an alternative to property access.

Note

All HTMLAllCollection \[p110\] objects are rooted at a Document \[p128\] and have a filter that matches all elements, so the elements represented by the collection of an HTMLAllCollection \[p110\] object consist of all the descendant elements of the root Document \[p128\].

Objects that implement the HTMLAllCollection \[p110\] interface are legacy platform objects with an additional [[Call]] internal method described in the section below \[p111\]. They also have an [[IsHTMLDDA]] internal slot.
Objects that implement the `HTMLAllCollection` interface have several unusual behaviors, due to the fact that they have an `[IsHTMLDDA]` internal slot:

- The `ToBoolean` abstract operation in JavaScript returns false when given objects implementing the `HTMLAllCollection` interface.
- The `IsLooselyEqual` abstract operation, when given objects implementing the `HTMLAllCollection` interface, returns true when compared to the `undefined` and `null` values. (Comparisons using the `IsStrictlyEqual` abstract operation, and `IsLooselyEqual` comparisons to other values such as strings or objects, are unaffected.)
- The `typeof` operator in JavaScript returns the string "undefined" when applied to objects implementing the `HTMLAllCollection` interface.

These special behaviors are motivated by a desire for compatibility with two classes of legacy content: one that uses the presence of `document.all` as a way to detect legacy user agents, and one that only supports those legacy user agents and uses the `document.all` object without testing for its presence first. [JAVASCRIPT]

```javascript
Note
```

IDL

```idl
[Exposed=Window,
 LegacyUnenumerableNamedProperties]
interface HTMLAllCollection {
   readonly attribute unsigned long length;
   getter Element (unsigned long index);
   getter (HTMLCollection or Element)? namedItem(DOMString name);
   (HTMLCollection or Element)? item(optional DOMString nameOrIndex);

   // Note: HTMLAllCollection objects have a custom [[Call]] internal method and an [[IsHTMLDDA]] internal slot.
};
```

The object's supported property indices are as defined for `HTMLCollection` objects.

The supported property names consist of the non-empty values of all the `id` attributes of all the elements represented by the collection, and the non-empty values of all the `name` attributes of all the "all"-named elements represented by the collection, in tree order, ignoring later duplicates, with the `id` of an element preceding its `name` if it contributes both, they differ from each other, and neither is the duplicate of an earlier entry.

The `length` getter steps are to return the number of nodes represented by the collection.

The indexed property getter must return the result of getting the "all"-indexed element from `this` given the passed index.

The `namedItem(name)` method steps are to return the result of getting the "all"-named element(s) from `this` given `name`.

The `item(nameOrIndex)` method steps are:

1. If `nameOrIndex` was not provided, return null.
2. Return the result of getting the "all"-indexed or named element(s) from `this`, given `nameOrIndex`.

The following elements are "all"-named elements: `a`, `button`, `embed`, `form`, `frame`, `frameset`, `iframe`, `img`, `input`, `map`, `meta`, `object`, `select`, and `textarea`.

To get the "all"-indexed element from an `HTMLAllCollection` collection given an index index, return the index\textsuperscript{th} element in collection, or null if there is no such index\textsuperscript{th} element.

To get the "all"-named element(s) from an `HTMLAllCollection` collection given a name name, perform the following steps:

1. If `name` is the empty string, return null.
2. Let `subCollection` be an `HTMLCollection` object rooted at the same `Document` as `collection`, whose filter matches only elements that are either:
   - "all"-named elements with a name attribute equal to `name`, or,
elements with an ID equal to name.

3. If there is exactly one element in subCollection, then return that element.

4. Otherwise, if subCollection is empty, return null.

5. Otherwise, return subCollection.

To get the "all"-indexed or named element(s) from an HTMLAllCollection collection given nameOrIndex:

1. If nameOrIndex, converted to a JavaScript String value, is an array index property name, return the result of getting the "all"-indexed element from collection given the number represented by nameOrIndex.

2. Return the result of getting the "all"-named element(s) from collection given nameOrIndex.

2.6.3.1 [[Call]] (thisArgument, argumentsList) §

1. If argumentsList's size is zero, or if argumentsList[0] is undefined, return null.

2. Let nameOrIndex be the result of converting argumentsList[0] to a DOMString.

3. Let result be the result of getting the "all"-indexed or named element(s) from this HTMLAllCollection given nameOrIndex.

4. Return the result of converting result to an ECMAScript value.

Note

The thisArgument is ignored, and thus code such as Function.prototype.call.call(document.all, null, "x") will still search for elements. (document.all.call does not exist, since document.all does not inherit from Function.prototype.)

2.6.3.2 The HTMLFormControlsCollection interface §

The HTMLFormControlsCollection interface is used for collections of listed elements in form elements.

IDL

```
[Exposed=Window]
interface HTMLFormControlsCollection : HTMLCollection {
    // inherits length and item()
    getter (RadioNodeList or Element)? namedItem(DOMString name); // shadows inherited namedItem();
};
```

For web developers (non-normative)

collection.length

Returns the number of elements in collection.

element = collection.item(index)
element = collection[index]

Returns the item at index index in collection. The items are sorted in tree order.

element = collection.namedItem(name)
radioNodeList = collection.namedItem(name)
element = collection[name]
radioNodeList = collection[name]

Returns the item with ID or name name from collection.
The object's supported property indices are as defined for HTMLCollection objects.

The supported property names consist of the non-empty values of all the id and name attributes of all the elements represented by the collection, in tree order, ignoring later duplicates, with the id of an element preceding its name if it contributes both, they differ from each other, and neither is the duplicate of an earlier entry.

The namedItem(name) method must act according to the following algorithm:

1. If name is the empty string, return null and stop the algorithm.
2. If, at the time the method is called, there is exactly one node in the collection that has either an id or a name attribute equal to name, then return that node and stop the algorithm.
3. Otherwise, if there are no nodes in the collection that have either an id attribute or a name attribute equal to name, then return null and stop the algorithm.
4. Otherwise, create a new RadioNodeList object representing a live view of the HTMLFormControlsCollection object, further filtered so that the only nodes in the RadioNodeList object are those that have either an id attribute or a name attribute equal to name. The nodes in the RadioNodeList object must be sorted in tree order.
5. Return that RadioNodeList object.

Members of the RadioNodeList object inherited from the NodeList interface must behave as they would on a NodeList object.

The value IDL attribute on the RadioNodeList object, on getting, must return the value returned by running the following steps:

1. Let element be the first element in tree order represented by the RadioNodeList object that is an input element whose type attribute is in the Radio Button state and whose checkedness attribute is true. Otherwise, let it be null.
2. If element is null, return the empty string.
3. If element is an element with no value attribute, return the string "on".
4. Otherwise, return the value of element's value attribute.

On setting, the value IDL attribute must run the following steps:

1. If the new value is the string "on": let element be the first element in tree order represented by the RadioNodeList object that is an input element whose type attribute is in the Radio Button state and whose value content attribute is either absent, or present and equal to the new value, if any. If no such element exists, then instead let element be null.
2. If element is not null, then set its checkedness attribute to true.

2.6.3.3 The HTMLOptionsCollection interface

The HTMLOptionsCollection interface is used for collections of option elements. It is always rooted on a select element and has attributes and methods that manipulate that element's descendants.
interface HTMLOptionsCollection : HTMLOptionsCollection {
    // inherits item(), namedItem()
    [CEReactions] attribute unsigned long length; // shadows inherited length
    [CEReactions] setter undefined (unsigned long index, HTMLOptionElement? option);
    [CEReactions] undefined add((HTMLOptionElement or HTMLOptGroupElement) element, optional (HTMLOptionElement or long) before = null);
    [CEReactions] undefined remove(long index);
    attribute long selectedIndex;
}

For web developers (non-normative)

```
collection.length
```

Returns the number of elements in collection.

```
collection.length = value
```

When set to a smaller number than the existing length, truncates the number of option elements in the container corresponding to collection.

When set to a greater number than the existing length, if that number is less than or equal to 100000, adds new blank option elements to the container corresponding to collection.

```
element = collection.item(index)
element = collection[index]
```

Returns the item at index index in collection. The items are sorted in tree order.

```
collection[index] = element
```

When index is a greater number than the number of items in collection, adds new blank option elements in the corresponding container.

When set to null, removes the item at index index from collection.

When set to an option element, adds or replaces it at index index in collection.

```
element = collection.namedItem(name)
element = collection[name]
```

Returns the item with ID or name name from collection.

If there are multiple matching items, then the first is returned.

```
collection.add(element[, before])
```

Inserts element before the node given by before.

The before argument can be a number, in which case element is inserted before the item with that number, or an element from collection, in which case element is inserted before that element.

If before is omitted, null, or a number out of range, then element will be added at the end of the list.

Throws a “HierarchyRequestError” DOMException if element is an ancestor of the element into which it is to be inserted.

```
collection.remove(index)
```

Removes the item with index index from collection.

```
collection.selectedIndex
```

Returns the index of the first selected item, if any, or −1 if there is no selected item.

```
collection.selectedIndex = index
```

Changes the selection to the option element at index index in collection.

The object's [supported property indices](https://www.w3.org/2021/PF114) are as defined for [HTMLCollection](https://www.w3.org/2021/PF114) objects.

The **length** getter steps are to return the number of nodes represented by the **collection**.

The **length** setter steps are:

1. Let **current** be the number of nodes represented by the **collection**.

2. If the given value is greater than **current**, then:

   ```
   \[
   \text{collection.length} = \text{value}
   \]
   ```
1. If the given value is greater than 100,000, then return.

2. Let \( n \) be \( \text{value} - \text{current} \).

3. Append \( n \) new `option` elements with no attributes and no child nodes to the `select` element on which this is rooted. Mutation events must be fired as if a `DocumentFragment` containing the new `option` elements had been inserted.

3. If the given value is less than \( \text{current} \), then:
   1. Let \( n \) be \( \text{current} - \text{value} \).
   2. Remove the last \( n \) nodes in the collection from their parent nodes.

---

**Note**

Setting `length` never removes or adds any `optgroup` elements, and never adds new children to existing `optgroup` elements (though it can remove children from them).

The supported property names consist of the non-empty values of all the `id` and `name` attributes of all the elements represented by the collection, in tree order, ignoring later duplicates, with the `id` of an element preceding its `name` if it contributes both, they differ from each other, and neither is the duplicate of an earlier entry.

When the user agent is to set the value of a new indexed property or set the value of an existing indexed property for a given property index `index` to a new value `value`, it must run the following algorithm:

1. If `value` is null, invoke the steps for the `remove` method with `index` as the argument, and return.
2. Let `length` be the number of nodes represented by the collection.
3. Let `n` be `index` minus `length`.
4. If `n` is greater than zero, then append a `DocumentFragment` consisting of `n-1` new `option` elements with no attributes and no child nodes to the `select` element on which the `HTMLOptionsCollection` is rooted.
5. If `n` is greater than or equal to zero, append `value` to the `select` element. Otherwise, replace the `index`th element in the collection by `value`.

The `add(element, before)` method must act according to the following algorithm:

1. If `element` is an ancestor of the `select` element on which the `HTMLOptionsCollection` is rooted, then throw a "HierarchyRequestError" DOMException.
2. If `before` is an element, but that element isn't a descendant of the `select` element on which the `HTMLOptionsCollection` is rooted, then throw a "NotFoundError" DOMException.
3. If `element` and `before` are the same element, then return.
4. If `before` is a node, then let `reference` be that node. Otherwise, if `before` is an integer, and there is a `before`th node in the collection, let `reference` be that node. Otherwise, let `reference` be null.
5. If `reference` is not null, let `parent` be the parent node of `reference`. Otherwise, let `parent` be the `select` element on which the `HTMLOptionsCollection` is rooted.
6. Pre-insert `element` into `parent` node before `reference`.

The `remove(index)` method must act according to the following algorithm:

1. If the number of nodes represented by the collection is zero, return.
2. If `index` is not a number greater than or equal to 0 and less than the number of nodes represented by the collection, return.
3. Let `element` be the `index`th element in the collection.
4. Remove `element` from its parent node.

The `selectedIndex` IDL attribute must act like the identically named attribute on the `select` element on which the `HTMLOptionsCollection` is rooted.
The DOMStringList interface is a non-fashionable retro way of representing a list of strings.

IDL

```idl
[Exposed=(Window, Worker)]
interface DOMStringList {
  readonly attribute unsigned long length;
  getter DOMString? item(unsigned long index);
  boolean contains(DOMString string);
};
```

⚠ Warning!

New APIs must use sequence<DOMString> or equivalent rather than DOMStringList.

For web developers (non-normative)

- `strings.length` Returns the number of strings in `strings`.
- `strings[index]` Returns the string with index `index` from `strings`.
- `strings.item(index)` Returns the string with index `index` from `strings`.
- `strings.contains(string)` Returns true if `strings` contains `string`, and false otherwise.

Each DOMStringList object has an associated list.

The DOMStringList interface supports indexed properties. The supported property indices are the indices of this's associated list.

The `length` getter steps are to return this's associated list's size.

The `item(index)` method steps are to return the `index`th item in this's associated list, or null if `index` plus one is greater than this's associated list's size.

The `contains(string)` method steps are to return true if this's associated list contains `string`, and false otherwise.

2.7 Safe passing of structured data

To support passing JavaScript objects, including platform objects, across realm boundaries, this specification defines the following infrastructure for serializing and deserializing objects, including in some cases transferring the underlying data instead of copying it. Collectively this serialization/deserialization process is known as "structured cloning", although most APIs perform separate serialization and deserialization steps. (With the notable exception being the `structuredClone()` method.)

This section uses the terminology and typographic conventions from the JavaScript specification. [JAVASCRIPT]

2.7.1 Serializable objects

Serializable objects support being serialized, and later deserialized, in a way that is independent of any given realm. This allows them to be stored on disk and later restored, or cloned across agent and even agent cluster boundaries.

Not all objects are serializable objects, and not all aspects of objects that are serializable objects are necessarily preserved when they are serialized.

Platform objects can be serializable objects if their primary interface is decorated with the `[Serializable] IDL extended attribute`. Such interfaces must also define the following algorithms:
**serialization steps**, taking a **platform object** value, a **Record** serialized, and a boolean forStorage

A set of steps that serializes the data in value into fields of serialized. The resulting data serialized into serialized must be independent of any realm.

These steps may throw an exception if serialization is not possible.

These steps may perform a sub-serialization\(^{120}\) to serialize nested data structures. They should not call StructuredSerialize\(^{121}\) directly, as doing so will omit the important memory argument.

The introduction of these steps should omit mention of the forStorage argument if it is not relevant to the algorithm.

**deserialization steps**, taking a **Record** serialized, a **platform object** value, and a realm targetRealm

A set of steps that deserializes the data in serialized, using it to set up value as appropriate. value will be a newly-created instance of the platform object type in question, with none of its internal data set up; setting that up is the job of these steps.

These steps may throw an exception if deserialization is not possible.

These steps may perform a sub-deserialization\(^{124}\) to deserialize nested data structures. They should not call StructuredDeserialize\(^{121}\) directly, as doing so will omit the important targetRealm and memory arguments.

It is up to the definition of individual platform objects to determine what data is serialized and deserialized by these steps. Typically the steps are very symmetric.

The [Serializable]\(^{115}\) extended attribute must take no arguments, and must only appear on an interface. It must not appear more than once on an interface.

For a given platform object, only the object's primary interface is considered during the (de)serialization process. Thus, if inheritance is involved in defining the interface, each [Serializable]\(^{115}\)-annotated interface in the inheritance chain needs to define standalone serialization steps\(^{116}\) and deserialization steps\(^{116}\), including taking into account any important data that might come from inherited interfaces.

---

**Example**

Let’s say we were defining a platform object Person, which had associated with it two pieces of associated data:

- a name value, which is a string; and
- a best friend value, which is either another Person instance or null.

We could then define Person instances to be serializable objects\(^{115}\) by annotating the Person interface with the [Serializable]\(^{115}\) extended attribute, and defining the following accompanying algorithms:

**serialization steps**\(^{116}\)

1. Set serialized.[[Name]] to value's associated name value.
2. Let serializedBestFriend be the sub-serialization\(^{120}\) of value's associated best friend value.

**deserialization steps**\(^{116}\)

1. Set value's associated name value to serialized.[[Name]].
2. Let deserializedBestFriend be the sub-deserialization\(^{122}\) of serialized.[[BestFriend]].
3. Set value's associated best friend value to deserializedBestFriend.

Objects defined in the JavaScript specification are handled by the StructuredSerialize\(^{121}\) abstract operation directly.

---

**Note**

*Originally, this specification defined the concept of “cloneable objects”, which could be cloned from one realm to another. However, to better specify the behavior of certain more complex situations, the model was updated to make the serialization and deserialization explicit.*
2.7.2 Transferable objects

Transferable objects support being transferred across agents. Transferring is effectively recreating the object while sharing a reference to the underlying data and then detaching the object being transferred. This is useful to transfer ownership of expensive resources. Not all objects are transferable objects and not all aspects of objects that are transferable objects are necessarily preserved when transferred.

Transferable objects are transferable if their primary interface is decorated with the [Transferable] IDL extended attribute. Such interfaces must also define the following algorithms:

**transfer steps, taking a platform object value and a Record dataHolder**

A set of steps that transfers the data in value into fields of dataHolder. The resulting data held in dataHolder must be independent of any realm.

These steps may throw an exception if transferral is not possible.

**transfer-receiving steps, taking a Record dataHolder and a platform object value**

A set of steps that receives the data in dataHolder, using it to set up value as appropriate. value will be a newly-created instance of the platform object type in question, with none of its internal data set up; setting that up is the job of these steps.

These steps may throw an exception if it is not possible to receive the transfer.

It is up to the definition of individual platform objects to determine what data is transferred by these steps. Typically the steps are very symmetric.

The [Transferable] extended attribute must take no arguments, and must only appear on an interface. It must not appear more than once on an interface.

For a given platform object, only the object's primary interface is considered during the transferring process. Thus, if inheritance is involved in defining the interface, each [Transferable]-annotated interface in the inheritance chain needs to define standalone transfer steps and transfer-receiving steps, including taking into account any important data that might come from inherited interfaces.

Platform objects that are transferable objects have a [[Detached]] internal slot. This is used to ensure that once a platform object has been transferred, it cannot be transferred again.

Objects defined in the JavaScript specification are handled by the StructuredSerializeWithTransfer abstract operation directly.

2.7.3 StructuredSerializeInternal (value, forStorage [, memory])

The StructuredSerializeInternal abstract operation takes as input a JavaScript value value and serializes it to a realm-independent form, represented here as a Record. This serialized form has all the information necessary to later deserialize into a new JavaScript value in a different realm.

This process can throw an exception, for example when trying to serialize un-serializable objects.

1. If memory was not supplied, let memory be an empty map.

   **Note**

   The purpose of the memory map is to avoid serializing objects twice. This ends up preserving cycles and the identity of duplicate objects in graphs.

2. If memory[value] exists, then return memory[value].

3. Let deep be false.

4. If Type[value] is Undefined, Null, Boolean, Number, BigInt, or String, then return { [[Type]]: "primitive", [[Value]]: value }.

Note: The purpose of the memory map is to avoid serializing objects twice. This ends up preserving cycles and the identity of duplicate objects in graphs.
5. If `Type(value)` is Symbol, then throw a "DataCloneError" DOMException.

6. Let `serialized` be an uninitialized value.

7. If `value` has a [[BooleanData]] internal slot, then set `serialized` to { [[Type]]: "Boolean", [[BooleanData]]: value.[[BooleanData]] }.

8. Otherwise, if `value` has a [[NumberData]] internal slot, then set `serialized` to { [[Type]]: "Number", [[NumberData]]: value.[[NumberData]] }.

9. Otherwise, if `value` has a [[BigIntData]] internal slot, then set `serialized` to { [[Type]]: "BigInt", [[BigIntData]]: value.[[BigIntData]] }.

10. Otherwise, if `value` has a [[StringData]] internal slot, then set `serialized` to { [[Type]]: "String", [[StringData]]: value.[[StringData]] }.

11. Otherwise, if `value` has a [[DateValue]] internal slot, then set `serialized` to { [[Type]]: "Date", [[DateValue]]: value.[[DateValue]] }.

12. Otherwise, if `value` has a [[RegExpMatcher]] internal slot, then set `serialized` to { [[Type]]: "RegExp", [[RegExpMatcher]]: value.[[RegExpMatcher]], [[OriginalSource]]: value.[[OriginalSource]], [[OriginalFlags]]: value.[[OriginalFlags]] }.

13. Otherwise, if `value` has an [[ArrayBufferData]] internal slot, then:

   1. If `isSharedArrayBuffer(value)` is true, then:
      
      1. If the current settings object's cross-origin isolated capability is false, then throw a "DataCloneError" DOMException.

      **Note**
      
      This check is only needed when serializing (and not when deserializing) as the cross-origin isolated capability cannot change over time and a SharedArrayBuffer cannot leave an agent cluster.

   2. If `forStorage` is true, then throw a "DataCloneError" DOMException.

   3. If `value` has an [[ArrayBufferMaxByteLength]] internal slot, then set `serialized` to { [[Type]]: "GrowableSharedArrayBuffer", [[ArrayBufferData]]: value.[[ArrayBufferData]], [[ArrayBufferByteLengthData]]: value.[[ArrayBufferByteLengthData]], [[ArrayBufferMaxByteLength]]: value.[[ArrayBufferMaxByteLength]], [[AgentCluster]]: the surrounding agent's agent cluster }.

   4. Otherwise, set `serialized` to { [[Type]]: "ResizableArrayBuffer", [[ArrayBufferData]]: value.[[ArrayBufferData]], [[ArrayBufferByteLength]]: value.[[ArrayBufferByteLength]], [[AgentCluster]]: the surrounding agent's agent cluster }.

2. Otherwise:

   1. If `isDetachedBuffer(value)` is true, then throw a "DataCloneError" DOMException.

   2. Let `size` be value.[[ArrayBufferByteLength]].

   3. Let `dataCopy` be `CreateByteDataBlock(size)`.

   **Note**
   
   This can throw a RangeError exception upon allocation failure.

4. Perform `CopyDataBlockBytes(dataCopy, 0, value.[[ArrayBufferData]], 0, size)`.

5. If `value` has an [[ArrayBufferMaxByteLength]] internal slot, then set `serialized` to { [[Type]]: "ResizableArrayBuffer", [[ArrayBufferData]]: `dataCopy`, [[ArrayBufferByteLength]]: `size`, [[ArrayBufferMaxByteLength]]: value.[[ArrayBufferMaxByteLength]] }.

6. Otherwise, set `serialized` to { [[Type]]: "ArrayBuffer", [[ArrayBufferData]]: `dataCopy`, [[ArrayBufferByteLength]]: `size` }.

14. Otherwise, if `value` has a [[ViewedArrayBuffer]] internal slot, then:

   1. If `isArrayBufferViewOutOfBounds(value)` is true, then throw a "DataCloneError" DOMException.

   2. Let `buffer` be the value of `value`'s [[ViewedArrayBuffer]] internal slot.
3. Let `bufferSerialized` be `StructuredSerializeInternal(buffer, forStorage, memory).

4. **Assert:** `bufferSerialized`.[[Type]] is "ArrayBuffer", "ResizableArrayBuffer", "SharedArrayBuffer", or "GrowableSharedArrayBuffer".

5. If `value` has a `[[DataView]]` internal slot, then set `serialized` to `{ [[Type]]: "ArrayBufferView", [[Constructor]]: "DataView", [[ArrayBufferSerialized]]: `bufferSerialized`, [[ByteLength]]: `value`.[[ByteLength]], [[ByteOffset]]: `value`.[[ByteOffset]] }.

6. Otherwise:
   1. **Assert:** `value` has a `[[TypedArrayName]]` internal slot.
   2. Set `serialized` to `{ [[Type]]: "ArrayBufferView", [[Constructor]]: `value`.[[TypedArrayName]], [[ArrayBufferSerialized]]: `bufferSerialized`, [[ByteLength]]: `value`.[[ByteLength]], [[ByteOffset]]: `value`.[[ByteOffset]], [[ArrayLength]]: `value`.[[ArrayLength]] }.

15. Otherwise, if `value` has `[[MapData]]` internal slot, then:
   1. Set `serialized` to `{ [[Type]]: "Map", [[MapData]]: a new empty `List` }.
   2. Set `deep` to true.

16. Otherwise, if `value` has `[[SetData]]` internal slot, then:
   1. Set `serialized` to `{ [[Type]]: "Set", [[SetData]]: a new empty `List` }.
   2. Set `deep` to true.

17. Otherwise, if `value` has an `[[ErrorData]]` internal slot and `value` is not a platform object, then:
   1. Let `name` be `? Get(value, "name")`.
   2. If `name` is not one of "Error", "EvalError", "RangeError", "ReferenceError", "SyntaxError", "TypeError", or "URIError", then set `name` to "Error".
   3. Let `valueMessageDesc` be `value`.[[GetOwnProperty]]("message").
   4. Let `message` be undefined if `IsDataDescriptor(valueMessageDesc)` is false, and `? ToString(valueMessageDesc.[[Value]])` otherwise.
   5. Set `serialized` to `{ [[Type]]: "Error", [[Name]]: `name`, [[Message]]: `message` }.
   6. User agents should attach a serialized representation of any interesting accompanying data which are not yet specified, notably the `stack` property, to `serialized`.

   **Note**
   See the Error Stacks proposal for in-progress work on specifying this data. [JSERRORSTACKS]

18. Otherwise, if `value` is an Array exotic object, then:
   1. Let `valueLenDescriptor` be `? `OrdinaryGetOwnProperty(value, "length").
   2. Let `valueLen` be `valueLenDescriptor`.[[Value]].
   3. Set `serialized` to `{ [[Type]]: "Array", [[Length]]: `valueLen`, [[Properties]]: a new empty `List` }.
   4. Set `deep` to true.

19. Otherwise, if `value` is a platform object that is a serializable object:
   1. If `value` has a `[[Detached]]` internal slot whose value is true, then throw a "DataCloneError" DOMException.
   2. Let `typeString` be the identifier of the primary interface of `value`.
   3. Set `serialized` to `{ [[Type]]: `typeString` }.
   4. Set `deep` to true.

20. Otherwise, if `value` is a platform object, then throw a "DataCloneError" DOMException.

21. Otherwise, if `IsCallable(value)` is true, then throw a "DataCloneError" DOMException.
22. Otherwise, if value has any internal slot other than [[Prototype]] or [[Extensible]], then throw a "DataCloneError" DOMException.

Example
For instance, a [[PromiseState]] or [[WeakMapData]] internal slot.

23. Otherwise, if value is an exotic object and value is not the %Object.prototype% intrinsic object associated with any realm, then throw a "DataCloneError" DOMException.

Example
For instance, a proxy object.

24. Otherwise:
   1. Set serialized to { [[Type]]: "Object", [[Properties]]: a new empty List }.
   2. Set deep to true.

Note
%Object.prototype% will end up being handled via this step and subsequent steps. The end result is that its exoticness is ignored, and after deserialization the result will be an empty object (not an immutable prototype exotic object).

25. Set memory[value] to serialized.

26. If deep is true, then:
   1. If value has a [[MapData]] internal slot, then:
      1. Let copiedList be a new empty List.
      2. For each Record { [[Key]], [[Value]] } entry of value.[[MapData]]:
         1. Let copiedEntry be a new Record { [[Key]], [[Value]]: entry.[[Value]] }.
         2. If copiedEntry.[[Key]] is not the special value empty, append copiedEntry to copiedList.
      3. For each Record { [[Key]], [[Value]] } entry of copiedList:
         1. Let serializedKey be ? StructuredSerializeInternal(entry.[[Key]], forStorage, memory).
         2. Let serializedValue be ? StructuredSerializeInternal(entry.[[Value]], forStorage, memory).
         3. Append { [[Key]]: serializedKey, [[Value]]: serializedValue } to serialized.[[MapData]].
   2. Otherwise, if value has a [[SetData]] internal slot, then:
      1. Let copiedList be a new empty List.
      2. For each entry of value.[[SetData]]:
         1. If entry is not the special value empty, append entry to copiedList.
      3. For each entry of copiedList:
         1. Let serializedEntry be ? StructuredSerializeInternal(entry, forStorage, memory).
         2. Append serializedEntry to serialized.[[SetData]].
   3. Otherwise, if value is a platform object that is a serializable object, then perform the serialization steps for value's primary interface, given value, serialized, and forStorage.

   The serialization steps may need to perform a sub-serialization. This is an operation which takes as input a value subValue, and returns StructuredSerializeInternal(subValue, forStorage, memory). (In other words, a sub-serialization is a specialization of StructuredSerializeInternal to be consistent within this invocation.)

   Otherwise, for each key in ! EnumerableOwnProperty(value, key):
      1. If ! HasOwnProperty(value, key) is true, then:
         1. Let inputValue be ? value.[[Get]](key, value).
2. Let `outputValue` be \texttt{StructuredSerializeInternal}(\texttt{inputValue}, \texttt{forStorage}, \texttt{memory}).

3. Append \{ [[Key]]: key, [[Value]]: outputValue \} to \texttt{serialized}.[[Properties]].

27. Return \texttt{serialized}.

\begin{example}
\begin{verbatim}
const o = {};
o.myself = o;
\end{verbatim}
\end{example}

It's important to realize that the \texttt{Records} produced by \texttt{StructuredSerializeInternal} might contain "pointers" to other records that create circular references. For example, when we pass the following JavaScript object into \texttt{StructuredSerializeInternal}:

\begin{verbatim}
const o = {};
o.myself = o;
\end{verbatim}

\begin{verbatim}
{ [[Type]]: "Object", 
  [[Properties]]: «
    { 
      [[Key]]: "myself",
      [[Value]]: <a pointer to this whole structure>
    }
  »
}
\end{verbatim}

\subsection{2.7.4 StructuredSerialize (value) \textsuperscript{p117}}

1. Return \texttt{StructuredSerializeInternal}(value, false).

\subsection{2.7.5 StructuredSerializeForStorage (value) \textsuperscript{p117}}

1. Return \texttt{StructuredSerializeInternal}(value, true).

\subsection{2.7.6 StructuredDeserialize (serialized, targetRealm [ , memory ] ) \textsuperscript{p117}}

The \texttt{StructuredDeserialize} abstract operation takes as input a \texttt{Record} \texttt{serialized}, which was previously produced by \texttt{StructuredSerialize} or \texttt{StructuredSerializeForStorage}, and deserializes it into a new JavaScript value, created in \texttt{targetRealm}.

This process can throw an exception, for example when trying to allocate memory for the new objects (especially \texttt{ArrayBuffer} objects).

1. If \texttt{memory} was not supplied, let \texttt{memory} be an empty \texttt{map}.

\begin{note}
The purpose of the memory map is to avoid deserializing objects twice. This ends up preserving cycles and the identity of duplicate objects in graphs.
\end{note}

2. If \texttt{memory[serialized]} \texttt{exists}, then return \texttt{memory[serialized]}.

3. Let \texttt{deep} be false.

4. Let \texttt{value} be an uninitialized value.

5. If \texttt{serialized.([[Type]])} is "primitive", then set \texttt{value} to \texttt{serialized.([[Value]])}.

6. Otherwise, if \texttt{serialized.([[Type]])} is "Boolean", then set \texttt{value} to a new Boolean object in \texttt{targetRealm} whose \texttt{[[BooleanData]]} internal slot value is \texttt{serialized.([[BooleanData]])}. 
Otherwise, if `serialized.([Type])` is "Number", then set `value` to a new Number object in `targetRealm` whose `[[NumberData]]` internal slot value is `serialized.([NumberData])`.

Otherwise, if `serialized.([Type])` is "BigInt", then set `value` to a new BigInt object in `targetRealm` whose `[[BigIntData]]` internal slot value is `serialized.([BigIntData])`.

Otherwise, if `serialized.([Type])` is "String", then set `value` to a new String object in `targetRealm` whose `[[StringData]]` internal slot value is `serialized.([StringData])`.

Otherwise, if `serialized.([Type])` is "Date", then set `value` to a new Date object in `targetRealm` whose `[[DateValue]]` internal slot value is `serialized.([DateValue])`.

Otherwise, if `serialized.([Type])` is "RegExp", then set `value` to a new RegExp object in `targetRealm` whose `[[RegExpMatcher]]` internal slot value is `serialized.([RegExpMatcher])`, whose `[[OriginalSource]]` internal slot value is `serialized.([OriginalSource])`, and whose `[[OriginalFlags]]` internal slot value is `serialized.([OriginalFlags])`.

Otherwise, if `serialized.([Type])` is "SharedArrayBuffer", then:

1. If `targetRealm`'s corresponding `agent cluster` is not `serialized.([AgentCluster])`, then then throw a "DataCloneError" `DOMException`.
2. Otherwise, set `value` to a new SharedArrayBuffer object in `targetRealm` whose `[[ArrayBufferData]]` internal slot value is `serialized.([ArrayBufferData])` and whose `[[ArrayBufferByteLength]]` internal slot value is `serialized.([ArrayBufferByteLength])`.

Otherwise, if `serialized.([Type])` is "GrowableSharedArrayBuffer", then:

1. If `targetRealm`'s corresponding `agent cluster` is not `serialized.([AgentCluster])`, then then throw a "DataCloneError" `DOMException`.
2. Otherwise, set `value` to a new SharedArrayBuffer object in `targetRealm` whose `[[ArrayBufferData]]` internal slot value is `serialized.([ArrayBufferData])`, whose `[[ArrayBufferByteLengthData]]` internal slot value is `serialized.([ArrayBufferByteLengthData])`, and whose `[[ArrayBufferMaxByteLength]]` internal slot value is `serialized.([ArrayBufferMaxByteLength])`.

Otherwise, if `serialized.([Type])` is "ResizableArrayBuffer", then set `value` to a new ArrayBuffer object in `targetRealm` whose `[[ArrayBufferData]]` internal slot value is `serialized.([ArrayBufferData])`, and whose `[[ArrayBufferByteLength]]` internal slot value is `serialized.([ArrayBufferByteLength])`.

If this throws an exception, catch it, and then throw a "DataCloneError" `DOMException`.

---

**Note**

*This step might throw an exception if there is not enough memory available to create such an ArrayBuffer object.*

Otherwise, if `serialized.([Type])` is "ResizableArrayBuffer", then set `value` to a new ArrayBuffer object in `targetRealm` whose `[[ArrayBufferData]]` internal slot value is `serialized.([ArrayBufferData])`, whose `[[ArrayBufferByteLength]]` internal slot value is `serialized.([ArrayBufferByteLength])`, and whose `[[ArrayBufferMaxByteLength]]` internal slot value is `serialized.([ArrayBufferMaxByteLength])`.

If this throws an exception, catch it, and then throw a "DataCloneError" `DOMException`.

---

**Note**

*This step might throw an exception if there is not enough memory available to create such an ArrayBuffer object.*

Otherwise, if `serialized.([Type])` is "ArrayBufferView", then:

1. Let `deserializedArrayBuffer` be `StructuredDeserializ`e\[^{21}\] (`serialized.([ArrayBufferSerialized])`, `targetRealm`, `memory`).
2. If `serialized.([Constructor])` is "DataView", then set `value` to a new DataView object in `targetRealm` whose `[[ViewedArrayBuffer]]` internal slot value is `deserializedArrayBuffer`, whose `[[ByteLength]]` internal slot value is `serialized.([ByteLength])`, and whose `[[ByteOffset]]` internal slot value is `serialized.([ByteOffset])`.
3. Otherwise, set `value` to a new typed array object in `targetRealm`, using the constructor given by `serialized.([Constructor])`, whose `[[ViewedArrayBuffer]]` internal slot value is `deserializedArrayBuffer`, whose `[[TypedArrayName]]` internal slot value is `serialized.([Constructor])`, whose `[[ByteLength]]` internal slot value is `serialized.([ByteLength])`, whose `[[ByteOffset]]` internal slot value is `serialized.([ByteOffset])`, and whose `[[ArrayLength]]` internal slot value is `serialized.([ArrayLength])`. 

[^21]: `StructuredDeserializ`e
17. Otherwise, if `serialized.[[Type]]` is "Map", then:
   1. Set `value` to a new Map object in `targetRealm` whose `[[MapData]]` internal slot value is a new empty List.
   2. Set `deep` to true.

18. Otherwise, if `serialized.[[Type]]` is "Set", then:
   1. Set `value` to a new Set object in `targetRealm` whose `[[SetData]]` internal slot value is a new empty List.
   2. Set `deep` to true.

19. Otherwise, if `serialized.[[Type]]` is "Array", then:
   1. Let `outputProto` be `targetRealm. [[Intrinsics]].[[%Array.prototype%]]`.
   2. Set `value` to `ArrayCreate(serialized.[[Length]], outputProto)`.
   3. Set `deep` to true.

20. Otherwise, if `serialized.[[Type]]` is "Object", then:
   1. Set `value` to a new Object in `targetRealm`.
   2. Set `deep` to true.

21. Otherwise, if `serialized.[[Type]]` is "Error", then:
   1. Let `prototype` be `%Error.prototype%`.
   2. If `serialized.[[Name]]` is "EvalError", then set `prototype` to `%EvalError.prototype%`.
   3. If `serialized.[[Name]]` is "RangeError", then set `prototype` to `%RangeError.prototype%`.
   4. If `serialized.[[Name]]` is "ReferenceError", then set `prototype` to `%ReferenceError.prototype%`.
   5. If `serialized.[[Name]]` is "SyntaxError", then set `prototype` to `%SyntaxError.prototype%`.
   6. If `serialized.[[Name]]` is "TypeError", then set `prototype` to `%TypeError.prototype%`.
   7. If `serialized.[[Name]]` is "URIError", then set `prototype` to `%URIError.prototype%`.
   8. Let `message` be `serialized.[[Message]]`.
   9. Set `value` to `OrdinaryObjectCreate(prototype, « [[ErrorData]] »)`.
   10. Let `messageDesc` be `PropertyDescriptor{ [[Value]]: message, [[Writable]]: true, [[Enumerable]]: false, [[Configurable]]: true }`.
   11. If `message` is not undefined, then perform `OrdinaryDefineOwnProperty(value, "message", messageDesc)`.
   12. Any interesting accompanying data attached to `serialized` should be deserialized and attached to `value`.

22. Otherwise:
   1. Let `interfaceName` be `serialized.[[Type]]`.
   2. If the interface identified by `interfaceName` is not exposed in `targetRealm`, then throw a "DataCloneError" `DOMException`.
   3. Set `value` to a new instance of the interface identified by `interfaceName`, created in `targetRealm`.
   4. Set `deep` to true.

23. Set `memory[serialized]` to `value`.

24. If `deep` is true, then:
   1. If `serialized.[[Type]]` is "Map", then:
      1. For each Record { [[Key]], [[Value]] } entry of `serialized.[[MapData]]`:
         1. Let `serializedKey` be `StructuredDeserialize(entry.[[Key]], targetRealm, memory)`.
2. Let deserializedValue be \( \text{StructuredDeserialize}(\text{entry}.[[\text{Value}]], \text{targetRealm}, \text{memory}) \).

3. \text{Append} \{ [[\text{Key}]]: deserializedKey, [[\text{Value}]]: deserializedValue \} to value.\[\text{[MapData]}\].

2. Otherwise, if serialized.\[\text{[Type]}\] is "Set", then:
   1. \text{For each} \text{entry} of serialized.\[\text{[SetData]}\]:
      1. Let deserializedEntry be \( \text{StructuredDeserialize}(\text{entry}, \text{targetRealm}, \text{memory}) \).
      2. \text{Append} deserializedEntry to value.\[\text{[SetData]}\].

3. Otherwise, if serialized.\[\text{[Type]}\] is "Array" or "Object", then:
   1. \text{For each} Record \{ [[\text{Key}]], [[\text{Value}]] \} \text{entry} of serialized.\[\text{[Properties]}\]:
      1. Let deserializedValue be \( \text{StructuredDeserialize}(\text{entry}.[[\text{Value}]], \text{targetRealm}, \text{memory}) \).
      2. Let result be \( \text{CreateDataProperty}(\text{value}, \text{entry}.[[\text{Key}]], \text{deserializedValue}) \).
      3. \text{Assert}: result is true.
   4. Otherwise:
      1. Perform the appropriate deserialization steps\[\text{p116}\] for the interface identified by serialized.\[\text{[Type]}\], given serialized, value, and targetRealm.

      The deserialization steps\[\text{p116}\] may need to perform a sub-deserialization. This is an operation which takes as input a previously-serialized Record subSerialized, and returns \text{StructuredDeserialize}(\text{subSerialized}, \text{targetRealm}, \text{memory}). (In other words, a sub-deserialization\[\text{p124}\] is a specialization of \text{StructuredDeserialize}\[\text{p121}\] to be consistent within this invocation.)

25. Return value.

2.7.7 StructuredSerializeWithTransfer ( \text{value}, \text{transferList} ) \[\text{p12}\]

1. Let memory be an empty map.

   \textbf{Note}
   
   In addition to how it is used normally by \text{StructuredSerializeInternal}\[\text{p117}\], in this algorithm memory is also used to ensure that \text{StructuredSerializeInternal}\[\text{p117}\] ignores items in transferList, and let us do our own handling instead.

2. \text{For each} transferable of transferList:
   1. If transferable has neither an [[ArrayBufferData]] internal slot nor a [[Detached]]\[\text{p117}\] internal slot, then throw a "DataCloneError" DOMException.
   2. If transferable has an [[ArrayBufferData]] internal slot and \text{isSharedArrayBuffer}(\text{transferable}) is true, then throw a "DataCloneError" DOMException.
   3. If memory[transferable] exists, then throw a "DataCloneError" DOMException.
   4. Set memory[transferable] to \{ [[\text{Type}]]: an uninitialized value \}.

   \textbf{Note}
   
   transferable is not transferred yet as transferring has side effects and \text{StructuredSerializeInternal}\[\text{p117}\] needs to be able to throw first.

3. Let serialized be \( \text{StructuredSerializeInternal}(\text{value}, \text{false}, \text{memory}) \).

4. Let transferDataHolders be a new empty List.

5. \text{For each} transferable of transferList:
   1. If transferable has an [[ArrayBufferData]] internal slot and \text{isDetachedBuffer}(\text{transferable}) is true, then throw a "DataCloneError" DOMException.

2. If `transferable` has a `[[Detached]]` internal slot and `transferable.[[Detached]]` is true, then throw a "DataCloneError" DOMException.

3. Let `dataHolder` be `memory[transferable]`.

4. If `transferable` has an `[[ArrayBufferData]]` internal slot, then:
   1. If `transferable` has an `[[ArrayBufferMaxByteLength]]` internal slot, then:
      1. Set `dataHolder.[[Type]]` to "ResizableArrayBuffer".
      2. Set `dataHolder.[[ArrayBufferData]]` to `transferable.[[ArrayBufferData]]`.
      3. Set `dataHolder.[[ArrayBufferByteLength]]` to `transferable.[[ArrayBufferByteLength]]`.
      4. Set `dataHolder.[[ArrayBufferMaxByteLength]]` to `transferable.[[ArrayBufferMaxByteLength]]`.
   2. Otherwise:
      1. Set `dataHolder.[[Type]]` to "ArrayBuffer".
      2. Set `dataHolder.[[ArrayBufferData]]` to `transferable.[[ArrayBufferData]]`.
      3. Set `dataHolder.[[ArrayBufferByteLength]]` to `transferable.[[ArrayBufferByteLength]]`.

5. Otherwise:
   1. Assert: `transferable` is a `platform object` that is a `transferable object`
   2. Let `interfaceName` be the identifier of the `primary interface` of `transferable`.
   3. Set `dataHolder.[[Type]]` to `interfaceName`.
   4. Perform the appropriate `transfer steps` for the interface identified by `interfaceName`, given `transferable` and `dataHolder`.
   5. Set `transferable.[[Detached]]` to true.
   6. Append `dataHolder` to `transferDataHolders`.

6. Return `{ [[Serialized]]: serialized, [[TransferDataHolders]]: transferDataHolders }`.

### 2.7.8 StructuredDeserializeWithTransfer (serializeWithTransferResult, targetRealm) §5

1. Let `memory` be an empty `map`.

   **Note** Analogous to `StructuredSerializeWithTransfer` in addition to how it is used normally by `StructuredDeserialize`, in this algorithm `memory` is also used to ensure that `StructuredDeserialize` ignores items in `serializeWithTransferResult. [[TransferDataHolders]]`, and let us do our own handling instead.

2. Let `transferredValues` be a new empty `List`.

3. `For each` `transferDataHolder` of `serializeWithTransferResult. [[TransferDataHolders]]`:
   1. Let `value` be an uninitialized value.
   2. If `transferDataHolder.[[Type]]` is "ArrayBuffer", then set `value` to a new `ArrayBuffer` object in `targetRealm` whose `[[ArrayBufferData]]` internal slot value is `transferDataHolder.[[ArrayBufferData]]`, and whose `[[ArrayBufferByteLength]]` internal slot value is `transferDataHolder.[[ArrayBufferByteLength]]`. 
3. Otherwise, if transferDataHolder.[[Type]] is "ResizableArrayBuffer", then set value to a new ArrayBuffer object in targetRealm whose [[ArrayBufferData]] internal slot value is transferDataHolder.[[ArrayBufferData]], whose [[ArrayBufferByteLength]] internal slot value is transferDataHolder.[[ArrayBufferByteLength]], and whose [[ArrayBufferMaxByteLength]] internal slot value is transferDataHolder.[[ArrayBufferMaxByteLength]].

4. Otherwise:
   1. Let interfaceName be transferDataHolder.[[Type]].
   2. If the interface identified by interfaceName is not exposed in targetRealm, then throw a "DataCloneError" DOMException.
   3. Set value to a new instance of the interface identified by interfaceName, created in targetRealm.
   4. Perform the appropriate transfer-receiving steps for the interface identified by interfaceName given transferDataHolder and value.
   5. Set memory[transferDataHolder] to value.
   6. Append value to transferredValues.

4. Let deserialized be ? StructuredDeserialize[serializeWithTransferResult.[[Serialized]], targetRealm, memory].

5. Return { [[Deserialized]]: deserialized, [[TransferredValues]]: transferredValues }.

2.7.9 Performing serialization and transferring from other specifications

Other specifications may use the abstract operations defined here. The following provides some guidance on when each abstract operation is typically useful, with examples.

**StructuredSerializeWithTransfer**

**StructuredDeserializeWithTransfer**

Cloning a value to another realm, with a transfer list, but where the target realm is not known ahead of time. In this case the serialization step can be performed immediately, with the deserialization step delayed until the target realm becomes known.

**Example**

messagePort.postMessage() uses this pair of abstract operations, as the destination realm is not known until the MessagePort has been shipped.

**StructuredSerialize**

**StructuredSerializeForStorage**

**StructuredDeserialize**

Creating a realm-independent snapshot of a given value which can be saved for an indefinite amount of time, and then reified back into a JavaScript value later, possibly multiple times.

**StructuredSerializeForStorage** can be used for situations where the serialization is anticipated to be stored in a persistent manner, instead of passed between realms. It throws when attempting to serialize SharedArrayBuffer objects, since storing shared memory does not make sense. Similarly, it can throw or possibly have different behavior when given a platform object with custom serialization steps when the forStorage argument is true.
In general, call sites may pass in Web IDL values instead of JavaScript values; this is to be understood to perform an implicit conversion to the JavaScript value before invoking these algorithms.

Call sites that are not invoked as a result of author code synchronously calling into a user agent method must take care to properly prepare to run script and prepare to run a callback before invoking StructuredSerialize, StructuredSerializeForStorage, or StructuredSerializeWithTransfer abstract operations, if they are being performed on arbitrary objects. This is necessary because the serialization process can invoke author-defined accessors as part of its final deep-serialization steps, and these accessors could call into operations that rely on the entry and incumbent concepts being properly set up.

Example

history.pushState() and history.replaceState() use StructuredSerializeForStorage on author-supplied state objects, storing them as serialized state in the appropriate session history entry. Then, StructuredDeserialize is used so that the history.state property can return a clone of the originally-supplied state object.

Example

broadcastChannel.postMessage() uses StructuredSerialize on its input, then uses StructuredDeserialize multiple times on the result to produce a fresh clone for each destination being broadcast to. Note that transferring does not make sense in multi-destination situations.

Example

Any API for persisting JavaScript values to the filesystem would also use StructuredSerializeForStorage on its input and StructuredDeserialize on its output.

In general, call sites may pass in Web IDL values instead of JavaScript values; this is to be understood to perform an implicit conversion to the JavaScript value before invoking these algorithms.

Call sites that are not invoked as a result of author code synchronously calling into a user agent method must take care to properly prepare to run script and prepare to run a callback, before invoking StructuredSerialize, StructuredSerializeForStorage, or StructuredSerializeWithTransfer abstract operations, if they are being performed on arbitrary objects. This is necessary because the serialization process can invoke author-defined accessors as part of its final deep-serialization steps, and these accessors could call into operations that rely on the entry and incumbent concepts being properly set up.

Example

window.postMessage() performs StructuredSerializeWithTransfer on its arguments, but is careful to do so immediately, inside the synchronous portion of its algorithm. Thus it is able to use the algorithms without needing to prepare to run script and prepare to run a callback.

Example

In contrast, a hypothetical API that used StructuredSerialize to serialize some author-supplied object periodically, directly from a task on the event loop, would need to ensure it performs the appropriate preparations beforehand. As of this time, we know of no such APIs on the platform; usually it is simpler to perform the serialization ahead of time, as a synchronous consequence of author code.

2.7.10 Structured cloning API

For web developers (non-normative)

result = self.structuredClone(value, { transfer })

Takes the input value and returns a deep copy by performing the structured clone algorithm. Transferable objects listed in the transfer array are transferred, not just cloned, meaning that they are no longer usable in the input value.

Throws a "DataCloneError" DOMException if any part of the input value is not serializable.

The structuredClone(value, options) method steps are:

1. Let serialized be ? StructuredSerializeWithTransfer(value, options["transfer"]).
2. Let deserializeRecord be ? StructuredDeserializeWithTransfer(serialized, this's relevant realm).
3. Return deserializeRecord. [[Deserialized]].

Example

history.pushState() and history.replaceState() use StructuredSerializeForStorage on author-supplied state objects, storing them as serialized state in the appropriate session history entry. Then, StructuredDeserialize is used so that the history.state property can return a clone of the originally-supplied state object.
3 Semantics, structure, and APIs of HTML documents

3.1 Documents

Every XML and HTML document in an HTML UA is represented by a Document object. [DOM]

The Document object's URL is defined in DOM. It is initially set when the Document object is created, but can change during the lifetime of the Document object; for example, it changes when the user navigates to a fragment method is called with a new URL. [DOM]

⚠ Warning!
Interactive user agents typically expose the Document object's URL in their user interface. This is the primary mechanism by which a user can tell if a site is attempting to impersonate another.

The Document object's origin is defined in DOM. It is initially set when the Document object is created, and can change during the lifetime of the Document object only upon setting document.domain. A Document's origin can differ from the origin of its URL; for example when a child navigable is created, its active document's origin is inherited from its parent's active document's origin, even though its active document's URL is about:blank. [DOM]

When a Document is created by a script using the createDocument() or createHTMLDocument() methods, the Document is ready for post-load tasks immediately.

The document's referrer is a string (representing a URL) that can be set when the Document object is created. If it is not explicitly set, then its value is the empty string.

3.1.1 The Document object

DOM defines a Document interface, which this specification extends significantly.

```idl
define DocumentReadyState { "loading", "interactive", "complete" };
define DocumentVisibilityState { "visible", "hidden" };
typedef (HTMLScriptElement or SVGScriptElement) HTMLOrSVGScriptElement;

[LegacyOverrideBuiltIns]
partial interface Document {
  static Document parseHTMLUnsafe(HTMLString html);

  // PutForwards=href, LegacyUnforgeable] readonly attribute Location location;
  attribute USVString domain;
  readonly attribute USVString referrer;
  attribute USVString cookie;
  readonly attribute DOMString lastModified;
  readonly attribute DocumentReadyState readyState;

  // DOM tree accessor
  getter object (DOMString name);
  [CEReactions] attribute DOMString title;
  [CEReactions] attribute DOMString dir;
  [CEReactions] attribute HTMLElement? body;
  readonly attribute HTMLHeadElement? head;
  [SameObject] readonly attribute HTMLCollection images;
  [SameObject] readonly attribute HTMLCollection embeds;
  [SameObject] readonly attribute HTMLCollection plugins;
  [SameObject] readonly attribute HTMLCollection links;
  [SameObject] readonly attribute HTMLCollection forms;
```
Each `Document` has a **policy container** (a `policy container`), initially a new policy container, which contains policies which apply to the `Document`.

Each `Document` has a **permissions policy**, which is a `permissions policy`, which is initially empty.

Each `Document` has a **module map**, which is a `module map`, initially empty.

Each `Document` has a **cross-origin opener policy**, which is a `cross-origin opener policy`, initially a new cross-origin opener policy.

Each `Document` has an **is initial about:blank**, which is a boolean, initially false.

Each `Document` has a **during-loading navigation ID for WebDriver BiDi**, which is a `navigation ID` or null, initially null.

**Note**

As the name indicates, this is used for interfacing with the WebDriver BiDi specification, which needs to be informed about certain occurrences during the early parts of the `Document`'s lifecycle, in a way that ties them to the original navigation ID used when the navigation that created this `Document` was the ongoing navigation. This eventually gets set back to null, after WebDriver BiDi considers the loading process to be finished.

Each `Document` has an **about base URL**, which is a `URL` or null, initially null.

**Note**

This is only populated for "about:"-schemed `Document`s.

Each `Document` has a **fire mutation events flag**, which is a boolean, initially true.
Each Document has a bfcache blocking details, which is a set of not restored reason details, initially empty.

3.1.2 The DocumentOrShadowRoot interface

DOM defines the DocumentOrShadowRoot mixin, which this specification extends.

```idl
partial interface mixin DocumentOrShadowRoot {
  readonly attribute Element? activeElement;
};
```

3.1.3 Resource metadata management

### For web developers (non-normative)

**document.referrer** Returns the URL of the Document from which the user navigated to this one, unless it was blocked or there was no such document, in which case it returns the empty string.

The noreferrer link type can be used to block the referrer.

The referrer attribute must return the document's referrer.

**document.cookie** Returns the HTTP cookies that apply to the Document. If there are no cookies or cookies can't be applied to this resource, the empty string will be returned.

Can be set, to add a new cookie to the element's set of HTTP cookies.

If the contents are sandboxed into an opaque origin (e.g., in an iframe with the sandbox attribute), a "SecurityError" DOMException will be thrown on getting and setting.

The cookie attribute represents the cookies of the resource identified by the document's URL.

A Document object that falls into one of the following conditions is a cookie-averse Document object:

- A Document object whose browsing context is null.
- A Document whose URL's scheme is not an HTTP(S) scheme.

On getting, if the document is a cookie-averse Document object, then the user agent must return the empty string. Otherwise, if the Document's origin is an opaque origin, the user agent must throw a "SecurityError" DOMException. Otherwise, the user agent must return the cookie-string for the document's URL for a "non-HTTP" API, decoded using UTF-8 decode without BOM.

On setting, if the document is a cookie-averse Document object, then the user agent must do nothing. Otherwise, if the Document's origin is an opaque origin, the user agent must throw a "SecurityError" DOMException. Otherwise, the user agent must act as it would when receiving a set-cookie-string for the document's URL via a "non-HTTP" API, consisting of the new value encoded as UTF-8.

### Note

Since the cookie attribute is accessible across frames, the path restrictions on cookies are only a tool to help manage which...
cookies are sent to which parts of the site, and are not in any way a security feature.

⚠ Warning! The `cookie` attribute's getter and setter synchronously access shared state. Since there is no locking mechanism, other browsing contexts in a multiprocess user agent can modify cookies while scripts are running. A site could, for instance, try to read a cookie, increment its value, then write it back out, using the new value of the cookie as a unique identifier for the session; if the site does this twice in two different browser windows at the same time, it might end up using the same "unique" identifier for both sessions, with potentially disastrous effects.

For web developers (non-normative)

`document.lastModified` Returns the date of the last modification to the document, as reported by the server, in the form "MM/DD/YYYY hh:mm:ss", in the user's local time zone.

If the last modification date is not known, the current time is returned instead.

The `lastModified` attribute, on getting, must return the date and time of the `Document`'s source file's last modification, in the user's local time zone, in the following format:

1. The month component of the date.
2. A U+002F SOLIDUS character (/).
3. The day component of the date.
4. A U+002F SOLIDUS character (/).
5. The year component of the date.
6. A U+0020 SPACE character.
7. The hours component of the time.
8. A U+003A COLON character (:).
9. The minutes component of the time.
10. A U+003A COLON character (:).
11. The seconds component of the time.

All the numeric components above, other than the year, must be given as two ASCII digits representing the number in base ten, zero-padded if necessary. The year must be given as the shortest possible string of four or more ASCII digits representing the number in base ten, zero-padded if necessary.

The `Document`'s source file's last modification date and time must be derived from relevant features of the networking protocols used, e.g. from the value of the HTTP `Last-Modified` header of the document, or from metadata in the file system for local files. If the last modification date and time are not known, the attribute must return the current date and time in the above format.

3.1.4 Reporting document loading status

For web developers (non-normative)

`document.readyState` Returns "loading" while the `Document` is loading, "interactive" once it is finished parsing but still loading subresources, and "complete" once it has loaded.

The `readystatechange` event fires on the `Document` object when this value changes.

The `DOMContentLoaded` event fires after the transition to "interactive" but before the transition to "complete", at the point where all subresources apart from `async` and `script` elements have loaded.
Each Document has a current document readiness, a string, initially "complete".

Note
For Document objects created via the create and initialize a Document object algorithm, this will be immediately reset to "loading" before any script can observe the value of document.readyState. This default applies to other cases such as initial about:blank Document’s or Document’s without a browsing context.

The readyState getter steps are to return this's current document readiness.

To update the current document readiness for Document document to readinessValue:

1. If document's current document readiness equals readinessValue, then return.
2. Set document's current document readiness to readinessValue.
3. If document is associated with an HTML parser, then:
   1. Let now be the current high resolution time given document's relevant global object.
   2. If readinessValue is "complete", and document's load timing info's DOM complete time is 0, then set document's load timing info's DOM complete time to now.
   3. Otherwise, if readinessValue is "interactive", and document's load timing info's DOM interactive time is 0, then set document's load timing info's DOM interactive time to now.
4. Fire an event named readystatechange at document.

A Document is said to have an active parser if it is associated with an HTML parser or an XML parser that has not yet been stopped or aborted.

A Document has a document load timing info load timing info.

A Document has a document unload timing info previous document unload timing.

A Document has a boolean was created via cross-origin redirects, initially false.

The document load timing info struct has the following items:

navigation start time (default 0)
A number

DOM interactive time (default 0)

DOM content loaded event start time (default 0)

DOM content loaded event end time (default 0)

DOM complete time (default 0)

load event start time (default 0)

load event end time (default 0)

DOMHighResTimeStamp values

The document unload timing info struct has the following items:

unload event start time (default 0)

unload event end time (default 0)

DOMHighResTimeStamp values

3.1.5 Render-blocking mechanism
Each Document has a render-blocking element set, a set of elements, initially the empty set.
A Document allows adding render-blocking elements if document's content type is "text/html" and the body element of document is null.

A Document document is render-blocked if both of the following are true:

- document's render-blocking element set is non-empty, or document allows adding render-blocking elements.
- The current high resolution time given document's relevant global object has not exceeded an implementation-defined timeout value.

An element el is render-blocking if el's node document is render-blocked, and el is in document's render-blocking element set.

To block rendering on an element el:

1. Let document be el's node document.
2. If document allows adding render-blocking elements, then append el to document's render-blocking element set.

To unblock rendering on an element el:

1. Let document be el's node document.
2. Remove el from document's render-blocking element set.

Whenever a render-blocking element el becomes browsing-context disconnected, or el's blocking attribute's value is changed so that el is no longer potentially render-blocking, then unblock rendering on el.

3.1.6 DOM tree accessors

The html element of a document is its document element, if it's an html element, and null otherwise.

For web developers (non-normative)

`document.head` Returns the head element.

The head element of a document is the first head element that is a child of the html element, if there is one, or null otherwise.

The head attribute, on getting, must return the head element of the document (a head element or null).

For web developers (non-normative)

`document.title [ = value ]` Returns the document's title, as given by the title element for HTML and as given by the SVG title element for SVG. Can be set, to update the document's title. If there is no appropriate element to update, the new value is ignored.

The title element of a document is the first title element in the document (in tree order), if there is one, or null otherwise.

The title attribute must, on getting, run the following algorithm:

1. If the document element is an SVG svg element, then let value be the child text content of the first SVG title element that is a child of the document element.
2. Otherwise, let value be the child text content of the title element, or the empty string if the title element is null.
3. Strip and collapse ASCII whitespace in value.
4. Return value.

On setting, the steps corresponding to the first matching condition in the following list must be run:
If the document element is an SVG svg element

1. If there is an SVG title element that is a child of the document element, let element be the first such element.
2. Otherwise:
   1. Let element be the result of creating an element given the document element's node document, title, and the SVG namespace.
   2. Insert element as the first child of the document element.
   3. String replace all with the given value within element.

If the document element is in the HTML namespace

1. If the title element is null and the head element is null, then return.
2. If the title element is non-null, let element be the title element.
3. Otherwise:
   1. Let element be the result of creating an element given the document element's node document, title, and the HTML namespace.
   2. Append element to the head element.
4. String replace all with the given value within element.

Otherwise

Do nothing.

For web developers (non-normative)

document.body [ = value ]

Returns the body element. Can be set, to replace the body element. If the new value is not a body or frameset element, this will throw a "HierarchyRequestError" DOMException.

The body element of a document is the first of the html element's children that is either a body or frameset element, or null if there is no such element.

The body attribute, on getting, must return the body element of the document (either a body or frameset element, or a frameset element, or null). On setting, the following algorithm must be run:

1. If the new value is not a body or frameset element, then throw a "HierarchyRequestError" DOMException.
2. Otherwise, if the new value is the same as the body element, return.
3. Otherwise, if the body element is null, then replace the body element with the new value within the body element's parent and return.
4. Otherwise, if there is no document element, throw a "HierarchyRequestError" DOMException.
5. Otherwise, the body element is null, but there's a document element, Append the new value to the document element.

Note

The value returned by the body getter is not always the one passed to the setter.

Example

In this example, the setter successfully inserts a body element (though this is non-conforming since SVG does not allow a body as child of SVG). However the getter will return null because the document element is not html.

<svg xmlns="http://www.w3.org/2000/svg">
<script>
document.body = document.createElementNS("http://www.w3.org/1999/xhtml", "body");
console.assert(document.body === null);
</script>
</svg>

For web developers (non-normative)

```
document.images
```

Returns an HTMLCollection of the `img` elements in the `Document`.

```
document.embeds
document.plugins
```

Returns an HTMLCollection of the `embed` elements in the `Document`.

```
document.links
```

Returns an HTMLCollection of the `a` and `area` elements in the `Document` that have `href` attributes.

```
document.forms
document.scripts
```

Returns an HTMLCollection of the `form` elements in the `Document`.

For web developers (non-normative)

```
collection = document.getElementsByTagName(name)
```

Returns a `NodeList` of elements in the `Document` that have a `name` attribute with the value `name`.

The `getElementsByTagName` method steps are to return a live `NodeList` containing all the `HTML elements` in that document that have a `name` attribute whose value is identical to the `elementName` argument, in tree order. When the method is invoked on a `Document` object again with the same argument, the user agent may return the same as the object returned by the earlier call. In other cases, a new `NodeList` object must be returned.

For web developers (non-normative)

```
document.currentScript
```

Returns the `script` element, or the `SVG script` element, that is currently executing, as long as the element represents a classic script. In the case of reentrant script execution, returns the one that most recently started executing amongst those that have not yet finished executing.

Returns null if the `Document` is not currently executing a `script` or `SVG script` element (e.g., because the running script is an event handler, or a timeout), or if the currently executing `script` or `SVG script` element represents a module script.

The `currentScript` attribute, on getting, must return the value to which it was most recently set. When the `Document` is created, the `currentScript` must be initialized to null.
This API has fallen out of favor in the implementer and standards community, as it globally exposes `script` or SVG `script` elements. As such, it is not available in newer contexts, such as when running module scripts or when running scripts in a shadow tree. We are looking into creating a new solution for identifying the running script in such contexts, which does not make it globally available: see issue #1013.

The `Document` interface supports named properties. The supported property names of a `Document` object document at any moment consist of the following, in tree order according to the element that contributed them, ignoring later duplicates, and with values from `id` attributes coming before values from `name` attributes when the same element contributes both:

- the value of the `name` content attribute for all `exposed` embed, form, iframe, img, and `exposed` object elements that have a non-empty name content attribute and are in a document tree with document as their root;
- the value of the `id` content attribute for all `exposed` object elements that have a non-empty `id` content attribute and are in a document tree with document as their root; and
- the value of the `id` content attribute for all img elements that have both a non-empty `id` content attribute and a non-empty name content attribute, and are in a document tree with document as their root.

To determine the value of a named property `name` for a `Document`, the user agent must return the value obtained using the following steps:

1. Let `elements` be the list of named elements with the name `name` that are in a document tree with the `Document` node as their root.

   **Note**
   
   There will be at least one such element, since the algorithm would otherwise not have been invoked by Web IDL.

2. If `elements` has only one element, and that element is an `iframe` element, and that `iframe` element’s content navigable is not null, then return the active `WindowProxy` of the element’s content navigable.

3. Otherwise, if `elements` has only one element, return that element.

4. Otherwise return an `HTMLCollection` rooted at the `Document` node, whose filter matches only named elements with the name `name`.

Named elements with the name `name`, for the purposes of the above algorithm, are those that are either:

- `Exposed` embed, form, iframe, img, or `exposed` object elements that have a name content attribute whose value is `name`, or
- `Exposed` object elements that have an `id` content attribute whose value is `name`, or
- img elements that have an `id` content attribute whose value is `name`, and that have a non-empty name content attribute present also.

An `embed` or `object` element is said to be `exposed` if it has no `exposed` object ancestor, and, for `object` elements, is additionally either not showing its fallback content or has no `object` or `embed` descendants.

**Note**

The `dir` attribute on the `Document` interface is defined along with the `dir` content attribute.

3.2 Elements

3.2.1 Semantics

Elements, attributes, and attribute values in HTML are defined (by this specification) to have certain meanings (semantics). For example, the `ol` element represents an ordered list, and the `lang` attribute represents the language of the content.

These definitions allow HTML processors, such as web browsers or search engines, to present and use documents and applications in a
wide variety of contexts that the author might not have considered.

**Example**

As a simple example, consider a web page written by an author who only considered desktop computer web browsers:

```html
<!DOCTYPE HTML>
<html lang="en">
<head>
<title>My Page</title>
</head>
<body>
<h1>Welcome to my page</h1>
<p>I like cars and lorries and have a big Jeep!</p>
<h2>Where I live</h2>
<p>I live in a small hut on a mountain!</p>
</body>
</html>
```

Because HTML conveys meaning, rather than presentation, the same page can also be used by a small browser on a mobile phone, without any change to the page. Instead of headings being in large letters as on the desktop, for example, the browser on the mobile phone might use the same size text for the whole page, but with the headings in bold.

But it goes further than just differences in screen size: the same page could equally be used by a blind user using a browser based around speech synthesis, which instead of displaying the page on a screen, reads the page to the user, e.g. using headphones. Instead of large text for the headings, the speech browser might use a different volume or a slower voice.

That's not all, either. Since the browsers know which parts of the page are the headings, they can create a document outline that the user can use to quickly navigate around the document, using keys for "jump to next heading" or "jump to previous heading". Such features are especially common with speech browsers, where users would otherwise find quickly navigating a page quite difficult.

Even beyond browsers, software can make use of this information. Search engines can use the headings to more effectively index a page, or to provide quick links to subsections of the page from their results. Tools can use the headings to create a table of contents (that is in fact how this very specification's table of contents is generated).

This example has focused on headings, but the same principle applies to all of the semantics in HTML.

Authors must not use elements, attributes, or attribute values for purposes other than their appropriate intended semantic purpose, as doing so prevents software from correctly processing the page.

**Example**

For example, the following snippet, intended to represent the heading of a corporate site, is non-conforming because the second line is not intended to be a heading of a subsection, but merely a subheading or subtitle (a subordinate heading for the same section).

```html
<body>
<h1>ACME Corporation</h1>
<h2>The leaders in arbitrary fast delivery since 1920</h2>
... 
```

The `hgroup` element can be used for these kinds of situations:

```html
<body>
<hgroup>
<h1>ACME Corporation</h1>
<p>The leaders in arbitrary fast delivery since 1920</p>
</hgroup>
... 
```
The document in this next example is similarly non-conforming, despite being syntactically correct, because the data placed in the cells is clearly not tabular data, and the cite element mis-used:

```html
<!DOCTYPE HTML>
<html lang="en-GB">
  <head>
    <title>Demonstration</title>
  </head>
  <body>
    <table>
      <tr><td>My favourite animal is the cat. </td></tr>
      <tr><td><a href="https://example.org/~ernest/">Ernest</a>, in an essay from 1992</td></tr>
    </table>
  </body>
</html>
```

This would make software that relies on these semantics fail: for example, a speech browser that allowed a blind user to navigate tables in the document would report the quote above as a table, confusing the user; similarly, a tool that extracted titles of works from pages would extract "Ernest" as the title of a work, even though it's actually a person's name, not a title.

A corrected version of this document might be:

```html
<!DOCTYPE HTML>
<html lang="en-GB">
  <head>
    <title>Demonstration</title>
  </head>
  <body>
    <blockquote>
      My favourite animal is the cat.
      <p>—<a href="https://example.org/~ernest/">Ernest</a>, in an essay from 1992</p>
    </blockquote>
  </body>
</html>
```

Authors must not use elements, attributes, or attribute values that are not permitted by this specification or other applicable specifications, as doing so makes it significantly harder for the language to be extended in the future.

Example
In the next example, there is a non-conforming attribute value ("carpet") and a non-conforming attribute ("texture"), which is not permitted by this specification:

```html
<label>Carpets: <input type="carpet" name="c" texture="deep pile"/></label>
```

Here would be an alternative and correct way to mark this up:

```html
<label>Carpets: <input type="text" class="carpet" name="c" data-texture="deep pile"/></label>
```

DOM nodes whose node document's browsing context is null are exempt from all document conformance requirements other than the HTML syntax requirements and XML syntax requirements.

Example
In particular, the template element's template contents's node document's browsing context is null. For example, the
Through scripting and using other mechanisms, the values of attributes, text, and indeed the entire structure of the document may change dynamically while a user agent is processing it. The semantics of a document at an instant in time are those represented by the state of the document at that instant in time, and the semantics of a document can therefore change over time. User agents must update their presentation of the document as this occurs.

The nodes representing HTML elements in the DOM must implement, and expose to scripts, the interfaces listed for them in the relevant sections of this specification. This includes HTML elements in XML documents, even when those documents are in another context (e.g. inside an XSLT transform).

Elements in the DOM represent things; that is, they have intrinsic meaning, also known as semantics.

Elements can be referenced (referred to) in some way, either explicitly or implicitly. One way that an element in the DOM can be explicitly referenced is by giving an `id` attribute to the element, and then creating a hyperlink with that `id` attribute's value as the fragment for the hyperlink's `href` attribute value. Hyperlinks are not necessary for a reference, however; any manner of referring to the element in question will suffice.

### Example

HTML has a `progress` element that describes a progress bar. If its "value" attribute is dynamically updated by a script, the UA would update the rendering to show the progress changing.

### 3.2.2 Elements in the DOM

The nodes representing HTML elements in the DOM must implement, and expose to scripts, the interfaces listed for them in the relevant sections of this specification. This includes HTML elements in XML documents, even when those documents are in another context (e.g. inside an XSLT transform).

Elements in the DOM represent things; that is, they have intrinsic meaning, also known as semantics.

Elements can be referenced (referred to) in some way, either explicitly or implicitly. One way that an element in the DOM can be explicitly referenced is by giving an `id` attribute to the element, and then creating a hyperlink with that `id` attribute's value as the fragment for the hyperlink's `href` attribute value. Hyperlinks are not necessary for a reference, however; any manner of referring to the element in question will suffice.

### Example

Consider the following `figure` element, which is given an `id` attribute:

```html
<figure id="module-script-graph">
  <img src="module-script-graph.svg" alt="Module A depends on module B, which depends on modules C and D.">
  <figcaption>Figure 27: a simple module graph</figcaption>
</figure>
```

A hyperlink-based reference could be created using the `a` element, like so:

```html
<a href="#module-script-graph">figure 27</a>, ...
```

However, there are many other ways of referencing the `figure` element, such as:
The basic interface, from which all the HTML elements\(^\text{p45}\) interfaces inherit, and which must be used by elements that have no additional requirements, is the HTMLElement\(^\text{p140}\) interface.

```
IDL
[Exposed=Window]
interface HTMLElement : Element {
    [HTMLConstructor] constructor();

    // metadata attributes
    [CEReactions] attribute DOMString title;
    [CEReactions] attribute DOMString lang;
    [CEReactions] attribute boolean translate;
    [CEReactions] attribute DOMString dir;

    // user interaction
    [CEReactions] attribute (boolean or unrestricted double or DOMString)? hidden;
    [CEReactions] attribute boolean inert;
    undefined click();
    [CEReactions] attribute DOMString accessKey;
    readonly attribute DOMString accessKeyLabel;
    [CEReactions] attribute boolean draggable;
    [CEReactions] attribute boolean spellcheck;
    [CEReactions] attribute DOMString writingSuggestions;
    [CEReactions] attribute DOMString autocapitalize;

    [CEReactions] attribute [LegacyNullToEmptyString] DOMString innerText;
    [CEReactions] attribute [LegacyNullToEmptyString] DOMString outerText;

    ElementInternals attachInternals();

    // The popover API
    undefined showPopover();
    undefined hidePopover();
    boolean togglePopover(optional boolean force);
    [CEReactions] attribute DOMString? popover;
}
```

The HTMLElement\(^\text{p140}\) interface holds methods and attributes related to a number of disparate features, and the members of this interface are therefore described in various different sections of this specification.

The element interface for an element with name name in the HTML namespace is determined as follows:

1. If name is applet\(^\text{p140}\), bgsound\(^\text{p140}\), blink\(^\text{p140}\), isindex\(^\text{p140}\), keygen\(^\text{p140}\), multicol\(^\text{p140}\), nextid\(^\text{p140}\), or space\(^\text{p140}\), then
2. If name is `acronym`, `basefont`, `big`, `center`, `nobr`, `noembed`, `noframes`, `plaintext`, `rb`, `rtc`, `strike`, or `tt`, then return `HTMLElement`.

3. If name is `listing` or `xmp`, then return `HTMLPreElement`.

4. Otherwise, if this specification defines an interface appropriate for the `element type` corresponding to the local name name, then return that interface.

5. If other applicable specifications define an appropriate interface for name, then return the interface they define.

6. If name is a `valid custom element name`, then return `HTMLElement`.

7. Return `HTMLUnknownElement`.

Note
The use of `HTMLElement` instead of `HTMLUnknownElement` in the case of valid custom element names is done to ensure that any potential future upgrades only cause a linear transition of the element's prototype chain, from `HTMLElement` to a subclass, instead of a lateral one, from `HTMLUnknownElement` to an unrelated subclass.

Features shared between HTML and SVG elements use the `HTMLOrSVGElement` interface mixin: [SVG]

IDL interface mixin HTMLOrSVGElement {

[SameObject] readonly attribute DOMStringMap dataset;
attribute DOMString nonce; // intentionally no [CEReactions]

[CEReactions] attribute boolean autofocus;
[CEReactions] attribute long tabIndex;
undefined focus(optional FocusOptions options = {});
undefined blur();
}

Example
An example of an element that is neither an HTML nor SVG element is one created as follows:

```javascript
const el = document.createElementNS("some namespace", "example");
console.assert(el.constructor === Element);
```

3.2.3 HTML element constructors
To support the custom elements feature, all HTML elements have special constructor behavior. This is indicated via the [HTMLConstructor] IDL extended attribute. It indicates that the interface object for the given interface will have a specific behavior when called, as defined in detail below.

The [HTMLConstructor] extended attribute must take no arguments, and must only appear on constructor operations. It must appear only once on a constructor operation, and the interface must contain only the single, annotated constructor operation, and no others. The annotated constructor operation must be declared to take no arguments.

Interfaces declared with constructor operations that are annotated with the [HTMLConstructor] extended attribute have the following overridden constructor steps:

1. Let registry be the current global object's `CustomElementRegistry` object.

2. If `NewTarget` is equal to the active function object, then throw a `TypeError`.

Example
This can occur when a custom element is defined using an `element interface` as its constructor:
3. Let `definition` be the entry in `registry` with `constructor` equal to `NewTarget`. If there is no such definition, then throw a `TypeError`.

4. Let `is value` be null.

5. If `definition`'s `local name` is equal to `definition`'s `name` (i.e., `definition` is for an autonomous custom element), then:
   1. If the `active function object` is not `HTMLElement`, then throw a `TypeError`.

6. Otherwise (i.e., if `definition` is for a customized built-in element):
   1. Let `valid local names` be the list of local names for elements defined in this specification or in other applicable specifications that use the `active function object` as their element interface.
   2. If `valid local names` does not contain `definition`'s `local name`, then throw a `TypeError`.

7. If `definition`'s `construction stack` is empty, then:
   1. Let `element` be the result of internally creating a new object implementing the interface to which the `active function object` corresponds, given the `current realm` and `NewTarget`.
   2. Set `element`'s `node document` to the `current global object`'s associated `Document`.
   3. Set `element`'s `namespace` to the `HTML namespace`.
   4. Set `element`'s `namespace prefix` to null.
   5. Set `element`'s `local name` to `definition`'s `local name`.

In this case, during the execution of `HTMLButtonElement` (either explicitly, as in (1), or implicitly, as in (2)), both the `active function object` and `NewTarget` are `HTMLButtonElement`. If this check was not present, it would be possible to create an instance of `HTMLButtonElement` whose local name was `bad-1`.

Note
Since there can be no entry in `registry` with a `constructor` of undefined, this step also prevents HTML element constructors from being called as functions (since in that case `NewTarget` will be undefined).

4. Let `is value` be null.

5. If `definition`'s `local name` is equal to `definition`'s `name` (i.e., `definition` is for an autonomous custom element), then:
   1. If the `active function object` is not `HTMLElement`, then throw a `TypeError`.

6. Otherwise (i.e., if `definition` is for a customized built-in element):
   1. Let `valid local names` be the list of local names for elements defined in this specification or in other applicable specifications that use the `active function object` as their element interface.
   2. If `valid local names` does not contain `definition`'s `local name`, then throw a `TypeError`.

7. If `definition`'s `construction stack` is empty, then:
   1. Let `element` be the result of internally creating a new object implementing the interface to which the `active function object` corresponds, given the `current realm` and `NewTarget`.
   2. Set `element`'s `node document` to the `current global object`'s associated `Document`.
   3. Set `element`'s `namespace` to the `HTML namespace`.
   4. Set `element`'s `namespace prefix` to null.
   5. Set `element`'s `local name` to `definition`'s `local name`.

In this case, during the (implicit) `super()` call that occurs when constructing an instance of `Bad2`, the `active function object` is `HTMLParagraphElement`, not `HTMLElement`.

Example
This can occur when a custom element is defined to extend a given local name but inherits from the wrong class:

```javascript
customElements.define("bad-3", class Bad3 extends HTMLQuoteElement {});
```

In this case, during the (implicit) `super()` call that occurs when constructing an instance of `Bad3`, `valid local names` is the list containing `q` and `blockquote`, but `definition`'s `local name` is `p`, which is not in that list.

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6. Set element's custom element state to "custom".

7. Set element's custom element definition to definition.

8. Set element's is value to is value.


**Note**
This occurs when author script constructs a new custom element directly, e.g. via new MyCustomElement().

8. Let prototype be ? Get(NewTarget, "prototype").

9. If Type(prototype) is not Object, then:
   2. Set prototype to the interface prototype object of realm whose interface is the same as the interface of the active function object.

**Note**
The realm of the active function object might not be realm, so we are using the more general concept of "the same interface" across realms; we are not looking for equality of interface objects. This fallback behavior, including using the realm of NewTarget and looking up the appropriate prototype there, is designed to match analogous behavior for the JavaScript built-ins and Web IDL's internally create a new object implementing the interface algorithm.

10. Let element be the last entry in definition's construction stack.

11. If element is an already constructed marker, then throw an "InvalidStateError" DOMException.

**Example**
This can occur when the author code inside the custom element constructor non-conformantly creates another instance of the class being constructed, before calling super():

```javascript
let doSillyThing = true;

class DontDoThis extends HTMLElement {
    constructor() {
        if (doSillyThing) {
            doSillyThing = false;
            new DontDoThis();
            // Now the construction stack will contain an already constructed marker.
        }
        // This will then fail with an "InvalidStateError" DOMException:
        super();
    }
}
```

**Example**
This can also occur when author code inside the custom element constructor non-conformantly calls super() twice, since per the JavaScript specification, this actually executes the superclass constructor (i.e. this algorithm) twice, before throwing an error:

```javascript
class DontDoThisEither extends HTMLElement {
    constructor() {
        super();
        // This will throw, but not until it has already called into the HTMLElement constructor
        super();
    }
}
```
12. Perform `element.[SetPrototypeOf](prototype).

13. Replace the last entry in `definition's construction stack`\(^756\) with an `already constructed marker`\(^756\).


**Note**

This step is normally reached when `upgrading`\(^760\) a custom element; the existing element is returned, so that the `super()` call inside the `custom element constructor`\(^754\) assigns that existing element to `this`.

In addition to the constructor behavior implied by `[HTMLConstructor]`\(^{141}\), some elements also have `named constructors` (which are really factory functions with a modified `prototype` property).

**Example**

Named constructors for HTML elements can also be used in an `extends` clause when defining a `custom element constructor`\(^{754}\).

```javascript
class AutoEmbiggenedImage extends Image {
    constructor(width, height) {
        super(width * 10, height * 10);
    }
}

customElements.define("auto-embiggened", AutoEmbiggenedImage, { extends: "img" });

const image = new AutoEmbiggenedImage(15, 20);
console.assert(image.width === 150);
console.assert(image.height === 200);
```

### 3.2.4 Element definitions \(^{144}_4\)

Each element in this specification has a definition that includes the following information:

**Categories**

A list of `categories`\(^{146}\) to which the element belongs. These are used when defining the `content models`\(^{145}\) for each element.

**Contexts in which this element can be used**

A `non-normative` description of where the element can be used. This information is redundant with the content models of elements that allow this one as a child, and is provided only as a convenience.

**Note**

For simplicity, only the most specific expectations are listed.

For example, all `phrasing content`\(^{148}\) is `flow content`\(^{147}\). Thus, elements that are `phrasing content`\(^{148}\) will only be listed as "where `phrasing content`\(^{148}\) is expected", since this is the more-specific expectation. Anywhere that expects `flow content`\(^{147}\) also expects `phrasing content`\(^{148}\), and thus also meets this expectation.

**Content model**

A normative description of what content must be included as children and descendants of the element.

**Tag omission in text/html**

A `non-normative` description of whether, in the `text/html`\(^{1424}\) syntax, the `start`\(^{1242}\) and `end`\(^{1243}\) tags can be omitted. This information is redundant with the normative requirements given in the `optional tags`\(^{1244}\) section, and is provided in the element definitions only as a convenience.

**Content attributes**

A normative list of attributes that may be specified on the element (except where otherwise disallowed), along with non-normative descriptions of those attributes. (The content to the left of the dash is normative, the content to the right of the dash is not.)
**Accessibility considerations**

For authors: Conformance requirements for use of ARIA `role` and `aria-*` attributes are defined in ARIA in HTML. [ARIA](aria.html)

For implementers: User agent requirements for implementing accessibility API semantics are defined in HTML Accessibility API Mappings. [HTMLAAM](htmlaccessibilityapi.html)

**DOM interface**

A normative definition of a DOM interface that such elements must implement.

This is then followed by a description of what the element represents, along with any additional normative conformance criteria that may apply to authors and implementations. Examples are sometimes also included.

### 3.2.4.1 Attributes

An attribute value is a string. Except where otherwise specified, attribute values on HTML elements may be any string value, including the empty string, and there is no restriction on what text can be specified in such attribute values.

### 3.2.5 Content models

Each element defined in this specification has a content model: a description of the element’s expected contents. An HTML element must have contents that match the requirements described in the element’s content model. The contents of an element are its children in the DOM.

ASCII whitespace is always allowed between elements. User agents represent these characters between elements in the source markup as `Text` nodes in the DOM. Empty `Text` nodes and `Text` nodes consisting of just sequences of those characters are considered inter-element whitespace.

Inter-element whitespace, comment nodes, and processing instruction nodes must be ignored when establishing whether an element’s contents match the element’s content model or not, and must be ignored when following algorithms that define document and element semantics.

**Note**

*Thus, an element A is said to be preceded or followed by a second element B if A and B have the same parent node and there are no other element nodes or `Text` nodes (other than inter-element whitespace) between them. Similarly, a node is the only child of an element if that element contains no other nodes other than inter-element whitespace, comment nodes, and processing instruction nodes.*

Authors must not use HTML elements anywhere except where they are explicitly allowed, as defined for each element, or as explicitly required by other specifications. For XML compound documents, these contexts could be inside elements from other namespaces, if those elements are defined as providing the relevant contexts.

**Example**

*The Atom Syndication Format defines a content element. When its type attribute has the value `xhtml`, The Atom Syndication Format requires that it contain a single HTML `div` element. Thus, a `div` element is allowed in that context, even though this is not explicitly normatively stated by this specification. [ATOM](atom.html)*

In addition, HTML elements may be orphan nodes (i.e. without a parent node).

**Example**

*For example, creating a `td` element and storing it in a global variable in a script is conforming, even though `td` elements are otherwise only supposed to be used inside `tr` elements.*

```javascript
var data = {
    name: "Banana",
    cell: document.createElement('td'),
```
3.2.5.1 The "nothing" content model

When an element's content model is **nothing**, the element must contain no **Text** nodes (other than **inter-element whitespace**) and no element nodes.

**Note**

*Most HTML elements whose content model is "nothing" are also, for convenience, **void elements** (elements that have no **end tag** in the **HTML syntax**). However, these are entirely separate concepts.*

3.2.5.2 Kinds of content

Each element in HTML falls into zero or more **categories** that group elements with similar characteristics together. The following broad categories are used in this specification:

- **Metadata content**
- **Flow content**
- **Sectioning content**
- **Heading content**
- **Phrasing content**
- **Embedded content**
- **Interactive content**

**Note**

*Some elements also fall into other categories, which are defined in other parts of this specification.*

These categories are related as follows:

Sectioning content, heading content, phrasing content, embedded content, and interactive content are all types of flow content. Metadata is sometimes flow content. Metadata and interactive content are sometimes phrasing content. Embedded content is also a type of phrasing content, and sometimes is interactive content.

Other categories are also used for specific purposes, e.g. form controls are specified using a number of categories to define common requirements. Some elements have unique requirements and do not fit into any particular category.
3.2.5.2.1 Metadata content

Metadata content is content that sets up the presentation or behavior of the rest of the content, or that sets up the relationship of the document with other documents, or that conveys other "out of band" information.

⇒ base\textsuperscript{p172}, link\textsuperscript{p174}, meta\textsuperscript{p186}, noscript\textsuperscript{p664}, script\textsuperscript{p648}, style\textsuperscript{p197}, template\textsuperscript{p666}, title\textsuperscript{p171}

Elements from other namespaces whose semantics are primarily metadata-related (e.g. RDF) are also metadata content\textsuperscript{p147}.

Example

Thus, in the XML serialization, one can use RDF, like this:

```html
<html xmlns="http://www.w3.org/1999/xhtml"
     xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xml:lang="en">
  <head>
    <title>Hedral's Home Page</title>
    <r:RDF>
      <Person xmlns="http://www.w3.org/2000/10/swap/pim/contact#"
               r:about="https://hedral.example.com/#"> "http://www.w3.org/1999/xhtml"
        <fullName>Cat Hedral</fullName>
        <mailbox r:resource="mailto:hedral@damowmow.com"/>
        <personalTitle>Sir</personalTitle>
      </Person>
    </r:RDF>
  </head>
  <body>
    <h1>My home page</h1>
    <p>I like playing with string, I guess. Sister says squirrels are fun too so sometimes I follow her to play with them.</p>
  </body>
</html>
```

This isn't possible in the HTML serialization, however.

3.2.5.2.2 Flow content

Most elements that are used in the body of documents and applications are categorized as flow content.

⇒ a\textsuperscript{p254}, abbr\textsuperscript{p266}, address\textsuperscript{p219}, area\textsuperscript{p468}, article\textsuperscript{p203}, aside\textsuperscript{p211}, audio\textsuperscript{p407}, b\textsuperscript{p289}, bdi\textsuperscript{p209}, bdo\textsuperscript{p294}, blockquote\textsuperscript{p232}, br\textsuperscript{p296}, button\textsuperscript{p661}, canvas\textsuperscript{p671}, cite\textsuperscript{p262}, code\textsuperscript{p281}, data\textsuperscript{p375}, datalist\textsuperscript{p578}, del\textsuperscript{p335}, details\textsuperscript{p62}, dfn\textsuperscript{p365}, dialog\textsuperscript{p662}, div\textsuperscript{p252}, dl\textsuperscript{p241}, em\textsuperscript{p257}, embed\textsuperscript{p299}, fieldset\textsuperscript{p588}, figure\textsuperscript{p346}, footer\textsuperscript{p221}, form\textsuperscript{p518}, h1\textsuperscript{p121}, h2\textsuperscript{p211}, h3\textsuperscript{p213}, h4\textsuperscript{p211}, h5\textsuperscript{p213}, h6\textsuperscript{p211}, header\textsuperscript{p155}, hgroup\textsuperscript{p121}, hr\textsuperscript{p228}, i\textsuperscript{p288}, iframe\textsuperscript{p387}, img\textsuperscript{p343}, input\textsuperscript{p517}, ins\textsuperscript{p334}, kbd\textsuperscript{p296}, label\textsuperscript{p514}, link\textsuperscript{p274}, main\textsuperscript{p350}, map\textsuperscript{p466}, mark\textsuperscript{p291}, MathML\textsuperscript{p237}, menu\textsuperscript{p188}, object\textsuperscript{p389}, ol\textsuperscript{p235}, output\textsuperscript{p588}, p\textsuperscript{p226}, picture\textsuperscript{p339}, pre\textsuperscript{p238}, progress\textsuperscript{p582}, q\textsuperscript{p283}, ruby\textsuperscript{p267}, s\textsuperscript{p261}, samp\textsuperscript{p285}, script\textsuperscript{p648}, search\textsuperscript{p261}, section\textsuperscript{p206}, select\textsuperscript{p254}, slot\textsuperscript{p669}, small\textsuperscript{p295}, span\textsuperscript{p205}, strong\textsuperscript{p268}, sub\textsuperscript{p287}, sup\textsuperscript{p287}, SVG\textsuperscript{p575}, table\textsuperscript{p474}, template\textsuperscript{p666}, textarea\textsuperscript{p575}, time\textsuperscript{p276}, u\textsuperscript{p236}, ul\textsuperscript{p236}, var\textsuperscript{p268}, video\textsuperscript{p463}, wbr\textsuperscript{p207}, autonomous custom elements\textsuperscript{p754}, text\textsuperscript{p148}

3.2.5.2.3 Sectioning content

Sectioning content is content that defines the scope of header\textsuperscript{p221} and footer\textsuperscript{p217} elements.

⇒ article\textsuperscript{p203}, aside\textsuperscript{p211}, nav\textsuperscript{p208}, section\textsuperscript{p206}

3.2.5.2.4 Heading content

Heading content defines the heading of a section (whether explicitly marked up using sectioning content\textsuperscript{p147} elements, or implied by the heading content itself).

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3.2.5.2.5 Phrasing content

Phrasing content is the text of the document, as well as elements that mark up that text at the intra-paragraph level. Runs of phrasing content form paragraphs.

Note:
Most elements that are categorized as phrasing content can only contain elements that are themselves categorized as phrasing content, not any flow content.

Text, in the context of content models, means either nothing, or Text nodes. Text is sometimes used as a content model on its own, but is also phrasing content, and can be inter-element whitespace (if the Text nodes are empty or contain just ASCII whitespace).

Text nodes and attribute values must consist of scalar values, excluding noncharacters, and controls other than ASCII whitespace. This specification includes extra constraints on the exact value of Text nodes and attribute values depending on their precise context.

3.2.5.2.6 Embedded content

Embedded content is content that imports another resource into the document, or content from another vocabulary that is inserted into the document.

Elements that are from namespaces other than the HTML namespace and that convey content but not metadata, are embedded content for the purposes of the content models defined in this specification. (For example, MathML or SVG.)

Some embedded content elements can have fallback content: content that is to be used when the external resource cannot be used (e.g. because it is of an unsupported format). The element definitions state what the fallback is, if any.

3.2.5.2.7 Interactive content

Interactive content is content that is specifically intended for user interaction.

As a general rule, elements whose content model allows any flow content or phrasing content should have at least one node in its contents that is palpable content and that does not have the hidden attribute specified.

Note:
Palpable content makes an element non-empty by providing either some descendant non-empty text, or else something users can hear (audio elements) or view (video, img, or canvas elements) or otherwise interact with (for example, interactive form controls).
This requirement is not a hard requirement, however, as there are many cases where an element can be empty legitimately, for example when it is used as a placeholder which will later be filled in by a script, or when the element is part of a template and would on most pages be filled in but on some pages is not relevant.

Conformance checkers are encouraged to provide a mechanism for authors to find elements that fail to fulfill this requirement, as an authoring aid.

The following elements are palpable content:

\[
\begin{align*}
\text{a}, & \text{ abbr}, \text{ address}, \text{ article}, \text{ aside}, \text{ audio}, \text{ b}, \text{ bdo}, \text{ blockquote}, \text{ button}, \text{ canvas}, \text{ cite}, \text{ code}, \text{ data}, \text{ del}, \text{ details}, \text{ dfn}, \text{ div}, \text{ dl}, \\
\text{h1}, & \text{ h2}, \text{ h3}, \text{ h4}, \text{ h5}, \text{ h6}, \text{ header}, \text{ hgroup}, \text{ i}, \text{ iframe}, \text{ img}, \text{ input}, \text{ ins}, \text{ kbd}, \text{ label}, \text{ main}, \text{ map}, \text{ mark}, \text{ MathML}, \text{ math}, \text{ menu}, \\
\text{li}, & \text{ meter}, \text{ nav}, \text{ object}, \text{ p}, \\
\text{output}, & \text{ p}, \text{ pre}, \text{ progress}, \text{ q}, \text{ ruby}, \text{ s}, \text{ samp}, \text{ search}, \text{ section}, \text{ select}, \text{ small}, \text{ span}, \text{ strong}, \text{ sub}, \text{ sup}, \text{ SVG}, \text{ svg}, \text{ table}, \text{ textarea}, \text{ time}, \text{ u}, \text{ ul}, \\
\text{var}, & \text{ video}, \text{ autonomous custom elements}, \\
\text{text}, & \text{ that is not}
\end{align*}
\]

that is not \text{inter-element whitespace}.

3.2.5.2.9 \text{Script-supporting elements} \textsuperscript{9}

\text{Script-supporting elements} are those that do not \text{represent} anything themselves (i.e. they are not rendered), but are used to support scripts, e.g. to provide functionality for the user.

The following elements are script-supporting elements:

\[
\begin{align*}
\text{script}, & \text{ template}
\end{align*}
\]

3.2.5.3 \text{Transparent content models} \textsuperscript{9}

Some elements are described as \text{transparent}; they have "transparent" in the description of their content model. The content model of a \text{transparent} element is derived from the content model of its parent element: the elements required in the part of the content model that is "transparent" are the same elements as required in the part of the content model of the parent of the transparent element in which the transparent element finds itself.

\textbf{Example}

For instance, an \text{ins} element inside a \text{ruby} element cannot contain an \text{rt} element, because the part of the \text{ruby} element's content model that allows \text{ins} elements is the part that allows \text{phrasing content}, and the \text{rt} element is not \text{phrasing content}.

\textbf{Note}

\textit{In some cases, where transparent elements are nested in each other, the process has to be applied iteratively.}

\textbf{Example}

Consider the following markup fragment:

\[
<p><object><param><ins><a href="/">Apples</a></ins></map></a></object></p>
\]

To check whether "Apples" is allowed inside the \text{a} element, the content models are examined. The \text{a} element's content model is transparent, as is the \text{map} element's, as is the \text{ins} element's, as is the part of the \text{object} element's in which the \text{ins} element is found. The \text{object} element is found in the \text{p} element, whose content model is \text{phrasing content}. Thus, "Apples" is allowed, as text is phrasing content.

When a transparent element has no parent, then the part of its content model that is "transparent" must instead be treated as accepting any \text{flow content}.
3.2.5.4 Paragraphs

Note

The term paragraph as defined in this section is used for more than just the definition of the \texttt{p} element. The concept defined here is used to describe how to interpret documents. The \texttt{p} element is merely one of several ways of marking up a paragraph.

A paragraph is typically a run of phrasing content that forms a block of text with one or more sentences that discuss a particular topic, as in typography, but can also be used for more general thematic grouping. For instance, an address is also a paragraph, as is a part of a form, a byline, or a stanza in a poem.

Example

In the following example, there are two paragraphs in a section. There is also a heading, which contains phrasing content that is not a paragraph. Note how the comments and inter-element whitespace do not form paragraphs.

```html
<section>
  <h2>Example of paragraphs</h2>
  This is the first paragraph in this example.
  <p>This is the second.</p>
  <!-- This is not a paragraph. -->
</section>
```

Paragraphs in flow content are defined relative to what the document looks like without the \texttt{a}, \texttt{ins}, \texttt{del}, and \texttt{map} elements complicating matters, since those elements, with their hybrid content models, can straddle paragraph boundaries, as shown in the first two examples below.

Note

Generally, having elements straddle paragraph boundaries is best avoided. Maintaining such markup can be difficult.

Example

The following example takes the markup from the earlier example and puts \texttt{ins} and \texttt{del} elements around some of the markup to show that the text was changed (though in this case, the changes admittedly don’t make much sense). Notice how this example has exactly the same paragraphs as the previous one, despite the \texttt{ins} and \texttt{del} elements — the \texttt{ins} element straddles the heading and the first paragraph, and the \texttt{del} element straddles the boundary between the two paragraphs.

```html
<ins><section>
  <h2>Example of paragraphs</h2>
  This is the first paragraph in this example.
  <p>This is the second.</p>
  <!-- This is not a paragraph. -->
</section></ins>
```

Example

Let view be a view of the DOM that replaces all \texttt{a}, \texttt{ins}, \texttt{del}, and \texttt{map} elements in the document with their content. Then, in view, for each run of sibling phrasing content nodes uninterrupted by other types of content, in an element that accepts content other than phrasing content, let \texttt{first} be the first node of the run, and let \texttt{last} be the last node of the run. For each such run that consists of at least one node that is neither embedded content nor inter-element whitespace, a paragraph exists in the original DOM from immediately before \texttt{first} to immediately after \texttt{last}. (Paragraphs can thus span across \texttt{a}, \texttt{ins}, \texttt{del}, and \texttt{map} elements.)

Conformance checkers may warn authors of cases where they have paragraphs that overlap each other (this can happen with object, video, audio, and canvas elements, and indirectly through elements in other namespaces that allow HTML to be further embedded therein, like SVG or MathML).

A paragraph is also formed explicitly by \texttt{p} elements.

Note

The \texttt{p} element can be used to wrap individual paragraphs when there would otherwise not be any content other than phrasing content to separate the paragraphs from each other.
In the following example, the link spans half of the first paragraph, all of the heading separating the two paragraphs, and half of the second paragraph. It straddles the paragraphs and the heading.

```html
<header>
  Welcome!
  <a href="about.html">This is home of...</a>
  <h1>The Falcons!</h1>
  <p>This page discusses the F-16 Fighting Falcon's innermost secrets.</p>
</header>
```

Here is another way of marking this up, this time showing the paragraphs explicitly, and splitting the one link element into three:

```html
<header>
  <p>Welcome! <a href="about.html">This is home of...</a></p>
  <h1><a href="about.html">The Falcons!</a></h1>
  <p><a href="about.html">The Lockheed Martin multirole jet fighter aircraft!</a> This page discusses the F-16 Fighting Falcon's innermost secrets.</p>
</header>
```

It is possible for paragraphs to overlap when using certain elements that define fallback content. For example, in the following section:

```html
<section>
  <h2>My Cats</h2>
  <p>You can play with my cat simulator.</p>
  <object data="cats.sim">
    To see the cat simulator, use one of the following links:
    <ul>
      <li><a href="cats.sim">Download simulator file</a></li>
      <li><a href="https://sims.example.com/watch?v=LYds5xY4INU">Use online simulator</a></li>
    </ul>
    Alternatively, upgrade to the Mellblom Browser.
  </object>
  I'm quite proud of it.
</section>
```

There are five paragraphs:

1. The paragraph that says "You can play with my cat simulator. object I'm quite proud of it.", where object is the `object` element.
2. The paragraph that says "To see the cat simulator, use one of the following links:".
3. The paragraph that says "Download simulator file".
4. The paragraph that says "Use online simulator".
5. The paragraph that says "Alternatively, upgrade to the Mellblom Browser.".

The first paragraph is overlapped by the other four. A user agent that supports the "cats.sim" resource will only show the first one, but a user agent that shows the fallback will confusingly show the first sentence of the first paragraph as if it was in the same paragraph as the second one, and will show the last paragraph as if it was at the start of the second sentence of the first paragraph.

To avoid this confusion, explicit `p` elements can be used. For example:

```html
<section>
  <h2>My Cats</h2>
  <p>You can play with my cat simulator.</p>
  <object data="cats.sim">
```
The following attributes are common to and may be specified on all HTML elements (even those not defined in this specification):

- `accesskey`
- `autocapitalize`
- `autofocus`
- `contenteditable`
- `dir`
- `draggable`
- `enterkeyhint`
- `hidden`
- `inert`
- `inputmode`
- `is`
- `itemid`
- `itemprop`
- `itemref`
- `itemscope`
- `itemtype`
- `lang`
- `nonce`
- `popover`
- `spellcheck`
- `style`
- `tabindex`
- `title`
- `translate`
- `writingsuggestions`

These attributes are only defined by this specification as attributes for HTML elements. When this specification refers to elements having these attributes, elements from namespaces that are not defined as having these attributes must not be considered as being elements with these attributes.

### Example

For example, in the following XML fragment, the "bogus" element does not have a `dir` attribute as defined in this specification, despite having an attribute with the literal name "dir". Thus, the `directionality` of the inner-most `span` element is `rtl`, inherited from the `div` element indirectly through the "bogus" element.

```xml
<div xmlns="http://www.w3.org/1999/xhtml" dir="rtl">
  <bogus xmlns="https://example.net/ns" dir="ltr">
    <span xmlns="http://www.w3.org/1999/xhtml">
    </span>
  </bogus>
</div>
```

**DOM** defines the user agent requirements for the `class`, `id`, and `slot` attributes for any element in any namespace. [DOM] The `class`, `id`, and `slot` attributes may be specified on all HTML elements.

When specified on HTML elements, the `class` attribute must have a value that is a set of space-separated tokens representing...
the various classes that the element belongs to.

**Note**
Assigning classes to an element affects class matching in selectors in CSS, the `getElementsByClassName()` method in the DOM, and other such features.

There are no additional restrictions on the tokens authors can use in the `class` attribute, but authors are encouraged to use values that describe the nature of the content, rather than values that describe the desired presentation of the content.

When specified on HTML elements, the `id` attribute value must be unique amongst all the IDs in the element’s tree and must contain at least one character. The value must not contain any ASCII whitespace.

**Note**
The `id` attribute specifies its element’s unique identifier (ID).

There are no other restrictions on what form an ID can take; in particular, IDs can consist of just digits, start with a digit, start with an underscore, consist of just punctuation, etc.

An element’s unique identifier can be used for a variety of purposes, most notably as a way to link to specific parts of a document using fragments, as a way to target an element when scripting, and as a way to style a specific element from CSS.

Identifiers are opaque strings. Particular meanings should not be derived from the value of the `id` attribute.

There are no conformance requirements for the `slot` attribute specific to HTML elements.

**Note**
The `slot` attribute is used to assign a slot to an element: an element with a `slot` attribute is assigned to the slot created by the `slot` element whose `name` attribute’s value matches that `slot` attribute’s value — but only if that `slot` element finds itself in the shadow tree whose root’s host has the corresponding `slot` attribute value.

To enable assistive technology products to expose a more fine-grained interface than is otherwise possible with HTML elements and attributes, a set of annotations for assistive technology products can be specified (the ARIA role and `aria-*` attributes).

[ARIA]

The following event handler content attributes may be specified on any HTML element:

- `onauxclick`
- `onbeforeinput`
- `onbeforematch`
- `onbeforetoggle`
- `onblur`
- `oncancel`
- `oncanplay`
- `oncanplaythrough`
- `onchange`
- `onclick`
- `onclose`
- `oncontextlost`
- `oncontextmenu`
- `oncontextrestored`
- `oncopy`
- `oncuechange`
- `oncut`
- `ondblclick`
- `ondrag`
- `ondragend`
- `ondragenter`
- `ondragleave`
- `ondragover`
- `ondragstart`
- `ondrop`
- `onemptied`
- `onended`
Custom data attributes (e.g. data-foldername or data-msgid) can be specified on any HTML element, to store custom data, state, annotations, and similar, specific to the page.

In HTML documents, elements in the HTML namespace may have an xmlns attribute specified, if, and only if, it has the exact value "http://www.w3.org/1999/xhtml". This does not apply to XML documents.

In HTML, the xmlns attribute has absolutely no effect. It is basically a talisman. It is allowed merely to make migration to and from XML mildly easier. When parsed by an HTML parser, the attribute ends up in no namespace, not the "http://www.w3.org/2000/xmlns/" namespace like namespace declaration attributes in XML do.

In XML, an xmlns attribute is part of the namespace declaration mechanism, and an element cannot actually have an xmlns attribute in no namespace specified.
XML also allows the use of the `xml:space` attribute in the XML namespace on any element in an XML document. This attribute has no effect on HTML elements, as the default behavior in HTML is to preserve whitespace. [XML]

There is no way to serialize the `xml:space` attribute on HTML elements in the text/html syntax.

3.2.6.1 The `title` attribute

The `title` attribute represents advisory information for the element, such as would be appropriate for a tooltip. On a link, this could be the title or a description of the target resource; on an image, it could be the image credit or a description of the image; on a paragraph, it could be a footnote or commentary on the text; on a citation, it could be further information about the source; on interactive content, it could be a label for, or instructions for, use of the element; and so forth. The value is text.

If this attribute is omitted from an element, then it implies that the `title` attribute of the nearest ancestor HTML element with a `title` attribute set is also relevant to this element. Setting the attribute overrides this, explicitly stating that the advisory information of any ancestors is not relevant to this element. Setting the attribute to the empty string indicates that the element has no advisory information.

If the `title` attribute's value contains U+000A LINE FEED (LF) characters, the content is split into multiple lines. Each U+000A LINE FEED (LF) character represents a line break.

Example

Caution is advised with respect to the use of newlines in `title` attributes.

For instance, the following snippet actually defines an abbreviation's expansion with a line break in it:

```html
<p>My logs show that there was some interest in <abbr title="Hypertext Transport Protocol">HTTP</abbr> today.</p>
```

Some elements, such as `link`, `abbr`, and `input`, define additional semantics for the `title` attribute beyond the semantics described above.

The advisory information of an element is the value that the following algorithm returns, with the algorithm being aborted once a value is returned. When the algorithm returns the empty string, then there is no advisory information.

1. If the element has a `title` attribute, then return the result of running `normalize newlines` on its value.
2. If the element has a parent element, then return the parent element's advisory information.
3. Return the empty string.

User agents should inform the user when elements have advisory information, otherwise the information would not be discoverable.

The `title` IDL attribute must reflect the `title` content attribute.

3.2.6.2 The `lang` and `xml:lang` attributes

The `lang` attribute (in no namespace) specifies the primary language for the element's contents and for any of the element's attributes that contain text. Its value must be a valid BCP 47 language tag, or the empty string. Setting the attribute to the empty string indicates that the primary language is unknown. [BCP47]
The `lang` attribute in the XML namespace is defined in XML. [XML]

If these attributes are omitted from an element, then the language of this element is the same as the language of its parent element, if any (except for slot elements in a shadow tree).

The `lang` attribute in no namespace may be used on any HTML element. The `lang` attribute in the XML namespace may be used on HTML elements in XML documents, as well as elements in other namespaces if the relevant specifications allow it (in particular, MathML and SVG allow `lang` attributes in the XML namespace to be specified on their elements). If both the `lang` attribute in no namespace and the `lang` attribute in the XML namespace are specified on the same element, they must have exactly the same value when compared in an ASCII case-insensitive manner.

Authors must not use the `lang` attribute in the XML namespace on HTML elements in HTML documents. To ease migration to and from XML, authors may specify an attribute in no namespace with no prefix and with the literal localname "xml:lang" on HTML elements in HTML documents, but such attributes must only be specified if a `lang` attribute in no namespace is also specified, and both attributes must have the same value when compared in an ASCII case-insensitive manner.

To determine the language of a node, user agents must use the first appropriate step in the following list:

¬ If the node is an element that has a `lang` attribute in the XML namespace set
   Use the value of that attribute.

¬ If the node is an HTML element or an element in the SVG namespace, and it has a `lang` in no namespace attribute set
   Use the value of that attribute.

¬ If the node's parent is a shadow root
   Use the `language` of that shadow root's host.

¬ If the node's parent element is not null
   Use the `language` of that parent element.

¬ Otherwise
   If there is a `pragma-set default language` set, then that is the language of the node. If there is no `pragma-set default language` set, then language information from a higher-level protocol (such as HTTP), if any, must be used as the final fallback language instead. In the absence of any such language information, and in cases where the higher-level protocol reports multiple languages, the language of the node is unknown, and the corresponding language tag is the empty string.

If the resulting value is not a recognized language tag, then it must be treated as an unknown language having the given language tag, distinct from all other languages. For the purposes of round-tripping or communicating with other services that expect language tags, user agents should pass unknown language tags through unmodified, and tagged as being BCP 47 language tags, so that subsequent services do not interpret the data as another type of language description. [BCP47]

Example

Thus, for instance, an element with `lang="xyzzy"` would be matched by the selector `:lang(xyzzy)` (e.g. in CSS), but it would not be matched by `:lang(abcd)`, even though both are equally invalid. Similarly, if a web browser and screen reader working in unison communicated about the language of the element, the browser would tell the screen reader that the language was "xyzzy", even if it knew it was invalid, just in case the screen reader actually supported a language with that tag after all. Even if the screen reader supported both BCP 47 and another syntax for encoding language names, and in that other syntax the string "xyzzy" was a way to denote the Belarusian language, it would be incorrect for the screen reader to then start treating text as Belarusian, because "xyzzy" is not how Belarusian is described in BCP 47 codes (BCP 47 uses the code "be" for Belarusian).

If the resulting value is the empty string, then it must be interpreted as meaning that the language of the node is explicitly unknown.

User agents may use the element's language to determine proper processing or rendering (e.g. in the selection of appropriate fonts or pronunciations, for dictionary selection, or for the user interfaces of form controls such as date pickers).

Note

The attribute in no namespace with no prefix and with the literal localname "xml:lang" has no effect on language processing.
The `lang` IDL attribute must reflect the `lang` content attribute in no namespace.

### 3.2.6.3 The `translate` attribute

The `translate` attribute is used to specify whether an element's attribute values and the values of its `Text` node children are to be translated when the page is localized, or whether to leave them unchanged. It is an attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
</table>
| `yes`   | `yes` | Sets `translation mode` to `translate-enabled`.
| (the empty string) | no | Sets `translation mode` to `no-translate`.
| `no`    | no    | Sets `translation mode` to `no-translate`.

The attribute's `missing value default` and `invalid value default` are both the `inherit` state.

Each element (even non-HTML elements) has a `translation mode`, which is in either the `translate-enabled` state or the `no-translate` state. If an HTML element's `translate` attribute is in the `yes` state, then the element's `translation mode` is in the `translate-enabled` state; otherwise, if the element's `translate` attribute is in the `no` state, then the element's `translation mode` is in the `no-translate` state. Otherwise, either the element's `translate` attribute is in the `inherit` state, or the element is not an HTML element and thus does not have a `translate` attribute; in either case, the element's `translation mode` is in the same state as its `parent element's`, if any, or in the `translate-enabled` state, if the element's `parent element` is null.

When an element is in the `translate-enabled` state, the element's `translatable attributes` and the values of its `Text` node children are to be translated when the page is localized.

When an element is in the `no-translate` state, the element's attribute values and the values of its `Text` node children are to be left as-is when the page is localized, e.g. because the element contains a person's name or a name of a computer program.

The following attributes are translatable attributes:

- `abbr` on `th` elements
- `alt` on `area`, `img`, and `input` elements
- `content` on `meta` elements, if the `name` attribute specifies a metadata name whose value is known to be translatable
- `download` on `a` and `area` elements
- `label` on `optgroup`, `option`, and `track` elements
- `lang` on HTML elements, must be "translated" to match the language used in the translation
- `placeholder` on `input` and `textarea` elements
- `srccdoc` on `iframe` elements; must be parsed and recursively processed
- `style` on HTML elements; must be parsed and recursively processed (e.g. for the values of `content` properties)
- `title` on all HTML elements
- `value` on `input` elements with a `type` attribute in the `Button` state or the `Reset Button` state

Other specifications may define other attributes that are also translatable attributes. For example, ARIA would define the `aria-label` attribute as translatable.

The `translate` IDL attribute must, on getting, return `true` if the element's `translation mode` is `translate-enabled`, and false otherwise. On setting, it must set the content attribute's value to "yes" if the new value is true, and set the content attribute's value to "no" otherwise.

#### Example

In this example, everything in the document is to be translated when the page is localized, except the sample keyboard input and sample program output:

```html
<!DOCTYPE HTML>
<html lang=en> <!-- default on the document element is translate=yes -->
<head>
  <title>The Bee Game</title> <!-- implied translate=yes inherited from ancestors -->
</head>
<body>
```

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The `dir` attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ltr</td>
<td>ltr</td>
<td>The contents of the element are explicitly directionally isolated left-to-right text.</td>
</tr>
<tr>
<td>rtl</td>
<td>rtl</td>
<td>The contents of the element are explicitly directionally isolated right-to-left text.</td>
</tr>
<tr>
<td>auto</td>
<td>auto</td>
<td>The contents of the element are explicitly directionally isolated text, but the direction is to be determined programmatically using the contents of the element (as described below).</td>
</tr>
</tbody>
</table>

The heuristic used by the `auto` state is very crude (it just looks at the first character with a strong directionality, in a manner analogous to the Paragraph Level determination in the bidirectional algorithm). Authors are urged to only use this value as a last resort when the direction of the text is truly unknown and no better server-side heuristic can be applied. [BIDI][p455]

For `textarea` and `pre` elements, the heuristic is applied on a per-paragraph level.

The attribute's missing value default and invalid value default are both the `undefined` state.

The directionality of an element (any element, not just an HTML element) is either 'ltr' or 'rtl'. To compute the directionality given an element `element`, switch on `element`'s `dir` attribute state:

- **ltr**
  - Return 'ltr'.

- **rtl**
  - Return 'rtl'.

- **auto**

  1. Let `result` be the `auto directionality` of `element`.
  2. If `result` is null, then return 'ltr'.
  3. Return `result`.

- **undefined**

  - If `element` is a `bdi` element
    1. Let `result` be the `auto directionality` of `element`.
    2. If `result` is null, then return 'ltr'.
    3. Return `result`.

  - If `element` is an `input` element whose `type` attribute is in the Telephone state
    Return 'ltr'.

  - Otherwise
    Return the `parent directionality` of `element`. 

---

<p>The Bee Game is a text adventure game in English.</p>
<p>When the game launches, the first thing you should do is type `<kbd translate=no>`eat honey`</kbd>. The game will respond with:`</p>
<pre>`Yum yum! That was some good honey!`</pre>
</body>
</html>
The **auto-directionality form-associated elements** are:

- **input** elements whose **type** attribute is in the `Hidden`, `Text`, `Search`, `Telephone`, `URL`, `Email`, `Password`, `Submit Button`, `Reset Button`, or `Button` state, and
- **textarea** elements.

To compute the **auto directionality** given an element `element`:

1. If `element` is an **auto-directionality form-associated element**:
   1. If `element`'s **value** contains a character of bidirectional character type AL or R, and there is no character of bidirectional character type L anywhere before it in the element's **value**, then return `'rtl'`.
   2. If `element`'s **value** is not the empty string, then return `'ltr'`.
   3. Return null.

2. If `element` is a **slot** element whose **root** is a shadow root and `element`'s **assigned nodes** are not empty:
   1. For each node `child` of `element`'s **assigned nodes**:
      1. Let `childDirection` be null.
      2. If `child` is a **Text** node, then set `childDirection` to the **text node directionality** of `child`.
      3. Otherwise:
         1. **Assert**: `child` is an **Element** node.
         2. Set `childDirection` to the **auto directionality** of `child`.
      4. If `childDirection` is not null, then return `childDirection`.
   2. Return null.

3. For each node **descendant** of `element`'s **descendants**, in **tree order**:
   1. If `descendant`, or any of its ancestor elements that are descendants of `element`, is one of
      - a **bdi** element
      - a **script** element
      - a **style** element
      - a **textarea** element
      - an element whose **dir** attribute is not in the `undefined` state
      then **continue**.
   2. If `descendant` is a **slot** element whose **root** is a shadow root, then return the **directionality** of that shadow root's **host**.
   3. If `descendant` is not a **Text** node, then **continue**.
   4. Let `result` be the **text node directionality** of `descendant`.
   5. If `result` is not null, then return `result`.
   4. Return null.

To compute the **text node directionality** given a **Text** node `text`:

1. If `text`'s **data** does not contain a code point whose bidirectional character type is L, AL, or R, then return null.
2. Let `codePoint` be the first code point in `text`'s **data** whose bidirectional character type is L, AL, or R.
3. If `codePoint` is of bidirectional character type AL or R, then return `'rtl'`.

---

**Note**

Since the **dir** attribute is only defined for **HTML elements**, it cannot be present on elements from other namespaces. Thus, elements from other namespaces always end up using the **parent directionality**.
4. If `codePoint` is of bidirectional character type L, then return 'ltr'.

To compute the **parent directionality** given an element `element`:

1. Let `parentNode` be `element`'s parent node.
2. If `parentNode` is a shadow root, then return the `directionality` of `parentNode`'s host.
3. If `parentNode` is an element, then return the `directionality` of `parentNode`.
4. Return 'ltr'.

**Note** has rendering requirements involving the bidirectional algorithm.

The **directionality of an attribute** of an HTML element, which is used when the text of that attribute is to be included in the rendering in some manner, is determined as per the first appropriate set of steps from the following list:

- **If the attribute is a directionality-capable attribute** and the element's `dir` attribute is in the auto state
  
  Find the first character (in logical order) of the attribute's value that is of bidirectional character type L, AL, or R. [BIDI]

  If such a character is found and it is of bidirectional character type AL or R, the directionality of the attribute is 'rtl'.

  Otherwise, the directionality of the attribute is 'ltr'.

- **Otherwise**

  The directionality of the attribute is the same as the element's directionality.

The following attributes are **directionality-capable attributes**:  

- `abbr` on `th` elements  
- `alt` on `area`, `img`, and `input` elements  
- `content` on `meta` elements, if the `name` attribute specifies a metadata name whose value is primarily intended to be human-readable rather than machine-readable  
- `label` on `optgroup`, `option`, and `track` elements  
- `placeholder` on `input` and `textarea` elements  
- `title` on all HTML elements

**For web developers (non-normative)**

```javascript
document.dir = value
```

Returns the `html` element's `dir` attribute's value, if any.

Can be set, to either "ltr", "rtl", or "auto" to replace the `html` element's `dir` attribute's value.

If there is no `html` element, returns the empty string and ignores new values.

The `dir` IDL attribute on an element must reflect the `dir` content attribute of that element, limited to only known values.

The `dir` IDL attribute on Document objects must reflect the `dir` content attribute of the `html` element, if any, limited to only known values. If there is no such element, then the attribute must return the empty string and do nothing on setting.

**Note** Authors are strongly encouraged to use the `dir` attribute to indicate text direction rather than using CSS, since that way their documents will continue to render correctly even in the absence of CSS (e.g. as interpreted by search engines).

**Example**

This markup fragment is of an IM conversation.

```html
<p dir="auto" class="u1">Student</bdi>: How do you write "What's your name?" in Arabic?</p>
<p dir="auto" class="u2">Teacher</bdi>: ما اسمك؟</p>
```
All HTML elements may have the style content attribute set. This is a style attribute as defined by CSS Style Attributes. In user agents that support CSS, the attribute's value must be parsed when the attribute is added or has its value changed, according to the rules given for style attributes. Documents that use style attributes on any of their elements must still be comprehensible and usable if those attributes were removed.

### 3.2.6.5 The style attribute

All HTML elements may have the style content attribute set. This is a style attribute as defined by CSS Style Attributes. In user agents that support CSS, the attribute's value must be parsed when the attribute is added or has its value changed, according to the rules given for style attributes. However, if the Should element's inline behavior be blocked by Content Security Policy algorithm returns "Blocked" when executed upon the attribute's element, style attribute, and the attribute's value, then the style rules defined in the attribute's value must not be applied to the element.

Documents that use style attributes on any of their elements must still be comprehensible and usable if those attributes were removed.

**Note**

In particular, using the style attribute to hide and show content, or to convey meaning that is otherwise not included in the document, is non-conforming. (To hide and show content, use the hidden attribute.)

**For web developers (non-normative)**

`element.style`

Returns a CSSStyleDeclaration object for the element's style attribute.

The style IDL attribute is defined in CSS Object Model.

**Example**

In the following example, the words that refer to colors are marked up using the `span` element and the style attribute to make those words show up in the relevant colors in visual media.

```html
<p>My sweat suit is <span style="color: green; background: transparent">green</span> and my eyes are <span style="color: blue; background: transparent">blue</span>.</p>
```
A **custom data attribute** is an attribute in no namespace whose name starts with the string "data-", has at least one character after the hyphen, is **XML-compatible**, and contains no **ASCII upper alphas**.

---

**Note**

*All attribute names on HTML elements* in HTML documents get ASCII-lowercased automatically, so the restriction on ASCII uppercase letters doesn't affect such documents.

---

**Custom data attributes** are intended to store custom data, state, annotations, and similar, private to the page or application, for which there are no more appropriate attributes or elements.

These attributes are not intended for use by software that is not known to the administrators of the site that uses the attributes. For generic extensions that are to be used by multiple independent tools, either this specification should be extended to provide the feature explicitly, or a technology like **microdata** should be used (with a standardized vocabulary).

---

**Example**

For instance, a site about music could annotate list items representing tracks in an album with custom data attributes containing the length of each track. This information could then be used by the site itself to allow the user to sort the list by track length, or to filter the list for tracks of certain lengths.

```html
<ol>
  <li data-length="2m11s">Beyond The Sea</li>
  ...
</ol>
```

It would be inappropriate, however, for the user to use generic software not associated with that music site to search for tracks of a certain length by looking at this data.

This is because these attributes are intended for use by the site's own scripts, and are not a generic extension mechanism for publicly usable metadata.

---

**Example**

Similarly, a page author could write markup that provides information for a translation tool that they are intending to use:

```html
<p>The third <span data-mytrans-de="Anspruch">claim</span> covers the case of <span translate="no">HTML</span> markup.</p>
```

In this example, the "data-mytrans-de" attribute gives specific text for the MyTrans product to use when translating the phrase "claim" to German. However, the standard `translate` attribute is used to tell it that in all languages, "HTML" is to remain unchanged. When a standard attribute is available, there is no need for a **custom data attribute** to be used.

---

**Example**

In this example, custom data attributes are used to store the result of a feature detection for [PaymentRequest](https://developer.mozilla.org/en-US/docs/Web/API/PaymentRequest), which could be used in CSS to style a checkout page differently.

```html
<script>
  if ('PaymentRequest' in window) {
    document.documentElement.dataset.hasPaymentRequest = '';
  }
</script>
```

Here, the data-has-payment-request attribute is effectively being used as a **boolean attribute**; it is enough to check the presence of the attribute. However, if the author so wishes, it could later be populated with some value, maybe to indicate limited functionality of the feature.

---

Every **HTML element** may have any number of **custom data attributes** specified, with any value.

Authors should carefully design such extensions so that when the attributes are ignored and any associated CSS dropped, the page is...
still usable.

User agents must not derive any implementation behavior from these attributes or values. Specifications intended for user agents must not define these attributes to have any meaningful values.

JavaScript libraries may use the custom data attributes, as they are considered to be part of the page on which they are used. Authors of libraries that are reused by many authors are encouraged to include their name in the attribute names, to reduce the risk of clashes. Where it makes sense, library authors are also encouraged to make the exact name used in the attribute names customizable, so that libraries whose authors unknowingly picked the same name can be used on the same page, and so that multiple versions of a particular library can be used on the same page even when those versions are not mutually compatible.

Example
For example, a library called "DoQuery" could use attribute names like data-doquery-range, and a library called "jJo" could use attributes names like data-jjo-range. The jJo library could also provide an API to set which prefix to use (e.g. J.setDataPrefix('j2'), making the attributes have names like data-j2-range).

For web developers (non-normative)

**element.dataset**

Returns a DOMStringMap object for the element’s data-* attributes.

Hyphenated names become camel-cased. For example, data-foo-bar="" becomes element.dataset.fooBar.

The dataset IDL attribute provides convenient accessors for all the data-* attributes on an element. On getting, the dataset IDL attribute must return a DOMStringMap whose associated element is this element.

The DOMStringMap interface is used for the dataset attribute. Each DOMStringMap has an associated element.

```idl
[Exposed=Window,
LegacyOverrideBuiltIns]
interface DOMStringMap {
  getter DOMString (DOMString name);
  [CEReactions] setter undefined (DOMString name, DOMString value);
  [CEReactions] deleter undefined (DOMString name);
};
```

To get a DOMStringMap’s name-value pairs, run the following algorithm:

1. Let list be an empty list of name-value pairs.
2. For each content attribute on the DOMStringMap’s associated element whose first five characters are the string "data-" and whose remaining characters (if any) do not include any ASCII upper alphas, in the order that those attributes are listed in the element’s attribute list, add a name-value pair to list whose name is the attribute’s name with the first five characters removed and whose value is the attribute’s value.
3. For each name in list, for each U+002D HYPHEN-MINUS character (-) in the name that is followed by an ASCII lower alpha, remove the U+002D HYPHEN-MINUS character (-) and replace the character that followed it by the same character converted to ASCII uppercase.
4. Return list.

The supported property names on a DOMStringMap object at any instant are the names of each pair returned from getting the DOMStringMap’s name-value pairs at that instant, in the order returned.

To determine the value of a named property name for a DOMStringMap, return the value component of the name-value pair whose name component is name in the list returned from getting the DOMStringMap’s name-value pairs.

To set the value of a new named property or set the value of an existing named property for a DOMStringMap, given a property name name and a new value, run the following steps:

1. If name contains a U+002D HYPHEN-MINUS character (-) followed by an ASCII lower alpha, then throw a "SyntaxError" DOMException.
2. For each ASCII upper alpha in name, insert a U+002D HYPHEN-MINUS character (-) before the character and replace the
3. Insert the string `data-` at the front of `name`.

4. If `name` does not match the XML `Name` production, throw an "InvalidCharacterError" `DOMException`.

5. Set an attribute value for the `DOMStringMap`'s associated element using `name` and `value`.

To delete an existing named property `name` for a `DOMStringMap`, run the following steps:

1. For each ASCII upper alpha in `name`, insert a U+002D HYPHEN-MINUS character (-) before the character and replace the character with the same character converted to ASCII lowercase.

2. Insert the string `data-` at the front of `name`.

3. Remove an attribute by name given `name` and the `DOMStringMap`'s associated element.

### Example

If a web page wanted an element to represent a space ship, e.g. as part of a game, it would have to use the `class` attribute along with `data-*` attributes:

```html
<div class="spaceship" data-ship-id="92432"
  data-weapons="laser 2" data-shields="50%"
  data-x="30" data-y="10" data-z="90">
  <button class="fire"
    onclick="spaceships[this.parentNode.dataset.shipId].fire()">Fire</button>
</div>
```

Notice how the hyphenated attribute name becomes camel-cased in the API.

### Example

Given the following fragment and elements with similar constructions:

```html
<img class="tower" id="tower5"
  data-x="12" data-y="5"
  data-ai="robotarget" data-hp="46"
  data-ability="flames"
  src="towers/rocket.png" alt="Rocket Tower">
```

...one could imagine a function `splashDamage()` that takes some arguments, the first of which is the element to process:

```javascript
function splashDamage(node, x, y, damage) {
  if (node.classList.contains('tower')) &
    // checking the 'class' attribute
  node.dataset.x = x &
    // reading the 'data-x' attribute
  node.dataset.y = y;  // reading the 'data-y' attribute
  var hp = parseInt(node.dataset.hp);  // reading the 'data-hp' attribute
  hp = hp - damage;
  if (hp < 0) {
    hp = 0;
    node.dataset.ai = 'dead';  // setting the 'data-ai' attribute
    delete node.dataset.ability;  // removing the 'data-ability' attribute
  }
  node.dataset.hp = hp;  // setting the 'data-hp' attribute
}
```
3.2.7 The `innerText` and `outerText` properties

The **get the text steps**, given an `HTMLElement` element, are:

1. If element is not being rendered or if the user agent is a non-CSS user agent, then return element's descendant text content.

2. Let results be a new empty list.

3. For each child node `node` of element:
   1. Let `current` be the list resulting in running the rendered text collection steps with `node`. Each item in results will either be a string or a positive integer (a required line break count).
   2. For each item `item` in `current`, append `item` to `results`.

4. Remove any items from `results` that are the empty string.

5. Remove any runs of consecutive required line break count items at the start or end of `results`.

6. Replace each remaining run of consecutive required line break count items with a string consisting of as many U+000A LF code points as the maximum of the values in the required line break count items.

7. Return the concatenation of the string items in `results`.

The `innerText` and `outerText` getter steps are to return the result of running get the text steps with this.

The **rendered text collection steps**, given a `node` node, are as follows:

1. Let `items` be the result of running the rendered text collection steps with each child node of `node` in tree order, and then concatenating the results to a single list.

2. If `node`'s computed value of `visibility` is not 'visible', then return `items`.

3. If `node` is not being rendered, then return `items`. For the purpose of this step, the following elements must act as described if the computed value of the 'display' property is not 'none':
   - `select` elements have an associated non-replaced inline `CSS box` whose child boxes include only those of `optgroup` and `option` element child nodes;
   - `optgroup` elements have an associated non-replaced block-level `CSS box` whose child boxes include only those of `option` element child nodes; and
   - `option` element have an associated non-replaced block-level `CSS box` whose child boxes are as normal for non-replaced block-level `CSS boxes`.

For web developers (non-normative)

```javascript
getElement.setAttribute('innerText', value)
```

Returns the element's text content "as rendered".

Can be set, to replace the element's children with the given value, but with line breaks converted to `br` elements.

```javascript
getElement.setAttribute('outerText', value)
```

Returns the element's text content "as rendered".

Can be set, to replace the element with the given value, but with line breaks converted to `br` elements.

This step can produce surprising results, as when the `innerText` getter is invoked on an element not being rendered, its text contents are returned, but when accessed on an element that is being rendered, all of its children that are not being rendered have their text contents ignored.

Intuitively, a required line break count item means that a certain number of line breaks appear at that point, but they can be collapsed with the line breaks induced by adjacent required line break count items, reminiscent to CSS margin-collapsing.
4. If node is a Text node, then for each CSS text box produced by node, in content order, compute the text of the box after application of the CSS 'white-space' processing rules and 'text-transform' rules, set items to the list of the resulting strings, and return items. The CSS 'white-space' processing rules are slightly modified: collapsible spaces at the end of lines are always collapsed, but they are only removed if the line is the last line of the block, or it ends with a `<br>` element. Soft hyphens should be preserved. [CSSTEXT]\(1467\)

5. If node is a `<br>` element, then append a string containing a single U+000A LF code point to items.

6. If node's computed value of 'display' is 'table-cell', and node's CSS box is not the last 'table-cell' box of its enclosing 'table-row' box, then append a string containing a single U+0009 TAB code point to items.

7. If node's computed value of 'display' is 'table-row', and node's CSS box is not the last 'table-row' box of the nearest ancestor 'table' box, then append a string containing a single U+000A LF code point to items.

8. If node is a `<p>` element, then append 2 (a required line break count) at the beginning and end of items.

9. If node's used value of 'display' is block-level or 'table-caption', then append 1 (a required line break count) at the beginning and end of items. [CSSDISPLAY]\(1456\)

10. Return items.

**Note**

Items can be non-empty due to 'display:contents'.

This algorithm is amenable to being generalized to work on ranges. Then we can use it as the basis for Selection's stringifier and maybe expose it directly on ranges. See Bugzilla bug 10583.

The set the inner text steps, given an HTML element element, and a string value are:

1. Let fragment be the rendered text fragment for value given element's node document.

2. Replace all with fragment within element.

The `<innerText>` setter steps are to run set the inner text steps.\(166\)

The `<outerText>` setter steps are:

1. If this's parent is null, then throw a "NoModificationAllowedError" DOMException.

2. Let next be this's next sibling.

3. Let previous be this's previous sibling.

4. Let fragment be the rendered text fragment for the given value given this's node document.

5. If fragment has no children, then append a new Text node whose data is the empty string and node document is this's node document to fragment.

6. Replace this with fragment within this's parent.

7. If next is non-null and next's previous sibling is a Text node, then merge with the next text node given next's previous sibling.

8. If previous is a Text node, then merge with the next text node given previous.

The rendered text fragment for a string input given a Document document is the result of running the following steps:
1. Let fragment be a new DocumentFragment whose node document is document.

2. Let position be a position variable for input, initially pointing at the start of input.

3. Let text be the empty string.

4. While position is not past the end of input:
   1. Collect a sequence of code points that are not U+000A LF or U+000D CR from input given position, and set text to the result.
   2. If text is not the empty string, then append a new Text node whose data is text and node document is document to fragment.
   3. While position is not past the end of input, and the code point at position is either U+000A LF or U+000D CR:
      1. If the code point at position is U+000D CR and the next code point is U+000A LF, then advance position to the next code point in input.
      2. Advance position to the next code point in input.
      3. Append the result of creating an element given document, br\textsuperscript{296}, and the HTML namespace to fragment.

5. Return fragment.

To merge with the next text node given a Text node node:

1. Let next be node's next sibling.
2. If next is not a Text node, then return.
3. Replace data with node, node's data's length, 0, and next's data.
4. If next's parent is non-null, then remove next.

Note

The parent check is necessary as the previous step might have triggered mutation events.

3.2.8 Requirements relating to the bidirectional algorithm

3.2.8.1 Authoring conformance criteria for bidirectional-algorithm formatting characters

Text content\textsuperscript{144} in HTML elements\textsuperscript{145} with Text nodes in their contents\textsuperscript{146}, and text in attributes of HTML elements\textsuperscript{146} that allow free-form text, may contain characters in the ranges U+202A to U+202E and U+2066 to U+2069 (the bidirectional-algorithm formatting characters). [BIDJ]\textsuperscript{144,145}

Note

Authors are encouraged to use the dir\textsuperscript{151} attribute, the bdo\textsuperscript{294} element, and the bdi\textsuperscript{293} element, rather than maintaining the bidirectional-algorithm formatting characters manually. The bidirectional-algorithm formatting characters interact poorly with CSS.

3.2.8.2 User agent conformance criteria

User agents must implement the Unicode bidirectional algorithm to determine the proper ordering of characters when rendering documents and parts of documents. [BIDJ]\textsuperscript{144,145}

The mapping of HTML to the Unicode bidirectional algorithm must be done in one of three ways. Either the user agent must implement CSS, including in particular the CSS 'unicode-bidi', 'direction', and 'content' properties, and must have, in its user agent style sheet, the rules using those properties given in this specification's rendering\textsuperscript{136} section, or, alternatively, the user agent must act as if it implemented just the aforementioned properties and had a user agent style sheet that included all the aforementioned rules, but without letting style sheets specified in documents override them, or, alternatively, the user agent must implement another styling language with equivalent semantics. [CSSGC]\textsuperscript{146}

The following elements and attributes have requirements defined by the rendering\textsuperscript{136} section that, due to the requirements in this
section, are requirements on all user agents (not just those that support the suggested default rendering):

- `dir` attribute
- `bdi` element
- `bdo` element
- `hr` element
- `pre` element
- `textarea` element
- `wbr` element

### 3.2.9 Requirements related to ARIA and to platform accessibility APIs

User agent requirements for implementing Accessibility API semantics on HTML elements are defined in HTML Accessibility API Mappings. In addition to the rules there, for a custom element element, the default ARIA role semantics are determined as follows:

1. Let `map` be element's internal content attribute map.
2. If `map["role"]` exists, then return it.
3. Return no role.

Similarly, for a custom element element, the default ARIA state and property semantics, for a state or property named `stateOrProperty`, are determined as follows:

1. If element's attached internals is non-null:
   1. If element's attached internals's get the stateOrProperty-associated element exists, then return the result of running it.
   2. If element's attached internals's get the stateOrProperty-associated elements exists, then return return the result of running it.
2. If element's internal content attribute map[stateOrProperty] exists, then return it.
3. Return the default value for stateOrProperty.

**Note**

The "default semantics" referred to here are sometimes also called "native", "implicit", or "host language" semantics in ARIA.

**Note**

One implication of these definitions is that the default semantics can change over time. This allows custom elements the same expressivity as built-in elements; e.g., compare to how the default ARIA role semantics of an `a` element change as the `href` attribute is added or removed.

For an example of this in action, see the custom elements section.

Conformance checker requirements for checking use of ARIA `role` and `aria-*` attributes on HTML elements are defined in ARIA in HTML.
4 The elements of HTML

4.1 The document element

4.1.1 The html element

Categories:
None.

Contexts in which this element can be used:
As document's document element.
Wherever a subdocument fragment is allowed in a compound document.

Content model:
A head element followed by a body element.

Tag omission in text/html:
An html element's start tag can be omitted if the first thing inside the html element is not a comment.
An html element's end tag can be omitted if the html element is not immediately followed by a comment.

Content attributes:
Global attributes
Accessibility considerations:
For authors.
For implementers.

DOM interface:

```idl
[Exposed=Window]
interface HTMLHtmlElement : HTMLElement {
    [HTMLConstructor] constructor();
    // also has obsolete members
}
```

The html element represents the root of an HTML document.

Authors are encouraged to specify a lang attribute on the root html element, giving the document's language. This aids speech synthesis tools to determine what pronunciations to use, translation tools to determine what rules to use, and so forth.

Example

The html element in the following example declares that the document's language is English.

```
<!DOCTYPE html>
<html lang="en">
<head>
<title>Swapping Songs</title>
</head>
<body>
<h1>Swapping Songs</h1>
<p>Tonight I swapped some of the songs I wrote with some friends, who gave me some of the songs they wrote. I love sharing my music.</p>
</body>
</html>
```
4.2 Document metadata

4.2.1 The head element

Categories:
None.

Contexts in which this element can be used:
As the first element in an html element.

Content model:
If the document is an iframe srcdoc document or if title information is available from a higher-level protocol: Zero or more elements of metadata content, of which no more than one is a title element and no more than one is a base element.
Otherwise: One or more elements of metadata content, of which exactly one is a title element and no more than one is a base element.

Tag omission in text/html:
A head element's start tag can be omitted if the element is empty, or if the first thing inside the head element is an element.
A head element's end tag can be omitted if the head element is not immediately followed by ASCII whitespace or a comment.

Content attributes:
Global attributes

Accessibility considerations:
For authors.
For implementers.

DOM interface:

The head element represents a collection of metadata for the Document.

Example
The collection of metadata in a head element can be large or small. Here is an example of a very short one:

```xml
<!doctype html>
<html lang=en>
<head>
  <title>A document with a short head</title>
</head>
<body>
...
</html>
```

Here is an example of a longer one:

```xml
<!DOCTYPE HTML>
<HTML LANG="EN">
<HEAD>
  <META CHARSET="UTF-8">
  <BASE HREF="https://www.example.com/">
  <TITLE>An application with a long head</TITLE>
  <LINK REL="STYLE" HREF="default.css">
  <LINK REL="STYLE" ALTERNATE="HREF="big.css" TITLE="Big Text">
  <SCRIPT SRC="support.js"></SCRIPT>
  <META NAME="APPLICATION-NAME" CONTENT="Long headed application">
</HEAD>
```
4.2.2 The **title** element

**Categories**: Metadata content.

**Contexts in which this element can be used**: In a **head** element containing no other **title** elements.

**Content model**: Text that is not inter-element whitespace.

**Tag omission in text/html**: Neither tag is omissible.

**Content attributes**: Global attributes

**Accessibility considerations**: For authors, For implementers.

**DOM interface**: Exposed=Window

```javascript
interface HTMLTitleElement : HTMLElement {
    [HTMLConstructor] constructor();
    [CEReactions] attribute DOMString text;
}
```

The **title** element represents the document's title or name. Authors should use titles that identify their documents even when they are used out of context, for example in a user's history or bookmarks, or in search results. The document's title is often different from its first heading, since the first heading does not have to stand alone when taken out of context.

There must be no more than one **title** element per document.

**Note**: If it's reasonable for the **Document** to have no title, then the **title** element is probably not required. See the **head** element's content model for a description of when the element is required.

**For web developers (non-normative)**

```javascript
title.text [ = value ]
```

Returns the child text content of the element.

Can be set, to replace the element's children with the given value.

The **text** attribute's getter must return this **title** element's child text content.

The **text** attribute's setter must string replace all with the given value within this **title** element.
Example

Here are some examples of appropriate titles, contrasted with the top-level headings that might be used on those same pages.

```html
<title>Introduction to The Mating Rituals of Bees</title>
...
<h1>Introduction</h1>
<p>This companion guide to the highly successful <cite>Introduction to Medieval Bee-Keeping</cite> book is...
```

The next page might be a part of the same site. Note how the title describes the subject matter unambiguously, while the first heading assumes the reader knows what the context is and therefore won't wonder if the dances are Salsa or Waltz:

```html
<title>Dances used during bee mating rituals</title>
...
<h1>The Dances</h1>
```

The string to use as the document's title is given by the `document.title` IDL attribute.

User agents should use the document's title when referring to the document in their user interface. When the contents of a `title` element are used in this way, the directionality of that `title` element should be used to set the directionality of the document's title in the user interface.

### 4.2.3 The `base` element

**Categories**: Metadata content.

**Contexts in which this element can be used**: In a `head` element containing no other `base` elements.

**Content model**: Nothing.

**Tag omission in text/html**: No end tag.

**Content attributes**:

- `href` — Document base URL.
- `target` — Default navigable for hyperlink navigation and form submission.

**Accessibility considerations**:

- For authors.
- For implementers.

**DOM interface**:

```javascript
IDL [Exposed=Window]
interface HTMLBaseElement : HTMLElement {
    [HTMLConstructor] constructor();

    [CFReactions] attribute USVString href;
    [CFReactions] attribute DOMString target;
};
```

The `base` element allows authors to specify the document base URL for the purposes of parsing URLs, and the name of the default navigable for the purposes of following hyperlinks. The element does not represent any content beyond this information.

There must be no more than one `base` element per document.
A base element must have either an href attribute, a target attribute, or both.

The href content attribute, if specified, must contain a valid URL potentially surrounded by spaces.

A base element, if it has an href attribute, must come before any other elements in the tree that have attributes defined as taking URLs, except the html element (its manifest attribute isn't affected by base elements).

Note
If there are multiple base elements with href attributes, all but the first are ignored.

The target attribute, if specified, must contain a valid navigable target name or keyword, which specifies which navigable is to be used as the default when hyperlinks and forms in the Document cause navigation.

A base element, if it has a target attribute, must come before any elements in the tree that represent hyperlinks.

Note
If there are multiple base elements with target attributes, all but the first are ignored.

To get an element's target, given an area, or form element, and an optional string-or-null target (default null), run these steps:

1. If target is null, then:
   1. If element has a target attribute, then set target to that attribute's value.
   2. Otherwise, if element's node document contains a base element with a target attribute, set target to the value of the target attribute of the first such base element.
2. If target is not null, and contains an ASCII tab or newline and a U+003C (<), then set target to "_blank".
3. Return target.

A base element that is the first base element with an href content attribute in a document tree has a frozen base URL. The frozen base URL must be immediately set for an element whenever any of the following situations occur:

- The base element becomes the first base element in tree order with an href content attribute in its Document.
- The base element is the first base element in tree order with an href content attribute in its Document, and its href content attribute is changed.

To set the frozen base URL for an element:

1. Let document be element's node document.
2. Let urlRecord be the result of parsing the value of element's href attribute with document's fallback base URL, and document's character encoding. (Thus, the base element isn't affected by itself.)
3. If any of the following are true:
   - urlRecord is failure;
   - urlRecord's scheme is "data" or "javascript"; or
   - running Is base allowed for Document? on urlRecord and document returns "Blocked",
   then set element's frozen base URL to document's fallback base URL and return.
4. Set element's frozen base URL to urlRecord.

The href IDL attribute, on getting, must return the result of running the following algorithm:

1. Let document be element's node document.
2. Let url be the value of the href attribute of this element, if it has one, and the empty string otherwise.
3. Let urlRecord be the result of parsing url with document's fallback base URL, and document's character encoding. (Thus, the base element isn't affected by other base elements or itself.)

4. If urlRecord is failure, return url.

5. Return the serialization of urlRecord.

The href IDL attribute, on setting, must set the href content attribute to the given new value.

The target IDL attribute must reflect the content attribute of the same name.

Example

In this example, a base element is used to set the document base URL:

```html
<!DOCTYPE html>
<html lang="en">
<head>
  <title>This is an example for the &lt;base&gt; element</title>
  <base href="https://www.example.com/news/index.html">
</head>
<body>
  <p>Visit the <a href="archives.html">archives</a>.</p>
</body>
</html>
```

The link in the above example would be a link to "https://www.example.com/news/archives.html".

4.2.4 The link element

Categories:

- Metadata content
- Flow content
- Phrasing content

Contexts in which this element can be used:

- Where metadata content is expected.
- In a noscript element that is a child of a head element.
- If the element is allowed in the body where phrasing content is expected.

Content model:

- Nothing.

Tag omission in text/html:

- No end tag.

Content attributes:

- Global attributes
  - href — Address of the hyperlink
  - crossorigin — How the element handles crossorigin requests
  - rel — Relationship between the document containing the hyperlink and the destination resource
  - media — Applicable media
  - integrity — Integrity metadata used in Subresource Integrity checks [SRI]
  - hrellang — Language of the linked resource
  - type — Hint for the type of the referenced resource
  - refererpolicy — Referrer policy for fetches initiated by the element
  - sizes — Sizes of the icons (for rel="icon")
  - imagesrcset — Images to use in different situations, e.g., high-resolution displays, small monitors, etc. (for rel="preload")
  - imagesizes — Image sizes for different page layouts (for rel="preload")
  - as — Potential destination for a preload request (for rel="preload" and rel="modulepreload")
  - blocking — Whether the element is potentially render-blocking

In this example, a base element is used to set the document base URL:
color — Color to use when customizing a site’s icon (for `rel` = “mask-icon”)
disabled — Whether the link is disabled
tfetchpriority — Sets the `priority` for fetched initiated by the element
Also, the `title` attribute has special semantics on this element: Title of the link; `CSS style sheet set name`

**Accessibility considerations:**
- For authors.
- For implementers.

**DOM interface:**

```idl
[Exposed=Window]
interface HTMLLinkElement : HTML Element {
    [HTMLConstructor] constructor();

    [CEReactions] attribute USVString href;
    [CEReactions] attribute DOMString? crossOrigin;
    [CEReactions] attribute DOMString rel;
    [CEReactions] attribute DOMString as;
    [SameObject, PutForwards=value] readonly attribute DOMTokenList relList;
    [CEReactions] attribute DOMString media;
    [CEReactions] attribute DOMString integrity;
    [CEReactions] attribute DOMString hreflang;
    [CEReactions] attribute DOMString type;
    [SameObject, PutForwards=value] readonly attribute DOMTokenList sizes;
    [CEReactions] attribute USVString imagesrcset;
    [CEReactions] attribute DOMString imageSizes;
    [CEReactions] attribute DOMString refererPolicy;
    [SameObject, PutForwards=value] readonly attribute DOMTokenList blocking;
    [CEReactions] attribute boolean disabled;
    [CEReactions] attribute DOMString fetchPriority;

    // also has obsolete members
}
HTMLLinkElement includes LinkStyle;
```

The `Link` element allows authors to link their document to other resources.

The address of the link(s) is given by the `href` attribute. If the `href` attribute is present, then its value must be a valid non-empty URL potentially surrounded by spaces. One or both of the `href` or `imagesrcset` attributes must be present.

If both the `href` and `imagesrcset` attributes are absent, then the element does not define a link.

The types of link indicated (the relationships) are given by the value of the `rel` attribute, which, if present, must have a value that is a unordered set of unique space-separated tokens. The allowed keywords and their meanings are defined in a later section. If the `rel` attribute is absent, has no keywords, or if none of the keywords used are allowed according to the definitions in this specification, then the element does not create any links.

A `Link` element's supported tokens are the keywords defined in HTML link types, which are allowed on `Link` elements, impact the processing model, and are supported by the user agent. The possible supported tokens are `alternate`, `dns-prefetch`, `expect`, `icon`, `manifest`, `modulepreload`, `next`, `pingback`, `preconnect`, `prefetch`, `preload`, `search`, and `stylesheet`. `Link`'s supported tokens must only include the tokens from this list that the user agent implements the processing model for.

**Note:** Theoretically a user agent could support the processing model for the `canonical` keyword — if it were a search engine that executed JavaScript. But in practice that's quite unlikely. So in most cases, `canonical` ought not be included in `Link`'s supported tokens.

A `Link` element must have either a `rel` attribute or an `itemprop` attribute, but not both.

If a `Link` element has an `itemprop` attribute, or has a `rel` attribute that contains only keywords that are `body-ok`, then the
element is said to be **allowed in the body**. This means that the element can be used where phrasing content is expected.

**Note**

If the `rel` attribute is used, the element can only sometimes be used in the body of the page. When used with the `itemprop` attribute, the element can be used both in the head element and in the body of the page, subject to the constraints of the microdata model.

Two categories of links can be created using the `<link>` element: **links to external resources** and **hyperlinks**. The **link types section** defines whether a particular link type is an external resource or a hyperlink. One `<link>` element can create multiple links (of which some might be external resource links and some might be hyperlinks); exactly which and how many links are created depends on the keywords given in the `rel` attribute. User agents must process the links on a per-link basis, not a per-element basis.

**Note**

Each link created for a `<link>` element is handled separately. For instance, if there are two `<link>` elements with `rel`="stylesheet", they each count as a separate external resource, and each is affected by its own attributes independently. Similarly, if a single `<link>` element has a `rel`="stylesheet" attribute with the value `next stylesheet`, it creates both a **hyperlink** (for the `next` keyword) and an **external resource link** (for the `stylesheet` `keyword), and they are affected by other attributes (such as `media` or `title`) differently.

**Example**

For example, the following `<link>` element creates two **hyperlinks** (to the same page):

```html
<link rel="author license" href="/about"/>
```

The two links created by this element are one whose semantic is that the target page has information about the current page's author, and one whose semantic is that the target page has information regarding the license under which the current page is provided.

**Hyperlinks** created with the `<link>` element and its `rel` attribute apply to the whole document. This contrasts with the `rel` attribute of `a` and `area` elements, which indicates the type of a link whose context is given by the link's location within the document.

Unlike those created by `a` and `area` elements, **hyperlinks** created by `<link>` elements are not displayed as part of the document by default, in user agents that **support the suggested default rendering**. And even if they are force-displayed using CSS, they have no **activation behavior**. Instead, they primarily provide semantic information which might be used by the page or by other software that consumes the page's contents. Additionally, the user agent can **provide its own UI for following such hyperlinks**.

The exact behavior for **links to external resources** depends on the exact relationship, as defined for the relevant **link type**.

The **crossorigin attribute is a CORS settings attribute**. It is intended for use with **external resource links**.

The **media** attribute says which media the resource applies to. The value must be a **valid media query list**.

The **integrity attribute represents the integrity metadata for requests which this element is responsible for.** The value is text. The attribute must only be specified on `<link>` elements that have a `rel` attribute that contains the `stylesheet`, `preload`, or `modulepreload` keyword. [ISRI] [MDN]

The `hreflang` attribute on the `<link>` element has the same semantics as the `hreflang attribute on the `a` element.`

The **type attribute gives the MIME type of the linked resource.** It is purely advisory. The value must be a **valid MIME type string**.

For **external resource links**, the `type` attribute is used as a hint to user agents so that they can avoid fetching resources they do not support.

The **referrerpolicy attribute is a referrer policy attribute**. It is intended for use with **external resource links**, where it helps set the **referrer policy** used when fetching and processing the linked resource. [REFERRERPOLICIES] [MDN]

The **title** attribute gives the title of the link. With one exception, it is purely advisory. The value is text. The exception is for style sheet links that are **in a document tree**, for which the `title` attribute defines **CSS style sheet sets**.
The `imagesrcset` attribute may be present, and is a `src` attribute.

The `imagesrcset` and `href` attributes (if width descriptors are not used) together contribute the image sources to the source set.

If the `imagesrcset` attribute is present and has any image candidate strings using a width descriptor, the `imagesizes` attribute must also be present, and is a `sizes` attribute. The `imagesizes` attribute contributes the source size to the source set.

The `imagesrcset` and `imagesizes` attributes must only be specified on `link` elements that have both a `rel` attribute that specifies the `preload` keyword, as well as an `as` attribute in the "image" state.

Example

These attributes allow preloading the appropriate resource that is later used by an `img` element that has the corresponding values for its `srcset` and `sizes` attributes:

```
<link rel="preload" as="image"
     imagesrcset="wolf_400px.jpg 400w, wolf_800px.jpg 800w, wolf_1600px.jpg 1600w"
     imagesizes="50vw">

<!-- ... later, or perhaps inserted dynamically ... -->
<img src="wolf.jpg" alt="A rad wolf"
     srcset="wolf_400px.jpg 400w, wolf_800px.jpg 800w, wolf_1600px.jpg 1600w"
     sizes="50vw">
```

Note how we omit the `href` attribute, as it would only be relevant for browsers that do not support `imagesrcset`, and in those cases it would likely cause the incorrect image to be preloaded.

Example

The `imagesrcset` attribute can be combined with the `media` attribute to preload the appropriate resource selected from a `picture` element's sources, for art direction:

```
<link rel="preload" as="image"
     imagesrcset="dog-cropped-1x.jpg, dog-cropped-2x.jpg 2x"
     media="(max-width: 800px)">

<link rel="preload" as="image"
     imagesrcset="dog-wide-1x.jpg, dog-wide-2x.jpg 2x"
     media="(min-width: 801px)">

<!-- ... later, or perhaps inserted dynamically ... -->
<picture>
  <source srcset="dog-cropped-1x.jpg, dog-cropped-2x.jpg 2x"
          media="(max-width: 800px)"
  >
  <img src="dog-wide-1x.jpg" srcset="dog-wide-2x.jpg 2x"
       alt="An awesome dog">
</picture>
```

The `sizes` attribute gives the sizes of icons for visual media. Its value, if present, is merely advisory. User agents may use the value to decide which icon(s) to use if multiple icons are available. If specified, the attribute must have a value that is an unordered set of unique space-separated tokens, which are ASCII case-insensitive. Each value must be either an ASCII case-insensitive match for the string "any", or a value that consists of two valid non-negative integers that do not have a leading U+0030 DIGIT ZERO (0) character and that are separated by a single U+0020 SPACE character. The attribute must only be specified on `link` elements that have a `rel` attribute that specifies the `icon` keyword or the `apple-touch-icon` keyword.
The `as` attribute specifies the potential destination for a preload request for the resource given by the `href` attribute. It is an enumerated attribute. Each potential destination is a keyword for this attribute, mapping to a state of the same name. The attribute must be specified on `link` elements that have a `rel` attribute that contains the `preload` keyword. It may be specified on `link` elements that have a `rel` attribute that contains the `modulepreload` keyword; in such cases it must have a value which is a script-like destination. For other `link` elements, it must not be specified.

The processing model for how the `as` attribute is used is given in an individual link type's fetch and process the linked resource algorithm.

The `blocking` attribute is a blocking attribute. It is used by link types `stylesheet` and `expect`, and it must only be specified on `link` elements that have a `rel` attribute containing those keywords.

The `color` attribute is used with the `mask-icon` link type. The attribute must only be specified on `link` elements that have a `rel` attribute that contains the `mask-icon` keyword. The value must be a string that matches the CSS `<color>` production, defining a suggested color that user agents can use to customize the display of the icon that the user sees when they pin your site.

The `disabled` attribute is a boolean attribute that is used with the `stylesheet` link type. The attribute must only be specified on `link` elements that have a `rel` attribute that contains the `stylesheet` keyword.

Whenever the `disabled` attribute is removed, set the `link` element's `explicitly enabled` attribute to true.

The `fetchpriority` attribute is a fetch priority attribute that is intended for use with external resource links, where it is used to set the priority used when fetching and processing the linked resource.

The IDL attributes `href`, `hreflang`, `integrity`, `media`, `rel`, `sizes`, `type`, `blocking`, and `disabled` each must reflect the respective content attributes of the same name.

There is no reflecting IDL attribute for the `color` attribute, but this might be added later.
The `as` IDL attribute must reflect the `as` content attribute, limited to only known values.

The `crossOrigin` IDL attribute must reflect the `crossorigin` content attribute, limited to only known values.

The `referrerPolicy` IDL attribute must reflect the `referrerpolicy` content attribute, limited to only known values.

The `fetchPriority` IDL attribute must reflect the `fetchpriority` content attribute, limited to only known values.

The `imageSrcset` IDL attribute must reflect the `imagesrcset` content attribute.

The `imageSizes` IDL attribute must reflect the `imagesizes` content attribute.

The `relList` IDL attribute must reflect the `rel` content attribute.

---

**Note**

The `relList` attribute can be used for feature detection, by calling its `supports()` method to check which types of links are supported.

---

### 4.2.4.1 Processing the `media` attribute

If the link is a hyperlink then the `media` attribute is purely advisory, and describes for which media the document in question was designed.

However, if the link is an external resource link, then the `media` attribute is prescriptive. The user agent must apply the external resource when the `media` attribute's value matches the environment and the other relevant conditions apply, and must not apply it otherwise.

The default, if the `media` attribute is omitted, is "all", meaning that by default links apply to all media.

---

**Note**

The external resource might have further restrictions defined within that limit its applicability. For example, a CSS style sheet might have some `@media` blocks. This specification does not override such further restrictions or requirements.

---

### 4.2.4.2 Processing the `type` attribute

If the `type` attribute is present, then the user agent must assume that the resource is of the given type (even if that is not a valid MIME type string, e.g. the empty string). If the attribute is omitted, but the `external resource link` type has a default type defined, then the user agent must assume that the resource is of that type. If the UA does not support the given MIME type for the given link relationship, then the UA should not fetch and process the linked resource; if the UA does support the given MIME type for the given link relationship, then the UA should fetch and process the linked resource at the appropriate time as specified for the external resource link's particular type. If the attribute is omitted, and the `external resource link` type does not have a default type defined, but the user agent would fetch and process the linked resource if the type was known and supported, then the user agent should fetch and process the linked resource under the assumption that it will be supported.

User agents must not consider the `type` attribute authoritative — upon fetching the resource, user agents must not use the `type` attribute to determine its actual type. Only the actual type (as defined in the next paragraph) is used to determine whether to apply the resource, not the aforementioned assumed type.

If the `external resource link` type defines rules for processing the resource's Content-Type metadata, then those rules apply. Otherwise, if the resource is expected to be an image, user agents may apply the image sniffing rules, with the official type being the type determined from the resource's Content-Type metadata, and use the resulting computed type of the resource as if it was the actual type. Otherwise, if neither of these conditions apply or if the user agent opts not to apply the image sniffing rules, then the user agent must use the resource's Content-Type metadata to determine the type of the resource. If there is no type metadata, but the `external resource link` type has a default type defined, then the user agent must assume that the resource is of that type.

**Note**

The stylesheet link type defines rules for processing the resource's Content-Type metadata.
Once the user agent has established the type of the resource, the user agent must apply the resource if it is of a supported type and the other relevant conditions apply, and must ignore the resource otherwise.

**Example**

If a document contains style sheet links labeled as follows:

```html
<link rel="stylesheet" href="A" type="text/plain"/>
<link rel="stylesheet" href="B" type="text/css"/>
<link rel="stylesheet" href="C"/>
```

...then a compliant UA that supported only CSS style sheets would fetch the B and C files, and skip the A file (since text/plain is not the MIME type for CSS style sheets).

For files B and C, it would then check the actual types returned by the server. For those that are sent as text/css, it would apply the styles, but for those labeled as text/plain, or any other type, it would not.

If one of the two files was returned without a Content-Type metadata, or with a syntactically incorrect type like Content-Type: "null", then the default type for stylesheet links would kick in. Since that default type is text/css, the style sheet would nonetheless be applied.

### 4.2.4.3 Fetching and processing a resource from a link element

All external resource links have a fetch and process the linked resource algorithm, which takes a link element el. They also have linked resource fetch setup steps which take a link element el and request. Individual link types may provide their own fetch and process the linked resource algorithm, but unless explicitly stated, they use the default fetch and process the linked resource algorithm. Similarly, individual link types may provide their own linked resource fetch setup steps, but unless explicitly stated, these steps just return true.

The default fetch and process the linked resource, given a link element el, is as follows:

1. Let options be the result of creating link options from el.
2. Let request be the result of creating a link request given options.
3. If request is null, then return.
4. Set request's synchronous flag.
5. Run the linked resource fetch setup steps, given el and request. If the result is false, then return.
6. Set request's initiator type to "css" if el's rel attribute contains the keyword stylesheet; "link" otherwise.
7. Fetch with processResponseConsumeBody set to the following steps given response and null, failure, or a byte sequence bodyBytes:
   1. Let success be true.
   2. If any of the following are true:
      - bodyBytes is null or failure; or
      - response's status is not an ok status,
     then set success to false.
   
Note

*Note that content-specific errors, e.g., CSS parse errors or PNG decoding errors, do not affect success.*

3. Otherwise, wait for the link resource's critical subresources to finish loading.

The specification that defines a link type's critical subresources (e.g., CSS) is expected to describe how these subresources are fetched and processed. However, since this is not currently explicit, this specification describes waiting for a link resource's critical subresources to be fetched and processed, with the
4. **Process the linked resource**\(^{p181}\) given \(el\), \(success\), \(response\), and \(bodyBytes\).

To **create a link request** given a **link processing options**\(^{p181}\) **options**:

1. **Assert**: \(options\)'s \(href\)\(^{p182}\) is not the empty string.
2. If \(options\)'s \(destination\)\(^{p182}\) is null, then return null.
3. Let \(url\) be the result of **encoding-parsing a URL**\(^{p96}\) given \(options\)'s \(href\)\(^{p182}\), relative to \(options\)'s \(base URL\)\(^{p182}\). **Passing the base URL instead of a document or environment is tracked by issue #9715.**
4. If \(url\) is failure, then return null.
5. Let \(request\) be the result of **creating a potential-CORS request**\(^{p97}\) given \(url\), \(options\)'s \(destination\)\(^{p182}\), and \(options\)'s \(crossorigin\)\(^{p182}\).
6. Set \(request\)'s \(policy container\) to \(options\)'s \(policy container\)\(^{p182}\).
7. Set \(request\)'s \(integrity metadata\) to \(options\)'s \(integrity\)\(^{p182}\).
8. Set \(request\)'s \(cryptographic nonce metadata\) to \(options\)'s \(cryptographic nonce metadata\)\(^{p182}\).
9. Set \(request\)'s \(referrer policy\) to \(options\)'s \(referrer policy\)\(^{p182}\).
10. Set \(request\)'s \(client\) to \(options\)'s \(environment\)\(^{p182}\).
11. Set \(request\)'s \(priority\) to \(options\)'s \(fetch priority\)\(^{p182}\).
12. Return \(request\).

User agents may opt to only try to **fetch and process**\(^{p180}\) such resources when they are needed, instead of pro-actively fetching all the **external resources**\(^{p299}\) that are not applied.

Similar to the **fetch and process the linked resource**\(^{p180}\) algorithm, all **external resource links**\(^{p299}\) have a **process the linked resource** algorithm which takes a **link**\(^{p174}\) element \(el\), boolean success, a **response** \(response\), and a **byte sequence** \(bodyBytes\). Individual link types may provide their own **process the linked resource**\(^{p181}\) algorithm, but unless explicitly stated, that algorithm does nothing.

Unless otherwise specified for a given \(rel\)\(^{p175}\) keyword, the element must **delay the load event**\(^{p1340}\) of the element's **node document** until all the attempts to **fetch and process the linked resource**\(^{p180}\) and its **critical subresources**\(^{p45}\) are complete. (Resources that the user agent has not yet attempted to fetch and process, e.g., because it is waiting for the resource to be needed, do not **delay the load event**\(^{p1340}\).)

### 4.2.4.4 Processing `Link` headers

All link types that can be **external resource links**\(^{p299}\) define a **process a link header** algorithm, which takes a **link processing options**\(^{p181}\). This algorithm defines whether and how they react to appearing in an HTTP `Link` response header.

**Note**

*For most link types, this algorithm does nothing. The **summary table**\(^{p311}\) is a good reference to quickly know whether a link type has defined **process a link header**\(^{p181}\) steps.*

**A link processing options** is a **struct**. It has the following **items**:
**href** (default the empty string)
**destination** (default the empty string)
**initiator** (default "link")
**integrity** (default the empty string)
**type** (default the empty string)
**cryptographic nonce metadata** (default the empty string)
   A string
**crossover** (default [CORS](https://developer.mozilla.org/en-US/docs/Web/HTTP/CORS) state)
**referrer policy** (default the empty string)
**source set** (default null)
   Null or a [source set](https://developer.mozilla.org/en-US/docs/Web/Guide/API/Canvas_API/CNRGBLUE)
**base URL**
**origin**
   An [origin](https://developer.mozilla.org/en-US/docs/Web/API/Window/origin)
**environment**
   An [environment](https://developer.mozilla.org/en-US/docs/Web/API/Window/environment)
**policy container**
**document** (default null)
**on document ready** (default null)
**fetch priority** (default [auto](https://developer.mozilla.org/en-US/docs/Web/API/Window/fetch priority attribute)
   A [fetch priority attribute](https://developer.mozilla.org/en-US/docs/Web/API/Window/fetch priority attribute) state

---

**Note**


---

**To create link options from element** given a [link](https://developer.mozilla.org/en-US/docs/Web/API/Link) element `el`:

2. Let `options` be a new [link processing options](https://developer.mozilla.org/en-US/docs/Web/API/Window/link processing options) with
   - **destination** the result of [translating](https://developer.mozilla.org/en-US/docs/Web/API/URL/parse) the state of `el`'s [as](https://developer.mozilla.org/en-US/docs/Web/API/URL) attribute.
   - **crossover** the state of `el`'s [crossorigin](https://developer.mozilla.org/en-US/docs/Web/API/URL/crossorigin) content attribute
   - **referrer policy** the state of `el`'s [referrer policy](https://developer.mozilla.org/en-US/docs/Web/API/Window/referrer policy) content attribute
   - **source set** `el`'s [source set](https://developer.mozilla.org/en-US/docs/Web/API/Canvas_API/CNRGBLUE)
   - **origin** document's [origin](https://developer.mozilla.org/en-US/docs/Web/API/Window/origin)
   - **environment** document's [environment](https://developer.mozilla.org/en-US/docs/Web/API/Window/environment)
   - **policy container** document's [policy container](https://developer.mozilla.org/en-US/docs/Web/API/Window/policy_container)
document

cryptographic nonce metadata

The current value of el's [[CryptographicNonce]]\(^{99}\) internal slot

fetch priority

the state of el's fetchpriority\(^{178}\) content attribute

3. If el has an href\(^{175}\) attribute, then set options's href to the value of el's href attribute.

4. If el has an integrity\(^{176}\) attribute, then set options's integrity to the value of el's integrity content attribute.

5. If el has a type\(^{176}\) attribute, then set options's type to the value of el's type attribute.

6. Assert: options's href is not the empty string, or options's source set is not null.

A link\(^{174}\) element with neither an href or an imagesrcset does not represent a link.

7. Return options.

To extract links from headers given a header list:

1. Let links be a new list.

2. Let rawLinkHeaders be the result of getting, decoding, and splitting `Link` from response's header list.

3. For each linkHeader of rawLinkHeaders:
   1. Let linkObject be the result of parsing linkHeader. [WEBLINK]\(^{1463}\)
   2. If linkObject['target-uri'] does not exist, then continue.
   3. Append linkObject to links.

4. Return links.

To process link headers given a Document\(^{128}\) doc, a response response, and a "pre-media" or "media" phase:

1. Let links be the result of extracting links from response's header list.

2. For each linkObject in links:
   1. Let rel be linkObject['relation-type'].
   2. Let attribs be linkObject['target-attributes'].
   3. Let expectedPhase be "media" if either "srcset", "imagesrcset", or "media", exist in attribs; otherwise "pre-media".
   4. If expectedPhase is not phase, then continue.
   5. If attribs["media"] exists and attribs["media"] does not match the environment, then continue.
   6. Let options be a new link processing options with
      
      1. href
      2. base URL
      3. origin
      4. environment
      5. policy container
      6. document

    7. Apply link options from parsed header attributes to options given attribs.

8. If attribs["imagesrcset"] exists and attribs["imagesizes"] exists, then set options's source set to the
result of creating a source set given linkObject["target_url"], attribs["imagesrcset"], attribs["imagesizes"], and null.

9. Run the process a link header steps for rel given options.

To apply link options from parsed header attributes to a link processing options options given attribs:

1. If attribs["as"] exists, then set options's destination to the result of translating attribs["as"].
2. If attribs["crossorigin"] exists and is an ASCII case-insensitive match for one of the CORS settings attribute keywords, then set options's crossorigin to the CORS settings attribute state corresponding to that keyword.
3. If attribs["integrity"] exists, then set options's integrity to attribs["integrity"].
4. If attribs["referrerpolicy"] exists and is an ASCII case-insensitive match for some referrer policy, then set options's referrer policy to that referrer policy.
5. If attribs["nonce"] exists, then set options's nonce to attribs["nonce"].
6. If attribs["type"] exists, then set options's type to attribs["type"].
7. If attribs["fetchpriority"] exists and is an ASCII case-insensitive match for a fetch priority attribute keyword, then set options's fetch priority to that fetch priority attribute keyword.

4.2.4.5 Early hints

Early hints allow user-agents to perform some operations, such as to speculatively load resources that are likely to be used by the document, before the navigation request is fully handled by the server and a response code is served. Servers can indicate early hints by serving a response with a 103 status code before serving the final response.

In addition to the `Link` headers, it is possible that the 103 response contains a Content Security Policy header, which is enforced when processing the early hint.

Example

For example, given the following sequence of responses:

103 Early Hint
Link: </image.png>; rel=preload; as=image

200 OK
Content-Type: text/html

<!DOCTYPE html>
...
<img src="/image.png">

the image will start loading before the HTML content arrives.

Note

For compatibility reasons early hints are typically delivered over HTTP/2 or above, but for readability we use HTTP/1.1-style notation below.

Example

For example, given the following sequence of responses:

103 Early Hint
Content-Security-Policy: style-src: self;
To process early hint headers given a `response` response and an `environment` reservedEnvironment:

1. Let `earlyPolicyContainer` be the result of creating a policy container from a fetch response given `response` and `reservedEnvironment`.

   **Note**
   
   This allows the early hint `response` to include a `Content Security Policy` which would be enforced when fetching the early hint request.

2. Let `links` be the result of extracting links from `response`'s header list.

3. Let `earlyHints` be an empty list.

4. For each `linkObject` in `links`:

   **Note**
   
   The moment we receive the early hint link header, we begin fetching `earlyRequest`. If it comes back before the `Document` is created, we set `earlyResponse` to the `response` of that fetch and once the `Document` is created we commit it (by making it available in the map of preloaded resources as if it was a `link` element). If the `Document` is created first, the `response` is committed as soon as it becomes available.

   1. Let `rel` be `linkObject["relation_type"]`.

   2. Let `options` be a new `link processing options` with

      - `href` `linkObject["target_uri"]`
      - `initiator"early-hint"
      - `base URL` `response`'s `URL`
      - `response`'s `URL`'s `origin`
      - `environment` `reservedEnvironment`
      - `policy container` `earlyPolicyContainer`

   3. Let `attribs` be `linkObject["target_attributes"]`.

   **Note**
   
   Only the `as`, `crossorigin`, `integrity`, and `type` attributes are handled as part of early hint.
4. **Apply link options from parsed header attributes** to options given in `attrs`.

5. Run the **process a link header** steps for `rel` given `options`.

6. **Append** `options` to `earlyHints`.

5. Return the following substeps given `Document` doc: for each `options` in `earlyHints`:

   1. If `options`'s `on document ready` is null, then set `options`'s `document` to doc.
   2. Otherwise, call `options`'s `on document ready` with doc.

### 4.2.4.6 Providing users with a means to follow hyperlinks created using the `link` element

Interactive user agents may provide users with a means to **follow the hyperlinks** created using the `link` element, somewhere within their user interface. Such invocations of the **follow the hyperlink** algorithm must set the `userInvolvement` argument to "browser UI". The exact interface is not defined by this specification, but it could include the following information (obtained from the element's attributes, again as defined below), in some form or another (possibly simplified), for each hyperlink created with each `link` element in the document:

- The relationship between this document and the resource (given by the `rel` attribute)
- The title of the resource (given by the `title` attribute).
- The address of the resource (given by the `href` attribute).
- The language of the resource (given by the `hreflang` attribute).
- The optimum media for the resource (given by the `media` attribute).

User agents could also include other information, such as the type of the resource (as given by the `type` attribute).

### 4.2.5 The `meta` element

**Categories**:
- Metadata content
- If the `itemprop` attribute is present: flow content
- If the `itemprop` attribute is present: phrasing content

**Contexts in which this element can be used**:
- If the `charset` attribute is present, or if the element's `http-equiv` attribute is in the **Encoding declaration state**: in a `head` element.
- If the `http-equiv` attribute is present but not in the **Encoding declaration state**: in a `head` element.
- If the `http-equiv` attribute is present but not in the **Encoding declaration state**: in a `noscript` element that is a child of a `head` element.
- If the `name` attribute is present: where metadata content is expected.
- If the `itemprop` attribute is present: where metadata content is expected.
- If the `itemprop` attribute is present: where phrasing content is expected.

**Content model**:
- Nothing

**Tag omission in text/html**:
- No end tag

**Content attributes**:
- Global attributes
  - name — Metadata name
The `meta` element represents various kinds of metadata that cannot be expressed using the `title`, `base`, `link`, `style`, and `script` elements.

The `meta` element can represent document-level metadata with the `name` attribute, pragma directives with the `http-equiv` attribute, and the file's character encoding declaration when an HTML document is serialized to string form (e.g. for transmission over the network or for disk storage) with the `charset` attribute.

Exactly one of the `name`, `http-equiv`, or `charset` attributes must be specified.

If either `name`, `http-equiv`, or `itemprop` is specified, then the `content` attribute must also be specified. Otherwise, it must be omitted.

The `charset` attribute specifies the character encoding used by the document. This is a character encoding declaration. If the attribute is present, its value must be an ASCII case-insensitive match for the string "utf-8".

There must not be more than one `meta` element with a `charset` attribute per document.

The `content` attribute gives the value of the document metadata or pragma directive when the element is used for those purposes. The allowed values depend on the exact context, as described in subsequent sections of this specification.

If a `meta` element has a `name` attribute, it sets document metadata. Document metadata is expressed in terms of name-value pairs, the `name` attribute on the `meta` element giving the name, and the `content` attribute on the same element giving the value. The name specifies what aspect of metadata is being set; valid names and the meaning of their values are described in the following sections. If a `meta` element has no `content` attribute, then the value part of the metadata name-value pair is the empty string.

The `media` attribute says which media the metadata applies to. The value must be a valid media query list. Unless the `name` is `theme-color`, the `media` attribute has no effect on the processing model and must not be used by authors.

The `name`, `content`, and `media` IDL attributes must reflect the respective content attributes of the same name. The IDL attribute `httpEquiv` must reflect the content attribute `http-equiv`.

### 4.2.5.1 Standard metadata names

This specification defines a few names for the `name` attribute of the `meta` element.
Names are case-insensitive, and must be compared in an ASCII case-insensitive manner.

**application-name**

The value must be a short free-form string giving the name of the web application that the page represents. If the page is not a web application, the `application-name` metadata name must not be used. Translations of the web application's name may be given, using the `lang` attribute to specify the language of each name.

There must not be more than one `meta` element with a given `language` and where the `name` attribute value is an ASCII case-insensitive match for `application-name` per document.

User agents may use the application name in UI in preference to the page's `title`, since the title might include status messages and the like relevant to the status of the page at a particular moment in time instead of just being the name of the application.

To find the application name to use given an ordered list of languages (e.g. British English, American English, and English), user agents must run the following steps:

1. Let `languages` be the list of languages.
2. Let `default language` be the `language` of the `Document`'s `document element`, if any, and if that language is not unknown.
3. If there is a `default language`, and if it is not the same language as any of the languages in `languages`, append it to `languages`.
4. Let `winning language` be the first language in `languages` for which there is a `meta` element in the `Document` where the `name` attribute value is an ASCII case-insensitive match for `application-name` and whose `language` is the language in question.
   
   If none of the languages have such a `meta` element, then return; there's no given application name.
5. Return the value of the `content` attribute of the first `meta` element in the `Document` in tree order where the `name` attribute value is an ASCII case-insensitive match for `application-name` and whose `language` is `winning language`.

**author**

The value must be a free-form string giving the name of one of the page's authors.

**description**

The value must be a free-form string that describes the page. The value must be appropriate for use in a directory of pages, e.g. in a search engine. There must not be more than one `meta` element where the `name` attribute value is an ASCII case-insensitive match for `description` per document.

**generator**

The value must be a free-form string that identifies one of the software packages used to generate the document. This value must not be used on pages whose markup is not generated by software, e.g. pages whose markup was written by a user in a text editor.

Here is what a tool called "Frontweaver" could include in its output, in the page's `head` element, to identify itself as the tool used to generate the page:

```html
<meta name=generator content="Frontweaver 8.2"/>
```

**keywords**

The value must be a set of comma-separated tokens, each of which is a keyword relevant to the page.
To obtain the list of keywords that the author has specified as applicable to the page, the user agent must run the following steps:

1. Let `keywords` be an empty list.
2. For each `meta` element with a `name` attribute and a `content` attribute and where the `name` attribute value is an ASCII case-insensitive match for `keywords`:
   1. Split the value of the element's `content` attribute on commas.
   2. Add the resulting tokens, if any, to `keywords`.
3. Remove any duplicates from `keywords`.
4. Return `keywords`. This is the list of keywords that the author has specified as applicable to the page.

User agents should not use this information when there is insufficient confidence in the reliability of the value.

---

**Note**

Many search engines do not consider such keywords, because this feature has historically been used unreliably and even misleadingly as a way to spam search engine results in a way that is not helpful for users.

To obtain the list of keywords that the author has specified as applicable to the page, the user agent must run the following steps:

1. Let `keywords` be an empty list.
2. For each `meta` element with a `name` attribute and a `content` attribute and where the `name` attribute value is an ASCII case-insensitive match for `keywords`:
   1. Split the value of the element's `content` attribute on commas.
   2. Add the resulting tokens, if any, to `keywords`.
3. Remove any duplicates from `keywords`.
4. Return `keywords`. This is the list of keywords that the author has specified as applicable to the page.

User agents should not use this information when there is insufficient confidence in the reliability of the value.

---

### Example

For instance, it would be reasonable for a content management system to use the keyword information of pages within the system to populate the index of a site-specific search engine, but a large-scale content aggregator that used this information would likely find that certain users would try to game its ranking mechanism through the use of inappropriate keywords.

---

**referrer**

The value must be a `referrer policy`, which defines the default `referrer policy` for the Document. If any `meta` element `element` is inserted into the document, or has its `name` or `content` attributes changed, user agents must run the following algorithm:

1. If `element` is not in a document tree, then return.
2. If `element` does not have a `name` attribute whose value is an ASCII case-insensitive match for `referrer`, then return.
3. If `element` does not have a `content` attribute, or that attribute's value is the empty string, then return.
4. Let `value` be the value of `element`'s `content` attribute, converted to ASCII lowercase.
5. If `value` is one of the values given in the first column of the following table, then set `value` to the value given in the second column:

<table>
<thead>
<tr>
<th>Legacy value</th>
<th>Referrer policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>never</td>
<td><code>no-referrer</code></td>
</tr>
<tr>
<td>default</td>
<td><code>default referrer policy</code></td>
</tr>
<tr>
<td>always</td>
<td><code>unsafe-url</code></td>
</tr>
<tr>
<td>origin-when-crossorigin</td>
<td><code>origin-when-cross-origin</code></td>
</tr>
</tbody>
</table>
6. If `value` is a `referrer policy`, then set `element`'s `node document`'s `policy container`'s `referrer policy` to `policy`.

**Note**

For historical reasons, unlike other standard metadata names, the processing model for `referrer` is not responsive to element removals, and does not use `tree order`. Only the most-recently-inserted or most-recently-modified `meta` element in this state has an effect.

---

### theme-color

The value must be a string that matches the CSS `<color>` production, defining a suggested color that user agents should use to customize the display of the page or of the surrounding user interface. For example, a browser might color the page's title bar with the specified value, or use it as a color highlight in a tab bar or task switcher.

Within an HTML document, the `media` attribute value must be unique amongst all the `meta` elements with their `name` attribute value set to an ASCII case-insensitive match for `theme-color`.

The `media` attribute may be used to describe the context in which the provided color should be used.

#### Example

This standard itself uses "WHATWG green" as its theme color:

```html
<!DOCTYPE HTML>
<title>HTML Standard</title>
<meta name="theme-color" content="#3c790a">
...
```

The `media` attribute may be used to describe the context in which the provided color should be used.

#### Example

If we only wanted to use "WHATWG green" as this standard's theme color in dark mode, we could use the `prefers-color-scheme` media feature:

```html
<!DOCTYPE HTML>
<title>HTML Standard</title>
<meta name="theme-color" content="#3c790a" media="(prefers-color-scheme: dark)">
...
```

To obtain a page's theme color, user agents must run the following steps:

1. Let `candidate elements` be the list of all `meta` elements that meet the following criteria, in `tree order`:
   - the element is in a document tree;
   - the element has a `name` attribute, whose value is an ASCII case-insensitive match for `theme-color`; and
   - the element has a `content` attribute.
2. For each `element` in `candidate elements`:
   1. If `element` has a `media` attribute and the value of `element`'s `media` attribute does not match the environment, then continue.
   2. Let `value` be the result of stripping leading and trailing ASCII whitespace from the value of `element`'s `content` attribute.
   3. Let `color` be the result of parsing `value`.
   4. If `color` is not failure, then return `color`.
3. Return nothing (the page has no theme color).

If any `meta` elements are inserted into the document or removed from the document, or existing `meta` elements have their `name`, `content`, or `media` attributes changed, or if the environment changes such that any `meta` element's `media` attribute's value may now or may no longer match the environment, user agents must re-run the above algorithm and apply the result to any affected UI.
When using the theme color in UI, user agents may adjust it in implementation-specific ways to make it more suitable for the UI in question. For example, if a user agent intends to use the theme color as a background and display white text over it, it might use a darker variant of the theme color in that part of the UI, to ensure adequate contrast.

**color-scheme**

To aid user agents in rendering the page background with the desired color scheme immediately (rather than waiting for all CSS in the page to load), a `color-scheme` value can be provided in a `meta` element.

The value must be a string that matches the syntax for the CSS `color-scheme` property value. It determines the page's supported color-schemes.

There must not be more than one `meta` element with its `name` attribute value set to an ASCII case-insensitive match for `color-scheme` per document.

**Example**

The following declaration indicates that the page is aware of and can handle a color scheme with dark background colors and light foreground colors:

```html
<meta name="color-scheme" content="dark">
```

To obtain a page's supported color-schemes, user agents must run the following steps:

1. Let candidate elements be the list of all `meta` elements that meet the following criteria, in tree order:
   - the element is in a document tree;
   - the element has a `name` attribute, whose value is an ASCII case-insensitive match for `color-scheme`;
   - the element has a `content` attribute.

2. For each element in candidate elements:
   1. Let parsed be the result of parsing a list of component values given the value of element's `content` attribute.
   2. If parsed is a valid CSS `color-scheme` property value, then return parsed.

3. Return null.

If any `meta` elements are inserted into the document or removed from the document, or existing `meta` elements have their `name` or `content` attributes changed, user agents must re-run the above algorithm.

**Note**

Because these rules check successive elements until they find a match, an author can provide multiple such values to handle fallback for legacy user agents. Opposite to how CSS fallback works for properties, the multiple meta elements needs to be arranged with the legacy values after the newer values.

### 4.2.5.2 Other metadata names

Anyone can create and use their own extensions to the predefined set of metadata names. There is no requirement to register such extensions.

However, a new metadata name should not be created in any of the following cases:

- If either the name is a URL, or the value of its accompanying `content` attribute is a URL; in those cases, registering it as an extension to the predefined set of link types is encouraged (rather than creating a new metadata name).
- If the name is for something expected to have processing requirements in user agents; in that case it ought to be standardized.

Also, before creating and using a new metadata name, consulting the WHATWG Wiki MetaExtensions page is encouraged — to avoid choosing a metadata name that's already in use, and to avoid duplicating the purpose of any metadata names that are already in use, and to avoid new standardized names clashing with your chosen name. [WHATWGWiki]
Anyone is free to edit the WHATWG Wiki MetaExtensions page at any time to add a metadata name. New metadata names can be specified with the following information:

**Keyword**
The actual name being defined. The name should not be confusingly similar to any other defined name (e.g. differing only in case).

**Brief description**
A short non-normative description of what the metadata name's meaning is, including the format the value is required to be in.

**Specification**
A link to a more detailed description of the metadata name's semantics and requirements. It could be another page on the wiki, or a link to an external page.

**Synonyms**
A list of other names that have exactly the same processing requirements. Authors should not use the names defined to be synonyms (they are only intended to allow user agents to support legacy content). Anyone may remove synonyms that are not used in practice; only names that need to be processed as synonyms for compatibility with legacy content are to be registered in this way.

**Status**
One of the following:

- **Proposed**
  The name has not received wide peer review and approval. Someone has proposed it and is, or soon will be, using it.

- **Ratified**
  The name has received wide peer review and approval. It has a specification that unambiguously defines how to handle pages that use the name, including when they use it in incorrect ways.

- **Discontinued**
  The metadata name has received wide peer review and it has been found wanting. Existing pages are using this metadata name, but new pages should avoid it. The “brief description” and “specification” entries will give details of what authors should use instead, if anything.

If a metadata name is found to be redundant with existing values, it should be removed and listed as a synonym for the existing value.

If a metadata name is added in the “proposed” state for a period of a month or more without being used or specified, then it may be removed from the WHATWG Wiki MetaExtensions page.

If a metadata name is added with the "proposed" status and found to be redundant with existing values, it should be removed and listed as a synonym for the existing value. If a metadata name is added with the "proposed" status and found to be harmful, then it should be changed to "discontinued" status.

Anyone can change the status at any time, but should only do so in accordance with the definitions above.

### 4.2.5.3 Pragma directives

When the `http-equiv` attribute is specified on a `meta` element, the element is a pragma directive.

The `http-equiv` attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Conforming</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>content-language</td>
<td>No</td>
<td>Content language</td>
<td>Sets the <a href="https://whatwg.org/#pragma-set-default-language">pragma-set default language</a></td>
</tr>
<tr>
<td>content-type</td>
<td></td>
<td>Encoding declaration</td>
<td>An alternative form of setting the <a href="https://whatwg.org/#charset">charset</a>.</td>
</tr>
<tr>
<td>default-style</td>
<td></td>
<td>Default style</td>
<td>Sets the <a href="https://whatwg.org/#name">name</a> of the default CSS style sheet set.</td>
</tr>
<tr>
<td>refresh</td>
<td></td>
<td>Refresh</td>
<td>Acts as a timed redirect.</td>
</tr>
<tr>
<td>set-cookie</td>
<td>No</td>
<td>Set-Cookie</td>
<td>Has no effect.</td>
</tr>
<tr>
<td>x-ua-compatible</td>
<td></td>
<td>X-UA-Compatible</td>
<td>In practice, encourages Internet Explorer to more closely follow the specifications.</td>
</tr>
</tbody>
</table>

When a `meta` element is inserted into the document, if its `http-equiv` attribute is present and represents one of the above states, then the user agent must run the algorithm appropriate for that state, as described in the following list:
This pragma sets the **pragma-set default language**. Until such a pragma is successfully processed, there is no **pragma-set default language**.

1. If the **meta** element has no **content** attribute, then return.
2. If the element's **content** attribute contains a U+002C COMMA character (,) then return.
3. Let `input` be the value of the element's **content** attribute.
4. Let `position` point at the first character of `input`.
5. **Skip ASCII whitespace** within `input` given `position`.
6. **Collect a sequence of code points** that are not **ASCII whitespace** from `input` given `position`.
7. Let `candidate` be the string that resulted from the previous step.
8. If `candidate` is the empty string, return.
9. Set the **pragma-set default language** to `candidate`.

---

This pragma is almost, but not quite, entirely unlike the HTTP `Content-Language` header of the same name. [HTTP] 

---

The **Encoding declaration state** is just an alternative form of setting the **charset** attribute: it is a character encoding declaration. This state's user agent requirements are all handled by the parsing section of the specification.

For **meta** elements with an `http-equiv` attribute in the **Encoding declaration state**, the **content** attribute must have a value that is an ASCII case-insensitive match for a string that consists of: "text/html;", optionally followed by any number of ASCII whitespace, followed by "charset=utf-8".

A document must not contain both a **meta** element with an `http-equiv` attribute in the **Encoding declaration state** and a **meta** element with the **charset** attribute present.

The **Encoding declaration state** may be used in **HTML documents**, but elements with an `http-equiv` attribute in that state must not be used in **XML documents**.

---

The **Default style state** sets the **name** of the default CSS style sheet set.

1. If the **meta** element has no **content** attribute, or if that attribute's value is the empty string, then return.
2. Change the preferred CSS style sheet set name with the name being the value of the element's **content** attribute. [CSSOM]

---

The **Refresh state** acts as a timed redirect.

A **Document** object has an associated **will declaratively refresh** (a boolean). It is initially false.

1. If the **meta** element has no **content** attribute, or if that attribute's value is the empty string, then return.
2. Let `input` be the value of the element's **content** attribute.
3. Run the shared declarative refresh steps with the **meta** element's **node document**, `input`, and the **meta** element.
The shared declarative refresh steps, given a Document object document, string input, and optionally a meta element meta, are as follows:

1. If document’s will declaratively refresh is true, then return.
2. Let position point at the first code point of input.
3. Skip ASCII whitespace within input given position.
4. Let time be 0.
5. Collect a sequence of code points that are ASCII digits from input given position, and let the result be timeString.
6. If timeString is the empty string, then:
   1. If the code point in input pointed to by position is not U+002E (.), then return.
7. Otherwise, set time to the result of parsing timeString using the rules for parsing non-negative integers.
8. Collect a sequence of code points that are ASCII digits and U+002E FULL STOP characters (.) from input given position. Ignore any collected characters.
9. Let urlRecord be document’s URL.
10. If position is not past the end of input, then:
    1. If the code point in input pointed to by position is not U+003B (;), U+002C (,), or ASCII whitespace, then return.
2. Skip ASCII whitespace within input given position.
3. If the code point in input pointed to by position is U+003B (;) or U+002C (,), then advance position to the next code point.
4. Skip ASCII whitespace within input given position.
5. If position is not past the end of input, then:
   1. Let urlString be the substring of input from the code point at position to the end of the string.
2. If the code point in input pointed to by position is U+0055 (U) or U+0075 (u), then advance position to the next code point. Otherwise, jump to the step labeled skip quotes.
3. If the code point in input pointed to by position is U+0052 (R) or U+0072 (r), then advance position to the next code point. Otherwise, jump to the step labeled parse.
4. If the code point in input pointed to by position is U+004C (L) or U+006C (l), then advance position to the next code point. Otherwise, jump to the step labeled parse.
5. Skip ASCII whitespace within input given position.
6. If the code point in input pointed to by position is U+003D (=), then advance position to the next code point. Otherwise, jump to the step labeled parse.
7. Skip ASCII whitespace within input given position.
8. Skip quotes: If the code point in input pointed to by position is U+0027 (‘) or U+0022 (“), then let quote be that code point, and advance position to the next code point. Otherwise, let quote be the empty string.
9. Set urlString to the substring of input from the code point at position to the end of the string.
10. If quote is not the empty string, and there is a code point in urlString equal to quote, then truncate urlString at that code point, so that it and all subsequent code points are removed.
11. Parse: Set urlRecord to the result of encoding-parsing a URL given urlString, relative to document.
12. If urlRecord is failure, then return.
13. Set document’s will declaratively refresh to true.
14. Perform one or more of the following steps:
   o After the refresh has come due (as defined below), if the user has not canceled the redirect and, if meta is
given, document's active sandboxing flag set\(^{696}\) does not have the sandboxed automatic features browsing context flag\(^{696}\) set, then navigate\(^{6100}\) document's node navigable\(^{697}\) to urlRecord using document, with historyHandling\(^{1103}\) set to "replace"\(^{1081}\).  

For the purposes of the previous paragraph, a refresh is said to have come due as soon as the later of the following two conditions occurs:

- At least time seconds have elapsed since document's completely loaded time\(^{1052}\), adjusted to take into account user or user agent preferences.
- If meta is given, at least time seconds have elapsed since meta was inserted into the document\(^{246}\) document, adjusted to take into account user or user agent preferences.

**Note**

It is important to use document here, and not meta's node document, as that might have changed between the initial set of steps and the refresh coming due and meta is not always given (in case of the HTTP 'Refresh'\(^{1658}\) header).

- Provide the user with an interface that, when selected, navigates\(^{1003}\) document's node navigable\(^{697}\) to urlRecord using document.
- Do nothing.

In addition, the user agent may, as with anything, inform the user of any and all aspects of its operation, including the state of any timers, the destinations of any timed redirects, and so forth.

For meta\(^{186}\) elements with an http-equiv\(^{192}\) attribute in the Refresh state\(^{193}\), the content\(^{187}\) attribute must have a value consisting either of:

- just a valid non-negative integer\(^{675}\), or
- a valid non-negative integer\(^{675}\), followed by a U+003B SEMICOLON character (;), followed by one or more ASCII whitespace, followed by a substring that is an ASCII case-insensitive match for the string "URL", followed by a U+003D EQUALS SIGN character (=), followed by a valid URL string that does not start with a literal U+0027 APOSTROPHE (') or U+0022 QUOTATION MARK (") character.

In the former case, the integer represents a number of seconds before the page is to be reloaded; in the latter case the integer represents a number of seconds before the page is to be replaced by the page at the given URL.

**Example**

A news organization's front page could include the following markup in the page's head\(^{170}\) element, to ensure that the page automatically reloads from the server every five minutes:

```
<meta http-equiv="Refresh" content="300">
```

**Example**

A sequence of pages could be used as an automated slide show by making each page refresh to the next page in the sequence, using markup such as the following:

```
<meta http-equiv="Refresh" content="20; URL=page4.html">
```

**Set-Cookie state** (http-equiv="set-cookie\(^{192}\)"

This pragma is non-conforming and has no effect.

User agents are required to ignore this pragma.

**X-UA-Compatible state** (http-equiv="x-ua-compatible\(^{193}\)"

In practice, this pragma encourages Internet Explorer to more closely follow the specifications.

For meta\(^{186}\) elements with an http-equiv\(^{192}\) attribute in the X-UA-Compatible state\(^{195}\), the content\(^{187}\) attribute must have a value that is an ASCII case-insensitive match for the string "IE=edge".

User agents are required to ignore this pragma.
This pragma enforces a Content Security Policy on a Document. [CSP]

1. If the *meta* element is not a child of a *head* element, return.

2. If the *meta* element has no *content* attribute, or if that attribute’s value is the empty string, then return.

3. Let *policy* be the result of executing Content Security Policy’s parse a serialized Content Security Policy algorithm on the *meta* element’s *content* attribute’s value, with a source of "meta", and a disposition of "enforce".

4. Remove all occurrences of the *report-uri*, *frame-ancestors*, and *sandbox* directives from *policy*.

5. Enforce the policy *policy*.

For *meta* elements with an `http-equiv` attribute in the Content security policy state, the *content* attribute must have a value consisting of a valid Content Security Policy, but must not contain any *report-uri*, *frame-ancestors*, or *sandbox* directives. The Content Security Policy given in the *content* attribute will be enforced upon the current document. [CSP]

There must not be more than one *meta* element with any particular state in the document at a time.

**Note**

At the time of inserting the *meta* element to the document, it is possible that some resources have already been fetched. For example, images might be stored in the list of available images prior to dynamically inserting a *meta* element with an `http-equiv` attribute in the Content security policy state. Resources that have already been fetched are not guaranteed to be blocked by a Content Security Policy that’s enforced late.

**Example**

A page might choose to mitigate the risk of cross-site scripting attacks by preventing the execution of inline JavaScript, as well as blocking all plugin content, using a policy such as the following:

```html
<meta http-equiv="Content-Security-Policy" content="script-src 'self'; object-src 'none'">  
```

4.2.5.4 Specifying the document’s character encoding

A character encoding declaration is a mechanism by which the character encoding used to store or transmit a document is specified.

The Encoding standard requires use of the UTF-8 character encoding and requires use of the "utf-8" encoding label to identify it. Those requirements necessitate that the document’s character encoding declaration, if it exists, specifies an encoding label using an ASCII case-insensitive match for "utf-8". Regardless of whether a character encoding declaration is present or not, the actual character encoding used to encode the document must be UTF-8. [ENCODING]

To enforce the above rules, authoring tools must default to using UTF-8 for newly-created documents.

The following restrictions also apply:

- The character encoding declaration must be serialized without the use of character references or character escapes of any kind.
- The element containing the character encoding declaration must be serialized completely within the first 1024 bytes of the document.

In addition, due to a number of restrictions on *meta* elements, there can only be one *meta*-based character encoding declaration per document.

If an HTML document does not start with a BOM, and its encoding is not explicitly given by Content-Type metadata, and the document is not an iframe srcdoc document, then the encoding must be specified using a *meta* element with a *charset* attribute or a *meta* element with an `http-equiv` attribute in the Encoding declaration state.
A character encoding declaration is required (either in the Content-Type metadata or explicitly in the file) even when all characters are in the ASCII range, because a character encoding is needed to process non-ASCII characters entered by the user in forms, in URLs generated by scripts, and so forth.

Using non-UTF-8 encodings can have unexpected results on form submission and URL encodings, which use the document’s character encoding by default.

If the document is an iframe srcdoc document, the document must not have a character encoding declaration. (In this case, the source is already decoded, since it is part of the document that contained the iframe.)

In XML, the XML declaration should be used for inline character encoding information, if necessary.

Example

In HTML, to declare that the character encoding is UTF-8, the author could include the following markup near the top of the document (in the head element):

```html
<meta charset="utf-8">
```

In XML, the XML declaration would be used instead, at the very top of the markup:

```xml
<?xml version="1.0" encoding="utf-8"?>
```

4.2.6 The style element

Categories:

Metadata content.

Contexts in which this element can be used:

Where metadata content is expected.

In a noscript element that is a child of a head element.

Content model:

Text that gives a conformant style sheet.

Tag omission in text/html:

Neither tag is omissible.

Content attributes:

Global attributes:

media — Applicable media

blocking — Whether the element is potentially render-blocking.

Also, the title attribute has special semantics on this element: CSS style sheet set name.

Accessibility considerations:

For authors.

For implementers.

DOM interface:

```idl
[Exposed=Window]
interface HTMLStyleElement : HTMLElement {
    [HTMLConstructor] constructor();

    attribute boolean disabled;
    [CEReactions] attribute DOMString media;
    [SameObject, PutForwards=value] readonly attribute DOMTokenList blocking;

    // also has obsolete members
};
```
The `style` element allows authors to embed CSS style sheets in their documents. The `style` element is one of several inputs to the styling processing model. The element does not represent content for the user.

The `disabled` getter steps are:

1. If `this` does not have an associated CSS style sheet, return false.
2. If `this`'s associated CSS style sheet's disabled flag is set, return true.
3. Return false.

The `disabled` setter steps are:

1. If `this` does not have an associated CSS style sheet, return.
2. If the given value is true, set `this`'s associated CSS style sheet's disabled flag. Otherwise, unset `this`'s associated CSS style sheet's disabled flag.

The `media` attribute says which media the styles apply to. The value must be a valid media query list. The user agent must apply the styles when the `media` attribute's value matches the environment and the other relevant conditions apply, and must not apply them otherwise.

The default, if the `media` attribute is omitted, is "all", meaning that by default styles apply to all media.

The `blocking` attribute is a blocking attribute.

The `title` attribute on `style` elements defines CSS style sheet sets. If the `style` element has no `title` attribute, then it has no title; the `title` attribute of ancestors does not apply to the `style` element. If the `style` element is not in a document tree, then the `title` attribute is ignored. [CSSOM]

Note

The `title` attribute on `style` elements, like the `title` attribute on `link` elements, differs from the global `title` attribute in that a `style` block without a title does not inherit the title of the parent element: it merely has no title.

The `child text content` of a `style` element must be that of a conformant style sheet.

A `style` element is implicitly potentially render-blocking if the element was created by its node document's parser.

The user agent must run the update a style block algorithm whenever any of the following conditions occur:

- The element is popped off the stack of open elements of an HTML parser or XML parser.
- The element is not on the stack of open elements of an HTML parser or XML parser, and it becomes connected or disconnected.
The element's children changed steps run.

The update a style block algorithm is as follows:

1. Let element be the style element.
2. If element has an associated CSS style sheet, remove the CSS style sheet in question.
3. If element is not connected, then return.
4. If element's type attribute is present and its value is neither the empty string nor an ASCII case-insensitive match for "text/css", then return.

   **Note**
   In particular, a type value with parameters, such as "text/css; charset=utf-8", will cause this algorithm to return early.

5. If the Should element's inline behavior be blocked by Content Security Policy? algorithm returns "Blocked" when executed upon the style element, "style", and the style element's child text content, then return. [CSP]

6. Create a CSS style sheet with the following properties:

   **type**
   text/css

   **owner node**
   element

   **media**
   The media attribute of element.

   **Note**
   This is a reference to the (possibly absent at this time) attribute, rather than a copy of the attribute's current value. CSSOM defines what happens when the attribute is dynamically set, changed, or removed.

   **title**
   The title attribute of element, if element is in a document tree, or the empty string otherwise.

   **Note**
   Again, this is a reference to the attribute.

   **alternate flag**
   Unset.

   **origin-clean flag**
   Set.

   **location**
   parent CSS style sheet
   owner CSS rule
   null

   **disabled flag**
   Left at its default value.

   **CSS rules**
   Left uninitialized.

   This doesn't seem right. Presumably we should be using the element's child text content? Tracked as issue #2997.

7. If element contributes a script-blocking style sheet, append element to its node document's script-blocking style sheet
8. If element's media attribute's value matches the environment and element is potentially render-blocking, then block rendering on element.

Once the attempts to obtain the style sheet's critical subresources, if any, are complete, or, if the style sheet has no critical subresources, once the style sheet has been parsed and processed, the user agent must run these steps:

- Fetching the critical subresources is not well-defined; probably issue #968 is the best resolution for that. In the meantime, any critical subresource request should have its render-blocking set to whether or not the style element is currently render-blocking.

1. Let element be the style element associated with the style sheet in question.
2. Let success be true.
3. If the attempts to obtain any of the style sheet's critical subresources failed for any reason (e.g., DNS error, HTTP 404 response, a connection being prematurely closed, unsupported Content-Type), set success to false.
4. Queue an element task on the networking task source given element and the following steps:
   1. If success is true, fire an event named load at element.
   2. Otherwise, fire an event named error at element.
   3. If element contributes a script-blocking style sheet:
      2. Remove element from its node document's script-blocking style sheet set.
   4. Unblock rendering on element.

The element must delay the load event of the element's node document until all the attempts to obtain the style sheet's critical subresources, if any, are complete.

- Note: This specification does not specify a style system, but CSS is expected to be supported by most web browsers.

The media and blocking IDL attributes must each reflect the respective content attributes of the same name.

The LinkStyle interface is also implemented by this element. [CSS]

Example

The following document has its stress emphasis styled as bright red text rather than italics text, while leaving titles of works and Latin words in their default italics. It shows how using appropriate elements enables easier restyling of documents.

```html
<!DOCTYPE html>
<html lang="en-US">
<head>
    <title>My favorite book</title>
    <style>
        body { color: black; background: white; }
        em { font-style: normal; color: red; }
    </style>
</head>
<body>
    <p>My <em>favorite</em> book of all time has <em>got</em> to be <cite>A Cat's Life</cite>. It is a book by P. Rahmel that talks</p>
</body>
</html>
```
4.2.7 Interactions of styling and scripting

If the style sheet referenced no other resources (e.g., it was an internal style sheet given by a \texttt{style} element with no @import rules), then the style rules must be immediately made available to script; otherwise, the style rules must only be made available to script once the \texttt{event loop} reaches its \texttt{update the rendering} step.

An element \texttt{el} in the context of a \texttt{Document} of an \texttt{HTML parser} or \texttt{XML parser} contributes a script-blocking style sheet if all of the following are true:

- \texttt{el} was created by that \texttt{Document}’s parser.
- \texttt{el} is either a \texttt{style} element or a \texttt{link} element that was an external resource link that contributes to the styling processing model when the \texttt{el} was created by the parser.
- \texttt{el}’s \texttt{media} attribute’s value matches the environment.
- \texttt{el}’s style sheet was enabled when the element was created by the parser.
- The last time the \texttt{event loop} reached \texttt{step 1}, \texttt{el}’s \texttt{root} was that \texttt{Document}.
- The user agent hasn’t given up on loading that particular style sheet yet. A user agent may give up on loading a style sheet at any time.

\begin{notesblock}
\textit{Give up on a style sheet before the style sheet loads, if the style sheet eventually does still load, means that the script might end up operating with incorrect information. For example, if a style sheet sets the color of an element to green, but a script that inspects the resulting style is executed before the sheet is loaded, the script will find that the element is black (or whatever the default color is), and might thus make poor choices (e.g., deciding to use black as the color elsewhere on the page, instead of green). Implementers have to balance the likelihood of a script using incorrect information with the performance impact of doing nothing while waiting for a slow network request to finish.}
\end{notesblock}

It is expected that counterparts to the above rules also apply to \texttt{<?xml-stylesheet?>} PIs. However, this has not yet been thoroughly investigated.

A \texttt{Document} has a script-blocking style sheet set, which is an ordered set, initially empty.

A \texttt{Document} \texttt{document} has a style sheet that is blocking scripts if the following steps return true:

1. If \texttt{document}’s script-blocking style sheet set is not empty, then return true.
2. If \texttt{document}’s node navigable is null, then return false.
3. Let containerDocument be \texttt{document}’s node navigable’s container document.
4. If containerDocument is non-null and containerDocument’s script-blocking style sheet set is not empty, then return true.
5. Return false.

A \texttt{Document} has no style sheet that is blocking scripts if it does not have a style sheet that is blocking scripts.
4.3 The body element

Categories:
None.

Contexts in which this element can be used:
As the second element in an html element.

Content model:
Flow content.

Tag omission in text/html:
A body element's start tag can be omitted if the element is empty, or if the first thing inside the body element is not ASCII whitespace or a comment, except if the first thing inside the body element is a meta, noscript, link, script, style, or template element. A body element's end tag can be omitted if the body element is not immediately followed by a comment.

Content attributes:
Global attributes:
onafterprint
onbeforeprint
onbeforeunload
onhashchange
onlanguagechange
onmessage
onmessageerror
onoffline
ononline
onpageswap
onpagehide
onpagereveal
onpageshow
onpopstate
onrejectionhandled
onstorage
onunhandledrejection
onunload

Accessibility considerations:
For authors.
For implementers.

DOM interface:

```html
[Exposed=Window]
interface HTMLBodyElement : HTMLElement {
    [HTMLConstructor] constructor();

    // also has obsolete members
};

HTMLBodyElement includes WindowEventHandlers;
```

The body element represents the contents of the document.

In conforming documents, there is only one body element. The document.body IDL attribute provides scripts with easy access to a document's body element.
The `body` element exposes a number of the `event handler content attributes` of the `Window` object. It also mirrors their `event handler IDL attributes`.

The `event handlers` of the `Window` object named by the `Window-reflecting body element event handler set`, exposed on the `body` element, replace the generic `event handlers` with the same names normally supported by `HTML elements`.

Thus, for example, a bubbling `error` event dispatched on a child of `the body element` of a `Document` would first trigger the `onerror` event handler `content attributes` of that element, then that of the root `html` element, and only then would it trigger the `onerror` `event handler content attribute` on the `body` element. This is because the event would bubble from the target, to the `body`, to the `html`, to the `Document`, to the `Window`, and the `event handler` on the `body` is watching the `Window` not the `body`. A regular event listener attached to the `body` using `addEventListener()`, however, would be run when the event bubbled through the `body` and not when it reaches the `Window` object.

This page updates an indicator to show whether or not the user is online:

```html
<!DOCTYPE HTML>
<html lang="en">
<head>
  <title>Online or offline?</title>
  <script>
    function update(online) {
      document.getElementById('status').textContent = online ? 'Online' : 'Offline';
    }
  </script>
</head>
<body ononline="update(true)"
onoffline="update(false)"
onload="update(navigator.onLine)">
  <p>You are: <span id="status">(Unknown)</span></p>
</body>
</html>
```

### 4.3.2 The `article` element

Categories:
- Flow content
- Sectioning content
- Palpable content

Contexts in which this element can be used:
Where `sectioning content` is expected.

Content model:
- Flow content

Tag omission in text/html:
Neither tag is omissible.

Content attributes:
- Global attributes
Accessibility considerations\textsuperscript{p145}:

For authors.
For implementers.

DOM interface\textsuperscript{p145}:

Uses \texttt{HTML}Element\textsuperscript{p146}.

The \texttt{article}\textsuperscript{p203} element represents\textsuperscript{p139} a complete, or self-contained, composition in a document, page, application, or site and that is, in principle, independently distributable or reusable, e.g. in syndication. This could be a forum post, a magazine or newspaper article, a blog entry, a user-submitted comment, an interactive widget or gadget, or any other independent item of content.

When \texttt{article}\textsuperscript{p203} elements are nested, the inner \texttt{article}\textsuperscript{p203} elements represent articles that are in principle related to the contents of the outer article. For instance, a blog entry on a site that accepts user-submitted comments could represent the comments as \texttt{article}\textsuperscript{p203} elements nested within the \texttt{article}\textsuperscript{p203} element for the blog entry.

Author information associated with an \texttt{article}\textsuperscript{p203} element (q.v. the \texttt{address}\textsuperscript{p219} element) does not apply to nested \texttt{article}\textsuperscript{p203} elements.

\textbf{Note}

\textit{When used specifically with content to be redistributed in syndication, the \texttt{article}\textsuperscript{p203} element is similar in purpose to the entry element in Atom. [ATOM]\textsuperscript{p145}}

\textbf{Note}

\textit{The schema.org microdata vocabulary can be used to provide the publication date for an \texttt{article}\textsuperscript{p203} element, using one of the CreativeWork subtypes.}

When the main content of the page (i.e. excluding footers, headers, navigation blocks, and sidebars) is all one single self-contained composition, that content may be marked with a \texttt{article}\textsuperscript{p203} element, but it is technically redundant in that case (since it's self-evident that the page is a single composition, as it is a single document).

\textbf{Example}

This example shows a blog post using the \texttt{article}\textsuperscript{p203} element, with some schema.org annotations:

```html
<article itemprop="http://schema.org/BlogPosting">
  <header>
    <h2 itemprop="headline">The Very First Rule of Life</h2>
    <p itemprop="datePublished" datetime="2009-10-09">3 days ago</p>
    <link itemprop="url" href="?comments=0"/>
  </header>
  <p>If there's a microphone anywhere near you, assume it's hot and sending whatever you're saying to the world. Seriously.</p>
  <footer>
    <a itemprop="discussionUrl" href="?comments=1">Show comments...</a>
  </footer>
</article>
```

Here is that same blog post, but showing some of the comments:

```html
<article itemprop="http://schema.org/BlogPosting">
  <header>
    <h2 itemprop="headline">The Very First Rule of Life</h2>
    <p itemprop="datePublished" datetime="2009-10-09">3 days ago</p>
    <link itemprop="url" href="?comments=0"/>
  </header>
  <p>If there's a microphone anywhere near you, assume it's hot and sending whatever you're saying to the world. Seriously.</p>
  <section>
```

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Notice the use of `footer` to give the information for each comment (such as who wrote it and when): the `footer` element can appear at the start of its section when appropriate, such as in this case. (Using `header` in this case wouldn't be wrong either; it's mostly a matter of authoring preference.)

Example

In this example, `article` elements are used to host widgets on a portal page. The widgets are implemented as `customized built-in elements` in order to get specific styling and scripted behavior.
4.3.3 The `section` element

The `section` element represents a generic section of a document or application. A section, in this context, is a thematic grouping of content, typically with a heading.

**Example**

Examples of sections would be chapters, the various tabbed pages in a tabbed dialog box, or the numbered sections of a thesis. A web site's home page could be split into sections for an introduction, news items, and contact information.

**Note**

Authors are encouraged to use the `article` element instead of the `section` element when it would make sense to syndicate the contents of the element.

**Note**

The `section` element is not a generic container element. When an element is needed only for styling purposes or as a convenience for scripting, authors are encouraged to use the `div` element instead. A general rule is that the `section` element is appropriate only if the element's contents would be listed explicitly in the document's outline.

**Example**

In the following example, we see an article (part of a larger web page) about apples, containing two short sections.

```html
<article>
  <hgroup>
    <h2>Apples</h2>
    <p>Tasty, delicious fruit!</p>
  </hgroup>
  <p>The apple is the pomaceous fruit of the apple tree.</p>
  <section>
    <h3>Red Delicious</h3>
    <p>These bright red apples are the most common found in many supermarkets.</p>
  </section>
  <section>
    <h3>Granny Smith</h3>
    <p>These juicy, green apples make a great filling for apple pies.</p>
  </section>
</article>
```
Example

Here is a graduation programme with two sections, one for the list of people graduating, and one for the description of the ceremony. (The markup in this example features an uncommon style sometimes used to minimize the amount of *inter-element whitespace*.)

```html
<!DOCTYPE Html>
<html lang="en">
<head>
  <title>Graduation Ceremony Summer 2022</title>
</head>
<body>
<h1>Graduation</h1>
<section>
  <h2>Ceremony</h2>
  <p>Opening Procession</p>
  <p>Speech by Valedictorian</p>
  <p>Speech by Class President</p>
  <p>Presentation of Diplomas</p>
  <p>Closing Speech by Headmaster</p>
</section>
<section>
  <h2>Graduates</h2>
  <ul>
    <li>Molly Carpenter</li>
    <li>Anastasia Luccio</li>
    <li>Ebenezar McCoy</li>
    <li>Karrin Murphy</li>
    <li>Thomas Raith</li>
    <li>Susan Rodriguez</li>
  </ul>
</section>
</body>
</html>
```

Example

In this example, a book author has marked up some sections as chapters and some as appendices, and uses CSS to style the headers in these two classes of section differently.

```css
section { border: double medium; margin: 2em; }
section.chapter h2 { font: 2em Roboto, Helvetica Neue, sans-serif; }
```
4.3.4 The **nav** element

**Categories**:
- Flow content
- Sectioning content
- Palpable content

**Contexts in which this element can be used**:
Where sectioning content is expected.

**Content model**:
- Flow content

**Tag omission in text/html**:
Neither tag is omissible.

**Content attributes**:
- Global attributes

**Accessibility considerations**:
- For authors
- For implementers

**DOM interface**:
Uses `HTMLElement`
The `nav` element represents a section of a page that links to other pages or to parts within the page: a section with navigation links.

**Note**

Not all groups of links on a page need to be in a `nav` element — the element is primarily intended for sections that consist of major navigation blocks. In particular, it is common for footers to have a short list of links to various pages of a site, such as the terms of service, the home page, and a copyright page. The `footer` element alone is sufficient for such cases; while a `nav` element can be used in such cases, it is usually unnecessary.

**Note**

User agents (such as screen readers) that are targeted at users who can benefit from navigation information being omitted in the initial rendering, or who can benefit from navigation information being immediately available, can use this element as a way to determine what content on the page to initially skip or provide on request (or both).

**Example**

In the following example, there are two `nav` elements, one for primary navigation around the site, and one for secondary navigation around the page itself.

```html
<body>
  <h1>The Wiki Center Of Exampland</h1>
  <nav>
    <ul>
      <li><a href="/">Home</a></li>
      <li><a href="/events">Current Events</a></li>
      ...more...
    </ul>
  </nav>
  <article>
    <header>
      <h2>Demos in Exampland</h2>
      <p>Written by A. N. Other.</p>
    </header>
    <nav>
      <ul>
        <li><a href="#public">Public demonstrations</a></li>
        <li><a href="#destroy">Demolitions</a></li>
        ...more...
      </ul>
    </nav>
    <div>
      <section id="public">
        <h2>Public demonstrations</h2>
        <p>...more...</p>
      </section>
      <section id="destroy">
        <h2>Demolitions</h2>
        <p>...more...</p>
      </section>
      ...more...
    </div>
    <footer>
      <p>a href="?edit">Edit</a> | <a href="?delete">Delete</a> | <a href="?Rename">Rename</a></p>
    </footer>
  </article>
  <footer>
    <p>© copyright 1998 Exampland Emperor</p>
  </footer>
</body>
```
In the following example, the page has several places where links are present, but only one of those places is considered a navigation section.

```html
<body itemscope itemtype="http://schema.org/Blog">
<header>
<h1>Wake up sheeple!</h1>
<p>
<a href="news.html">News</a> -
<a href="blog.html">Blog</a> -
<a href="forums.html">Forums</a>
</p>
<p>Last Modified: <span itemprop="dateModified">2009-04-01</span></p>
<nav>
<h2>Navigation</h2>
<ul>
<li><a href="articles.html">Index of all articles</a></li>
<li><a href="today.html">Things sheeple need to wake up for today</a></li>
<li><a href="successes.html">Sheeple we have managed to wake</a></li>
</ul>
</nav>
</header>
<main>
<article itemprop="blogPosts" itemscope itemtype="http://schema.org/BlogPosting">
<header>
<h2 itemprop="headline">My Day at the Beach</h2>
</header>
<div itemprop="articleBody">
<p>Today I went to the beach and had a lot of fun.</p>
...more content...
</div>
<footer>
<p>Posted <time itemprop="datePublished" datetime="2009-10-10">Thursday</time>.</p>
</footer>
...more blog posts...
</article>
</main>
<footer>
<p>Copyright ©<span itemprop="copyrightYear">2010</span></p>
<p>The Example Company</p>
<p>
<a href="about.html">About</a> -
<a href="policy.html">Privacy Policy</a> -
<a href="contact.html">Contact Us</a>
</p>
</footer>
</body>
```

You can also see microdata annotations in the above example that use the schema.org vocabulary to provide the publication date and other metadata about the blog post.

Example

A `<nav>` element doesn't have to contain a list, it can contain other kinds of content as well. In this navigation block, links are provided in prose:

```html
<nav>
<h1>Navigation</h1>
<p>You are on my home page. To the north lies <a href="/blog">my blog</a>, from whence the sounds of battle can be heard. To the east you can see a large mountain, upon which many <a href="/school">school papers</a> are littered. Far up thus mountain you can spy a little figure who appears to be me, desperately scribbling a <a href="/school/thesis">thesis</a>.</p>
</nav>
```
<p>To the west are several exits. One fun-looking exit is labeled <a href="https://games.example.com/">"games"</a>. Another more boring-looking exit is labeled <a href="https://isp.example.net/">"ISP"</a>.</p>
<p>To the south lies a dark and dank <a href="/about">contacts page</a>. Cobwebs cover its disused entrance, and at one point you see a rat run quickly out of the page.</p>

```html
<p><input type="button" value="Compose" onclick="compose()"></p>
<nav><h1>Folders</h1>
<ul>
<li><a href="/inbox" onclick="return openFolder(this.href)">Inbox</a> <span class="count"></span></li>
<li><a href="/sent" onclick="return openFolder(this.href)">Sent</a></li>
<li><a href="/drafts" onclick="return openFolder(this.href)">Drafts</a></li>
<li><a href="/trash" onclick="return openFolder(this.href)">Trash</a></li>
<li><a href="/customers" onclick="return openFolder(this.href)">Customers</a></li>
</ul></nav>
```

### 4.3.5 The aside element

The aside element represents a section of a page that consists of content that is tangentially related to the content around the aside element, and which could be considered separate from that content. Such sections are often represented as sidebars in printed typography.

The element can be used for typographical effects like pull quotes or sidebars, for advertising, for groups of nav elements, and for other content that is considered separate from the main content of the page.
It's not appropriate to use the `<aside>` element just for parentheticals, since those are part of the main flow of the document.

**Example**
The following example shows how an aside is used to mark up background material on Switzerland in a much longer news story on Europe.

```html
<aside>
    <h2>Switzerland</h2>
    <p>Switzerland, a land-locked country in the middle of geographic Europe, has not joined the geopolitical European Union, though it is a signatory to a number of European treaties.</p>
</aside>
```

**Example**
The following example shows how an aside is used to mark up a pull quote in a longer article.

```html
...<p>He later joined a large company, continuing on the same work.</p>
```<q>I love my job. People ask me what I do for fun when I'm not at work. But I'm paid to do my hobby, so I never know what to answer. Some people wonder what they would do if they didn't have to work... but I know what I would do, because I was unemployed for a year, and I filled that time doing exactly what I do now.</q></p>
```html
<aside>
    <q>People ask me what I do for fun when I'm not at work. But I'm paid to do my hobby, so I never know what to answer.</q>
</aside>

```html
<p>Of course his work – or should that be hobby? – isn't his only passion. He also enjoys other pleasures.</p>
...```

**Example**
The following extract shows how `<aside>` can be used for blogrolls and other side content on a blog:

```html
<body>
    <header>
        <h1>My wonderful blog</h1>
        <p>My tagline</p>
    </header>

    <aside>
        <!-- this aside contains two sections that are tangentially related to the page, namely, links to other blogs, and links to blog posts from this blog -->

        <nav>
            <h2>My blogroll</h2>
            <ul>
                <li><a href="https://blog.example.com/">Example Blog</a></li>
            </ul>
        </nav>

        <nav>
            <h2>Archives</h2>
            <ol reversed="">
                <li><a href="/last-post">My last post</a></li>
                <li><a href="/first-post">My first post</a></li>
            </ol>
        </nav>
    </aside>
</body>`
4.3.6 The h1, h2, h3, h4, h5, and h6 elements

Categories:
- Flow content
- Heading content
- Palpable content

Contexts in which this element can be used:
As a child of an hgroup element.
Where heading content is expected.
Content model:\footnote{p144} Phrasing content:\footnote{p148}

Tag omission in text/html:\footnote{p144}

Neither tag is omissible.

Content attributes:\footnote{p144}

Global attributes:\footnote{p152}

Accessibility considerations:\footnote{p145}

For authors.

For implementers.

DOM interface:\footnote{p145}

\begin{verbatim}
IDL [Exposed=Window]
 interface HTMLHeadingElement : HTMLElement {
    [HTMLConstructor] constructor();

    // also has obsolete members
}
\end{verbatim}

These elements represent\footnote{p139} headings for their sections.

The semantics and meaning of these elements are defined in the section on headings and outlines\footnote{p220}.

These elements have a heading level\footnote{p220} given by the number in their name. The heading level\footnote{p220} corresponds to the levels of nested sections. The h1\footnote{p213} element is for a top-level section, h2\footnote{p213} for a subsection, h3\footnote{p213} for a sub-subsection, and so on.

Example

As far as their respective document outlines (their heading and section structures) are concerned, these two snippets are semantically equivalent:

\begin{verbatim}
<body>
 <h1>Let's call it a draw(ing surface)</h1>
 <h2>Diving in</h2>
 <h2>Simple shapes</h2>
 <h2>Canvas coordinates</h2>
 <h3>Canvas coordinates diagram</h3>
 <h2>Paths</h2>
</body>
\end{verbatim}

\begin{verbatim}
<body>
 <h1>Let's call it a draw(ing surface)</h1>
 <section>
  <h2>Diving in</h2>
 </section>
 <section>
  <h2>Simple shapes</h2>
 </section>
 <section>
  <h2>Canvas coordinates</h2>
 </section>
 <section>
  <h3>Canvas coordinates diagram</h3>
 </section>
 <section>
  <h2>Paths</h2>
 </section>
</body>
\end{verbatim}

Authors might prefer the former style for its terseness, or the latter style for its additional styling hooks. Which is best is purely an
4.3.7 The **hgroup** element

**Categories**:  
- **Flow content**  
- **Heading content**  
- **Palpable content**

**Contexts in which this element can be used**:  
Where **heading content** is expected.

**Content model**:  
Zero or more **p** elements, followed by one **h1**—**h6** element, followed by zero or more **p** elements, optionally intermixed with **script-supporting elements**.

**Tag omission in text/html**:  
Neither tag is omissible.

**Content attributes**:  
- **Global attributes**

**Accessibility considerations**:  
- For authors
- For implementers

**DOM interface**:  
Uses **HTMLElement**.

The **hgroup** element **represents** a heading and related content. The element may be used to group an **h1**—**h6** element with one or more **p** elements containing content representing a subheading, alternative title, or tagline.

**Example**  
Here are some examples of valid headings contained within an **hgroup** element.

```html
<hgroup>
  <h1>The reality dysfunction</h1>
  <p>Space is not the only void</p>
</hgroup>

<hgroup>
  <h1>Dr. Strangelove</h1>
  <p>Or: How I Learned to Stop Worrying and Love the Bomb</p>
</hgroup>
```

4.3.8 The **header** element

**Categories**:  
- **Flow content**  
- **Palpable content**

**Contexts in which this element can be used**:  
Where **flow content** is expected.

**Content model**:  
**Flow content**, but with no **header** or **footer** element descendants.
Tag omission in text/html:
Neither tag is omissible.

Content attributes:
Global attributes

Accessibility considerations:
If there is an ancestor sectioning content element: for authors; for implementers.
Otherwise: for authors; for implementers.

DOM interface:
Uses HTMLElement.

The header element represents a group of introductory or navigational aids.

Note
A header element is intended to usually contain a heading (an \texttt{h1}–\texttt{h6} element or an hgroup element), but this is not required. The header element can also be used to wrap a section’s table of contents, a search form, or any relevant logos.

Example
Here are some sample headers. This first one is for a game:

```html
<header>
  <p>Welcome to...</p>
  <h1Voidwars!\</h1> 
</header>
```

The following snippet shows how the element can be used to mark up a specification’s header:

```html
<header>
  <hgroup>
    <h1>Fullscreen API</h1>
    <p>Living Standard — Last Updated 19 October 2015</p>
  </hgroup>
  <dt>Participate:</dt>
  <dd><a href="https://github.com/whatwg/fullscreen">GitHub whatwg/fullscreen</a></dd>
  <dt>Commits:</dt>
  <dd><a href="https://github.com/whatwg/fullscreen/commits">GitHub whatwg/fullscreen/commits</a></dd>
</header>
```

Note
The header element is not sectioning content; it doesn't introduce a new section.

Example
In this example, the page has a page heading given by the \texttt{h1} element, and two subsections whose headings are given by \texttt{h2} elements. The content after the header element is still part of the last subsection started in the header element, because the header element doesn't take part in the outline algorithm.

```html
<body>
  <header>
    <h1>Little Green Guys With Guns</h1>
    <nav>
      <ul>
        <li><a href="/games">Games</a></li>
        <li><a href="/forum">Forum</a></li>
        <li><a href="/download">Download</a></li>
      </ul>
    </nav>
</header>
```
4.3.9 The `footer` element \(^{p21}\)

**Categories**\(^{p144}\):
- Flow content\(^{p147}\)
- Palpable content\(^{p148}\)

**Contexts in which this element can be used**\(^{p144}\):
Where flow content\(^{p147}\) is expected.

**Content model**\(^{p144}\):
- Flow content\(^{p147}\), but with no header\(^{p215}\) or footer\(^{p217}\) element descendants.

**Tag omission in text/html**\(^{p144}\):
Neither tag is omissible.

**Content attributes**\(^{p144}\):
- Global attributes\(^{p152}\)

**Accessibility considerations**\(^{p145}\):
- If there is an ancestor sectioning content\(^{p147}\) element: for authors; for implementers.
- Otherwise: for authors; for implementers.

**DOM interface**\(^{p145}\):
Uses `HTMLElement`\(^{p140}\).

The `footer`\(^{p217}\) element represents\(^{p139}\) a footer for its nearest ancestor sectioning content\(^{p147}\) element, or for the body element\(^{p134}\) if there is no such ancestor. A footer typically contains information about its section such as who wrote it, links to related documents, copyright data, and the like.

When the `footer`\(^{p217}\) element contains entire sections, they represent\(^{p139}\) appendices, indices, long colophons, verbose license agreements, and other such content.

**Note**
Contact information for the author or editor of a section belongs in an address\(^{p219}\) element, possibly itself inside a `footer`\(^{p217}\). Bylines and other information that could be suitable for both a header\(^{p215}\) or a `footer`\(^{p217}\) can be placed in either (or neither). The primary purpose of these elements is merely to help the author write self-explanatory markup that is easy to maintain and style; they are not intended to impose specific structures on authors.

Footers don't necessarily have to appear at the end of a section, though they usually do.

When there is no ancestor sectioning content\(^{p147}\) element, then it applies to the whole page.

**Note**
The `footer`\(^{p217}\) element is not itself sectioning content\(^{p147}\); it doesn't introduce a new section.
Example

Here is a page with two footers, one at the top and one at the bottom, with the same content:

```html
<body>
<footer><a href="../">Back to index...</a></footer>
<hgroup>
<h1>Lorem ipsum</h1>
<p>The ipsum of all lorems</p>
</hgroup>
<p>A dolor sit amet, consectetur adipisicing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.</p>
<footer><a href="../">Back to index...</a></footer>
</body>
```

Example

Here is an example which shows the footer element being used both for a site-wide footer and for a section footer.

```html
<!DOCTYPE HTML>
<html lang="en">
<head>
<title>The Ramblings of a Scientist</title>
</head>
<body>
<h1>The Ramblings of a Scientist</h1>
<article>
<h1>Episode 15</h1>
<video src="/fm/015.ogv" controls preload>Download video</video>
<p>Published <time datetime="2009-10-21T18:26-07:00">on 2009/10/21 at 6:26pm</time></p>
</article>
<article>
<h1>My Favorite Trains</h1>
<p>I love my trains. My favorite train of all time is a Köf.</p>
<p>It is fun to see them pull some coal cars because they look so dwarfed in comparison.</p>
<p>Published <time datetime="2009-09-15T14:54-07:00">on 2009/09/15 at 2:54pm</time></p>
</article>
<footer> <!-- site wide footer -->
<nav>
<a href="/credits.html">Credits</a> — 
<a href="/tos.html">Terms of Service</a> — 
<a href="/index.html">Blog Index</a></nav>
<p>Copyright © 2009 Gordon Freeman</p>
</footer>
</body>
</html>
```

Example

Some site designs have what is sometimes referred to as "fat footers" — footers that contain a lot of material, including images, links to other articles, links to pages for sending feedback, special offers... in some ways, a whole "front page" in the footer.
This fragment shows the bottom of a page on a site with a "fat footer":

```html
...  
<footer>
  <nav>
    <section>
      <h1>Articles</h1>
      <p><img src="images/somersaults.jpeg" alt=""> Go to the gym with our somersaults class! Our teacher Jim takes you through the paces in this two-part article. <a href="articles/somersaults/1">Part 1</a> · <a href="articles/somersaults/2">Part 2</a></p>
      <p><img src="images/kindplus.jpeg"> Tired of walking on the edge of a cliff! sic --? Our guest writer Lara shows you how to bumble your way through the bars. <a href="articles/kindplus/1">Read more...</a></p>
      <p><img src="images/crisps.jpeg"> The chips are down, now all that's left is a potato. What can you do with it? <a href="articles/crisps/1">Read more...</a></p>
    </section>
    <ul>
      <li><a href="/about">About us...</a></li>
      <li><a href="/feedback">Send feedback!</a></li>
      <li><a href="/sitemap">Sitemap</a></li>
    </ul>
  </nav>
  <p><small>Copyright © 2015 The Snacker — <a href="/tos">Terms of Service</a></small></p>
</footer>
</body>
```

4.3.10 The **address** element

Categories:
- Flow content
- Palpable content

Contexts in which this element can be used:
Where flow content is expected.

Content model:
- Flow content, but with no heading content descendants, no sectioning content descendants, and no header, footer, or address element descendants.

Tag omission in text/html:
Neither tag is omissible.

Content attributes:
- Global attributes

Accessibility considerations:
- For authors
- For implementers

DOM interface:
Uses HTML Element

The address element represents the contact information for its nearest article or body element ancestor. If that is the body element, then the contact information applies to the document as a whole.
The address [p219] element must not be used to represent arbitrary addresses (e.g. postal addresses), unless those addresses are in fact the relevant contact information. (The p [p226] element is the appropriate element for marking up postal addresses in general.)

The address [p219] element must not contain information other than contact information.

Typically, the address [p219] element would be included along with other information in a footer [p217] element.

The contact information for a node node is a collection of address [p219] elements defined by the first applicable entry from the following list:

- If node is an article [p203] element
- If node is a body [p202] element
  - The contact information consists of all the address [p219] elements that have node as an ancestor and do not have another body [p202] or article [p203] element ancestor that is a descendant of node.
- If node has an ancestor element that is an article [p203] element
- If node has an ancestor element that is a body [p202] element
  - The contact information of node is the same as the contact information of the nearest article [p203] or body [p202] element ancestor, whichever is nearest.
- If node's node document has a body element [p134]
  - The contact information of node is the same as the contact information of the body element [p134] of the Document [p128].
- Otherwise
  - There is no contact information for node.

User agents may expose the contact information of a node to the user, or use it for other purposes, such as indexing sections based on the sections' contact information.

Example

For example, a page at the W3C web site related to HTML might include the following contact information:

```html
<ADDRESS>
  <A href="../People/Raggett/">Dave Raggett</A>,
  <A href="../People/Arnaud/">Arnaud Le Hors</A>,
  contact persons for the <A href="Activity">W3C HTML Activity</A>
</ADDRESS>
```

Example

For example, the following is non-conforming use of the address [p219] element:

```html
<ADDRESS> Last Modified: 1999/12/24 23:37:50 </ADDRESS>
```

Example

In this example the footer contains contact information and a copyright notice.

```html
<footer>
  <address>
    For more details, contact
    <a href="mailto:js@example.com">John Smith</a>.
  </address>
  <p><small>© copyright 2038 Example Corp.</small></p>
</footer>
```

4.3.11 Headings and outlines [p22]

h1 [p213] - h6 [p213] elements have a heading level, which is given by the number in the element's name.
These elements represent headings. The lower a heading's heading level is, the fewer ancestor sections the heading has.

The outline is all headings in a document, in tree order.

The outline should be used for generating document outlines, for example when generating tables of contents. When creating an interactive table of contents, entries should jump the user to the relevant heading.

If a document has one or more headings, at least a single heading within the outline should have a heading level of 1.

Each heading following another heading lead in the outline must have a heading level that is less than, equal to, or 1 greater than lead's heading level.

Example

The following example is non-conforming:

```html
<body>
  <h1>Apples</h1>
  <p>Apples are fruit.</p>
  <section>
    <h3>Taste</h3>
    <p>They taste lovely.</p>
  </section>
</body>
```

It could be written as follows and then it would be conforming:

```html
<body>
  <h1>Apples</h1>
  <p>Apples are fruit.</p>
  <section>
    <h2>Taste</h2>
    <p>They taste lovely.</p>
  </section>
</body>
```

4.3.11.1 Sample outlines

Example

The following markup fragment:

```html
<body>
  <hgroup id="document-title">
    <h1>HTML: Living Standard</h1>
    <p>Last Updated 12 August 2016</p>
  </hgroup>
  <p>Some intro to the document.</p>
  <h2>Table of contents</h2>
  <ol id="toc">
    <li>Some intro to the first section.</li>
  </ol>
</body>
```

...results in 3 document headings:

1. <h1>HTML: Living Standard</h1>
2. <h2>Table of contents</h2>
3. <h2>First section</h2>.
First, here is a document, which is a book with very short chapters and subsections:

```html
<!DOCTYPE HTML>
<html lang=en>
<title>The Tax Book (all in one page)</title>
<h1>The Tax Book</h1>
<h2>Earning money</h2>
<p>Earning money is good.</p>
<h3>Getting a job</h3>
<p>To earn money you typically need a job.</p>
<h2>Spending money</h2>
<p>Spending is what money is mainly used for.</p>
<h3>Cheap things</h3>
<p>Buying cheap things often not cost-effective.</p>
<h3>Expensive things</h3>
<p>The most expensive thing is often not the most cost-effective either.</p>
<h2>Investing money</h2>
<p>You can lend your money to other people.</p>
<h2>Losing money</h2>
<p>If you spend money or invest money, sooner or later you will lose money.</p>
<h3>Poor judgement</h3>
<p>Usually if you lose money it's because you made a mistake.</p>
</html>
```

It's outline could be presented as follows:

1. The Tax Book
   1. Earning money
   2. Getting a job
   3. Spending money
      1. Cheap things
      2. Expensive things
   4. Investing money
   5. Losing money
      1. Poor judgement

Notice that the `title` element is not a `heading`.

Example

A document can contain multiple top-level headings:

```html
<!DOCTYPE HTML>
<html lang=en>
<title>Alphabetic Fruit</title>
<h1>Apples</h1>
<p>Pomaceous.</p>
<h1>Bananas</h1>
<p>Edible.</p>
<h1>Carambola</h1>
</html>
```
The document's outline could be presented as follows:

1. Apples
2. Bananas
3. Carambola

Example

header elements do not influence the outline of a document:

```html
<!DOCTYPE HTML>
<html lang="en">
<title>We're adopting a child! — Ray's blog</title>
<h1>Ray's blog</h1>
<article>
<header>
<nav>
<a href="?t=-1d">Yesterday</a>;
<a href="?t=-7d">Last week</a>;
<a href="?t=-1m">Last month</a>
</nav>
<h2>We're adopting a child!</h2>
</header>
<p>As of today, Janine and I have signed the papers to become the proud parents of baby Diane! We've been looking forward to this day for weeks.</p>
</article>
</html>
```

The document's outline could be presented as follows:

1. Ray's blog
   1. We're adopting a child!

Example

The following example is conforming, but not encouraged as it has no heading whose heading level is 1:

```html
<!DOCTYPE HTML>
<html lang="en">
<title>Alphabetic Fruit</title>
<section>
<h2>Apples</h2>
<p>Pomaceous.</p>
</section>
<section>
<h2>Bananas</h2>
<p>Edible.</p>
</section>
<section>
<h2>Carambola</h2>
<p>Star.</p>
</section>
```

The document's outline could be presented as follows:

1. 1. Apples
    2. Bananas
    3. Carambola
Example

The following example is conforming, but not encouraged as the first heading's heading level is not 1:

```html
<!DOCTYPE HTML>
<html lang="en">
<head>
<title>Feathers on The Site of Encyclopedic Knowledge</title>
</head>
<body>
<h2>A plea from our caretakers</h2>
<p>Please, we beg of you, send help! We're stuck in the server room!</p>
<h1>Feathers</h1>
<p>Epidermal growths.</p>
</body>
</html>
```

The document's outline could be presented as follows:

1. A plea from our caretakers
2. Feathers

4.3.11.2 Exposing outlines to users

User agents are encouraged to expose page outlines to users to aid in navigation. This is especially true for non-visual media, e.g. screen readers.

Example

For instance, a user agent could map the arrow keys as follows:

- **Shift + ← Left**: Go to previous heading
- **Shift + → Right**: Go to next heading
- **Shift + ↑ Up**: Go to next heading whose level is one less than the current heading's level
- **Shift + ↓ Down**: Go to next heading whose level is the same as the current heading's level

4.3.12 Usage summary

This section is non-normative.

<table>
<thead>
<tr>
<th>Element</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>body</td>
<td>The contents of the document.</td>
</tr>
<tr>
<td>article</td>
<td>A complete, or self-contained, composition in a document, page, application, or site and that is, in principle, independently distributable or reusable, e.g. in syndication. This could be a forum post, a magazine or newspaper article, a blog entry, a user-submitted comment, an interactive widget or gadget, or any other independent item of content.</td>
</tr>
</tbody>
</table>

```
<!DOCTYPE HTML>
<html lang="en">
<head>
<title>Steve Hill's Home Page</title>
</head>
<body>
<p>Hard Trance is My Life.</p>
</body>
</html>
```
<table>
<thead>
<tr>
<th>Element</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>section</td>
<td>A generic section of a document or application. A section, in this context, is a thematic grouping of content, typically with a heading.</td>
</tr>
<tr>
<td>nav</td>
<td>A section of a page that links to other pages or to parts within the page: a section with navigation links.</td>
</tr>
<tr>
<td>aside</td>
<td>A section of a page that consists of content that is tangentially related to the content around the aside element, and which could be considered separate from that content. Such sections are often represented as sidebars in printed typography.</td>
</tr>
<tr>
<td>h1-h6</td>
<td>A heading</td>
</tr>
<tr>
<td>hgroup</td>
<td>A heading and related content. The element may be used to group an h1-h6 element with one or more p elements containing content representing a subheading, alternative title, or tagline.</td>
</tr>
<tr>
<td>header</td>
<td>A group of introductory or navigational aids.</td>
</tr>
<tr>
<td>footer</td>
<td>A footer for its nearest ancestor sectioning content element, or for the body element if there is no such ancestor. A footer typically contains information about its section such as who wrote it, links to related documents, copyright data, and the like.</td>
</tr>
</tbody>
</table>
4.3.12.1 Article or section? §622

This section is non-normative.

A section\(^{206}\) forms part of something else. An article\(^{203}\) is its own thing. But how does one know which is which? Mostly the real answer is “it depends on author intent”.

For example, one could imagine a book with a “Granny Smith” chapter that just said “These juicy, green apples make a great filling for apple pies.”; that would be a section\(^{206}\) because there’d be lots of other chapters on (maybe) other kinds of apples.

On the other hand, one could imagine a tweet or reddit comment or tumblr post or newspaper classified ad that just said “Granny Smith. These juicy, green apples make a great filling for apple pies.”; it would then be article\(^{203}\)s because that was the whole thing.

A comment on an article is not part of the article\(^{203}\) on which it is commenting, therefore it is its own article\(^{203}\).

4.4 Grouping content §622

4.4.1 The p element §622

Categories\(^{144}\):

Flow content\(^{147}\).

Palpable content\(^{148}\).

Contexts in which this element can be used\(^{144}\):

Where flow content\(^{144}\) is expected.

Content model\(^{144}\):

Phrasing content\(^{148}\).

Tag omission in text/html\(^{144}\):

A p\(^{226}\) element’s end tag\(^{1243}\) can be omitted if the p\(^{226}\) element is immediately followed by an address\(^{219}\), article\(^{203}\), aside\(^{211}\), blockquote\(^{222}\), details\(^{632}\), div\(^{253}\), dl\(^{281}\), fieldset\(^{589}\), figcaption\(^{149}\), figure\(^{246}\), footer\(^{217}\), form\(^{310}\), h1\(^{213}\), h2\(^{213}\), h3\(^{213}\), h4\(^{213}\), h5\(^{213}\), h6\(^{213}\), header\(^{211}\), hgroup\(^{215}\), hr\(^{228}\), main\(^{228}\), menu\(^{327}\), nav\(^{288}\), ol\(^{236}\), p\(^{226}\), pre\(^{238}\), search\(^{251}\), section\(^{206}\), table\(^{674}\), or ul\(^{228}\) element, or if there is no more content in the parent element and the parent element is an HTML element\(^{495}\) that is not an a\(^{824}\), audio\(^{247}\), del\(^{335}\), ins\(^{334}\), map\(^{466}\), noscript\(^{664}\), or video\(^{403}\) element, or an autonomous custom element\(^{3754}\).

Content attributes\(^{144}\):

Global attributes\(^{152}\).

Accessibility considerations\(^{145}\):

For authors.

For implementers.

DOM interface\(^{145}\):

```javascript
[Exposed=Window]
interface HTMLParagraphElement : HTMLElement {
    [HTMLConstructor] constructor();

    // also has obsolete members
};
```
The `<p>` element represents a paragraph.

**Note**

While paragraphs are usually represented in visual media by blocks of text that are physically separated from adjacent blocks through blank lines, a style sheet or user agent would be equally justified in presenting paragraph breaks in a different manner, for instance using inline pilcrows (¶).

**Example**

The following examples are conforming HTML fragments:

```html
<p>The little kitten gently seated herself on a piece of carpet. Later in her life, this would be referred to as the time the cat sat on the mat.</p>

<fieldset>
<legend>Personal information</legend>
<p>
<label>Name: <input name="n"></label>
<label><input name="anon" type="checkbox"> Hide from other users</label>
</p>
<p><label>Address: <textarea name="a"></textarea></label></p>
</fieldset>

<p>There was once an example from Femley, Whose markup was of dubious quality. The validator complained, So the author was pained, To move the error from the markup to the rhyming.</p>
```

The `<p>` element should not be used when a more specific element is more appropriate.

**Example**

The following example is technically correct:

```html
<section>
<!-- ... -->
<p>Last modified: 2001-04-23</p>
<p>Author: fred@example.com</p>
</section>
```

However, it would be better marked-up as:

```html
<section>
<!-- ... -->
<footer>Last modified: 2001-04-23</footer>
<address>Author: fred@example.com</address>
</section>
```

Or:

```html
<section>
<!-- ... -->
<footer>
<p>Last modified: 2001-04-23</p>
<address>Author: fred@example.com</address>
</footer>
</section>
```
List elements (in particular, `ol` and `ul` elements) cannot be children of `p` elements. When a sentence contains a bulleted list, therefore, one might wonder how it should be marked up.

**Example**

For instance, this fantastic sentence has bullets relating to

- wizards,
- faster-than-light travel, and
- telepathy,

and is further discussed below.

The solution is to realize that a paragraph, in HTML terms, is not a logical concept, but a structural one. In the fantastic example above, there are actually five paragraphs as defined by this specification: one before the list, one for each bullet, and one after the list.

**Example**

The markup for the above example could therefore be:

```html
<p>For instance, this fantastic sentence has bullets relating to</p>
<ul>
<li>wizards,</li>
<li>faster-than-light travel, and</li>
<li>telepathy,</li>
</ul>
<p>and is further discussed below.</p>
```

Authors wishing to conveniently style such "logical" paragraphs consisting of multiple "structural" paragraphs can use the `div` element instead of the `p` element.

**Example**

Thus for instance the above example could become the following:

```html
<div>For instance, this fantastic sentence has bullets relating to

<ul>
<li>wizards,</li>
<li>faster-than-light travel, and</li>
<li>telepathy,</li>
</ul>

and is further discussed below.</div>
```

This example still has five structural paragraphs, but now the author can style just the `div` element instead of having to consider each part of the example separately.

### 4.4.2 The `hr` element

**Categories**: Flow content.

**Contexts in which this element can be used**: Where flow content is expected. As a child of a `select` element.

**Content model**: Nothing.
Tag omission in text/html:
No end tag.

Content attributes:

Global attributes:

Accessibility considerations:
For authors.
For implementers.

DOM interface:

IDL

```javascript
[Exposed=Window]
interface HTMLHRElement : HTMLElement {
  [HTMLConstructor] constructor();

  // also has obsolete members
};
```

The `hr` element represents a paragraph-level thematic break, e.g., a scene change in a story, or a transition to another topic within a section of a reference book; alternatively, it represents a separator between a set of options of a `select` element.

**Example**

The following fictional extract from a project manual shows two sections that use the `hr` element to separate topics within the section.

```html
<section>
  <h1>Communication</h1>
  <p>There are various methods of communication. This section covers a few of the important ones used by the project.</p>
  <hr/>
  <p>Communication stones seem to come in pairs and have mysterious properties:</p>
  <ul>
    <li>They can transfer thoughts in two directions once activated if used alone.</li>
    <li>If used with another device, they can transfer one's consciousness to another body.</li>
    <li>If both stones are used with another device, the consciousnesses switch bodies.</li>
  </ul>
  <hr/>
  <p>Radios use the electromagnetic spectrum in the meter range and longer.</p>
  <hr/>
  <p>Signal flares use the electromagnetic spectrum in the nanometer range.</p>
</section>

<section>
  <h1>Food</h1>
  <p>All food at the project is rationed:</p>
  <dl>
    <dt>Potatoes</dt>
    <dd>Two per day</dd>
    <dt>Soup</dt>
    <dd>One bowl per day</dd>
  </dl>
  <hr/>
  <p>Cooking is done by the chefs on a set rotation.</p>
</section>
```

There is no need for an `hr` element between the sections themselves, since the `section` elements and the `h1` elements
imply thematic changes themselves.

Example

The following extract from Pandora's Star by Peter F. Hamilton shows two paragraphs that precede a scene change and the paragraph that follows it. The scene change, represented in the printed book by a gap containing a solitary centered star between the second and third paragraphs, is here represented using the hr element.

Dudley was ninety-two, in his second life, and fast approaching time for another rejuvenation. Despite his body having the physical age of a standard fifty-year-old, the prospect of a long degrading campaign within academia was one he regarded with dread. For a supposedly advanced civilization, the Intersolar Commonwealth could be appallingly backward at times, not to mention cruel. Maybe it won’t be that bad, he told himself. The lie was comforting enough to get him through the rest of the night’s shift.

The Carlton AllLander drove Dudley home just after dawn. Like the astronomer, the vehicle was old and worn, but perfectly capable of doing its job. It had a cheap diesel engine, common enough on a semi-frontier world like Gralmond, although its drive array was a thoroughly modern photoneural processor. With its high suspension and deep-tread tyres it could plough along the dirt track to the observatory in all weather and seasons, including the metre-deep snow of Gralmond’s winters.

Note

The hr element does not affect the document’s outline.

4.4.3 The pre element

Categories:
Flow content. Palpable content.

Contexts in which this element can be used:
Where flow content is expected.

Content model:
Phrasing content.

Tag omission in text/html:
Neither tag is omissible.

Content attributes:
Global attributes.

Accessibility considerations:
For authors. For implementers.

DOM interface:

IDL

```
[Exposed=Window]
interface HTMLPreElement : HTMLElement {
    [HTMLConstructor] constructor();
```
The `<pre>` element represents a block of preformatted text, in which structure is represented by typographic conventions rather than by elements.

**Note**

In the HTML syntax, a leading newline character immediately following the `<pre>` element start tag is stripped.

Some examples of cases where the `<pre>` element could be used:

- Including an email, with paragraphs indicated by blank lines, lists indicated by lines prefixed with a bullet, and so on.
- Including fragments of computer code, with structure indicated according to the conventions of that language.
- Displaying ASCII art.

**Note**

Authors are encouraged to consider how preformatted text will be experienced when the formatting is lost, as will be the case for users of speech synthesizers, braille displays, and the like. For cases like ASCII art, it is likely that an alternative presentation, such as a textual description, would be more universally accessible to the readers of the document.

To represent a block of computer code, the `<pre>` element can be used with a `<code>` element; to represent a block of computer output the `<pre>` element can be used with a `<samp>` element. Similarly, the `<kbd>` element can be used within a `<pre>` element to indicate text that the user is to enter.

**Note**

This element has rendering requirements involving the bidirectional algorithm.

**Example**

In the following snippet, a sample of computer code is presented.

```html
<p>This is the <code>Panel</code> constructor:</p>
<pre><code>
function Panel(element, canClose, closeHandler) {
  this.element = element;
  this.canClose = canClose;
  this.closeHandler = function () { if (closeHandler) closeHandler() };
}</code></pre>
```

**Example**

In the following snippet, `<samp>` and `<kbd>` elements are mixed in the contents of a `<pre>` element to show a session of Zork I.

```html
<pre><samp>You are in an open field west of a big white house with a boarded front door.
There is a small mailbox here.

> <kbd>open mailbox</kbd>

Opening the mailbox reveals:
A leaflet.
</samp></pre>
```

**Example**

The following shows a contemporary poem that uses the `<pre>` element to preserve its unusual formatting, which forms an intrinsic part of the poem itself.
The *blockquote* element \(^p23\) represents a section that is quoted from another source.

Content inside a *blockquote* \(^p23\) must be quoted from another source, whose address, if it has one, may be cited in the *cite* attribute.

If the *cite* \(^p23\) attribute is present, it must be a valid URL potentially surrounded by spaces \(^p99\). To obtain the corresponding citation link, the value of the attribute must be parsed \(^p99\) relative to the element's *node document*. User agents may allow users to follow such citation links, but they are primarily intended for private use (e.g., by server-side scripts collecting statistics about a site's use of quotations), not for readers.
The content of a blockquote may be abbreviated or may have context added in the conventional manner for the text's language.

**Example**

For example, in English this is traditionally done using square brackets. Consider a page with the sentence "Jane ate the cracker. She then said she liked apples and fish."; it could be quoted as follows:

```
<blockquote>
  <p>[Jane] then said she liked [...] fish.</p>
</blockquote>
```

Attribution for the quotation, if any, must be placed outside the blockquote element.

**Example**

For example, here the attribution is given in a paragraph after the quote:

```
<blockquote>
  <p>I contend that we are both atheists. I just believe in one fewer god than you do. When you understand why you dismiss all the other possible gods, you will understand why I dismiss yours.</p>
</blockquote>
<p>— Stephen Roberts</p>
```

The other examples below show other ways of showing attribution.

The cite IDL attribute must reflect the element's cite content attribute.

**Example**

Here a blockquote element is used in conjunction with a figure element and itsfigcaption to clearly relate a quote to its attribution (which is not part of the quote and therefore doesn't belong inside the blockquote itself):

```
<figure>
  <blockquote>
    <p>The truth may be puzzling. It may take some work to grapple with. It may be counterintuitive. It may contradict deeply held prejudices. It may not be consonant with what we desperately want to be true. But our preferences do not determine what's true. We have a method, and that method helps us to reach not absolute truth, only asymptotic approaches to the truth — never there, just closer and closer, always finding vast new oceans of undiscovered possibilities. Cleverly designed experiments are the key.</p>
  </blockquote>
</figure>
```

**Example**

This next example shows the use of cite alongside blockquote.

```
<p>His next piece was the aptly named Sonnet 130:</p>
<blockquote cite="https://quotes.example.org/s/sonnet130.html">
  <p>My mistress' eyes are nothing like the sun,<br>Coral is far more red, than her lips red,</p>
</blockquote>
```
This example shows how a forum post could use `<blockquote>` to show what post a user is replying to. The `<article>` element is used for each post, to mark up the threading.

```html
<article>
  <h1><a href="https://bacon.example.com/?blog=109431">Bacon on a crowbar</a></h1>
  <article>
    <header><strong>t3yw</strong> 12 points 1 hour ago</header>
    <p>I bet a narwhal would love that.</p>
    <footer><a href="#pid=29578">permalink</a></footer>
  </article>
  <article>
    <header><strong>greg</strong> 8 points 1 hour ago</header>
    <blockquote><p>I bet a narwhal would love that.</p></blockquote>
    <p>Dude narwhals don't eat bacon.</p>
    <footer><a href="#pid=29579">permalink</a></footer>
  </article>
  <article>
    <header><strong>t3yw</strong> 15 points 1 hour ago</header>
    <blockquote><blockquote><p>I bet a narwhal would love that.</p></blockquote>
    <p>Dude narwhals don't eat bacon.</p></blockquote>
    <p>Next thing you'll be saying they don't get capes and wizard hats either!</p>
    <footer><a href="#pid=29580">permalink</a></footer>
  </article>
  <article>
    <header><strong>boing</strong> -5 points 1 hour ago</header>
    <p>narwhals are worse than ceiling cat</p>
    <footer><a href="#pid=29581">permalink</a></footer>
  </article>
  <article>
    <header><strong>fred</strong> 1 points 23 minutes ago</header>
    <blockquote><p>I bet a narwhal would love that.</p></blockquote>
    <p>I bet they'd love to peel a banana too.</p>
    <footer><a href="#pid=29582">permalink</a></footer>
  </article>
</article>

Example

This example shows the use of a `<blockquote>` for short snippets, demonstrating that one does not have to use `<p>` elements inside `<blockquote>` elements:

```html
<p>He began his list of "lessons" with the following:</p>
<blockquote>One should never assume that his side of the issue will be recognized, let alone that it will be conceded to have merits.</blockquote>
<p>He continued with a number of similar points, ending with:</p>
<blockquote>Finally, one should be prepared for the threat of breakdown in negotiations at any given moment and not be cowed by the possibility.</blockquote>
<p>We shall now discuss these points...</p>
```

Note

Examples of how to represent a conversation are shown in a later section; it is not appropriate to use the `<cite>` and `<blockquote>` elements for this purpose.
4.4.5 The **ol** element

**Categories**:  
Flow content

If the element’s children include at least one **li** element: Palpable content.

**Contexts in which this element can be used**:  
Where flow content is expected.

**Content model**:  
Zero or more **li** and script-supporting elements.

**Tag omission in text/html**:  
Neither tag is omissible.

**Content attributes**:  
- **reversed** — Number the list backwards  
- **start** — Starting value of the list  
- **type** — Kind of list marker

**Accessibility considerations**:  
For authors.  
For implementers.

**DOM interface**:  

```idl
[Exposed=Window]
interface HTMLOLListElement : HTMLElement {
    [HTMLConstructor] constructor();

    [CEReactions] attribute boolean reversed;
    [CEReactions] attribute long start;
    [CEReactions] attribute DOMString type;

    // also has obsolete members
}
```

The **ol** element represents a list of items, where the items have been intentionally ordered, such that changing the order would change the meaning of the document.

The items of the list are the **li** element child nodes of the **ol** element, in tree order.

The **reversed** attribute is a boolean attribute. If present, it indicates that the list is a descending list (..., 3, 2, 1). If the attribute is omitted, the list is an ascending list (1, 2, 3, ...).

The **start** attribute, if present, must be a valid integer. It is used to determine the starting value of the list.

An **ol** element has a starting value, which is an integer determined as follows:

1. If the **ol** element has a **start** attribute, then:
   1. Let *parsed* be the result of parsing the value of the attribute as an integer.
   2. If *parsed* is not an error, then return *parsed*.
2. If the **ol** element has a **reversed** attribute, then return the number of owned **li** elements.

The **type** attribute can be used to specify the kind of marker to use in the list, in the cases where that matters (e.g., because items are to be referenced by their number/letter). The attribute, if specified, must have a value that is identical to one of the characters given in the first cell of one of the rows of the following table. The **type** attribute represents the state given in the cell in the second column of the row whose first cell matches the attribute’s value; if none of the cells match, or if the attribute is omitted, then the attribute represents the decimal state.
User agents should render the items of the list in a manner consistent with the state of the `type` attribute of the `ol` element. Numbers less than or equal to zero should always use the decimal system regardless of the `type` attribute.

**Note**

For CSS user agents, a mapping for this attribute to the 'list-style-type' CSS property is given in the Rendering section (the mapping is straightforward: the states above have the same names as their corresponding CSS values).

**Note**

It is possible to redefine the default CSS list styles used to implement this attribute in CSS user agents; doing so will affect how list items are rendered.

The `reversed` and `type` IDL attributes must reflect the respective content attributes of the same name.

The `start` IDL attribute must reflect the content attribute of the same name, with a default value of 1.

**Note**

This means that the `start` IDL attribute does not necessarily match the list's starting value, in cases where the `start` content attribute is omitted and the `reversed` content attribute is specified.

**Example**

The following markup shows a list where the order matters, and where the `ol` element is therefore appropriate. Compare this list to the equivalent list in the `ul` section to see an example of the same items using the `ul` element.

```html
<p>I have lived in the following countries (given in the order of when I first lived there):</p>
<ol>
  <li>Switzerland</li>
  <li>United Kingdom</li>
  <li>United States</li>
  <li>Norway</li>
</ol>
```

Note how changing the order of the list changes the meaning of the document. In the following example, changing the relative order of the first two items has changed the birthplace of the author:

```html
<p>I have lived in the following countries (given in the order of when I first lived there):</p>
<ol>
  <li>United Kingdom</li>
  <li>Switzerland</li>
  <li>United States</li>
  <li>Norway</li>
</ol>
```

### 4.4.6 The `ul` element

**Categories:** Flow content.

If the element's children include at least one `li` element: Palpable content.
The `ul` element represents a list of items, where the order of the items is not important — that is, where changing the order would not materially change the meaning of the document.

The items of the list are the `li` element child nodes of the `ul` element.

### Example

The following markup shows a list where the order does not matter, and where the `ul` element is therefore appropriate. Compare this list to the equivalent list in the `ol` section to see an example of the same items using the `ol` element.

```
<p> I have lived in the following countries: </p>
<ul>
  <li>Norway</li>
  <li>Switzerland</li>
  <li>United Kingdom</li>
  <li>United States</li>
</ul>
```

Note that changing the order of the list does not change the meaning of the document. The items in the snippet above are given in alphabetical order, but in the snippet below they are given in order of the size of their current account balance in 2007, without changing the meaning of the document whatsoever:

```
<p> I have lived in the following countries: </p>
<ul>
  <li>Switzerland</li>
  <li>Norway</li>
  <li>United Kingdom</li>
  <li>United States</li>
</ul>
```
The `<menu>` element represents a toolbar consisting of its contents, in the form of an unordered list of items (represented by `<li>` elements), each of which represents a command that the user can perform or activate.

**Note**
The `<menu>` element is simply a semantic alternative to `<ul>` to express an unordered list of commands (a "toolbar").

**Example**
In this example, a text-editing application uses a `<menu>` element to provide a series of editing commands:

```html
<menu>
  <li><button onclick="copy()"><img src="copy.svg" alt="Copy"></button></li>
  <li><button onclick="cut()"><img src="cut.svg" alt="Cut"></button></li>
  <li><button onclick="paste()"><img src="paste.svg" alt="Paste"></button></li>
</menu>
```

Note that the styling to make this look like a conventional toolbar menu is up to the application.

### 4.4.8 The `<li>` element

**Categories:**
None.

**Contexts in which this element can be used:**
- Inside `<ol>` elements.
- Inside `<ul>` elements.
- Inside `<menu>` elements.

**Content model:**
Flow content.

**Tag omission in text/html:**
An `<li>` element's end tag can be omitted if the `<li>` element is immediately followed by another `<li>` element or if there is no more content in the parent element.
Content attributes:

If the element is not a child of an `<ul>` or `<menu>` element: `value` — Ordinal value of the list item

Accessibility considerations:

For authors.
For implementers.

DOM interface:

```
[Exposed=Window]
interface HTMLLIElement : HTMLElement {
    [HTMLConstructor] constructor();
    [CEReactions] attribute long value;
    // also has obsolete members
};
```

The `<li>` element represents a list item. If its parent element is an `<ol>`, `<ul>`, or `<menu>` element, then the element is an item of the parent element’s list, as defined for those elements. Otherwise, the list item has no defined list-related relationship to any other `<li>` element.

The `value` attribute, if present, must be a valid integer. It is used to determine the ordinal value of the list item, when the `<li>`’s list owner is an `<ol>` element.

Any element whose computed value of ‘display’ is ‘list-item’ has a list owner, which is determined as follows:

1. If the element is not being rendered, return null; the element has no list owner.
2. Let `ancestor` be the element’s parent.
3. If the element has an `<ol>`, `<ul>`, or `<menu>` ancestor, set `ancestor` to the closest such ancestor element.
4. Return the closest inclusive ancestor of `ancestor` that produces a CSS box.

To determine the ordinal value of each element owned by a given list owner owner, perform the following steps:

1. Let `i` be 1.
2. If `owner` is an `<ol>`, let `numbering` be owner’s starting value. Otherwise, let `numbering` be 1.
3. Loop: If `i` is greater than the number of list items that `owner` owns, then return; all of owner’s owned list items have been assigned ordinal values.
4. Let `item` be the ith of owner’s owned list items, in tree order.
5. If `item` is an `<li>` element that has a `value` attribute, then:
   1. Let `parsed` be the result of parsing the value of the attribute as an integer.
   2. If `parsed` is not an error, then set `numbering` to `parsed`.
6. The ordinal value of `item` is `numbering`.
7. If `owner` is an `<ol>`, and `owner` has a reversed attribute, decrement `numbering` by 1; otherwise, increment `numbering` by 1.
8. Increment `i` by 1.
9. Go to the step labeled `loop`. Such an element will always exist, as at the very least the document element will always produce a CSS box.
The value IDL attribute must reflect the value of the value content attribute.

**Example**

The element's value IDL attribute does not directly correspond to its ordinal value; it simply reflects the content attribute. For example, given this list:

```html
<ol>
  <li>Item 1</li>
  <li value="3">Item 3</li>
  <li>Item 4</li>
</ol>
```

The ordinal values are 1, 3, and 4, whereas the value IDL attributes return 0, 3, 0 on getting.

**Example**

The following example, the top ten movies are listed (in reverse order). Note the way the list is given a title by using a figure element and its figcaption element.

```html
<figure>
  <figcaption>The top 10 movies of all time</figcaption>
  <ol reversed="">
    <li><cite>Josie and the Pussycats</cite>, 2001</li>
    <li lang="sh">Црна мачка, бели мачор</li>, 1998
    <li><cite>A Bug's Life</cite>, 1998</li>
    <li><cite>Toy Story</cite>, 1995</li>
    <li><cite>Monsters, Inc</cite>, 2001</li>
    <li><cite>Cars</cite>, 2006</li>
    <li><cite>Toy Story 2</cite>, 1999</li>
    <li><cite>Finding Nemo</cite>, 2003</li>
    <li><cite>The Incredibles</cite>, 2004</li>
    <li><cite>Ratatouille</cite>, 2007</li>
  </ol>
</figure>
```

The markup could also be written as follows, using the reversed attribute on the ol element:

```html
<figure>
  <figcaption>The top 10 movies of all time</figcaption>
  <ol reversed="">
    <li><cite>Josie and the Pussycats</cite>, 2001</li>
    <li lang="sh">Црна мачка, бели мачор</li>, 1998
    <li><cite>A Bug’s Life</cite>, 1998</li>
    <li><cite>Toy Story</cite>, 1995</li>
    <li><cite>Monsters, Inc</cite>, 2001</li>
    <li><cite>Cars</cite>, 2006</li>
    <li><cite>Toy Story 2</cite>, 1999</li>
    <li><cite>Finding Nemo</cite>, 2003</li>
    <li><cite>The Incredibles</cite>, 2004</li>
    <li><cite>Ratatouille</cite>, 2007</li>
  </ol>
</figure>
```

**Note**

While it is conforming to include heading elements (e.g. h1 inside li elements, it likely does not convey the semantics that the author intended. A heading starts a new section, so a heading in a list implicitly splits the list into spanning multiple sections.
4.4.9 The *dl* element

**Categories**:  
Flow content

If the element's children include at least one name-value group: Palpable content.

**Contexts in which this element can be used**:  
Where flow content is expected.

**Content model**:  
Either: Zero or more groups each consisting of one or more *dt* elements followed by one or more *dd* elements, optionally intermixed with script-supporting elements.

Or: One or more *div* elements, optionally intermixed with script-supporting elements.

**Tag omission in text/html**:  
Neither tag is omissible.

**Content attributes**:  
Global attributes

**Accessibility considerations**:

For authors.

For implementers.

**DOM interface**:

```idl
[Exposed=Window]
interface HTMLDListElement : HTMLElement {
    [HTMLConstructor] constructor();

    // also has obsolete members
};
```

The *dl* element represents an association list consisting of zero or more name-value groups (a description list). A name-value group consists of one or more names (*dt* elements, possibly as children of a *div* element child) followed by one or more values (*dd* elements, possibly as children of a *div* element child), ignoring any nodes other than *dt* and *dd* element children, and *dt* and *dd* elements that are children of *div* element children. Within a single *dl* element, there should not be more than one *dt* element for each name.

Name-value groups may be terms and definitions, metadata topics and values, questions and answers, or any other groups of name-value data.

The values within a group are alternatives; multiple paragraphs forming part of the same value must all be given within the same *dd* element.

The order of the list of groups, and of the names and values within each group, may be significant.

In order to annotate groups with microdata attributes, or other global attributes that apply to whole groups, or just for styling purposes, each group in a *dl* element can be wrapped in a *div* element. This does not change the semantics of the *dl* element.

The name-value groups of a *dl* element *dl* are determined using the following algorithm. A name-value group has a name (a list of *dt* elements, initially empty) and a value (a list of *dd* elements, initially empty).

1. Let *groups* be an empty list of name-value groups.
2. Let *current* be a new name-value group.
3. Let *seenDd* be false.
4. Let *child* be *dl*'s first child.
5. Let *grandchild* be null.
6. While *child* is not null:
   1. If *child* is a *div* element, then:
1. Let grandchild be child's first child.

2. While grandchild is not null:
   1. Process dt or dd^{242} for grandchild.
   2. Set grandchild to grandchild's next sibling.
   2. Otherwise, process dt or dd^{242} for child.
   3. Set child to child's next sibling.

7. If current is not empty, then append current to groups.

8. Return groups.

To process dt or dd for a node node means to follow these steps:

1. Let groups, current, and seenDd be the same variables as those of the same name in the algorithm that invoked these steps.

2. If node is a dt^{244} element, then:
   1. If seenDd is true, then append current to groups, set current to a new name-value group, and set seenDd to false.
   2. Append node to current's name.

3. Otherwise, if node is a dd^{245} element, then append node to current's value and set seenDd to true.

---

**Note**

When a name-value group has an empty list as name or value, it is often due to accidentally using dd\textsuperscript{245} elements in the place of dt\textsuperscript{244} elements and vice versa. Conformance checkers can spot such mistakes and might be able to advise authors how to correctly use the markup.

---

**Example**

In the following example, one entry ("Authors") is linked to two values ("John" and "Luke").

```xml
<dl>
  <dt>Authors</dt>
  <dd>John</dd>
  <dd>Luke</dd>
  <dt>Editor</dt>
  <dd>Frank</dd>
</dl>
```

**Example**

In the following example, one definition is linked to two terms.

```xml
<dl>
  <dt lang="en-US">color</dt>
  <dd>A sensation which (in humans) derives from the ability of the fine structure of the eye to distinguish three differently filtered analyses of a view.</dd>
</dl>
```

**Example**

The following example illustrates the use of the dt^{244} element to mark up metadata of sorts. At the end of the example, one group has two metadata labels ("Authors" and "Editors") and two values ("Robert Rothman" and "Daniel Jackson"). This example also uses the div^{253} element around the groups of dt^{244} and dd^{245} element, to aid with styling.

```xml
<dl>
  <div>
    <dt>Authors</dt>
    <dd>Robert Rothman</dd>
    <dd>Daniel Jackson</dd>
  </div>
</dl>
The following example shows the `dl` element used to give a set of instructions. The order of the instructions here is important (in the other examples, the order of the blocks was not important).

```html
<p>Determine the victory points as follows (use the first matching case):
</p>
<dl>
  <dt>If you have exactly five gold coins</dt>
  <dd>You get five victory points</dd>
  <dt>If you have one or more gold coins, and you have one or more silver coins</dt>
  <dd>You get two victory points</dd>
  <dt>If you have one or more silver coins</dt>
  <dd>You get one victory point</dd>
  <dt>Otherwise</dt>
  <dd>You get no victory points</dd>
</dl>
```

The following snippet shows a `dl` element being used as a glossary. Note the use of `dfn` to indicate the word being defined.

```html
<dl>
  <dt>Apartments</dt>
  <dd>An execution context grouping one or more threads with one or more COM objects.</dd>
  <dt>Flat</dt>
  <dd>A deflated tire.</dd>
  <dt>Home</dt>
  <dd>The user's login directory.</dd>
</dl>
```

This example uses `microdata` attributes in a `dl` element, together with the `div` element, to annotate the ice cream desserts at a French restaurant.

```html
<dl>
  <div itemscope itemtype="http://schema.org/Product">
    <dt itemprop="name">Café ou Chocolat Liégeois</dt>
    <dd itemscope itemtype="http://schema.org/Offer">
      <span itemprop="price">3.50</span><br>
      €
    </dd>
  </div>
</dl>
```
2 boules Café ou Chocolat, 1 boule Vanille, sauce café ou chocolat, chantilly
</div>

Without the <div itemscope itemtype="http://schema.org/Product"> element the markup would need to use the <dt itemprop="name"> attribute to link the data in the <dd itemscope itemtype="http://schema.org/Offer"> elements with the item, as follows.

<dt itemscope itemtype="http://schema.org/Product" itemref="1-offer 1-description"> Café ou Chocolat Liégeois </dt>
<dd id="1-offer" itemprop="offers" itemscope itemtype="http://schema.org/Offer"> <span itemprop="price">3.50</span> </dd>
<data itemprop="priceCurrency" value="EUR">€</data>
<dd id="1-description" itemprop="description"> 2 boules Café ou Chocolat, 1 boule Vanille, sauce café ou chocolat, chantilly </dd>

The <dt> element is inappropriate for marking up dialogue. See some examples of how to mark up dialogue.

4.4.10 The <dt> element

Categories:
None.

Contexts in which this element can be used:
Before <dd> or <dt> elements inside <dl> elements.
Before <dd> or <dt> elements inside <div> elements that are children of a <dl> element.

Content model:
Flow content, but with no <header>, <footer>, <sectioning content>, or <heading content> descendants.

Tag omission in text/html:
A <dt> element's end tag can be omitted if the <dt> element is immediately followed by another <dt> element or a <dd> element.

Content attributes:
Global attributes

Accessibility considerations:
For authors.
The **dt** element represents the term, or name, part of a term-description group in a description list (**dl** element).

**Note**

The **dt** element itself, when used in a **dl** element, does not indicate that its contents are a term being defined, but this can be indicated using the **dfn** element.

**Example**

This example shows a list of frequently asked questions (a FAQ) marked up using the **dt** element for questions and the **dd** element for answers.

```html
<article>
  <h1>FAQ</h1>
  <dl>
    <dt>What do we want?</dt>
    <dd>Our data.</dd>
    <dt>When do we want it?</dt>
    <dd>Now.</dd>
    <dt>Where is it?</dt>
    <dd>We are not sure.</dd>
  </dl>
</article>
```

### 4.4.11 The **dd** element

**Categories**

None.

**Contexts in which this element can be used**:

- After **dt** or **dd** elements inside **dl** elements.
- After **dt** or **dd** elements inside **div** elements that are children of a **dl** element.

**Content model**:

Flow content.

**Tag omission in text/html**.

A **dd** element's end tag can be omitted if the **dd** element is immediately followed by another **dd** element or a **dt** element, or if there is no more content in the parent element.

**Content attributes**:

Global attributes.

**Accessibility considerations**:

For authors.

For implementers.

**DOM interface**:

Uses **HTMLElement**.

The **dd** element represents the description, definition, or value, part of a term-description group in a description list (**dl** element).

**Example**

A **dl** can be used to define a vocabulary list, like in a dictionary. In the following example, each entry, given by a **dt** with a **dfn** element, has several **dd**'s, showing the various parts of the definition.
4.4.12 The **figure** element

The **figure** element represents some flow content, optionally with a caption, that is self-contained (like a complete sentence) and is typically referenced as a single unit from the main flow of the document.

**Categories**:
- Flow content
- Palpable content

**Contexts in which this element can be used**:
Where flow content is expected.

**Content model**:
- Either: one `figcaption` element followed by flow content.
- Or: flow content followed by one `figcaption` element.
- Or: flow content.

**Tag omission in text/html**:
Neither tag is omissible.

**Content attributes**:
- Global attributes

**Accessibility considerations**:
- For authors.
- For implementers.

**DOM interface**:
Uses `HTMLElement`.

The **figure** element represents some flow content, optionally with a caption, that is self-contained (like a complete sentence) and is typically referenced as a single unit from the main flow of the document.

**Note**
"Self-contained" in this context does not necessarily mean independent. For example, each sentence in a paragraph is self-contained; an image that is part of a sentence would be inappropriate for **figure**, but an entire sentence made of images would be fitting.

The element can thus be used to annotate illustrations, diagrams, photos, code listings, etc.

**Note**
When a **figure** is referred to from the main content of the document by identifying it by its caption (e.g., by figure number), it enables such content to be easily moved away from that primary content, e.g., to the side of the page, to dedicated pages, or to an appendix, without affecting the flow of the document.

If a **figure** element is referenced by its relative position, e.g., "in the photograph above" or "as the next figure shows", then moving the figure would disrupt the page's meaning. Authors are encouraged to consider using labels to refer to figures, rather than using such relative references, so that the page can easily be restyled without affecting the page's meaning.
The first figcaption element child of the element, if any, represents the caption of the figure element's contents. If there is no child figcaption element, then there is no caption.

A figure element's contents are part of the surrounding flow. If the purpose of the page is to display the figure, for example a photograph on an image sharing site, the figure and figcaption elements can be used to explicitly provide a caption for that figure. For content that is only tangentially related, or that serves a separate purpose than the surrounding flow, the aside element should be used (and can itself wrap a figure). For example, a pull quote that repeats content from an article would be more appropriate in an aside than in a figure, because it isn't part of the content, it's a repetition of the content for the purposes of enticing readers or highlighting key topics.

Example

This example shows the figure element to mark up a code listing.

```html
<p>In <a href="#l4">listing 4</a> we see the primary core interface API declaration.</p>
<figure id="l4">
  <figcaption>Listing 4. The primary core interface API declaration.</figcaption>
  <pre><code>
  interface PrimaryCore {
    boolean verifyDataLine();
    undefined sendData(sequence&lt;byte&gt; data);
    undefined initSelfDestruct();
  }
</code></pre>
</figure>
<p>The API is designed to use UTF-8.</p>
```

Example

Here we see a figure element to mark up a photo that is the main content of the page (as in a gallery).

```html
<!DOCTYPE HTML>
<html lang="en">
<title>Bubbles at work — My Gallery™</title>

<figure>
  <img src="bubbles-work.jpeg" alt="Bubbles, sitting in his office chair, works on his latest project intently.">
  <figcaption>Bubbles at work</figcaption>
</figure>

<nav><a href="19414.html">Prev</a> — <a href="19416.html">Next</a></nav>
```

Example

In this example, we see an image that is not a figure, as well as an image and a video that are. The first image is literally part of the example's second sentence, so it's not a self-contained unit, and thus figure would be inappropriate.

```html
<h2>Malinko's comics</h2>

<p>This case centered on some sort of "intellectual property" infringement related to a comic (see Exhibit A). The suit started after a trailer ending with these words:</p>

<blockquote>
  <img src="promblem-packed-action.png" alt="ROUGH COPY! Promblem-Packed Action!">
</blockquote>

<p>...was aired. A lawyer, armed with a Bigger Notebook, launched a preemptive strike using snowballs. A complete copy of the trailer is included with Exhibit B.</p>

<figure>
  <img src="ex-a.png" alt="Two squiggles on a dirty piece of paper.">
</figure>
```
Exhibit A. The alleged rough copy comic.

<figure>
<video src="ex-b.mov"></video>
<figcaption>Exhibit B. The Rough Copy trailer.</figcaption>
</figure>

<p>The case was resolved out of court.</p>

Exhibit A. The alleged rough copy comic.

Exhibit B. The Rough Copy trailer.

The case was resolved out of court.

Example

Here, a part of a poem is marked up using <cite>Jabberwocky</cite> (first verse). Lewis Carroll, 1832-98.

Example

In this example, which could be part of a much larger work discussing a castle, nested <cite>title</cite> attributes in place of the nested <cite>figure</cite> pairs:

Example

The previous example could also be more succinctly written as follows (using <cite>title</cite> attributes in place of the nested <cite>figure</cite> pairs):
The figure is sometimes referenced\textsuperscript{139} only implicitly from the content:

```html
<article>
  <h1>Fiscal negotiations stumble in Congress as deadline nears</h1>
  <figure>
    <img src="obama-reid.jpeg" alt="Obama and Reid sit together smiling in the Oval Office.">
    <figcaption>Barack Obama and Harry Reid. White House press photograph.</figcaption>
  </figure>
  <p>Negotiations in Congress to end the fiscal impasse sputtered on Tuesday, leaving both chambers grasping for a way to reopen the government and raise the country's borrowing authority with a Thursday deadline drawing near.</p>
  ...
</article>
```

### 4.4.13 The \texttt{figcaption} element \textsuperscript{24}

#### Categories\textsuperscript{144}:
None.

#### Contexts in which this element can be used\textsuperscript{144}:
As the first or last child of a \texttt{figure}\textsuperscript{246} element.

#### Content model\textsuperscript{144}:
- \texttt{Flow content}\textsuperscript{247}.

#### Tag omission in text/html\textsuperscript{144}:
Neither tag is omissible.

#### Content attributes\textsuperscript{144}:
- \texttt{Global attributes}\textsuperscript{252}

#### Accessibility considerations\textsuperscript{145}:
- \texttt{For authors}.
- \texttt{For implementers}.

#### DOM interface\textsuperscript{146}:
- Uses \texttt{HTMLElement}\textsuperscript{146}.

The \texttt{figcaption}\textsuperscript{249} element \texttt{represents}\textsuperscript{139} a caption or legend for the rest of the contents of the \texttt{figcaption}\textsuperscript{249} element's parent \texttt{figure}\textsuperscript{246} element, if any.

#### Example

The element can contain additional information about the source:

```html
<figcaption>
  <p>A duck.</p>
  <p>&lt;small&gt;Photograph courtesy of 🌟 News.&lt;/small&gt;</p>
</figcaption>

<figcaption>
  <p>Average rent for 3-room apartments, excluding non-profit apartments</p>
  <p>Zürich's Statistics Office – <time datetime="2017-11-14">14 November 2017</time></p>
</figcaption>
```
4.4.14 The `main` element

Categories:
- Flow content
- Palpable content

Contexts in which this element can be used:
Where flow content is expected, but only if it is a hierarchically correct `main` element.

Content model:
Flow content.

Tag omission in text/html:
Neither tag is omissible.

Content attributes:
Global attributes

Accessibility considerations:
For authors.
For implementers.

DOM interface:
Uses `HTMLElement`.

The `main` element represents the dominant contents of the document.

A document must not have more than one `main` element that does not have the `hidden` attribute specified.

A hierarchically correct `main` element is one whose ancestor elements are limited to `html`, `body`, `div`, `form` without an accessible name, and autonomous custom elements. Each `main` element must be a hierarchically correct `main` element.

Example

In this example, the author has used a presentation where each component of the page is rendered in a box. To wrap the main content of the page (as opposed to the header, the footer, the navigation bar, and a sidebar), the `main` element is used.

```html
<!DOCTYPE html>
<html lang="en">
<title>RPG System 17</title>
<style>
  header, nav, aside, main, footer {
    margin: 0.5em; border: thin solid; padding: 0.5em;
    background: #EFF; color: black; box-shadow: 0 0 0.25em #033;
  }
  h1, h2, p { margin: 0; }
  nav, main { float: left; }
  aside { float: right; }
  footer { clear: both; }
</style>
<header>
  <h1>System Eighteen</h1>
</header>
<nav>
  <a href="../16/">← System 17</a>
  <a href="../18/">RPXIX →</a>
</nav>
<aside>
  <p>This system has no HP mechanic, so there's no healing.</p>
</aside>
<main>
  <h2>Character creation</h2>
  <p>Attributes (magic, strength, agility) are purchased at the cost of one point per level.</p>
  <h2>Rolls</h2>
</main>
```
Each encounter, roll the dice for all your skills. If you roll more than the opponent, you win.

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In the following example, multiple `main` elements are used and script is used to make navigation work without a server roundtrip and to set the `hidden` attribute on those that are not current:

```html
<!doctype html>
<html lang=en-CA>
<meta charset=utf-8>
<title>…</title>
<link rel=stylesheet href=spa.css>
<script src=spa.js async></script>
<nav>
  <a href=/Home>Home</a>
  <a href=/about>About</a>
  <a href=/contact>Contact</a>
</nav>
<main>
  <h1>Home</h1>
  …
</main>
<main hidden>
  <h1>About</h1>
  …
</main>
<main hidden>
  <h1>Contact</h1>
  …
</main>
<footer>Made with ❤ by <a href=https://example.com/>Example ☹</a>.</footer>
```

4.4.15 The `search` element

**Categories**: Flow content, Palpable content.

**Contexts in which this element can be used**:
Where `flow content` is expected.

**Content model**: Flow content.

**Tag omission in text/html**: Neither tag is omissible.

**Content attributes**: Global attributes.

**Accessibility considerations**: For authors, For implementers.
The **search** element represents a part of a document or application that contains a set of form controls or other content related to performing a search or filtering operation. This could be a search of the web site or application; a way of searching or filtering search results on the current web page; or a global or Internet-wide search function.

**Note**

It's not appropriate to use the **search** element just for presenting search results, though suggestions and links as part of "quick search" results can be included as part of a search feature. Rather, a returned web page of search results would instead be expected to be presented as part of the main content of that web page.

**Example**

In the following example, the author is including a search form within the **header** of the web page:

```html
<header>
  <h1><a href="/">My fancy blog</a></h1>
  ...
  <form action="search.php">
    <label for="query">Find an article</label>
    <input id="query" name="q" type="search">
    <button type="submit">Go!</button>
  </form>
</header>
```

**Example**

In this example, the author has implemented their web application's search functionality entirely with JavaScript. There is no use of the **form** element to perform server-side submission, but the containing **search** element semantically identifies the purpose of the descendant content as representing search capabilities.

```html
<form action="search.php">
  <label>Find and filter your query</label>
  <input type="search" id="query">
  
  <label>Exact matches only</label>
  <input type="checkbox" id="exact-only">
  
  <section>
    <h3>Results found:</h3>
    <ul id="results">
      <li>
        <p><a href="services/consulting">Consulting services</a></p>
        Find out how can we help you improve your business with our integrated consultants, Bob and Bob.
      </li>
      ...
    </ul>
    <output id="no-results">-->
    when a query returns or filters out all results render the no results message here
    -->
  </output>
</form>
```
Example

In the following example, the page has two search features. The first is located in the web page's header and serves as a global mechanism to search the website's content. Its purpose is indicated by its specified title attribute. The second is included as part of the main content of the page, as it represents a mechanism to search and filter the content of the current page. It contains a heading to indicate its purpose.

```html
<body>
  <header>
    ...
    <search title="Website"> ...
    </search>
  </header>
  <main>
    <h1>Hotels near your location</h1>
    <search> ...
    </search>
    <article> <!-- search result content --> </article>
  </main>
</body>
```

4.4.16 The div element

Categories:
- Flow content
- Palpable content

Contexts in which this element can be used:
- Where flow content is expected.
- As a child of a dl element.

Content model:
- If the element is a child of a dl element: one or more dt elements followed by one or more dd elements, optionally intermixed with script-supporting elements.
- If the element is not a child of a dl element: flow content.

Tag omission in text/html:
- Neither tag is omissible.

Content attributes:
- Global attributes

Accessibility considerations:
- For authors.
- For implementers.

DOM interface:
```
[Exposed=Window]
interface HTMLDivElement : HTMLElement {
  [HTMLConstructor] constructor();
}
```
The `div` element has no special meaning at all. It represents its children. It can be used with the `class`, `lang`, and `title` attributes to mark up semantics common to a group of consecutive elements. It can also be used in a `dl` element, wrapping groups of `dt` and `dd` elements.

**Note**

Authors are strongly encouraged to view the `div` element as an element of last resort, for when no other element is suitable. Use of more appropriate elements instead of the `div` element leads to better accessibility for readers and easier maintainability for authors.

**Example**

For example, a blog post would be marked up using `article`, a chapter using `section`, a page’s navigation aids using `nav`, and a group of form controls using `fieldset`.

On the other hand, `div` elements can be useful for stylistic purposes or to wrap multiple paragraphs within a section that are all to be annotated in a similar way. In the following example, we see `div` elements used as a way to set the language of two paragraphs at once, instead of setting the language on the two paragraph elements separately:

```html
<article lang="en-US">
  <h1>My use of language and my cats</h1>
  <p>My cat’s behavior hasn’t changed much since her absence, except that she plays her new physique to the neighbors regularly, in an attempt to get pets.</p>
  <div lang="en-GB">
    <p>My other cat, coloured black and white, is a sweetie. He followed us to the pool today, walking down the pavement with us. Yesterday he apparently visited our neighbours. I wonder if he recognises that their flat is a mirror image of ours.</p>
    <p>Hm, I just noticed that in the last paragraph I used British English. But I’m supposed to write in American English. So I shouldn’t say "pavement" or "flat" or "colour"...</p>
  </div>
  <p>I should say "sidewalk" and "apartment" and "color"!</p>
</article>
```

### 4.5 Text-level semantics

#### 4.5.1 The `a` element

**Categories:**

- Flow content
- Phrasing content
- If the element has an `href` attribute: Interactive content
- Palpable content

**Contexts in which this element can be used:**

Where phrasing content is expected.

**Content model:**

- Transparent, but there must be no interactive content descendant, a element descendant, or descendant with the `tabindex` attribute specified.

**Tag omission in text/html:**

Neither tag is omissible.
Content attributes

Global attributes:
- `href` — Address of the hyperlink
- `target` — Navigable for hyperlink navigation
- `download` — Whether to download the resource instead of navigating to it, and its filename if so
- `ping` — URIs to ping
- `rel` — Relationship between the location in the document containing the hyperlink and the destination resource
- `hreflang` — Language of the linked resource
- `type` — Hint for the type of the referenced resource
- `referrerPolicy` — Referrer policy for fetches initiated by the element

Accessibility considerations:
- If the element has an `href` attribute: for authors; for implementers.
- Otherwise: for authors; for implementers.

DOM interface:

```idl
[Exposed=Window]
interface HTMLAnchorElement : HTMLElement {
  [HTMLConstructor] constructor();

  [CEReactions] attribute DOMString target;
  [CEReactions] attribute DOMString download;
  [CEReactions] attribute USVString ping;
  [CEReactions] attribute DOMString rel;
  [SameObject, PutForwards=\value] readonly attribute DOMTokenList relList;

  [CEReactions] attribute DOMString hreflang;
  [CEReactions] attribute DOMString type;

  [CEReactions] attribute DOMString text;

  [CEReactions] attribute DOMString referrerPolicy;
}

// also has obsolete members
HTMLAnchorElement includes HTMLHyperlinkElementUtils;
```

If the `a` element has an `href` attribute, then it represents a hyperlink (a hypertext anchor) labeled by its contents.

If the `a` element has no `href` attribute, then the element represents a placeholder for where a link might otherwise have been placed, if it had been relevant, consisting of just the element's contents.

The `target`, `download`, `ping`, `rel`, `hreflang`, `type`, and `referrerPolicy` attributes must be omitted if the `href` attribute is not present.

If the `itemprop` attribute is specified on an `a` element, then the `href` attribute must also be specified.

Example

If a site uses a consistent navigation toolbar on every page, then the link that would normally link to the page itself could be marked up using an `a` element:

```html
<nav>
  <ul>
    <li> <a href="/">Home</a> </li>
    <li> <a href="/news">News</a> </li>
    <li> <a href="/examples">Examples</a> </li>
    <li> <a href="/legal">Legal</a> </li>
  </ul>
</nav>
```

The `href`, `target`, `download`, `ping`, and `referrerPolicy` attributes affect what happens when users follow the link.
hyperlinks or download hyperlinks created using the `a` element. The `rel`, `hreflang`, and `type` attributes may be used to indicate to the user the likely nature of the target resource before the user follows the link.

For web developers (non-normative)

Same as `textContent`.

The IDL attributes `download`, `ping`, `target`, `rel`, `hreflang`, and `type`, must reflect the respective content attributes of the same name.

The IDL attribute `relList` must reflect the `rel` content attribute.

The IDL attribute `referrerPolicy` must reflect the `referrerPolicy` content attribute, limited to only known values.

The `text` attribute's getter must return this element's descendant text content.

The `text` attribute's setter must `string replace all` with the given value within this element.

Example

The `a` element can be wrapped around entire paragraphs, lists, tables, and so forth, even entire sections, so long as there is no interactive content within (e.g., buttons or other links). This example shows how this can be used to make an entire advertising block into a link:

```html
<aside class="advertising">
  <h1>Advertising</h1>
  <a href="https://ad.example.com/?adid=1929&amp;pubid=1422">
    <section>
      <h1>Mellblomatic 9000!</h1>
      <p>Turn all your widgets into mellbloms!</p>
      <p>Only $9.99 plus shipping and handling.</p>
    </section>
  </a>
  <a href="https://ad.example.com/?adid=375&amp;pubid=1422">
    <section>
      <h1>The Mellblom Browser</h1>
      <p>Web browsing at the speed of light.</p>
      <p>No other browser goes faster!</p>
    </section>
  </a>
</aside>
```

Example

The following example shows how a bit of script can be used to effectively make an entire row in a job listing table a hyperlink:

```html
<table>
  <tr>
    <th>Position</th>
    <th>Team</th>
    <th>Location</th>
  </tr>
  <tr>
    <td><a href="/jobs/manager">Manager</a></td>
    <td>Remotees</td>
    <td>Remote</td>
  </tr>
  <tr>
    <td><a href="/jobs/director">Director</a></td>
    <td>Remotees</td>
    <td>Remote</td>
  </tr>
  <tr>
    <td><a href="/jobs/astronaut">Astronaut</a></td>
    <td>Architecture</td>
  </tr>
</table>
```
4.5.2 The em element

Categories:
Flow content
Phrasing content
Palpable content

Contexts in which this element can be used:
Where phrasing content is expected.

Content model:
Phrasing content

Tag omission in text/html:
Neither tag is omissible.

Content attributes:
Global attributes

Accessibility considerations:
For authors.
For implementers.

DOM interface:
Uses HTMLElement

The em element represents stress emphasis of its contents.

The level of stress that a particular piece of content has is given by its number of ancestor em elements.

The placement of stress emphasis changes the meaning of the sentence. The element thus forms an integral part of the content. The precise way in which stress is used in this way depends on the language.

Example
These examples show how changing the stress emphasis changes the meaning. First, a general statement of fact, with no stress:

<p>Cats are cute animals.</p>

By emphasizing the first word, the statement implies that the kind of animal under discussion is in question (maybe someone is asserting that dogs are cute):

<p>Cats are cute animals.</p>

Moving the stress to the verb, one highlights that the truth of the entire sentence is in question (maybe someone is saying cats are not cute):
The `<em>` element isn't a generic "italics" element. Sometimes, text is intended to stand out from the rest of the paragraph, as if it was in a different mood or voice. For this, the `<i>` element is more appropriate.

The `<em>` element also isn't intended to convey importance; for that purpose, the `<strong>` element is more appropriate.

4.5.3 The `<strong>` element

Categories:
- Flow content
- Phrasing content
- Palpable content

Contexts in which this element can be used:
- Where phrasing content is expected.

Content model:
- Phrasing content

Tag omission in text/html:
- Neither tag is omissible.

Content attributes:
- Global attributes

Accessibility considerations:
- For authors
- For implementers

DOM interface:
- Uses `HTMLElement`

The `<strong>` element represents strong importance, seriousness, or urgency for its contents.

Importance: the `<strong>` element can be used in a heading, caption, or paragraph to distinguish the part that really matters from other parts that might be more detailed, more jovial, or merely boilerplate. (This is distinct from marking up subheadings, for which the `<hgroup>` element is appropriate.)
Seriousness: the `<strong>` element can be used to mark up a warning or caution notice.

Urgency: the `<strong>` element can be used to denote contents that the user needs to see sooner than other parts of the document.

The relative level of importance of a piece of content is given by its number of ancestor `<strong>` elements; each `<strong>` element increases the importance of its contents.

Changing the importance of a piece of text with the `<strong>` element does not change the meaning of the sentence.

Example

Here, the word "chapter" and the actual chapter number are mere boilerplate, and the actual name of the chapter is marked up with `<strong>`:

```html
<h1>Chapter 1: <strong>The Praxis</strong></h1>
```

In the following example, the name of the diagram in the caption is marked up with `<strong>`, to distinguish it from boilerplate text (before) and the description (after):

```html
<figcaption>Figure 1. <strong>Ant colony dynamics</strong>. The ants in this colony are affected by the heat source (upper left) and the food source (lower right).</figcaption>
```

In this example, the heading is really "Flowers, Bees, and Honey", but the author has added a light-hearted addition to the heading. The `<strong>` element is thus used to mark up the first part to distinguish it from the latter part.

```html
<h1><strong>Flowers, Bees, and Honey</strong> and other things I don't understand</h1>
```

Example

Here is an example of a warning notice in a game, with the various parts marked up according to how important they are:

```html
<p><strong>Warning.</strong> This dungeon is dangerous.  
Avoid the ducks. <strong>Take any gold you find.</strong> Do not take any of the diamonds <strong>, they are explosive and will destroy anything within ten meters.</strong> You have been warned.</p>
```

Example

In this example, the `<strong>` element is used to denote the part of the text that the user is intended to read first.

```html
<p>Welcome to Remy, the reminder system.</p>
<p>Your tasks for today:</p>
<ul>
<li><strong>Turn off the oven.</strong></li>
<li><strong>Put out the trash.</strong></li>
<li><strong>Do the laundry.</strong></li>
</ul>
```

4.5.4 The `<small>` element

Categories: Flow content, Phrasing content.
The `small` element represents side comments such as small print.

**Note**

Small print typically features disclaimers, caveats, legal restrictions, or copyrights. Small print is also sometimes used for attribution, or for satisfying licensing requirements.

**Note**

The `small` element does not "de-emphasize" or lower the importance of text emphasized by the `em` element or marked as important with the `strong` element. To mark text as not emphasized or important, simply do not mark it up with the `em` or `strong` elements respectively.

The `small` element should not be used for extended spans of text, such as multiple paragraphs, lists, or sections of text. It is only intended for short runs of text. The text of a page listing terms of use, for instance, would not be a suitable candidate for the `small` element: in such a case, the text is not a side comment, it is the main content of the page.

The `small` element must not be used for subheadings; for that purpose, use the `hgroup` element.

**Example**

In this example, the `small` element is used to indicate that value-added tax is not included in a price of a hotel room:

```html
<dl>
  <dt>Single room</dt>
  <dd>199 € <small>breakfast included, VAT not included</small></dd>
  <dt>Double room</dt>
  <dd>239 € <small>breakfast included, VAT not included</small></dd>
</dl>
```

**Example**

In this second example, the `small` element is used for a side comment in an article.

```html
<p>Example Corp today announced record profits for the second quarter <small>(Full Disclosure: Foo News is a subsidiary of Example Corp)</small>, leading to speculation about a third quarter merger with Demo Group.</p>
```

This is distinct from a sidebar, which might be multiple paragraphs long and is removed from the main flow of text. In the following example, we see a sidebar from the same article. This sidebar also has small print, indicating the source of the information in the
The `s` element represents contents that are no longer accurate or no longer relevant.

**Note**

The `s` element is not appropriate when indicating document edits; to mark a span of text as having been removed from a document, use the `del` element.

### Example

In this example a recommended retail price has been marked as no longer relevant as the product in question has a new sale price.

```html
<p>Buy our Iced Tea and Lemonade!</p>
<p><s>Recommended retail price: $3.99 per bottle</s></p>
```
The cite element

Categories:
- Flow content
- Phrasing content
- Palpable content

Contexts in which this element can be used:
Where phrasing content is expected.

Content model:
Phrasing content.

Tag omission in text/html:
Neither tag is omissible.

Content attributes:
Global attributes

Accessibility considerations:
For authors.
For implementers.

DOM interface:
Uses HTMLElement.

The cite element represents the title of a work (e.g. a book, a paper, an essay, a poem, a score, a song, a script, a film, a TV show, a game, a sculpture, a painting, a theatre production, a play, an opera, a musical, an exhibition, a legal case report, a computer program, etc.). This can be a work that is being quoted or referenced in detail (i.e., a citation), or it can just be a work that is mentioned in passing.

A person's name is not the title of a work — even if people call that person a piece of work — and the element must therefore not be used to mark up people's names. (In some cases, the b element might be appropriate for names; e.g. in a gossip article where the names of famous people are keywords rendered with a different style to draw attention to them. In other cases, if an element is really needed, the span element can be used.)

Example
This next example shows a typical use of the cite element:

```
<p>My favorite book is <cite>The Reality Dysfunction</cite> by Peter F. Hamilton. My favorite comic is <cite>Pearls Before Swine</cite> by Stephan Pastis. My favorite track is <cite>Jive Samba</cite> by the Cannonball Adderley Sextet.</p>
```

Example
This is correct usage:

```
<p>According to the Wikipedia article <cite>HTML</cite>, as it stood in mid-February 2008, leaving attribute values unquoted is unsafe. This is obviously an over-simplification.</p>
```

The following, however, is incorrect usage, as the cite element here is containing far more than the title of the work:

```
<!-- do not copy this example, it is an example of bad usage! -->
<p>According to <cite>the Wikipedia article on HTML</cite>, as it
```

Now selling for just $2.99 a bottle!
stood in mid-February 2008, leaving attribute values unquoted is unsafe. This is obviously an over-simplification.<p></p>

### Example

The `cite` element is a key part of any citation in a bibliography, but it is only used to mark the title:

```html
<p>&lt;cite&gt;Universal Declaration of Human Rights&lt;/cite&gt;, United Nations, December 1948. Adopted by General Assembly resolution 217 A (III).&lt;/p&gt;
```

### Note

A citation is not a quote (for which the `q` element is appropriate).

### Example

This is incorrect usage, because `cite` is not for quotes:

```html
<p>&lt;cite&gt;This is wrong!&lt;/cite&gt;, said Ian.&lt;/p&gt;
```

This is also incorrect usage, because a person is not a work:

```html
<p>&lt;q&gt;This is still wrong!&lt;/q&gt;, said &lt;cite&gt;Ian&lt;/cite&gt;.&lt;/p&gt;
```

The correct usage does not use a `cite` element:

```html
<p>&lt;q&gt;This is correct&lt;/q&gt;, said Ian.&lt;/p&gt;
```

As mentioned above, the `b` element might be relevant for marking names as being keywords in certain kinds of documents:

```html
<p>And then &lt;b&gt;Ian&lt;/b&gt; said &lt;q&gt;this might be right, in a gossip column, maybe!&lt;/q&gt;.&lt;/p&gt;
```

### 4.5.7 The `q` element

**Categories**:
- Flow content
- Phrasing content
- Palpable content

**Contexts in which this element can be used**:
Where phrasing content is expected.

**Content model**:
- Phrasing content

**Tag omission in text/html**:
Neither tag is omissible.

**Content attributes**:
- Global attributes
  - `cite` — Link to the source of the quotation or more information about the edit

**Accessibility considerations**:
- For authors
- For implementers
The `q` element represents some phrasing content quoted from another source.

Quotation punctuation (such as quotation marks) that is quoting the contents of the element must not appear immediately before, after, or inside `q` elements; they will be inserted into the rendering by the user agent.

Content inside a `q` element must be quoted from another source, whose address, if it has one, may be cited in the `cite` attribute. The source may be fictional, as when quoting characters in a novel or screenplay.

If the `cite` attribute is present, it must be a valid URL potentially surrounded by spaces. To obtain the corresponding citation link, the value of the attribute must be parsed relative to the element's node document. User agents may allow users to follow such citation links, but they are primarily intended for private use (e.g., by server-side scripts collecting statistics about a site's use of quotations), not for readers.

The `q` element must not be used in place of quotation marks that do not represent quotes; for example, it is inappropriate to use the `q` element for marking up sarcastic statements.

The use of `q` elements to mark up quotations is entirely optional; using explicit quotation punctuation without `q` elements is just as correct.

Example
Here is a simple example of the use of the `q` element:

```html
<p>The man said <q>Things that are impossible just take longer</q>. I disagreed with him.</p>
```

Example
Here is an example with both an explicit citation link in the `q` element, and an explicit citation outside:

```html
<p>The W3C page <cite>About W3C</cite> says the W3C's mission is <q cite="https://www.w3.org/Consortium/">To lead the World Wide Web to its full potential by developing protocols and guidelines that ensure long-term growth for the Web</q>. I disagree with this mission.</p>
```

Example
In the following example, the quotation itself contains a quotation:

```html
<p>In <cite>Example One</cite>, he writes <q>The man said <q>Things that are impossible just take longer</q>. I disagreed with him</q>. Well, I disagree even more!</p>
```

Example
In the following example, quotation marks are used instead of the `q` element:

```html
<p>His best argument was “I disagree”, which I thought was laughable.</p>
```

Example
In the following example, there is no quote — the quotation marks are used to name a word. Use of the `q` element in this case would be inappropriate.

```html
<p>The word “ineffable” could have been used to describe the disaster resulting from the campaign's mismanagement.</p>
```
4.5.8 The `dfn` element

Categories:
- Flow content
- Phrasing content
- Palpable content

Contexts in which this element can be used:
Where phrasing content is expected.

Content model:
Phrasing content, but there must be no `dfn` element descendants.

Tag omission in text/html:
Neither tag is omissible.

Content attributes:
- Global attributes
  - `title` has special semantics on this element: Full term or expansion of abbreviation

Accessibility considerations:
- For authors
- For implementers

DOM interface:
Uses `HTMLElement`.

The `dfn` element represents the defining instance of a term. The `paragraph`, `description list group`, or `section`, that is the nearest ancestor of the `dfn` element must also contain the definition(s) for the `term` given by the `dfn` element.

**Defining term:** if the `dfn` element has a `title` attribute, then the exact value of that attribute is the term being defined. Otherwise, if it contains exactly one element child node and no child `Text` nodes, and that child element is an `abbr` element with a `title` attribute, then the exact value of that attribute is the term being defined. Otherwise, it is the descendant text content of the `dfn` element that gives the term being defined.

If the `title` attribute of the `dfn` element is present, then it must contain only the term being defined.

**Note**
The `title` attribute of ancestor elements does not affect `dfn` elements.

An `a` element that links to a `dfn` element represents an instance of the term defined by the `dfn` element.

**Example**
In the following fragment, the term "Garage Door Opener" is first defined in the first paragraph, then used in the second. In both cases, its abbreviation is what is actually displayed.

```html
<p>The <dfn><abbr title="Garage Door Opener">GDO</abbr></dfn>
is a device that allows off-world teams to open the iris.</p>
<!-- ... later in the document: -->
<p>Teal'c activated his <dfn><abbr title="Garage Door Opener">GDO</abbr></dfn>
and so Hammond ordered the iris to be opened.</p>
```

With the addition of an `a` element, the reference can be made explicit:

```html
<p>The <dfn id="gdo"><abbr title="Garage Door Opener">GDO</abbr></dfn>
is a device that allows off-world teams to open the iris.</p>
<!-- ... later in the document: -->
<p>Teal'c activated his <a href="#gdo"><abbr title="Garage Door Opener">GDO</abbr></a>
and so Hammond ordered the iris to be opened.</p>
```
4.5.9 The abbr element

Categories:
- Flow content
- Phrasing content
- Palpable content

Contexts in which this element can be used:
- Where phrasing content is expected.

Content model:
- Phrasing content

Tag omission in text/html:
- Neither tag is omissible.

Content attributes:
- Global attributes
- Also, the title attribute has special semantics on this element: Full term or expansion of abbreviation

Accessibility considerations:
- For authors.
- For implementers.

DOM interface:
- Uses HTMLElement.

The abbr element represents an abbreviation or acronym, optionally with its expansion. The title attribute may be used to provide an expansion of the abbreviation. The attribute, if specified, must contain an expansion of the abbreviation, and nothing else.

Example

The paragraph below contains an abbreviation marked up with the abbr element. This paragraph defines the term "Web Hypertext Application Technology Working Group".

```html
<p>The <dfn id=whatwg><abbr title="Web Hypertext Application Technology Working Group">WHATWG</abbr></dfn> is a loose unofficial collaboration of web browser manufacturers and interested parties who wish to develop new technologies designed to allow authors to write and deploy Applications over the World Wide Web.</p>
```

An alternative way to write this would be:

```html
<p>The <dfn id=whatwg>Web Hypertext Application Technology Working Group</dfn> (<abbr title="Web Hypertext Application Technology Working Group">WHATWG</abbr>) is a loose unofficial collaboration of web browser manufacturers and interested parties who wish to develop new technologies designed to allow authors to write and deploy Applications over the World Wide Web.</p>
```

Example

This paragraph has two abbreviations. Notice how only one is defined; the other, with no expansion associated with it, does not use the abbr element.

```html
<p>The <abbr title="Web Hypertext Application Technology Working Group">WHATWG</abbr> started working on HTML5 in 2004.</p>
```
This paragraph links an abbreviation to its definition.

```html
<p>The <a href="#whatwg"><abbr title="Web Hypertext Application Technology Working Group">WHATWG</abbr></a> community does not have much representation from Asia.</p>
```

### Example
This paragraph marks up an abbreviation without giving an expansion, possibly as a hook to apply styles for abbreviations (e.g. smallcaps).

```html
<p>Philip` and Dashiva both denied that they were going to get the issue counts from past revisions of the specification to backfill the <abbr title="WHATWG">WHATWG</abbr> issue graph.</p>
```

If an abbreviation is pluralized, the expansion's grammatical number (plural vs singular) must match the grammatical number of the contents of the element.

### Example
Here the plural is outside the element, so the expansion is in the singular:

```html
<p>Two <abbr title="Working Group">WG</abbr>s worked on this specification: the <abbr title="WHATWG">WHATWG</abbr> and the <abbr title="HTMLWG">HTMLWG</abbr>.</p>
```

Here the plural is inside the element, so the expansion is in the plural:

```html
<p>Two <abbr title="Working Groups">WGs</abbr> worked on this specification: the <abbr title="WHATWG">WHATWG</abbr> and the <abbr title="HTMLWG">HTMLWG</abbr>.</p>
```

Abbreviations do not have to be marked up using this element. It is expected to be useful in the following cases:

- Abbreviations for which the author wants to give expansions, where using the `abbr` element with a `title` attribute is an alternative to including the expansion inline (e.g. in parentheses).

- Abbreviations that are likely to be unfamiliar to the document’s readers, for which authors are encouraged to either mark up the abbreviation using an `abbr` element with a `title` attribute or include the expansion inline in the text the first time the abbreviation is used.

- Abbreviations whose presence needs to be semantically annotated, e.g. so that they can be identified from a style sheet and given specific styles, for which the `abbr` element can be used without a `title` attribute.

Providing an expansion in a `title` attribute once will not necessarily cause other `abbr` elements in the same document with the same contents but without a `title` attribute to behave as if they had the same expansion. Every `abbr` element is independent.

### 4.5.10 The `ruby` element

#### Categories:
- Flow content
- Phrasing content
- Palpable content

#### Contexts in which this element can be used:
- Where `phrasing content` is expected.

#### Content model:
See prose.
The `ruby` element allows one or more spans of phrasing content to be marked with ruby annotations. Ruby annotations are short runs of text presented alongside base text, primarily used in East Asian typography as a guide for pronunciation or to include other annotations. In Japanese, this form of typography is also known as *furigana*.

The content model of `ruby` elements consists of one or more of the following sequences:

1. One or the other of the following:
   - Phrasing content, but with no `ruby` elements and with no `ruby` element descendants
   - A single `ruby` element that itself has no `ruby` element descendants

2. One or the other of the following:
   - One or more `rt` elements
   - An `rp` element followed by one or more `rt` elements, each of which is itself followed by an `rp` element

The `ruby` and `rt` elements can be used for a variety of kinds of annotations, including in particular (though by no means limited to) those described below. For more details on Japanese Ruby in particular, and how to render Ruby for Japanese, see *Requirements for Japanese Text Layout*. [JLREQ]

---

**Note**

*At the time of writing, CSS does not yet provide a way to fully control the rendering of the HTML `ruby` element. It is hoped that CSS will be extended to support the styles described below in due course.*

---

### Mono-ruby for individual base characters in Japanese

One or more hiragana or katakana characters (the ruby annotation) are placed with each ideographic character (the base text). This is used to provide readings of kanji characters.

#### Example

```html
<ruby>8<rt>annotation</rt></ruby>
```

#### Example

In this example, notice how each annotation corresponds to a single base character.

```html
<ruby>君<rt>くん</rt>子<rt>し</rt>は<ruby>和<rt>わ</rt>して<ruby>同<rt>どう</rt>ぜず。

君くん子は和して同どうぜ。
```

This example can also be written as follows, using one `ruby` element with two segments of base text and two annotations (one for each) rather than two back-to-back `ruby` elements each with one base text segment and annotation (as in the markup above):

```html
<ruby>君<rt>くん</rt>子<rt>し</rt>は<ruby>和<rt>わ</rt>して<ruby>同<rt>どう</rt>ぜず。
```

### Mono-ruby for compound words (jukugo)

This is similar to the previous case: each ideographic character in the compound word (the base text) has its reading given in
hiragana or katakana characters (the ruby annotation). The difference is that the base text segments form a compound word rather than being separate from each other.

Example

```html
<ruby>B<rt>annotation</rt>B<rt>annotation</rt></ruby>
```

Example

In this example, notice again how each annotation corresponds to a single base character. In this example, each compound word (jukugo) corresponds to a single `<ruby>` element.

The rendering here is expected to be that each annotation be placed over (or next to, in vertical text) the corresponding base character, with the annotations not overhanging any of the adjacent characters.

Example

This is the same example as above for mono-ruby for compound words. The different rendering is expected to be achieved using different styling (e.g. in CSS), and is not shown here.

Note

For more details on Jukugo Ruby rendering, see Appendix F in the Requirements for Japanese Text Layout. [JLREQ]

Group ruby for describing meanings

The annotation describes the meaning of the base text, rather than (or in addition to) the pronunciation. As such, both the base text and the annotation can be multiple characters long.

Example

```html
<ruby BASE<rt>annotation</rt></ruby>
```

Example

Here a compound ideographic word has its corresponding katakana given as an annotation.

```html
<ruby>境界面<rt>インターフェース</rt></ruby>
```

Example

Here a compound ideographic word has its translation in English provided as an annotation.

```html
<ruby lang="ja">編集者<rt lang="en">editor</rt></ruby>
```

Group ruby for Jukuji readings

A phonetic reading that corresponds to multiple base characters, because a one-to-one mapping would be difficult. (In English, the
words "Colonel" and "Lieutenant" are examples of words where a direct mapping of pronunciation to individual letters is, in some dialects, rather unclear.)

**Example**

In this example, the name of a species of flowers has a phonetic reading provided using group ruby:

```
<ruby>紫陽花<rt>あじさい</ruby>
```

紫陽花あじさい

**Text with both phonetic and semantic annotations (double-sided ruby)**

Sometimes, ruby styles described above are combined.

If this results in two annotations covering the same single base segment, then the annotations can just be placed back to back.

**Example**

```
<ruby>BASE<rt>annotation 1</rt>annotation 2</ruby>
```

**Example**

```
<ruby>B<rt>a</rt>a</ruby><ruby>A<rt>a</rt>a</ruby><ruby>S<rt>a</rt>a</ruby><ruby>E<rt>a</rt>a</ruby>
```

**Example**

In this contrived example, some symbols are given names in English and French.

```
<ruby>
♥ <rt>Heart <rt lang=fr>Cœur</rt></rt>
☘ <rt>Shamrock <rt lang=fr>Trèfle</rt></rt>
✶ <rt>Star <rt lang=fr>Étoile</rt></rt>
</ruby>
```

In more complicated situations such as the following examples, a nested `ruby` element is used to give the inner annotations, and then that whole `ruby` is then given an annotation at the "outer" level.

**Example**

```
<ruby><ruby>B<rt>a</rt>a</ruby><ruby>A<rt>n</rt>S<rt>t</rt>E<rt>n</rt></ruby><rt>annotation</rt></ruby>
```

**Example**

Here both a phonetic reading and the meaning are given in ruby annotations. The annotation on the nested `ruby` element gives a mono-ruby phonetic annotation for each base character, while the annotation in the `rt` element that is a child of the outer `ruby` element gives the meaning using hiragana.

```
<ruby><ruby>東<rt>とう</rt>南<rt>なん</rt></ruby><ruby>たつみ</ruby></ruby><rt>の方角</rt>
```

東とう南なんたつみの方角

**Example**

This is the same example, but the meaning is given in English instead of Japanese:

```
<ruby><ruby>東<rt>とう</rt>南<rt>なん</rt></ruby><ruby><rt lang=en>Southeast</rt></ruby></ruby><rt>の方角</rt>
```

東とう南なんSoutheastの方角

Within a `ruby` element that does not have a `ruby` element ancestor, content is segmented and segments are placed into three categories: base text segments, annotation segments, and ignored segments. Ignored segments do not form part of the document’s
At any particular time, the segmentation and categorization of content of a ruby element is the result that would be obtained from running the following algorithm:

1. Let base text segments be an empty list of base text segments, each potentially with a list of base text subsegments.
2. Let annotation segments be an empty list of annotation segments, each potentially being associated with a base text segment or subsegment.
3. Let root be the ruby element for which the algorithm is being run.
4. If root has a ruby element ancestor, then jump to the step labeled end.
5. Let current parent be root.
6. Let index be 0.
7. Let start index be null.
8. Let parent start index be null.
9. Let current base text be null.
10. Start mode: If index is greater than or equal to the number of child nodes in current parent, then jump to the step labeled end mode.
11. If the indexth node in current parent is an rt or rp element, jump to the step labeled annotation mode.
12. Set start index to the value of index.
13. Base mode: If the indexth node in current parent is a ruby element, and if current parent is the same element as root, then push a ruby level, and then jump to the step labeled start mode.
14. If the indexth node in current parent is an rt or rp element, then set the current base text, and then jump to the step labeled annotation mode.
15. Increment index by one.
16. Base mode post-increment: If index is greater than or equal to the number of child nodes in current parent, then jump to the step labeled end mode.
17. Jump back to the step labeled base mode.
18. Annotation mode: If the indexth node in current parent is an rt element, then push a ruby annotation and jump to the step labeled annotation mode increment.
19. If the indexth node in current parent is an rp element, jump to the step labeled annotation mode increment.
20. If the indexth node in current parent is not a Text node, or is a Text node that is not inter-element whitespace, then jump to the step labeled base mode.
21. Annotation mode increment: Let lookahead index be index plus one.
22. Annotation mode white-space skipper: If lookahead index is equal to the number of child nodes in current parent then jump to the step labeled end mode.
23. If the lookahead indexth node in current parent is an rt element or an rp element, then set index to lookahead index and jump to the step labeled annotation mode.
24. If the lookahead indexth node in current parent is not a Text node, or is a Text node that is not inter-element whitespace, then jump to the step labeled base mode (without further incrementing index, so the inter-element whitespace seen so
far becomes part of the next base text segment).

25. Increment lookahead index by one.

26. Jump to the step labeled annotation mode white-space skipper.

27. End mode: If current parent is not the same element as root, then pop a ruby level and jump to the step labeled base mode post-increment.

28. End: Return base text segments and annotation segments. Any content of the ruby element not described by segments in either of those lists is implicitly in an ignored segment.

When the steps above say to set the current base text, it means to run the following steps at that point in the algorithm:

1. Let text range be a DOM range whose start is the boundary point (current parent, start index) and whose end is the boundary point (current parent, index).
2. Let new text segment be a base text segment described by the range annotation range.
3. Add new text segment to base text segments.
4. Let current base text be new text segment.
5. Let start index be null.

When the steps above say to push a ruby level, it means to run the following steps at that point in the algorithm:

1. Let current parent be the indexth node in current parent.
2. Let index be 0.
3. Set saved start index to the value of start index.
4. Let start index be null.

When the steps above say to pop a ruby level, it means to run the following steps at that point in the algorithm:

1. Let index be the position of current parent in root.
2. Let current parent be root.
3. Increment index by one.
4. Set start index to the value of saved start index.
5. Let saved start index be null.

When the steps above say to push a ruby annotation, it means to run the following steps at that point in the algorithm:

1. Let rt be the element that is the indexth node of current parent.
2. Let annotation range be a DOM range whose start is the boundary point (current parent, index) and whose end is the boundary point (current parent, index plus one) (i.e. that contains only rt).
3. Let new annotation segment be an annotation segment described by the range annotation range.
4. If current base text is not null, associate new annotation segment with current base text.
5. Add new annotation segment to annotation segments.

Example

In this example, each ideograph in the Japanese text 漢字 is annotated with its reading in hiragana.

```xml
...<ruby>漢<rt>かん</rt>字<rt>じ</rt></ruby>...
```

This might be rendered as:
Example

In this example, each ideograph in the traditional Chinese text 漢字 is annotated with its bopomofo reading.

```html
<ruby>漢<rt>ㄏㄢˋ</rt>字</ruby>
```

This might be rendered as:

![漢字](image)

Example

In this example, each ideograph in the simplified Chinese text 汉字 is annotated with its pinyin reading.

```html
...<ruby>汉<rt>hàn</rt>字</ruby>...
```

This might be rendered as:

![汉字](image)

Example

In this more contrived example, the acronym "HTML" has four annotations: one for the whole acronym, briefly describing what it is, one for the letters "HT" expanding them to "Hypertext", one for the letter "M" expanding it to "Markup", and one for the letter "L" expanding it to "Language".

```html
<ruby>
<ruby>HT<rt>Hypertext</rt>M<rt>Markup</rt>L<rt>Language</rt></ruby>  
<rt>An abstract language for describing documents and applications</rt>
</ruby>
```

4.5.11 The rt element

- **Categories**: None.
- **Contexts in which this element can be used**: As a child of a ruby element.
- **Content model**: Phrasing content.
Tag omission in text/html:
An `rt` element's end tag can be omitted if the `rt` element is immediately followed by an `rt` or `rp` element, or if there is no more content in the parent element.

Content attributes:
- Global attributes
- Accessibility considerations:
  - For authors.
  - For implementers.

DOM interface:
- Uses `HTMLElement`.

The `rt` element marks the ruby text component of a ruby annotation. When it is the child of a `ruby` element, it doesn't represent anything itself, but the `ruby` element uses it as part of determining what it represents.

An `rt` element that is not a child of a `ruby` element represents the same thing as its children.

4.5.12 The `rp` element:

Categories:
None.

Contexts in which this element can be used:
As a child of a `ruby` element, either immediately before or immediately after an `rt` element.

Content model:
- Text.

Tag omission in text/html:
An `rp` element's end tag can be omitted if the `rp` element is immediately followed by an `rt` or `rp` element, or if there is no more content in the parent element.

Content attributes:
- Global attributes
- Accessibility considerations:
  - For authors.
  - For implementers.

DOM interface:
- Uses `HTMLElement`.

The `rp` element can be used to provide parentheses or other content around a ruby text component of a ruby annotation, to be shown by user agents that don't support ruby annotations.

An `rp` element that is a child of a `ruby` element represents nothing. An `rp` element whose parent element is not a `ruby` element represents its children.

Example:
The example above, in which each ideograph in the text 漢字 is annotated with its phonetic reading, could be expanded to use `rp` so that in legacy user agents the readings are in parentheses:

```html
... <ruby>漢<rp>（</rp>かん</rt><rt>）</rt><rp>（</rp>じ</rt><rt>）</rt><rp></rp></ruby>...
```

In conforming user agents the rendering would be as above, but in user agents that do not support ruby, the rendering would be:

```plaintext
... 漢（かん）字（じ）...
```
4.5.13 The `data` element

When there are multiple annotations for a segment, `rp` elements can also be placed between the annotations. Here is another copy of an earlier contrived example showing some symbols with names given in English and French, but this time with `rp` elements as well:

```xml
<ruby>
♥<rp>: </rp><rt>Heart</rt><rp>, </rp><rt lang=fr>Cœur</rt><rp>.</rp>
♠<rp>: </rp><rt>Shamrock</rt><rp>, </rp><rt lang=fr>Trèfle</rt><rp>.</rp>
♦<rp>: </rp><rt>Star</rt><rp>, </rp><rt lang=fr>Étoile</rt><rp>.</rp>
</ruby>
```

This would make the example render as follows in non-ruby-capable user agents:


The `data` element represents its contents, along with a machine-readable form of those contents in the `value` attribute. The `value` attribute must be present. Its value must be a representation of the element's contents in a machine-readable format.

Note

When the value is date- or time-related, the more specific `time` element can be used instead.

The element can be used for several purposes.

When combined with microformats or the `microdata` attributes defined in this specification, the element serves to provide both a machine-readable value for the purposes of data processors, and a human-readable value for the purposes of rendering in a web browser. In this case, the format to be used in the `value` attribute is determined by the microformats or microdata vocabulary in
The element can also, however, be used in conjunction with scripts in the page, for when a script has a literal value to store alongside a human-readable value. In such cases, the format to be used depends only on the needs of the script. (The `data-*` attributes can also be useful in such situations.)

The **value** IDL attribute must reflect the content attribute of the same name.

**Example**

Here, a short table has its numeric values encoded using the `data` element so that the table sorting JavaScript library can provide a sorting mechanism on each column despite the numbers being presented in textual form in one column and in a decomposed form in another.

```html
<script src="sortable.js"></script>
<table class="sortable">
<thead><tr><th>Game Corporations</th><th>Map Size</th></tr></thead>
<tbody>
<tr><td>1830</td><td data-value="8">Eight</td><td data-value="93">19+74 hexes (93 total)</td></tr>
<tr><td>1856</td><td data-value="11">Eleven</td><td data-value="99">12+87 hexes (99 total)</td></tr>
<tr><td>1870</td><td data-value="10">Ten</td><td data-value="149">4+145 hexes (149 total)</td></tr>
</tbody>
</table>
```

### 4.5.14 The **time** element

**Categories**: Flow content, Phrasing content, Palpable content.

**Contexts in which this element can be used**: Where phrasing content is expected.

**Content model**: If the element has a `datetime` attribute: Phrasing content. Otherwise: Text, but must match requirements described in prose below.

**Tag omission in text/html**: Neither tag is omissible.

**Content attributes**: `Global attributes` `datetime` — Machine-readable value

**Accessibility considerations**: For authors. For implementers.

**DOM interface**: `IDL` [Exposed=Window]

```
interface HTMLTimeElement : HTMLElement {
    [HTMLConstructor] constructor();

    [CEReactions] attribute DOMString dateTime;
};
```

The **time** element represents its contents, along with a machine-readable form of those contents in the `datetime` attribute. The kind of content is limited to various kinds of dates, times, time-zone offsets, and durations, as described below.
The `datetime` attribute may be present. If present, its value must be a representation of the element's contents in a machine-readable format.

A `time` element that does not have a `datetime` content attribute must not have any element descendants.

The datetime value of a `time` element is the value of the element's `datetime` content attribute, if it has one, otherwise the child text content of the `time` element.

The datetime value of a `time` element must match one of the following syntaxes.

A valid month string

Example

```xml
<time>2011-11</time>
```

A valid date string

Example

```xml
<time>2011-11-18</time>
```

A valid yearless date string

Example

```xml
<time>11-18</time>
```

A valid time string

Example

```xml
<time>14:54</time>
```

Example

```xml
<time>14:54:39</time>
```

Example

```xml
<time>14:54:39.929</time>
```

A valid local date and time string

Example

```xml
<time>2011-11-18T14:54</time>
```

Example

```xml
<time>2011-11-18T14:54:39</time>
```

Example

```xml
<time>2011-11-18T14:54:39.929</time>
```

Example

```xml
<time>2011-11-18 14:54</time>
```
A valid time-zone offset string

Example

\(<\text{time}>2011-11-18\ 14:54:39</\text{time}>\)

Example

\(<\text{time}>2011-11-18\ 14:54:39.929</\text{time}>\)

Note

Times with dates but without a time zone offset are useful for specifying events that are observed at the same specific time in each time zone, throughout a day. For example, the 2020 new year is celebrated at 2020-01-01 00:00 in each time zone, not at the same precise moment across all time zones. For events that occur at the same time across all time zones, for example a videoconference meeting, a valid global date and time string\(^{44}\) is likely more useful.

A valid time-zone offset string\(^{44}\)

Example

\(<\text{time}>Z</\text{time}>\)

Example

\(<\text{time}>+0000</\text{time}>\)

Example

\(<\text{time}>+00:00</\text{time}>\)

Example

\(<\text{time}>-0800</\text{time}>\)

Example

\(<\text{time}>-08:00</\text{time}>\)

Note

For times without dates (or times referring to events that recur on multiple dates), specifying the geographic location that controls the time is usually more useful than specifying a time zone offset, because geographic locations change time zone offsets with daylight saving time. In some cases, geographic locations even change time zone, e.g. when the boundaries of those time zones are redrawn, as happened with Samoa at the end of 2011. There exists a time zone database that describes the boundaries of time zones and what rules apply within each such zone, known as the time zone database. [TZDATABASE]\(^{462}\)

A valid global date and time string\(^{44}\)

Example

\(<\text{time}>2011-11-18\text{T}14:54:39\text{Z}</\text{time}>\)

Example

\(<\text{time}>2011-11-18\text{T}14:54:39\text{Z}</\text{time}>\)

Example

\(<\text{time}>2011-11-18\text{T}14:54:39.929\text{Z}</\text{time}>\)
Example

<time>2011-11-18T14:54+0000</time>

Example

<time>2011-11-18T14:54:39+0000</time>

Example

<time>2011-11-18T14:54:39.929+0000</time>

Example

<time>2011-11-18T14:54+00:00</time>

Example

<time>2011-11-18T14:54:39+00:00</time>

Example

<time>2011-11-18T14:54:39.929+00:00</time>

Example

<time>2011-11-18T06:54-0800</time>

Example

<time>2011-11-18T06:54:39-0800</time>

Example

<time>2011-11-18T06:54:39.929-0800</time>

Example

<time>2011-11-18T06:54-08:00</time>

Example

<time>2011-11-18T06:54:39-08:00</time>

Example

<time>2011-11-18T06:54:39.929-08:00</time>

Example

<time>2011-11-18 14:54Z</time>

Example

<time>2011-11-18 14:54:39Z</time>
Example
<time>2011-11-18 14:54:39.929Z</time>

Example
<time>2011-11-18 14:54+0000</time>

Example
<time>2011-11-18 14:54:39+0000</time>

Example
<time>2011-11-18 14:54:39.929+0000</time>

Example
<time>2011-11-18 14:54+00:00</time>

Example
<time>2011-11-18 14:54:39+00:00</time>

Example
<time>2011-11-18 14:54:39.929+00:00</time>

Example
<time>2011-11-18 06:54-0800</time>

Example
<time>2011-11-18 06:54:39-0800</time>

Example
<time>2011-11-18 06:54:39.929-0800</time>

Example
<time>2011-11-18 06:54-08:00</time>

Example
<time>2011-11-18 06:54:39-08:00</time>

Example
<time>2011-11-18 06:54:39.929-08:00</time>

Note
Times with dates and a time zone offset are useful for specifying specific events, or recurring virtual events where the time is not anchored to a specific geographic location. For example, the precise time of an asteroid impact, or a particular meeting in a series of meetings held at 1400 UTC every day, regardless of whether any particular part of the world is observing daylight saving time or not. For events where the precise time varies by the local time zone offset of a specific geographic location, a
valid local date and time string combined with that geographic location is likely more useful.

A **valid week string**

Example

```html
<time>2011-W47</time>
```

Four or more ASCII digits, at least one of which is not U+0030 DIGIT ZERO (0)

Example

```html
<time>2011</time>
```

Example

```html
<time>0001</time>
```

A **valid duration string**

Example

```html
<time>PT4H18M3S</time>
```

Example

```html
<time>4h 18m 3s</time>
```

The **machine-readable equivalent of the element's contents** must be obtained from the element's **datetime value** by using the following algorithm:

1. If parsing a month string from the element's **datetime value** returns a month, that is the machine-readable equivalent; return.
2. If parsing a date string from the element's **datetime value** returns a date, that is the machine-readable equivalent; return.
3. If parsing a yearless date string from the element's **datetime value** returns a yearless date, that is the machine-readable equivalent; return.
4. If parsing a time string from the element's **datetime value** returns a time, that is the machine-readable equivalent; return.
5. If parsing a local date and time string from the element's **datetime value** returns a local date and time, that is the machine-readable equivalent; return.
6. If parsing a time-zone offset string from the element's **datetime value** returns a time-zone offset, that is the machine-readable equivalent; return.
7. If parsing a global date and time string from the element's **datetime value** returns a global date and time, that is the machine-readable equivalent; return.
8. If parsing a week string from the element's **datetime value** returns a week, that is the machine-readable equivalent; return.
9. If the element's **datetime value** consists of only ASCII digits, at least one of which is not U+0030 DIGIT ZERO (0), then the machine-readable equivalent is the base-ten interpretation of those digits, representing a year; return.
10. If parsing a duration string from the element's **datetime value** returns a duration, that is the machine-readable equivalent; return.
11. There is no machine-readable equivalent.
The `date` IDL attribute must reflect the element's `datetime` content attribute.

**Example**

The `time` element can be used to encode dates, for example in microformats. The following shows a hypothetical way of encoding an event using a variant on hCalendar that uses the `time` element:

```html
<div class="vevent">
  http://www.web2con.com/  
  <time class="dtstart" datetime="2005-10-05">October 5</time> - <time class="dtend" datetime="2005-10-07">7</time>, at the Argent Hotel, San Francisco, CA.
</div>
```

**Example**

Here, a fictional microdata vocabulary based on the Atom vocabulary is used with the `time` element to mark up a blog post's publication date.

```html
<article itemscope itemtype="https://n.example.org/rfc4287">
  <h1 itemprop="title">Big tasks</h1>
  <footer>Published <time itemprop="published" datetime="2009-08-29">two days ago</time>.</footer>
  <p itemprop="content">Today, I went out and bought a bike for my kid.</p>
</article>
```

**Example**

In this example, another article's publication date is marked up using `time`, this time using the schema.org microdata vocabulary:

```html
<article itemscope itemtype="http://schema.org/BlogPosting">
  <h1 itemprop="headline">Small tasks</h1>
  <footer>Published <time itemprop="datePublished" datetime="2009-08-30">yesterday</time>.</footer>
  <p itemprop="articleBody">I put a bike bell on her bike.</p>
</article>
```

**Example**

In the following snippet, the `time` element is used to encode a date in the ISO8601 format, for later processing by a script:

```html
<p>Our first date was <time datetime="2006-09-23">a Saturday</time>.</p>
```

In this second snippet, the value includes a time:

```html
<p>We stopped talking at <time datetime="2006-09-24T05:00-07:00">5am the next morning</time>.</p>
```

A script loaded by the page (and thus privy to the page's internal convention of marking up dates and times using the `time` element) could scan through the page and look at all the `time` elements therein to create an index of dates and times.

**Example**

For example, this element conveys the string "Friday" with the additional semantic that the 18th of November 2011 is the meaning that corresponds to "Friday":

```html
<p>Example</p>
```
Today is <time datetime="2011-11-18">Friday</time>.

Example

In this example, a specific time in the Pacific Standard Time timezone is specified:

Your next meeting is at <time datetime="2011-11-18T15:00-08:00">3pm</time>.

4.5.15 The code element §p28

Categories

Flow content p147.
Phrasing content p148.
Palpable content p148.

Contexts in which this element can be used:
Where phrasing content p148 is expected.

Content model:
Phrasing content p148.

Tag omission in text/html:
Neither tag is omissible.

Content attributes:
Global attributes p152.

Accessibility considerations:
For authors.
For implementers.

DOM interface:
Uses HTMLElement p140.

The code element represents a fragment of computer code. This could be an XML element name, a filename, a computer program, or any other string that a computer would recognize.

There is no formal way to indicate the language of computer code being marked up. Authors who wish to mark code elements with the language used, e.g. so that syntax highlighting scripts can use the right rules, can use the class attribute, e.g. by adding a class prefixed with "language-" to the element.

Example

The following example shows how the element can be used in a paragraph to mark up element names and computer code, including punctuation.

<p>The <code>code</code> element represents a fragment of computer code.</p>

<p>When you call the <code>activate()</code> method on the <code>robotSnowman</code> object, the eyes glow.</p>

<p>The example below uses the <code>begin</code> keyword to indicate the start of a statement block. It is paired with an <code>end</code> keyword, which is followed by the <code>}</code> punctuation character (full stop) to indicate the end of the program.</p>
The following example shows how a block of code could be marked up using the `<pre>` and `<code>` elements.

```html
<pre><code class="language-pascal">var i: Integer;
begin
  i := 1;
end.</code></pre>
```

A class is used in that example to indicate the language used.

---

### 4.5.16 The `var` element

**Categories**:  
Flow content, Phrasing content, Palpable content.

**Contexts in which this element can be used**:  
Where **phrasing content** is expected.

**Content model**:  
Phrasing content.

**Tag omission in text/html**:  
Neither tag is omissible.

**Content attributes**:  
Global attributes.

**Accessibility considerations**:  
For authors.  
For implementers.

**DOM interface**:  
Uses `HTMLElement`.

The `var` element represents a variable. This could be an actual variable in a mathematical expression or programming context, an identifier representing a constant, a symbol identifying a physical quantity, a function parameter, or just be a term used as a placeholder in prose.

**Example**

In the paragraph below, the letter "n" is being used as a variable in prose:

```html
<p>If there are <var>n</var> pipes leading to the ice cream factory then I expect at least <em>n</em> flavors of ice cream to be available for purchase!</p>
```

For mathematics, in particular for anything beyond the simplest of expressions, MathML is more appropriate. However, the `var` element can still be used to refer to specific variables that are then mentioned in MathML expressions.

**Example**

In this example, an equation is shown, with a legend that references the variables in the equation. The expression itself is marked up with MathML, but the variables are mentioned in the figure's legend using `var`.

```html
<figure>
```

Example

Here, the equation describing mass-energy equivalence is used in a sentence, and the `var` element is used to mark the variables and constants in that equation:

```html
<p>Then she turned to the blackboard and picked up the chalk. After a few moment's thought, she wrote \( E = m c^2 \). The teacher looked pleased.</p>
```

4.5.17 The `samp` element

Categories:
- Flow content
- Phrasing content
- Palpable content

Contexts in which this element can be used:
Where phrasing content is expected.

Content model:
- Phrasing content

Tag omission in text/html:
Neither tag is omissible.

Content attributes:
- Global attributes

Accessibility considerations:
- For authors.
- For implementers.

DOM interface:
Uses `HTMLElement`.

The `samp` element represents sample or quoted output from another program or computing system.

Note
- See the `pre` and `kbd` elements for more details.

Note
- This element can be contrasted with the `output` element, which can be used to provide immediate output in a web application.
4.5.18 The **kbd** element

The **kbd** element represents user input (typically keyboard input, although it may also be used to represent other input, such as voice commands).

When the **kbd** element is nested inside a **samp** element, it represents the input as it was echoed by the system.

When the **kbd** element contains a **samp** element, it represents input based on system output, for example invoking a menu item.
When the `<kbd>` element is nested inside another `<kbd>` element, it represents an actual key or other single unit of input as appropriate for the input mechanism.

**Example**

Here the `<kbd>` element is used to indicate keys to press:

```html
<p>To make George eat an apple, press `<kbd>`<kbd>Shift</kbd>`</p>
```

In this second example, the user is told to pick a particular menu item. The outer `<kbd>` element marks up a block of input, with the inner `<kbd>` elements representing each individual step of the input, and the `<samp>` elements inside them indicating that the steps are input based on something being displayed by the system, in this case menu labels:

```html
<p>To make George eat an apple, select `<kbd>`<samp>File</samp>`</p>
```

Such precision isn't necessary; the following is equally fine:

```html
<p>To make George eat an apple, select `<kbd>`File | Eat Apple...</kbd>`</p>
```

### 4.5.19 The `<sub>` and `<sup>` elements

**Categories**: Flow content, Phrasing content, Palpable content.

**Contexts in which this element can be used**: Where phrasing content is expected.

**Content model**: Phrasing content.

**Tag omission in text/html**: Neither tag is omissible.

**Content attributes**: Global attributes.

**Accessibility considerations**: The `<sub>` element: for authors, for implementers. The `<sup>` element: for authors, for implementers.

**DOM Interface**: Use `HTML.Element`.

The `<sup>` element represents a superscript and the `<sub>` element represents a subscript.

These elements must be used only to mark up typographical conventions with specific meanings, not for typographical presentation for presentation's sake. For example, it would be inappropriate for the `<sub>` and `<sup>` elements to be used in the name of the LaTeX document preparation system. In general, authors should use these elements only if the absence of those elements would change the meaning of the content.

In certain languages, superscripts are part of the typographical conventions for some abbreviations.

**Example**

```html
<p>Their names are `<span lang="fr">Mlle</span>` Gwendoline and `<span lang="fr">Mme</span>` Denise.</p>
```
The `sub` element can be used inside a `var` element, for variables that have subscripts.

**Example**

Here, the `sub` element is used to represent the subscript that identifies the variable in a family of variables:

```xml
<p>The coordinate of the <var>i</var>th point is (<var>x</var><sub><var>i</var></sub>, <var>y</var><sub><var>i</var></sub>). For example, the 10th point has coordinate (<var>x</var><sub>10</sub>, <var>y</var><sub>10</sub>).</p>
```

Mathematical expressions often use subscripts and superscripts. Authors are encouraged to use MathML for marking up mathematics, but authors may opt to use `sub` and `sup` if detailed mathematical markup is not desired. [MATHML]

**Example**

```xml
<p>\( f(<var>x</var>, <var>n</var>) = \log<sub>4</sub><var>x</var><sup><var>n</var></sup> \)</p>
```

### 4.5.20 The `i` element

**Categories**

- Flow content
- Phrasing content
- Palpable content

**Contexts in which this element can be used**

Where phrasing content is expected.

**Content model**

- Phrasing content

**Tag omission in text/html**

Neither tag is omissible.

**Content attributes**

- Global attributes

**Accessibility considerations**

- For authors
- For implementers

**DOM interface**

Uses `HTMLElement`

The `i` element represents a span of text in an alternate voice or mood, or otherwise offset from the normal prose in a manner indicating a different quality of text, such as a taxonomic designation, a technical term, an idiomatic phrase from another language, transliteration, a thought, or a ship name in Western texts.

Terms in languages different from the main text should be annotated with `lang` attributes (or, in XML, `lang` attributes in the XML namespace).

**Example**

The examples below show uses of the `i` element:

```xml
<p>The <i class="taxonomy">Felis silvestris catus</i> is cute.</p>
<p>The term <i>prose content</i> is defined above.</p>
<p>There is a certain <i lang="fr">je ne sais quoi</i> in the air.</p>
```
In the following example, a dream sequence is marked up using `<i>` elements.

```html
<p>Raymond tried to sleep.</p>
<p><i>The ship sailed away on Thursday, he dreamt. The ship had many people aboard, including a beautiful princess called Carey. He watched her, day-in, day-out, hoping she would notice him, but she never did.</i></p>
<p>Finally one night he picked up the courage to speak with her—</p>
<p>Raymond woke with a start as the fire alarm rang out.</p>
```

Authors can use the `class` attribute on the `<i>` element to identify why the element is being used, so that if the style of a particular use (e.g. dream sequences as opposed to taxonomic terms) is to be changed at a later date, the author doesn't have to go through the entire document (or series of related documents) annotating each use.

Authors are encouraged to consider whether other elements might be more applicable than the `<i>` element, for instance the `<em>` element for marking up stress emphasis, or the `<dfn>` element to mark up the defining instance of a term.

### Note

Style sheets can be used to format `<i>` elements, just like any other element can be restyled. Thus, it is not the case that content in `<i>` elements will necessarily be italicized.

#### 4.5.21 The `<b>` element

**Categories**:

- Flow content
- Phrasing content
- Palpable content

**Contexts in which this element can be used**:

Where phrasing content is expected.

**Content model**:

- Phrasing content

**Tag omission in text/html**:

Neither tag is omissible.

**Content attributes**:

- Global attributes

**Accessibility considerations**:

- For authors
- For implementers

**DOM interface**:

Uses `HTML Element`.

The `<b>` element represents a span of text to which attention is being drawn for utilitarian purposes without conveying any extra importance and with no implication of an alternate voice or mood, such as key words in a document abstract, product names in a review, actionable words in interactive text-driven software, or an article lede.

#### Example

The following example shows a use of the `<b>` element to highlight key words without marking them up as important:

```html
<p>The `<b>frobonitor</b>` and `<b>barbinator</b>` components are fried.</p>
```
As with the `i` element, authors can use the `class` attribute on the `b` element to identify why the element is being used, so that if the style of a particular use is to be changed at a later date, the author doesn’t have to go through annotating each use.

The `b` element should be used as a last resort when no other element is more appropriate. In particular, headings should use the `h1` to `h6` elements, stress emphasis should use the `em` element, importance should be denoted with the `strong` element, and text marked or highlighted should use the `mark` element.

As with the `i` element, authors can use the `class` attribute on the `b` element to identify why the element is being used, so that if the style of a particular use is to be changed at a later date, the author doesn’t have to go through annotating each use.

The `b` element should be used as a last resort when no other element is more appropriate. In particular, headings should use the `h1` to `h6` elements, stress emphasis should use the `em` element, importance should be denoted with the `strong` element, and text marked or highlighted should use the `mark` element.

Example
In the following example, objects in a text adventure are highlighted as being special by use of the `b` element.

```html
<p>You enter a small room. Your <b>sword</b> glows brighter. A <b>rat</b> scurries past the corner wall.</p>
```

Example
Another case where the `b` element is appropriate is in marking up the lede (or lead) sentence or paragraph. The following example shows how a [BBC article about kittens adopting a rabbit as their own](https://www.bbc.com) could be marked up:

```html
<article>
  <h2>Kittens 'adopted' by pet rabbit</h2>
  <p><b class="lede">Six abandoned kittens have found an unexpected new mother figure — a pet rabbit.</b></p>
  <p>Veterinary nurse Melanie Humble took the three-week-old kittens to her Aberdeen home.</p>
</article>
```

As with the `i` element, authors can use the `class` attribute on the `b` element to identify why the element is being used, so that if the style of a particular use is to be changed at a later date, the author doesn’t have to go through annotating each use.

The `b` element should be used as a last resort when no other element is more appropriate. In particular, headings should use the `h1` to `h6` elements, stress emphasis should use the `em` element, importance should be denoted with the `strong` element, and text marked or highlighted should use the `mark` element.

Example
The following would be incorrect usage:

```html
<p><b>WARNING!</b> Do not frob the barbinator!</p>
```

In the previous example, the correct element to use would have been `strong`, not `b`.

**Note**
`Style sheets can be used to format `b` elements, just like any other element can be restyled. Thus, it is not the case that content in `b` elements will necessarily be boldened.`

4.5.22 The `u` element

- **Categories**: Flow content, Phrasing content, Palpable content

- **Contexts in which this element can be used**: Where phrasing content is expected.

- **Content model**: Phrasing content

- **Tag omission in text/html**: Neither tag is omissible.

- **Content attributes**: Global attributes

- **Accessibility considerations**: For authors
The `u` element represents a span of text with an unarticulated, though explicitly rendered, non-textual annotation, such as labeling the text as being a proper name in Chinese text (a Chinese proper name mark), or labeling the text as being misspelt.

In most cases, another element is likely to be more appropriate: for marking stress emphasis, the `em` element should be used; for marking key words or phrases either the `b` element or the `mark` element should be used, depending on the context; for marking book titles, the `cite` element should be used; for labeling text with explicit textual annotations, the `ruby` element should be used; for technical terms, taxonomic designation, transliteration, a thought, or for labeling ship names in Western texts, the `i` element should be used.

**Note**

The default rendering of the `u` element in visual presentations clashes with the conventional rendering of hyperlinks (underlining). Authors are encouraged to avoid using the `u` element where it could be confused for a hyperlink.

**Example**

In this example, a `u` element is used to mark a word as misspelt:

```html
<p>The <u>see</u> is full of fish.</p>
```

### 4.5.23 The `mark` element

**Categories**

Flow content

Phrasing content

Palpable content

**Contexts in which this element can be used**: Where phrasing content is expected.

**Content model**: Phrasing content

**Tag omission in text/html**: Neither tag is omissible.

**Content attributes**: Global attributes

**Accessibility considerations**: For authors. For implementers.

**DOM interface**: Uses `HTMLElement`.

The `mark` element represents a run of text in one document marked or highlighted for reference purposes, due to its relevance in another context. When used in a quotation or other block of text referred to from the prose, it indicates a highlight that was not originally present but which has been added to bring the reader's attention to a part of the text that might not have been considered important by the original author when the block was originally written, but which is now under previously unexpected scrutiny. When used in the main prose of a document, it indicates a part of the document that has been highlighted due to its likely relevance to the user's current activity.

**Example**

This example shows how the `mark` element can be used to bring attention to a particular part of a quotation:
Consider the following quote:

Look around and you will find, no-one's really colour blind.

As we can tell from the spelling of the word, the person writing this quote is clearly not American.

(If the goal was to mark the element as misspelt, however, the element, possibly with a class, would be more appropriate.)

Another example of the element is highlighting parts of a document that are matching some search string. If someone looked at a document, and the server knew that the user was searching for the word "kitten", then the server might return the document with one paragraph modified as follows:

I also have some kitten(s) who are visiting me these days. They're really cute. I think they like my garden! Maybe I should adopt a kitten.

In the following snippet, a paragraph of text refers to a specific part of a code fragment.

The highlighted part below is where the error lies:

This is separate from syntax highlighting, for which is more appropriate. Combining both, one would get:

This is another example showing the use of to highlight a part of quoted text that was originally not emphasized. In this example, common typographic conventions have led the author to explicitly style elements in quotes to render in italics.
Example

The following example shows the difference between denoting the importance of a span of text (strong) as opposed to denoting the relevance of a span of text (mark). It is an extract from a textbook, where the extract has had the parts relevant to the exam highlighted. The safety warnings, important though they may be, are apparently not relevant to the exam.

Wormhole Physics Introduction

A wormhole in normal conditions can be held open for a maximum of just under 39 minutes. Conditions that can increase the time include a powerful energy source coupled to one or both of the gates connecting the wormhole, and a large gravity well (such as a black hole).

Momentum is preserved across the wormhole. Electromagnetic radiation can travel in both directions through a wormhole, but matter cannot.

When a wormhole is created, a vortex normally forms. Warning: The vortex caused by the wormhole opening will annihilate anything in its path. Vortexes can be avoided when using sufficiently advanced dialing technology.

An obstruction in a gate will prevent it from accepting a wormhole connection.

4.5.24 The bdi element

Categories:
Flow content
Phrasing content
Palpable content

Contexts in which this element can be used:
Where phrasing content is expected.

Content model:
Phrasing content

Tag omission in text/html:
Neither tag is omissible.

Content attributes:
Global attributes
Also, the dir global attribute has special semantics on this element.

Accessibility considerations:
For authors.
For implementers.

DOM interface:

Uses `HTMLElement`.

The `bdi` element represents a span of text that is to be isolated from its surroundings for the purposes of bidirectional text formatting. [BIDI]

Note

The `dir` global attribute defaults to `auto` on this element (it never inherits from the parent element like with other elements).

Note

This element has rendering requirements involving the bidirectional algorithm.

Example

This element is especially useful when embedding user-generated content with an unknown directionality.

In this example, usernames are shown along with the number of posts that the user has submitted. If the `bdi` element were not used, the username of the Arabic user would end up confusing the text (the bidirectional algorithm would put the colon and the number "3" next to the word "User" rather than next to the word "posts").

```html
<ul>
  <li>User <bdi>jcrammer</bdi>: 12 posts.</li>
  <li>User <bdi>hober</bdi>: 5 posts.</li>
  <li>User <bdi>إيان</bdi>: 3 posts.</li>
</ul>
```

When using the `bdi` element, the username acts as expected.

```html
• User jcrammer: 12 posts.
• User hober: 5 posts.
• User إيان: 3 posts.
```

If the `bdi` element were to be replaced by a `b` element, the username would confuse the bidirectional algorithm and the third bullet would end up saying "User 3 :", followed by the Arabic name (right-to-left), followed by "posts" and a period.

4.5.25 The `bdo` element

Categories:

- Flow content
- Phrasing content
- Palpable content

Contexts in which this element can be used:

Where `phrasing content` is expected.

Content model:

- Phrasing content

Tag omission in `text/html`:

Neither tag is omissible.
Content attributes:\footnote{144}:

Global attributes:\footnote{152}
Also, the \texttt{dir} \footnote{158} global attribute has special semantics on this element.

Accessibility considerations:\footnote{145}:

For authors.
For implementers.

DOM interface:\footnote{145}:

Uses \textit{HTMLElement} \footnote{140}.

The \texttt{bdo} \footnote{294} element \texttt{represents} \footnote{139} explicit text directionality formatting control for its children. It allows authors to override the Unicode bidirectional algorithm by explicitly specifying a direction override. \texttt{[BIDI]} \footnote{1455}

Authors must specify the \texttt{dir} \footnote{158} attribute on this element, with the value \texttt{ltr} \footnote{158} to specify a left-to-right override and with the value \texttt{rtl} \footnote{158} to specify a right-to-left override. The \texttt{auto} \footnote{158} value must not be specified.

\textbf{Note}

This element \textit{has rendering requirements involving the bidirectional algorithm} \footnote{167}.

4.5.26 The \texttt{span} element \footnote{295}

Categories:\footnote{144}:

Flow content\footnote{147}.
Phrasing content\footnote{148}.
Palpable content\footnote{148}.

Contexts in which this element can be used:\footnote{144}:

Where phrasing content\footnote{148} is expected.

Content model:\footnote{144}:

Phrasing content\footnote{148}.

Tag omission in text/html\footnote{144}:

Neither tag is omissible.

Content attributes:\footnote{144}:

Global attributes\footnote{152}.

Accessibility considerations:\footnote{145}:

For authors.
For implementers.

DOM interface:\footnote{145}:

\begin{verbatim}
IDL [Exposed=Window]
interface HTMLSpanElement : HTMLElement {
    [HTMLConstructor] constructor();
};
\end{verbatim}

The \texttt{span} \footnote{295} element doesn't mean anything on its own, but can be useful when used together with the \texttt{global attributes} \footnote{152}, e.g. \texttt{class} \footnote{153}, \texttt{lang} \footnote{155}, or \texttt{dir} \footnote{158}. It \texttt{represents} \footnote{139} its children.

\textbf{Example}

In this example, a code fragment is marked up using \texttt{span} \footnote{295} elements and \texttt{class} \footnote{152} attributes so that its keywords and identifiers can be color-coded from CSS:

\begin{verbatim}
<pre><code class="lang-c"&gt;&lt;span class="keyword">for</span>&lt;/span&gt; (&lt;span class="ident">j</span>&lt;/span&gt; = 0;
&lt;span class="ident">j</span>&lt;/span&gt; &lt;lt; 256; &lt;span class="ident">j</span>&lt;/span&gt;++) {
    &lt;span class="ident">i_t3</span>&lt;/span&gt; = (&lt;span class="ident">i_t3</span>&lt;/span&gt; &amp; 0x1ffff) | (&lt;span
\end{verbatim}
4.5.27 The `br` element

**Categories**: Flow content, Phrasing content

**Contexts in which this element can be used**: Where phrasing content is expected.

**Content model**: Nothing.

**Tag omission in text/html**: No end tag.

**Content attributes**: Global attributes

**Accessibility considerations**: For authors, For implementers.

**DOM interface**: Exposed = Window

```javascript
[Exposed=Window]
interface HTMLBRElement : HTMLElement {
    [HTMLConstructor] constructor();
    // also has obsolete members
};
```

The `br` element represents a line break.

**Note**: While line breaks are usually represented in visual media by physically moving subsequent text to a new line, a style sheet or user agent would be equally justified in causing line breaks to be rendered in a different manner, for instance as green dots, or as extra spacing.

`br` elements must be used only for line breaks that are actually part of the content, as in poems or addresses.

**Example**: The following example is correct usage of the `br` element:

```html
<p>P. Sherman<br />
42 Wallaby Way<br />
Sydney</p>
```

`br` elements must not be used for separating thematic groups in a paragraph.
The following examples are non-conforming, as they abuse the `br` element:

```html
<p><a>34 comments</a><br>Add a comment</p>
<p><label>Name: <input name="name"></label><br>Address: <input name="address"></p>
```

Here are alternatives to the above, which are correct:

```html
<p><a>34 comments</a></p>
<p><a>Add a comment</a></p>
<p><label>Name: <input name="name"></label></p>
<p><label>Address: <input name="address"></label></p>
```

If a paragraph consists of nothing but a single `br` element, it represents a placeholder blank line (e.g. as in a template). Such blank lines must not be used for presentation purposes.

Any content inside `br` elements must not be considered part of the surrounding text.

### Example

This element has rendering requirements involving the bidirectional algorithm.

### 4.5.28 The `wbr` element

**Categories**:
- Flow content
- Phrasing content

**Contexts in which this element can be used**:
Where phrasing content is expected.

**Content model**:
- Nothing

**Tag omission in text/html**:
- No `end tag`

**Content attributes**:
- Global attributes

**Accessibility considerations**:
- For authors.
- For implementers.

**DOM interface**:
- Uses `HTMLElement`

The `wbr` element represents a line break opportunity.

### Example

In the following example, someone is quoted as saying something which, for effect, is written as one long word. However, to ensure that the text can be wrapped in a readable fashion, the individual words in the quote are separated using a `wbr` element.

```html
<p>So then she pointed at the tiger and screamed "there is no way are ever going to catch me!"</p>
```
4.5.29 Usage summary

This section is non-normative.

<table>
<thead>
<tr>
<th>Element</th>
<th>Purpose</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Hyperlinks</td>
<td>Visit my <code>&lt;a href=&quot;drinks.html&quot;&gt;drinks&lt;/a&gt;</code> page.</td>
</tr>
<tr>
<td>em</td>
<td>Stress emphasis</td>
<td>I must say I <code>&lt;em&gt;adore&lt;/em&gt;</code> lemonade.</td>
</tr>
<tr>
<td>strong</td>
<td>Importance</td>
<td>This tea is <code>&lt;strong&gt;very hot&lt;/strong&gt;</code>.</td>
</tr>
<tr>
<td>small</td>
<td>Side comments</td>
<td>These grapes are made into wine. <code>&lt;small&gt;Alcohol is addictive.&lt;/small&gt;</code></td>
</tr>
<tr>
<td>s</td>
<td>Inaccurate text</td>
<td>Price: <code>&lt;s&gt;£4.50&lt;/s&gt; £2.00!</code></td>
</tr>
<tr>
<td>cite</td>
<td>Titles of works</td>
<td>The case <code>&lt;cite&gt;Hugo v. Danielle&lt;/cite&gt;</code> is relevant here.</td>
</tr>
<tr>
<td>q</td>
<td>Quotations</td>
<td>The judge said <code>&lt;q&gt;You can drink water from the fish tank&lt;/q&gt;</code> but advised against it.</td>
</tr>
<tr>
<td>dfn</td>
<td>Defining instance</td>
<td>The term <code>&lt;dfn&gt;organic food&lt;/dfn&gt;</code> refers to food produced without synthetic chemicals.</td>
</tr>
</tbody>
</table>
| abbr     | Abbreviations | Organic food in Ireland is certified by the `<abbr title="Irish Organic Farmers and Growers Association">IOFGA</abbr>`.
| ruby     | Ruby annotations | `<ruby> OJ <rt>Orange Juice</rt></ruby>` |
| rt       | Machine-readable equivalent of date- or time-related data | Available starting today! `<time datetime="2011-11-18">November 18th</time>`! |
| code     | Computer code | The `<code>fruitdb</code>` program can be used for tracking fruit production. |
| var      | Variables | If there are `<var>n</var>` fruit in the bowl, at least `<var>n</var> + 2 will be ripe. |
| samp     | Computer output | The computer said `<samp>Unknown error -3</samp>`.
| kbd      | User input | Hit `<kbd>F1</kbd>` to continue. |
| sub      | Subscripts | Water is `<sub>H</sub>2O`. |
| sup      | Superscripts | The Hydrogen in heavy water is usually `<sup>2</sup>H`. |
| i        | Alternative voice | Lemonade consists primarily of `<i>Citrus limon</i>`.
| b        | Keywords | Take a `<b>lemon</b>` and squeeze it with a `<b>juicer</b>`. |
| u        | Annotations | The mixture of apple juice and `<u class="spelling">elderflower</u>` juice is very pleasant. |
| mark     | Highlight | Elderflower cordial, with one `<mark>part</mark>` cordial to ten `<mark>part</mark>` water, stands `<mark>part</mark>` from the rest. |
| bd       | Text directionality isolation | The recommended restaurant is `<bd lang=""">My Juice Café (At The Beach)</bd>`.
## 4.6 Links

### 4.6.1 Introduction

Links are a conceptual construct, created by `a`\(^{254}\), `area`\(^{468}\), `form`\(^{510}\), and `link`\(^{5174}\) elements, that represent a connection between two resources, one of which is the current Document\(^{328}\). There are three kinds of links in HTML:

#### Links to external resources

These are links to resources that are to be used to augment the current document, generally automatically processed by the user agent. All external resource links\(^{299}\) have a fetch and process the linked resource\(^{5180}\) algorithm which describes how the resource is obtained.

#### Hyperlinks

These are links to other resources that are generally exposed to the user by the user agent so that the user can cause the user agent to navigate\(^{1003}\) to those resources, e.g. to visit them in a browser or download them.

#### Internal resource links

These are links to resources within the current document, used to give those resources special meaning or behavior.

For `link`\(^{5174}\) elements with an `href`\(^{5175}\) attribute and a `rel`\(^{5175}\) attribute, links must be created for the keywords of the `rel`\(^{5175}\) attribute, as defined for those keywords in the `link types`\(^{312}\) section.

Similarly, for `a`\(^{254}\) and `area`\(^{468}\) elements with an `href`\(^{5299}\) attribute and a `rel`\(^{5289}\) attribute, links must be created for the keywords of the `rel`\(^{5289}\) attribute as defined for those keywords in the `link types`\(^{312}\) section. Unlike `link`\(^{5174}\) elements, however, `a`\(^{254}\) and `area`\(^{468}\) elements with an `href`\(^{5299}\) attribute that either do not have a `rel`\(^{5289}\) attribute, or whose `rel`\(^{5288}\) attribute has no keywords that are defined as specifying `hyperlinks`\(^{5299}\), must also create a `hyperlink`\(^{5299}\). This implied hyperlink has no special meaning (it has no `link type`\(^{310}\) beyond linking the element's node document to the resource given by the element's `href`\(^{5299}\) attribute.

Similarly, for `form`\(^{510}\) elements with a `rel`\(^{5112}\) attribute, links must be created for the keywords of the `rel`\(^{5112}\) attribute as defined for those keywords in the `link types`\(^{310}\) section. `form`\(^{510}\) elements that do not have a `rel`\(^{5112}\) attribute, or whose `rel`\(^{5112}\) attribute has no keywords that are defined as specifying `hyperlinks`\(^{5299}\), must also create a `hyperlink`\(^{5299}\).

A `hyperlink`\(^{5299}\) can have one or more `hyperlink annotations` that modify the processing semantics of that hyperlink.

### 4.6.2 Links created by `a`\(^{254}\) and `area`\(^{468}\) elements

The `href` attribute on `a`\(^{254}\) and `area`\(^{468}\) elements must have a value that is a valid URL potentially surrounded by spaces\(^{95}\).

#### Note

The `href`\(^{5299}\) attribute on `a`\(^{254}\) and `area`\(^{468}\) elements is not required; when those elements do not have `href`\(^{5299}\) attributes they do not create hyperlinks.

The `target` attribute, if present, must be a valid navigable target name or keyword\(^{985}\). It gives the name of the navigable\(^{978}\) that will be used. User agents use this name when following hyperlinks\(^{506}\).

The `download` attribute, if present, indicates that the author intends the hyperlink to be used for downloading a resource\(^{507}\). The attribute may have a value; the value, if any, specifies the default filename that the author recommends for use in labeling the resource in a local file system. There are no restrictions on allowed values, but authors are cautioned that most file systems have
limitations with regard to what punctuation is supported in filenames, and user agents are likely to adjust filenames accordingly.

The **ping** attribute, if present, gives the URLs of the resources that are interested in being notified if the user follows the hyperlink. The value must be a set of space-separated tokens\(^93\), each of which must be a valid non-empty URL\(^94\) whose scheme is an HTTP(S) scheme. The value is used by the user agent for hyperlink auditing\(^300\).

The **rel** attribute on a\(^254\) and area\(^468\) elements controls what kinds of links the elements create. The attribute’s value must be an unordered set of unique space-separated tokens\(^93\). The allowed keywords and their meanings\(^310\) are defined below.

**rel\(^93\)**'s supported tokens are the keywords defined in HTML link types\(^310\) which are allowed on a\(^254\) and area\(^468\) elements, impact the processing model, and are supported by the user agent. The possible supported tokens are noreferer\(^322\), noopen\(^321\), and opener\(^322\). rel\(^93\)'s supported tokens must only include the tokens from this list that the user agent implements the processing model for.

The **rel** attribute has no default value. If the attribute is omitted or if none of the values in the attribute are recognized by the user agent, then the document has no particular relationship with the destination resource other than there being a hyperlink between the two.

The **hreflang** attribute on a\(^254\) elements that create hyperlinks\(^329\), if present, gives the language of the linked resource. It is purely advisory. The value must be a valid BCP 47 language tag. \([\text{BCP47}]\)\(^1455\) User agents must not consider this attribute authoritative — upon fetching the resource, user agents must use only language information associated with the resource to determine its language, not metadata included in the link to the resource.

The **type** attribute, if present, gives the MIME type of the linked resource. It is purely advisory. The value must be a valid MIME type string. User agents must not consider the **type** attribute authoritative — upon fetching the resource, user agents must not use metadata included in the link to the resource to determine its type.

The **referrerpolicy** attribute is a referrer policy attribute\(^398\). Its purpose is to set the **referrer policy** used when following hyperlinks\(^306\). \([\text{REFERRERPOLICY}]\)\(^1461\)

When an a\(^254\) or area\(^468\) element's activation behavior is invoked, the user agent may allow the user to indicate a preference regarding whether the hyperlink is to be used for navigation\(^1003\) or whether the resource it specifies is to be downloaded.

In the absence of a user preference, the default should be navigation if the element has no **download** attribute, and should be to download the specified resource if it does.

The **activation behavior** of an a\(^254\) or area\(^468\) element element given an event event is:

1. If **element** has no **href** attribute, then return.
2. Let hyperlinkSuffix be null.
3. If **element** is an a\(^254\) element, and event's target is an img\(^343\) with an ismap\(^347\) attribute specified, then:
   1. Let x and y be 0.
   2. If event's isTrusted attribute is initialized to true, then set x to the distance in CSS pixels from the left edge of the image to the location of the click, and set y to the distance in CSS pixels from the top edge of the image to the location of the click.
   3. If x is negative, set x to 0.
   4. If y is negative, set y to 0.
   5. Set hyperlinkSuffix to the concatenation of U+003F (?), the value of x expressed as a base-ten integer using ASCII digits, U+002C (,), and the value of y expressed as a base-ten integer using ASCII digits.
4. Let userInvolvement be event's user navigation involvement\(^1003\).
5. If the user has expressed a preference to download the hyperlink, then set userInvolvement to "browser UI"\(^1003\).

Note

That is, if the user has expressed a specific preference for downloading, this no longer counts as merely "activation".

300
6. If `element` has a `download` attribute, or if the user has expressed a preference to download the hyperlink, then `download the hyperlink` created by `element` with `hyperlinkSuffix` set to `hyperlinkSuffix` and `userInvolvement` set to `userInvolvement`.

7. Otherwise, follow the hyperlink created by `element` with `hyperlinkSuffix` set to `hyperlinkSuffix` and `userInvolvement` set to `userInvolvement`.

### 4.6.3 API for `a` and `area` elements

**IDL**

```idl
interface mixin HTMLHyperlinkElementUtils {
    [CEReactions] stringifier attribute USVString href;
    readonly attribute USVString origin;
    [CEReactions] attribute USVString protocol;
    [CEReactions] attribute USVString username;
    [CEReactions] attribute USVString password;
    [CEReactions] attribute USVString host;
    [CEReactions] attribute USVString hostname;
    [CEReactions] attribute USVString port;
    [CEReactions] attribute USVString pathname;
    [CEReactions] attribute USVString search;
    [CEReactions] attribute USVString hash;
}
```

**For web developers (non-normative)**

- `hyperlink.toString()`
- `hyperlink.href` (returns the hyperlink's URL. Can be set to change the URL.)
- `hyperlink.origin` (returns the hyperlink's URL's origin.)
- `hyperlink.protocol` (returns the hyperlink's URL's scheme. Can be set, to change the URL's scheme.)
- `hyperlink.username` (returns the hyperlink's URL's username. Can be set, to change the URL's username.)
- `hyperlink.password` (returns the hyperlink's URL's password. Can be set, to change the URL's password.)
- `hyperlink.host` (returns the hyperlink's URL's host and port (if different from the default port for the scheme). Can be set, to change the URL's host and port.)
- `hyperlink.hostname` (returns the hyperlink's URL's host. Can be set, to change the URL's host.)
- `hyperlink.port` (returns the hyperlink's URL's port. Can be set, to change the URL's port.)
- `hyperlink.pathname` (returns the hyperlink's URL's path.)
An element implementing the `HTMLHyperlinkElementUtils` mixin has an associated `url` (null or a URL). It is initially null.

An element implementing the `HTMLHyperlinkElementUtils` mixin has an associated `set the url` algorithm, which runs these steps:

1. Set this element's `url` to null.
2. If this element's `href` content attribute is absent, then return.
3. Let `url` be the result of `encoding-parsing a URL` given this element's `href` content attribute's value, relative to this element's `node document`.
4. If `url` is not failure, then set this element's `url` to `url`.

When elements implementing the `HTMLHyperlinkElementUtils` mixin are created, and whenever those elements have their `href` content attribute set, changed, or removed, the user agent must `set the url`.

Note

This is only observable for `blob` URLs as parsing them involves a Blob URL Store lookup.

An element implementing the `HTMLHyperlinkElementUtils` mixin has an associated `reinitialize url` algorithm, which runs these steps:

1. If element's `url` is non-null, its `scheme` is "blob", and it has an `opaque path`, then terminate these steps.
2. Set the `url`.

To `update href`, set the element's `href` content attribute's value to the element's `url`, serialized.

The `href` getter steps are:

1. Reinitialize `url`.
2. Let `url` be this's `url`.
3. If `url` is null and this has no `href` content attribute, return the empty string.
4. Otherwise, if `url` is null, return this's `href` content attribute's value.
5. Return `url`, serialized.

The `href` setter steps are to set this's `href` content attribute's value to the given value.

The `origin` getter steps are:

1. Reinitialize `url`.
2. If this's `url` is null, return the empty string.
3. Return the `serialization` of this's `url`'s `origin`.

The `protocol` getter steps are:
1. Reinitialize url.
2. If this's url is null, return ":".
3. Return this's url's scheme, followed by ":".

The protocol setter steps are:

1. Reinitialize url.
2. If this's url is null, then return.
3. Basic URL parse the given value, followed by ":", with this's url as url and scheme start state as state override.

**Note**

Because the URL parser ignores multiple consecutive colons, providing a value of "https:" (or even "https:::" ) is the same as providing a value of "https:"

4. Update href.

The username getter steps are:

1. Reinitialize url.
2. If this's url is null, return the empty string.
3. Return this's url's username.

The username setter steps are:

1. Reinitialize url.
2. Let url be this's url.
3. If url is null or url cannot have a username/password/port, then return.
4. Set the username, given url and the given value.
5. Update href.

The password getter steps are:

1. Reinitialize url.
2. Let url be this's url.
3. If url is null, then return the empty string.
4. Return url's password.

The password setter steps are:

1. Reinitialize url.
2. Let url be this's url.
3. If url is null or url cannot have a username/password/port, then return.
4. Set the password, given url and the given value.
5. Update href.

The host getter steps are:

1. Reinitialize url.
2. Let url be this's url.
3. If url or url's host is null, return the empty string.
4. If url's port is null, return url's host, serialized.

5. Return url's host, serialized, followed by ":" and url's port, serialized.

The host setter steps are:
1. Reinitialize url.
2. Let url be this's url.
3. If url is null or url has an opaque path, then return.
4. Basic URL parse the given value, with url as url and host state as state override.
5. Update href.

The hostname getter steps are:
1. Reinitialize url.
2. Let url be this's url.
3. If url or url's host is null, return the empty string.
4. Return url's host, serialized.

The hostname setter steps are:
1. Reinitialize url.
2. Let url be this's url.
3. If url is null or url has an opaque path, then return.
4. Basic URL parse the given value, with url as url and hostname state as state override.
5. Update href.

The port getter steps are:
1. Reinitialize url.
2. Let url be this's url.
3. If url or url's port is null, return the empty string.
4. Return url's port, serialized.

The port setter steps are:
1. Reinitialize url.
2. Let url be this's url.
3. If url is null or url cannot have a username/password/port, then return.
4. If the given value is the empty string, then set url's port to null.
5. Otherwise, basic URL parse the given value, with url as url and port state as state override.
6. Update href.

The pathname getter steps are:
1. Reinitialize url.
2. Let url be this's url.
3. If url is null, then return the empty string.
4. Return the result of URL path serializing url.
The `pathname` setter steps are:

1. Reinitialize `url`.
2. Let `url` be this's `url`.
3. If `url` is null or `url` has an opaque path, then return.
4. Set `url`'s `path` to the empty list.
5. Basic URL parse the given value, with `url` as `url` and `path start state` as `state override`.
6. Update `href`.

The `search` getter steps are:

1. Reinitialize `url`.
2. Let `url` be this's `url`.
3. If `url` is null, or `url`'s `query` is either null or the empty string, return the empty string.
4. Return `"?"`, followed by `url`'s `query`.

The `search` setter steps are:

1. Reinitialize `url`.
2. Let `url` be this's `url`.
3. If `url` is null, terminate these steps.
4. If the given value is the empty string, set `url`'s `query` to null.
5. Otherwise:
   1. Let `input` be the given value with a single leading `"?"` removed, if any.
   2. Set `url`'s `query` to the empty string.
   3. Basic URL parse `input`, with `url` as `url` and `query state` as `state override`.
6. Update `href`.

The `hash` getter steps are:

1. Reinitialize `url`.
2. Let `url` be this's `url`.
3. If `url` is null, or `url`'s `fragment` is either null or the empty string, return the empty string.
4. Return `"#"`, followed by `url`'s `fragment`.

The `hash` setter steps are:

1. Reinitialize `url`.
2. Let `url` be this's `url`.
3. If `url` is null, then return.
4. If the given value is the empty string, set `url`'s `fragment` to null.
5. Otherwise:
   1. Let `input` be the given value with a single leading `"#"` removed, if any.
   2. Set `url`'s `fragment` to the empty string.
   3. Basic URL parse `input`, with `url` as `url` and `fragment state` as `state override`.
4.6.4 Following hyperlinks

An element `element` cannot navigate if any of the following are true:

- `element`'s `node document` is not fully active; or
- `element` is not an `a` element and is not connected.

To get an element's `noopen`, given an `a`, `area`, or `form` element `element` and a string `target`:

1. If `element`'s `link types` include the `noopener` or `noreferrer` keyword, then return true.
2. If `element`'s `link types` do not include the `opener` keyword and `target` is an ASCII case-insensitive match for " _blank", then return true.
3. Return false.

To follow the hyperlink created by an element `subject`, given an optional `hyperlinkSuffix` (default null) and an optional `userInvolvement` (default "none"):

1. If `subject` cannot navigate, then return.
2. Let `replace` be false.
3. Let `targetAttributeValue` be the empty string.
4. If `subject` is an `a` or `area` element, then set `targetAttributeValue` to the result of getting an element's target given `subject`.
5. Let `noopen` be the result of getting an element's `noopen` with `subject` and `targetAttributeValue`.
6. Let `targetNavigable` be the first return value of applying the rules for choosing a navigable given `targetAttributeValue`, `subject`'s `node navigable`, and `noopen`.
7. If `targetNavigable` is null, then return.
8. Let `urlString` be the result of encoding-parsing-and-serializing a URL given `subject`'s `href` attribute value, relative to `subject`'s `node document`.
9. If `urlString` is failure, then return.
10. If `hyperlinkSuffix` is non-null, then append it to `urlString`.
11. Let `referrerPolicy` be the current state of `subject`'s `referrerpolicy` content attribute.
12. If `subject`'s `link types` includes the `noreferrer` keyword, then set `referrerPolicy` to "no-referrer".
13. Navigate `targetNavigable` to `urlString` using `subject`'s `node document`, with `referrerPolicy` set to `referrerPolicy` and `userInvolvement` set to `userInvolvement`.

Note
Unlike many other types of navigations, following hyperlinks does not have special "replace" behavior for when documents are not completely loaded. This is true for both user-initiated instances of following hyperlinks, as well as script-triggered ones via, e.g., `aElement.click()`.
4.6.5 Downloading resources

In some cases, resources are intended for later use rather than immediate viewing. To indicate that a resource is intended to be downloaded for use later, rather than immediately used, the `download` attribute can be specified on the `a` or `area` element that creates the hyperlink to that resource.

The attribute can furthermore be given a value, to specify the filename that user agents are to use when storing the resource in a file system. This value can be overridden by the `Content-Disposition` HTTP header's filename parameters. [RFC6266]

In cross-origin situations, the `download` attribute has to be combined with the `Content-Disposition` HTTP header, specifically with the attachment disposition type, to avoid the user being warned of possibly nefarious activity. (This is to protect users from being made to download sensitive personal or confidential information without their full understanding.)

To download the hyperlink created by an element `subject`, given an optional `hyperlinkSuffix` (default null) and an optional `userInvolvement` (default "none"):

1. If `subject` cannot navigate, then return.
2. If `subject`'s node document's active sandboxing flag has the sandboxed downloads browsing context flag set, then return.
3. Let `urlString` be the result of encoding-parsing-and-serializing a URL given `subject`'s `href` attribute value, relative to `subject`'s node document.
4. If `urlString` is failure, then return.
5. If `hyperlinkSuffix` is non-null, then append it to `urlString`.
6. If `userInvolvement` is not "browser UI", then:
   1. Assert: `subject` has a `download` attribute.
   2. Let `navigation` be `subject`'s relevant global object's navigation API.
   3. Let `filename` be the value of `subject`'s `download` attribute.
   4. Let `continue` be the result of firing a download request navigate event at navigation with `destinationURL` set to `urlString`, `userInvolvement` set to `userInvolvement`, and `filename` set to `filename`.
   5. If `continue` is false, then return.
7. Run these steps in parallel:
   1. Optionally, the user agent may abort these steps, if it believes doing so would safeguard the user from a potentially hostile download.
   2. Let `request` be a new request whose URL is `urlString`, client is entry settings object, initiator is "download", destination is the empty string, and whose synchronous flag and use-URL-credentials flag are set.
   3. Handle the result of fetching request as a download.

When a user agent is to handle a resource obtained from a fetch as a download, it should provide the user with a way to save the resource for later use, if a resource is successfully obtained. Otherwise, it should report any problems downloading the file to the user.

If the user agent needs a filename for a resource being handled as a download, it should select one using the following algorithm.

⚠ Warning!

This algorithm is intended to mitigate security dangers involved in downloading files from untrusted sites, and user agents are strongly urged to follow it.

1. Let `filename` be the undefined value.
2. If the resource has a `Content-Disposition` header, that header specifies the attachment disposition type, and the header includes filename information, then let `filename` have the value specified by the header, and jump to the step labeled sanitize below. [RFC6266]
3. Let interface origin be the origin of the Document in which the download or navigate action resulting in the download was initiated, if any.

4. Let resource origin be the origin of the URL of the resource being downloaded, unless that URL's scheme component is data, in which case let resource origin be the same as the interface origin, if any.

5. If there is no interface origin, then let trusted operation be true. Otherwise, let trusted operation be true if resource origin is the same origin as interface origin, and false otherwise.

6. If trusted operation is true and the resource has a `Content-Disposition` header and that header includes filename information, then let filename have the value specified by the header, and jump to the step labeled sanitize below. [RFC6266][1461]

7. If the download was not initiated from a hyperlink created by an a or area element, or if the element of the hyperlink from which it was initiated did not have a download attribute when the download was initiated, or if there was such an attribute but its value when the download was initiated was the empty string, then jump to the step labeled no proposed filename.

8. Let proposed filename have the value of the download attribute of the element of the hyperlink that initiated the download at the time the download was initiated.

9. If trusted operation is true, let filename have the value of proposed filename, and jump to the step labeled sanitize below.

10. If the resource has a `Content-Disposition` header and that header specifies the attachment disposition type, let filename have the value of proposed filename, and jump to the step labeled sanitize below. [RFC6266][1461]

11. No proposed filename: If trusted operation is true, or if the user indicated a preference for having the resource in question downloaded, let filename have a value derived from the URL of the resource in an implementation-defined manner, and jump to the step labeled sanitize below.

12. Let filename be set to the user's preferred filename or to a filename selected by the user agent, and jump to the step labeled sanitize below.

⚠️Warning! If the algorithm reaches this step, then a download was begun from a different origin than the resource being downloaded, and the origin did not mark the file as suitable for downloading, and the download was not initiated by the user. This could be because a download attribute was used to trigger the download, or because the resource in question is not of a type that the user agent supports.

This could be dangerous, because, for instance, a hostile server could be trying to get a user to unknowingly download private information and then re-upload it to the hostile server, by tricking the user into thinking the data is from the hostile server.

Thus, it is in the user's interests that the user be somehow notified that the resource in question comes from a different source, and to prevent confusion, any suggested filename from the potentially hostile interface origin should be ignored.

13. Sanitize: Optionally, allow the user to influence filename. For example, a user agent could prompt the user for a filename, potentially providing the value of filename as determined above as a default value.

14. Adjust filename to be suitable for the local file system.

Example

For example, this could involve removing characters that are not legal in filenames, or trimming leading and trailing whitespace.

15. If the platform conventions do not in any way use extensions to determine the types of file on the file system, then return filename as the filename.

16. Let claimed type be the type given by the resource's Content-Type metadata, if any is known. Let named type be the type given by filename's extension, if any is known. For the purposes of this step, a type is a mapping of a MIME type to an extension.

17. If named type is consistent with the user's preferences (e.g., because the value of filename was determined by prompting the user), then return filename as the filename.

18. If claimed type and named type are the same type (i.e., the type given by the resource's Content-Type metadata is
consistent with the type given by filename's extension, then return filename as the filename.

19. If the claimed type is known, then alter filename to add an extension corresponding to claimed type. Otherwise, if named type is known to be potentially dangerous (e.g. it will be treated by the platform conventions as a native executable, shell script, HTML application, or executable-macro-capable document) then optionally alter filename to add a known-safe extension (e.g. ".txt").

20. Return filename as the filename.

For the purposes of this algorithm, a file extension consists of any part of the filename that platform conventions dictate will be used for identifying the type of the file. For example, many operating systems use the part of the filename following the last dot (".") in the filename to determine the type of the file, and from that the manner in which the file is to be opened or executed.

User agents should ignore any directory or path information provided by the resource itself, its URL, and any download attribute, in deciding where to store the resulting file in the user's file system.

4.6.6 Hyperlink auditing

If a hyperlink created by an or element has a ping attribute, and the user follows the hyperlink, and the value of the element's attribute can be parsed, relative to the element's node document, without failure, then the user agent must take the ping attribute's value, split that string on ASCII whitespace, parse each resulting token, relative to the element's node document, and then run these steps for each resulting URL, ignoring when parsing returns failure:

1. If ping URL's scheme is not an HTTP(S) scheme, then return.
2. Optionally, return. (For example, the user agent might wish to ignore any or all ping URLs in accordance with the user's expressed preferences.)
3. Let settingsObject be the element's node document's relevant settings object.
4. Let request be a new request whose URL is ping URL, method is "POST", header list is « ("Content-Type", "text/ping") », body is "PING", client is settingsObject, destination is the empty string, credentials mode is "include", referrer is "no-referrer", and whose use-URL-credentials flag is set, and whose initiator type is "ping".
5. Let target URL be the result of encoding-parsing-and-serializing a URL given the element's attribute's value, relative to the element's node document, and then:
   ⊣ If the URL of the Document object containing the hyperlink being audited and ping URL have the same origin, request must include a `Ping-From` header with, as its value, the URL of the document containing the hyperlink, and a `Ping-To` HTTP header with, as its value, the target URL.
   ⊣ If the origins are different, but the scheme of the URL of the Document containing the hyperlink being audited is not "https" request must include a `Ping-From` header with, as its value, the URL of the document containing the hyperlink, and a `Ping-To` HTTP header with, as its value, the target URL.
   ⊣ Otherwise request must include a `Ping-To` HTTP header with, as its value, target URL.
6. Fetch request.

This may be done in parallel with the primary fetch, and is independent of the result of that fetch.

User agents should allow the user to adjust this behavior, for example in conjunction with a setting that disables the sending of HTTP `Referer` (sic) headers. Based on the user's preferences, UAs may either ignore the ping attribute altogether, or selectively ignore URLs in the list (e.g. ignoring any third-party URLs); this is explicitly accounted for in the steps above.

User agents must ignore any entity bodies returned in the responses. User agents may close the connection prematurely once they start receiving a response body.
When the `ping` attribute is present, user agents should clearly indicate to the user that following the hyperlink will also cause secondary requests to be sent in the background, possibly including listing the actual target URLs.

**Example**

For example, a visual user agent could include the hostnames of the target ping URLs along with the hyperlink’s actual URL in a status bar or tooltip.

**Note**

The `ping` attribute is redundant with pre-existing technologies like HTTP redirects and JavaScript in allowing web pages to track which off-site links are most popular or allowing advertisers to track click-through rates.

However, the `ping` attribute provides these advantages to the user over those alternatives:

- It allows the user to see the final target URL unobscured.
- It allows the UA to inform the user about the out-of-band notifications.
- It allows the user to disable the notifications without losing the underlying link functionality.
- It allows the UA to optimize the use of available network bandwidth so that the target page loads faster.

Thus, while it is possible to track users without this feature, authors are encouraged to use the `ping` attribute so that the user agent can make the user experience more transparent.

### 4.6.6.1 The `Ping-From` and `Ping-To` headers

The `Ping-From` and `Ping-To` HTTP request headers are included in hyperlink auditing requests. Their value is a URL, serialized.

### 4.6.7 Link types

The following table summarizes the link types that are defined by this specification, by their corresponding keywords. This table is non-normative; the actual definitions for the link types are given in the next few sections.

In this section, the term **referenced document** refers to the resource identified by the element representing the link, and the term **current document** refers to the resource within which the element representing the link finds itself.

To determine which link types apply to a `link`, `area`, or `form` element, the element’s `rel` attribute must be split on ASCII whitespace. The resulting tokens are the keywords for the link types that apply to that element.

Except where otherwise specified, a keyword must not be specified more than once per `rel` attribute.

Some of the sections that follow the table below list synonyms for certain keywords. The indicated synonyms are to be handled as specified by user agents, but must not be used in documents (for example, the keyword "copyright").

Keywords are always ASCII case-insensitive, and must be compared as such.

**Example**

Thus, `rel="next"` is the same as `rel="NEXT"`.

Keywords that are **body-ok** affect whether `link` elements are allowed in the body. The **body-ok** keywords are `dns-prefetch`, `modulepreload`, `pingback`, `preconnect`, `prefetch`, `preload`, and `stylesheet`.

New link types that are to be implemented by web browsers are to be added to this standard. The remainder can be registered as extensions.
<table>
<thead>
<tr>
<th>Link type</th>
<th>Effect on...</th>
<th>body-ok</th>
<th>Has ‘Link’ processing</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>alternate</td>
<td>Hyperlink</td>
<td>not allowed</td>
<td></td>
<td>Gives alternate representations of the current document.</td>
</tr>
<tr>
<td>canonical</td>
<td>Hyperlink</td>
<td>not allowed</td>
<td></td>
<td>Gives the preferred URL for the current document.</td>
</tr>
<tr>
<td>author</td>
<td>Hyperlink</td>
<td>not allowed</td>
<td></td>
<td>Gives a link to the author of the current document or article.</td>
</tr>
<tr>
<td>bookmark</td>
<td>Hyperlink</td>
<td>not allowed</td>
<td></td>
<td>Gives the permalink for the nearest ancestor section.</td>
</tr>
<tr>
<td>dns-prefetch</td>
<td>External</td>
<td>not allowed</td>
<td>Yes</td>
<td>Specifies that the user agent should preemptively perform DNS resolution for the target resource’s origin.</td>
</tr>
<tr>
<td>expect</td>
<td>Internal</td>
<td>not allowed</td>
<td></td>
<td>Expect an element with the target ID to appear in the current document.</td>
</tr>
<tr>
<td>external</td>
<td>Annotation</td>
<td>not allowed</td>
<td></td>
<td>Indicates that the referenced document is not part of the same site as the current document.</td>
</tr>
<tr>
<td>help</td>
<td>Hyperlink</td>
<td></td>
<td></td>
<td>Provides a link to context-sensitive help.</td>
</tr>
<tr>
<td>icon</td>
<td>External</td>
<td>not allowed</td>
<td></td>
<td>Imports an icon to represent the current document.</td>
</tr>
<tr>
<td>manifest</td>
<td>External</td>
<td>not allowed</td>
<td></td>
<td>Imports or links to an application manifest.</td>
</tr>
<tr>
<td>modulepreload</td>
<td>External</td>
<td>not allowed</td>
<td>Yes</td>
<td>Specifies that the user agent must preemptively fetch the module script and store it in the document’s module map for later evaluation. Optionally, the module’s dependencies can be fetched as well.</td>
</tr>
<tr>
<td>license</td>
<td>Hyperlink</td>
<td></td>
<td></td>
<td>Indicates that the main content of the current document is covered by the copyright license described by the referenced document.</td>
</tr>
<tr>
<td>next</td>
<td>Hyperlink</td>
<td></td>
<td></td>
<td>Indicates that the current document is a part of a series, and that the next document in the series is the referenced document.</td>
</tr>
<tr>
<td>nofollow</td>
<td>Annotation</td>
<td>not allowed</td>
<td></td>
<td>Indicates that the current document’s original author or publisher does not endorse the referenced document.</td>
</tr>
<tr>
<td>noopener</td>
<td>Annotation</td>
<td>not allowed</td>
<td></td>
<td>Creates a top-level traversable with a non- auxiliary browsing context if the hyperlink would otherwise create one that was auxiliary (i.e., has an appropriate target attribute value).</td>
</tr>
<tr>
<td>noreferrer</td>
<td>Annotation</td>
<td>not allowed</td>
<td></td>
<td>No 'Referer' (sic) header will be included. Additionally, has the same effect as noopen.</td>
</tr>
<tr>
<td>opener</td>
<td>Annotation</td>
<td>not allowed</td>
<td></td>
<td>Creates a top-level traversable with a non- auxiliary browsing context if the hyperlink would otherwise create a one that was auxiliary (i.e., has a blank attribute value).</td>
</tr>
<tr>
<td>pingback</td>
<td>External</td>
<td>not allowed</td>
<td>Yes</td>
<td>Gives the address of the pingback server that handles pingbacks to the current document.</td>
</tr>
<tr>
<td>preconnect</td>
<td>External</td>
<td>not allowed</td>
<td>Yes</td>
<td>Specifies that the user agent should preemptively connect to the target resource’s origin.</td>
</tr>
<tr>
<td>prefetch</td>
<td>External</td>
<td>not allowed</td>
<td>Yes</td>
<td>Specifies that the user agent should preemptively fetch and cache the target resource as it is likely to be required for a followup navigation.</td>
</tr>
<tr>
<td>preload</td>
<td>External</td>
<td>not allowed</td>
<td>Yes</td>
<td>Specifies that the user agent must preemptively fetch and cache the target resource for current navigation according to the potential destination given by the as attribute (and the priority associated with the corresponding destination).</td>
</tr>
<tr>
<td>prev</td>
<td>Hyperlink</td>
<td></td>
<td></td>
<td>Indicates that the current document is a part of a series, and that the previous document in the series is the referenced document.</td>
</tr>
<tr>
<td>privacy-policy</td>
<td>Hyperlink</td>
<td>not allowed</td>
<td></td>
<td>Gives a link to information about the data collection and usage practices that apply to the current document.</td>
</tr>
<tr>
<td>search</td>
<td>Hyperlink</td>
<td></td>
<td></td>
<td>Gives a link to a resource that can be used to search through the current document and its related pages.</td>
</tr>
<tr>
<td>stylesheet</td>
<td>External</td>
<td>not allowed</td>
<td>Yes</td>
<td>Imports a style sheet.</td>
</tr>
<tr>
<td>tag</td>
<td>Hyperlink</td>
<td>not allowed</td>
<td></td>
<td>Gives a tag (identified by the given address) that applies to the current document.</td>
</tr>
<tr>
<td>terms-of-service</td>
<td>Hyperlink</td>
<td>not allowed</td>
<td></td>
<td>Gives a link to information about the agreements between the current document’s provider and users who wish to use the current document.</td>
</tr>
</tbody>
</table>
4.6.7.1 Link type "alternate" Paragraph

The alternate keyword may be used with link, a, and area elements.

The meaning of this keyword depends on the values of the other attributes.

→ If the element is a link element and the rel attribute also contains the keyword stylesheet

The alternate keyword modifies the meaning of the stylesheet keyword in the way described for that keyword. The alternate keyword does not create a link of its own.

Example

Here, a set of link elements provide some style sheets:

```
<!-- a persistent style sheet -->
<link rel="stylesheet" href="default.css">

<!-- the preferred alternate style sheet -->
<link rel="stylesheet" href="green.css" title="Green styles">

<!-- some alternate style sheets -->
<link rel="alternate stylesheet" href="contrast.css" title="High contrast">
<link rel="alternate stylesheet" href="big.css" title="Big fonts">
<link rel="alternate stylesheet" href="wide.css" title="Wide screen">
```

→ If the alternate keyword is used with the type attribute set to the value application/rss+xml or the value application/atom+xml

The keyword creates a hyperlink referencing a syndication feed (though not necessarily syndicating exactly the same content as the current page).

For the purposes of feed autodiscovery, user agents should consider all link elements in the document with the alternate keyword used and with their type attribute set to the value application/rss+xml or the value application/atom+xml. If the user agent has the concept of a default syndication feed, the first such element (in tree order) should be used as the default.

Example

The following link elements give syndication feeds for a blog:

```
<link rel="alternate" type="application/atom+xml" href="posts.xml" title="Cool Stuff Blog">
<link rel="alternate" type="application/atom+xml" href="posts.xml?category=robots" title="Cool Stuff Blog: robots category">
<link rel="alternate" type="application/atom+xml" href="comments.xml" title="Cool Stuff Blog: Comments">
```

Such link elements would be used by user agents engaged in feed autodiscovery, with the first being the default (where applicable).

The following example offers various different syndication feeds to the user, using a elements:

```
<p>You can access the planets database using Atom feeds:</p>
<ul>
  <li><a href="recently-visited-planets.xml" rel="alternate" type="application/atom+xml">Recently Visited Planets</a></li>
  <li><a href="known-bad-planets.xml" rel="alternate" type="application/atom+xml">Known Bad Planets</a></li>
  <li><a href="unexplored-planets.xml" rel="alternate" type="application/atom+xml">Unexplored Planets</a></li>
</ul>
```

These links would not be used in feed autodiscovery.
The keyword creates a hyperlink referencing an alternate representation of the current document. The nature of the referenced document is given by the hreflang and type attributes.

If the alternate keyword is used with the hreflang attribute, and that attribute's value differs from the document element's language, it indicates that the referenced document is a translation.

If the alternate keyword is used with the type attribute, it indicates that the referenced document is a reformulation of the current document in the specified format.

The hreflang and type attributes can be combined when specified with the alternate keyword. This relationship is transitive — that is, if a document links to two other documents with the link type "alternate", then, in addition to implying that those documents are alternative representations of the first document, it is also implying that those two documents are alternative representations of each other.

### Example

The following example shows how you can specify versions of the page that use alternative formats, are aimed at other languages, and that are intended for other media:

```html
<link rel="alternate" href="/en/html" hreflang="en" type="text/html" title="English HTML"/>
<link rel="alternate" href="/fr/html" hreflang="fr" type="text/html" title="French HTML"/>
<link rel="alternate" href="/en/html/print" hreflang="en" type="text/html" media="print" title="English HTML (for printing)"/>
<link rel="alternate" href="/fr/html/print" hreflang="fr" type="text/html" media="print" title="French HTML (for printing)"/>
<link rel="alternate" href="/en/pdf" hreflang="en" type="application/pdf" title="English PDF"/>
<link rel="alternate" href="/fr/pdf" hreflang="fr" type="application/pdf" title="French PDF"/>
```

This relationship is transitive — that is, if a document links to two other documents with the link type "alternate", then, in addition to implying that those documents are alternative representations of the first document, it is also implying that those two documents are alternative representations of each other.

### 4.6.7.2 Link type "author"

The author keyword may be used with link, a, and area elements. This keyword creates a hyperlink.

For a and area elements, the author keyword indicates that the referenced document provides further information about the author of the nearest article element ancestor of the element defining the hyperlink, if there is one, or of the page as a whole, otherwise.

For link elements, the author keyword indicates that the referenced document provides further information about the author for the page as a whole.

**Note**

The "referenced document" can be, and often is, a mailto: URL giving the email address of the author. [MAILTO]

**Synonyms:** For historical reasons, user agents must also treat link, a, and area elements that have a rev attribute with the value "made" as having the author keyword specified as a link relationship.

### 4.6.7.3 Link type "bookmark"

The bookmark keyword may be used with a and area elements. This keyword creates a hyperlink.

The bookmark keyword gives a permalink for the nearest ancestor article element of the linking element in question, or of the section the linking element is most closely associated with, if there are no ancestor article elements.

**Example**

The following snippet has three permalinks. A user agent could determine which permalink applies to which part of the spec by...
The `canonical` keyword may be used with `link` element. This keyword creates a hyperlink.

The `canonical` keyword indicates that URL given by the `href` attribute is the preferred URL for the current document. That helps search engines reduce duplicate content, as described in more detail in *The Canonical Link Relation*. [RFC6596]

The `dns-prefetch` keyword may be used with `link` elements. This keyword creates an external resource link. This keyword is `body-ok`.

The `dns-prefetch` keyword indicates that preemptively performing DNS resolution for the `origin` of the specified resource is likely to be beneficial, as it is highly likely that the user will require resources located at that `origin`, and the user experience would be improved by preempting the latency costs associated with DNS resolution.

There is no default type for resources given by the `dns-prefetch` keyword.

The appropriate times to fetch and process this type of link are:

- When the external resource link is created on a `link` element that is already browsing-context connected.
- When the external resource link's `link` element becomes browsing-context connected.
- When the `href` attribute of the `link` element of an external resource link that is already browsing-context connected is changed.

The `fetch and process the linked resource` steps for this type of linked resource, given a `link` element `el`, are:

1. Let `url` be the result of `encoding-parsing a URL` given `el`'s `href` attribute's value, relative to `el`'s `node document`.
2. If `url` is failure, then return.
3. Let `partitionKey` be the result of `determining the network partition key` given `el`'s `node document`'s `relevant settings object`.
4. The user agent should `resolve an origin` given `partitionKey` and `url`'s `origin`.

---

Example of permalinks

...
4.6.7.6 Link type "expect" §31

The `expect` keyword may be used with `link` elements. This keyword creates an internal resource link.

An internal resource link created by the `expect` keyword can be used to block rendering until the element that it indicates is connected to the document and fully parsed.

There is no default type for resources given by the `expect` keyword.

Whenever any of the following conditions occur for a `link` element `el`:

• the `expect` internal resource link is created on `el` that is already browsing-context connected;
• an `expect` internal resource link has been created on `el` and `el` becomes browsing-context connected;
• an `expect` internal resource link has been created on `el`, `el` is already browsing-context connected, and `el`'s `href` attribute is set, changed, or removed; or
• an `expect` internal resource link has been created on `el`, `el` is already browsing-context connected, and `el`'s `media` attribute is set, changed, or removed,

then process `el`.

To process internal resource link given a `link` element `el`, run these steps:

1. Let `doc` be `el`'s node document.
2. Let `url` be the result of encoding-parsing a URL given `el`'s `href` attribute's value, relative to `doc`.
3. If this fails, or if `url` does not equal `doc`'s URL with exclude fragments set to false, then unblock rendering on `el` and return.
4. Let `indicatedElement` be the result of selecting the indicated part given `doc` and `url`.
5. If all of the following are true:
   ◦ `doc`'s current document readiness is "loading";
   ◦ `el` creates an internal resource link;
   ◦ `el` is browsing-context connected;
   ◦ `el`'s `rel` attribute contains `expect`;
   ◦ `el` is potentially render-blocking;
   ◦ `el`'s `media` attribute matches the environment; and
   ◦ `indicatedElement` is not an element, or is on a stack of open elements of an HTML parser whose associated Document is `doc`,

then block rendering on `el`.
6. Otherwise, unblock rendering on `el`.

To process internal resource links given a `Document` `doc`:

1. For each `expect` `link` element link in `doc`'s render-blocking element set, process `link`.

The following attribute change steps, given element, `localName`, value, and `namespace`, are used to ensure `expect` `link` elements respond to dynamic `id` and `name` changes:

1. If `namespace` is not null, then return.
2. If `element` is in a stack of open elements of an HTML parser, then return.
3. If any of the following is true:
   ◦ `localName` is `id`, or
   ◦ `localName` is `name` and `element` is an `a` element,

   then process internal resource links given `element`'s node document.

4.6.7.7 Link type "external"

The `external` keyword may be used with `a`, `area`, and `form` elements. This keyword does not create a hyperlink, but annotates any other hyperlinks created by the element (the implied hyperlink, if no other keywords create one).

The `external` keyword indicates that the link is leading to a document that is not part of the site that the current document forms a part of.

4.6.7.8 Link type "help"

The `help` keyword may be used with `link`, `a`, `area`, and `form` elements. This keyword creates a hyperlink.

For `a`, `area`, and `form` elements, the `help` keyword indicates that the referenced document provides further help information for the parent of the element defining the hyperlink, and its children.

Example

In the following example, the form control has associated context-sensitive help. The user agent could use this information, for example, displaying the referenced document if the user presses the "Help" or "F1" key.

```html
<p><label> Topic: </label> <input name=topic> <a href="help/topic.html" rel="help">(Help)</a></p>
```

For `link` elements, the `help` keyword indicates that the referenced document provides help for the page as a whole.

For `a` and `area` elements, on some browsers, the `help` keyword causes the link to use a different cursor.

4.6.7.9 Link type "icon"

The `icon` keyword may be used with `link` elements. This keyword creates an external resource link.

The specified resource is an icon representing the page or site, and should be used by the user agent when representing the page in the user interface.

Icons could be auditory icons, visual icons, or other kinds of icons. If multiple icons are provided, the user agent must select the most appropriate icon according to the `type`, `media`, and `sizes` attributes. If there are multiple equally appropriate icons, user agents must use the last one declared in tree order at the time that the user agent collected the list of icons. If the user agent tries to use an icon but that icon is determined, upon closer examination, to in fact be inappropriate (e.g. because it uses an unsupported format), then the user agent must try the next-most-appropriate icon as determined by the attributes.

Note

User agents are not required to update icons when the list of icons changes, but are encouraged to do so.

There is no default type for resources given by the `icon` keyword. However, for the purposes of determining the type of the resource, user agents must expect the resource to be an image.

The `sizes` keywords represent icon sizes in raw pixels (as opposed to CSS pixels).

Note

An icon that is 50 CSS pixels wide intended for displays with a device pixel density of two device pixels per CSS pixel (2x, 192dpi)
To parse and process the attribute's value, the user agent must first split the attribute's value on ASCII whitespace, and must then parse each resulting keyword to determine what it represents.

The **any** keyword represents that the resource contains a scalable icon, e.g. as provided by an SVG image.

Other keywords must be further parsed as follows to determine what they represent:

- If the keyword doesn't contain exactly one U+0078 LATIN SMALL LETTER X or U+0058 LATIN CAPITAL LETTER X character, then this keyword doesn't represent anything. Return for that keyword.
- Let **width string** be the string before the "x" or "X".
- Let **height string** be the string after the "x" or "X".
- If either **width string** or **height string** start with a U+0030 DIGIT ZERO (0) character or contain any characters other than ASCII digits, then this keyword doesn't represent anything. Return for that keyword.
- Apply the rules for parsing non-negative integers to **width string** to obtain **width**.
- Apply the rules for parsing non-negative integers to **height string** to obtain **height**.
- The keyword represents that the resource contains a bitmap icon with a width of **width** device pixels and a height of **height** device pixels.

The keywords specified on the **sizes** attribute must not represent icon sizes that are not actually available in the linked resource.

The **linked resource fetch setup steps** for this type of linked resource, given a **link** element `el` and **request** `request`, are:

1. Set **request**'s **destination** to "image".
2. Return true.

The **process a link header** steps for this type of linked resource are to do nothing.

In the absence of a **link** with the **icon** keyword, for **Document** objects whose **URL**'s **scheme** is an HTTP(S) scheme, user agents may instead run these steps in parallel:

1. Let **request** be a new **request** whose **URL** is the **URL record** obtained by resolving the **URL** "favicon.ico" against the **Document** object's **URL**, **client** is the **Document** object's **relevant settings object**, **destination** is "image", **synchronous flag** is set, **credentials mode** is "include", and whose **use-URL-credentials flag** is set.
2. Let **response** be the result of fetching **request**.
3. Use **response**'s **unsafe response** as an icon as if it had been declared using the **icon** keyword.

**Example**

The following snippet shows the top part of an application with several icons.

```html
<!DOCTYPE HTML>
<html lang="en">
<head>
<title>lsForums — Inbox</title>
<link rel="icon" href="favicon.png" sizes="16x16" type="image/png">
<link rel="icon" href="windows.ico" sizes="32x32 48x48" type="image/vnd.microsoft.icon">
<link rel="icon" href="mac.icns" sizes="128x128 512x512 8192x8192 32768x32768">
<link rel="icon" href="iphone.png" sizes="57x57" type="image/png">
<link rel="icon" href="gnome.svg" sizes="any" type="image/svg+xml">
<link rel="stylesheet" href="lsforums.css">
<script src="lsforums.js"></script>
<meta name="application-name" content="lsForums">
</head>
```
For historical reasons, the `icon` keyword may be preceded by the keyword "shortcut". If the "shortcut" keyword is present, the `rel` attribute's entire value must be an ASCII case-insensitive match for the string "shortcut icon" (with a single U+0020 SPACE character between the tokens and no other ASCII whitespace).

4.6.7.10 Link type "license"

The `license` keyword may be used with `link`, `area`, and `form` elements. This keyword creates a hyperlink.

The `license` keyword indicates that the referenced document provides the copyright license terms under which the main content of the current document is provided.

This specification does not specify how to distinguish between the main content of a document and content that is not deemed to be part of that main content. The distinction should be made clear to the user.

**Example**

Consider a photo sharing site. A page on that site might describe and show a photograph, and the page might be marked up as follows:

```html
<!DOCTYPE HTML>
<html lang="en">
  <head>
    <title>Exampl Pictures: Kissat</title>
    <link rel="stylesheet" href="/style/default">
  </head>
  <body>
    <h1>Kissat</h1>
    <nav>
      <a href="../">Return to photo index</a>
    </nav>
    <figure>
      <img src="/pix/39627052_fd8dcd98b5.jpg">
      <figcaption>Kissat</figcaption>
    </figure>
    <p>One of them has six toes!</p>
    <p><small><a rel="license" href="http://www.opensource.org/licenses/mit-license.php">MIT Licensed</a></small></p>
    <footer>
      <a href="/">Home</a> | <a href="../">Photo index</a>
      <p>© copyright 2009 Exampl Pictures. All Rights Reserved.</p>
    </footer>
  </body>
</html>
```

In this case the `license` applies to just the photo (the main content of the document), not the whole document. In particular not the design of the page itself, which is covered by the copyright given at the bottom of the document. This could be made clearer in the styling (e.g. making the license link prominently positioned near the photograph, while having the page copyright in light small text at the foot of the page).

**Synonyms:** For historical reasons, user agents must also treat the keyword "copyright" like the `license` keyword.

4.6.7.11 Link type "manifest"

The `manifest` keyword may be used with `link` elements. This keyword creates an external resource link.

_in MDN_
The `manifest` keyword indicates the manifest file that provides metadata associated with the current document. There is no default type for resources given by the `manifest` keyword.

When a web application is not installed, the appropriate time to fetch and process the linked resource for this link type is when the user agent deems it necessary. For example, when the user chooses to install the web application.

For an installed web application, the appropriate times to fetch and process the linked resource for this link type are:

- When the external resource link is created on a link element that is already browsing-context connected.
- When the external resource link's link element becomes browsing-context connected.
- When the `href` attribute of the link element of an external resource link that is already browsing-context connected is changed.

In any case, only the first link element in tree order whose `rel` attribute contains the token `manifest` may be used.

A user agent must not delay the load event for this link type.

The linked resource fetch setup steps, given a link element `el` and request `request`, are:

1. Let `navigable` be `el`'s node document's `node navigable`.
2. If `navigable` is null, then return false.
3. If `navigable` is not a top-level traversable, then return false.
4. Set request's `initiator` to "manifest".
5. Set request's `destination` to "manifest".
6. Set request's `mode` to "cors".
7. Set request's `credentials mode` to the CORS settings attribute `credentials mode` for `el`'s `crossorigin` content attribute.
8. Return true.

To process this type of linked resource, given a link element `el`, boolean `success`, response `response`, and byte sequence `bodyBytes`:

1. If `response`'s `Content-Type metadata` is not a JSON MIME type, then set `success` to false.
2. If `success` is true:
   1. Let `document URL` be `el`'s node document's URL.
   2. Let `manifest URL` be `response`'s URL.
   3. Process the manifest given `document URL`, `manifest URL`, and `bodyBytes`.

The process a link header steps for this type of linked resource are to do nothing.

### 4.6.7.12 Link type `"modulepreload"`

The `modulepreload` keyword may be used with link elements. This keyword creates an external resource link. This keyword is `body-ok`.

The `modulepreload` keyword is a specialized alternative to the `preload` keyword, with a processing model geared toward preloading module scripts. In particular, it uses the specific fetch behavior for module scripts (including, e.g., a different interpretation of the `crossorigin` attribute), and places the result into the appropriate module map for later evaluation. In contrast, a similar external resource link using the `preload` keyword would place the result in the preload cache, without affecting the document's module map.

Additionally, implementations can take advantage of the fact that module scripts declare their dependencies in order to fetch the specified module'sdependency as well. This is intended as an optimization opportunity, since the user agent knows that, in all
likelihood, those dependencies will also be needed later. It will not generally be observable without using technology such as service workers, or monitoring on the server side. Notably, the appropriate `load` or `error` events will occur after the specified module is fetched, and will not wait for any dependencies.

A user agent must not `delay the load event` for this link type.

The appropriate times to `fetch and process the linked resource` for such a link are:

- When the `external resource link` is created on a `link` element that is already `browsing-context connected`.
- When the `external resource link`'s `link` element becomes `browsing-context connected`.
- When the `href` attribute of the `link` element of an `external resource link` that is already `browsing-context connected` is changed.

The `fetch and process the linked resource` algorithm for `modulepreload` links, given a `link` element `el`, is as follows:

1. If `el`'s `href` attribute's value is the empty string, then return.
2. Let `destination` be the current state of `el`'s `as` attribute (a `destination`), or "script" if it is in no state.
3. If `destination` is not `script-like`, then queue an element task on the `networking task source` given `el` to fire an event named `error` at `el`, and return.
4. Let `url` be the result of `encoding-parsing a URL` given `el`'s `href` attribute's value, relative to `el`'s `node document`.
5. If `url` is failure, then return.
6. Let `settings object` be `el`'s `node document`'s `relevant settings object`.
7. Let `credentials mode` be the CORS settings attribute credentials mode for `el`'s `crossorigin` attribute.
8. Let `cryptographic nonce` be `el`'s `[[CryptographicNonce]]`.
9. Let `integrity metadata` be the value of `el`'s `integrity` attribute, if it is specified, or the empty string otherwise.
10. If `el` does not have an `integrity` attribute, then set `integrity metadata` to the result of `resolving a module integrity metadata` with `url` and `settings object`.
11. Let `referrer policy` be the current state of `el`'s `referrerpolicy` attribute.
12. Let `fetch priority` be the current state of `el`'s `fetchpriority` attribute.
13. Let `options` be a `script fetch options` whose `cryptographic nonce` is `cryptographic nonce`, `integrity metadata` is `integrity metadata`, `parser metadata` is "not-parser-inserted", `credentials mode` is `credentials mode`, `referrer policy` is `referrer policy`, and `fetch priority` is `fetch priority`.
14. Fetch a `modulepreload module script graph` given `url`, `destination`, `settings object`, `options`, and with the following steps given `result`:
   1. If `result` is null, then fire an event named `error` at `el`, and return.
   2. Fire an event named `load` at `el`.

The `process a link header` steps for this type of linked resource are to do nothing.

The following snippet shows the top part of an application with several modules preloaded:

```html
<!DOCTYPE html>
<html lang="en">
```

Note

Unlike some other link relations, changing the relevant attributes (such as `as`, `crossorigin`, and `referrerpolicy`) of such a `link` does not trigger a new fetch. This is because the document's `module map` has already been populated by a previous fetch, and so re-fetching would be pointless.

Example

The following snippet shows the top part of an application with several modules preloaded:
4.6.7.13 Link type "nofollow"

The `nofollow` keyword may be used with `a`, `area`, and `form` elements. This keyword does not create a `hyperlink`, but annotates any other hyperlinks created by the element (the implied hyperlink, if no other keywords create one).

The `nofollow` keyword indicates that the link is not endorsed by the original author or publisher of the page, or that the link to the referenced document was included primarily because of a commercial relationship between people affiliated with the two pages.

4.6.7.14 Link type "noopener"

The `noopener` keyword may be used with `a`, `area`, and `form` elements. This keyword does not create a `hyperlink`, but annotates any other hyperlinks created by the element (the implied hyperlink, if no other keywords create one).

The keyword indicates that any newly created `top-level traversable` which results from following the `hyperlink` will not contain an `auxiliary browsing context`. E.g., the resulting `Window`'s `opener` getter will return null.
The `noreferrer` keyword may be used with `a`, `area`, and `form` elements. This keyword does not create a hyperlink, but annotates any other hyperlinks created by the element (the implied hyperlink, if no other keywords create one). It indicates that no referrer information is to be leaked when following the link and also implies the `noopener` keyword behavior under the same conditions.

**Example**

This typically creates a top-level traversable with an auxiliary browsing context (assuming there is no existing navigable whose target name is "example"):

```html
<a href=help.html target=example>Help!</a>
```

This creates a top-level traversable with a non-auxiliary browsing context (assuming the same thing):

```html
<a href=help.html target=example rel=noopener>Help!</a>
```

These are equivalent and only navigate the parent navigable:

```html
<a href=index.html target=_parent>Home</a>
<a href=index.html target=_parent rel=noopener>Home</a>
```

### 4.6.7.15 Link type "noreferrer"

The `noreferrer` keyword may be used with `a`, `area`, and `form` elements. This keyword does not create a hyperlink, but annotates any other hyperlinks created by the element (the implied hyperlink, if no other keywords create one).

It indicates that no referrer information is to be leaked when following the link and also implies the `noopener` keyword behavior under the same conditions.

**Note**

See also the processing model where referrer is directly manipulated.

**Example**

`<a href="..." rel=noreferrer target="_blank">` has the same behavior as `<a href="..." rel=noreferrer noopener target="_blank">`.

### 4.6.7.16 Link type "opener"

The `opener` keyword may be used with `a`, `area`, and `form` elements. This keyword does not create a hyperlink, but annotates any other hyperlinks created by the element (the implied hyperlink, if no other keywords create one).

The keyword indicates that any newly created top-level traversable which results from following the hyperlink will contain an auxiliary browsing context.

**Note**

See also the processing model.

**Example**

In the following example the `opener` is used to allow the help page popup to navigate its opener, e.g., in case what the user is looking for can be found elsewhere. An alternative might be to use a named target, rather than _blank, but this has the potential to clash with existing names.

```html
<a href="..." rel=opener target=_blank>Help!</a>
```
4.6.7.17 Link type "pingback" §3

The **pingback** keyword may be used with **link** elements. This keyword creates an **external resource link**. This keyword is **body-ok**.

For the semantics of the **pingback** keyword, see **Pingback 1.0**. [PINGBACK][1]

4.6.7.18 Link type "preconnect" §3

The **preconnect** keyword may be used with **link** elements. This keyword creates an **external resource link**. This keyword is **body-ok**.

The **preconnect** keyword indicates that preemptively initiating a connection to the **origin** of the specified resource is likely to be beneficial, as it is highly likely that the user will require resources located at that **origin**, and the user experience would be improved by preempting the latency costs associated with establishing the connection.

There is no default type for resources given by the **preconnect** keyword.

A user agent must not **delay the load event** for this link type.

The appropriate times to **fetch and process** this type of link are:

- When the **external resource link** is created on a **link** element that is already **browsing-context connected**.
- When the **external resource link**’s **link** element **becomes browsing-context connected**.
- When the **href** attribute of the **link** element of an **external resource link** that is already **browsing-context connected** is changed.
- When the **crossorigin** attribute of the **link** element of an **external resource link** that is already **browsing-context connected** is set, changed, or removed.

The **fetch and process the linked resource** steps for this type of linked resource, given a **link** element `el`, are to **create link options** from `el` and to **preconnect** given the result.

The **process a link header** step for this type of linked resource given a **link processing options** options are to **preconnect** given options.

To **preconnect** given a **link processing options** options:

1. If options's **href** is an empty string, returns.

2. Let `url` be the result of **encoding-parsing a URL** given options's **href**, relative to options's **base URL**.

   Passing the base URL instead of a document or environment is tracked by **issue #9715**.

3. If `url` is failure, then return.

4. If `url`'s **scheme** is not an **HTTP(S) scheme**, then return.

5. Let `partitionKey` be the result of **determining the network partition key** given options's **environment**.

6. Let `useCredentials` be true.

7. If options's **crossorigin** is `Anonymous` and options's **origin** does not have the **same origin** as `url`'s **origin**, then set `useCredentials` to false.

8. The user agent should **obtain a connection** given `partitionKey`, `url`'s **origin**, and `useCredentials`.

   **Note**
   
   *This connection is obtained but not used directly. It will remain in the connection pool for subsequent use.*

   The user agent should attempt to initiate a preconnect and perform the full connection handshake (DNS+TCP for HTTP, and DNS+TCP+TLS for HTTPS origins) whenever possible, but is allowed to elect to perform a partial handshake (DNS only for HTTP, and DNS or DNS+TCP for HTTPS origins), or skip it entirely, due to resource constraints or other reasons.
The optimal number of connections per origin is dependent on the negotiated protocol, users current connectivity profile, available device resources, global connection limits, and other context specific variables. As a result, the decision for how many connections should be opened is deferred to the user agent.

4.6.7.19 Link type "prefetch" §4

The `prefetch` keyword may be used with `link` elements. This keyword creates an external resource link. This keyword is body-ok.

The `prefetch` keyword indicates that preemptively fetching and caching the specified resource or same-site document is likely to be beneficial, as it is highly likely that the user will require this resource for future navigations.

There is no default type for resources given by the `prefetch` keyword.

The appropriate times to fetch and process this type of link are:

- When the external resource link is created on a link element that is already browsing-context connected.
- When the external resource link's link element becomes browsing-context connected.
- When the `href` attribute of the link element of an external resource link that is already browsing-context connected is changed.
- When the `crossorigin` attribute of the link element of an external resource link that is already browsing-context connected is set, changed, or removed.

The fetch and process the linked resource algorithm for `prefetch` links, given a link element `el`, is as follows:

1. If `el`'s `href` attribute's value is the empty string, then return.
2. Let `options` be the result of creating link options from `el`.
3. Set `options`'s destination to the empty string.
4. Let `request` be the result of creating a link request given `options`.
5. If `request` is null, then return.
6. Set `request`'s initiator to "prefetch".
7. Let `processPrefetchResponse` be the following steps given a response and null, failure, or a byte sequence:
   1. If response is a network error, fire an event named error at `el`.
   2. Otherwise, fire an event named `load` at `el`.
8. The user agent should fetch, with `processResponseConsumeBody` set to `processPrefetchResponse`. User agents may delay the fetching of request to prioritize other requests that are necessary for the current document.

The process a link header steps for this type of linked resource are to do nothing.

4.6.7.20 Link type "preload" §4

The `preload` keyword may be used with `link` elements. This keyword creates an external resource link. This keyword is body-ok.

The `preload` keyword indicates that the user agent will preemptively fetch and cache the specified resource according to the potential destination given by the `as` attribute, and the priority given by the `fetchpriority` attribute, as it is highly likely that the user will require this resource for the current navigation.

User-agents might perform additional operations when a resource is loaded, such as preemptively decoding images or creating...
There is no default type for resources given by the `preload` keyword.

A user agent must not *delay the load event* for this link type.

The appropriate times to *fetch and process the linked resource* for such a link are:

- When the `external resource link` is created on a `link` element that is already *browsing-context connected*.
- When the `external resource link`'s `link` element *becomes* *browsing-context connected*.
- When the `href` attribute of the `link` element of an `external resource link` that is already *browsing-context connected* is changed.
- When the `as` attribute of the `link` element of an `external resource link` that is already *browsing-context connected* is changed.
- When the `type` attribute of the `link` element of an `external resource link` that is already *browsing-context connected*, but was previously not obtained due to the `type` attribute specifying an unsupported type for the request destination, is set, removed, or changed.
- When the `media` attribute of the `link` element of an `external resource link` that is already *browsing-context connected*, but was previously not obtained due to the `media` attribute not matching the environment, is changed or removed.

A Document has a *map of preloaded resources*, which is a `map`, initially empty.

A `preload key` is a `struct`. It has the following `items`:

- `URL`
  - A `URL`

- `destination`
  - A string

- `mode`
  - A request mode, either "same-origin", "cors", or "no-cors"

- `credentials mode`
  - A credentials mode

A `preload entry` is a `struct`. It has the following `items`:

- `integrity metadata`
  - A string

- `response`
  - Null or a `response`

- `on response available`
  - Null, or an algorithm accepting a `response` or null

To *consume a preloaded resource* for *Window* window, given a `URL` url, a string destination, a string mode, a string credentialsMode, a string integrityMetadata, and `onResponseAvailable`, which is an algorithm accepting a `response`:

1. Let key be a `preload key` whose `URL` is url, `destination` is destination, `mode` is mode, and `credentials mode` is credentialsMode.
2. Let preloads be window's associated Document's `map of preloaded resources`.
3. If key does not exist in preloads, then return false.
4. Let entry be preloads[key].
5. Let `consumerIntegrityMetadata` be the result of parsing integrityMetadata.
6. Let `preloadIntegrityMetadata` be the result of parsing entry’s integrity metadata.

7. If none of the following conditions apply:
   - `consumerIntegrityMetadata` is no metadata;
   - `consumerIntegrityMetadata` is equal to `preloadIntegrityMetadata`;

   then return false.

   This comparison would ignore unknown integrity options. See issue #116.

8. Remove preloads[ key].

9. If entry `response` is null, then set entry’s on response available to onResponseAvailable.

10. Otherwise, call onResponseAvailable with entry’s response.

11. Return true.

For the purposes of this section, a string type matches a string destination if the following algorithm returns true:

1. If type is an empty string, then return true.

2. If destination is "fetch", then return true.

3. Let mimeTypeRecord be the result of parsing type.

4. If mimeTypeRecord is failure, then return false.

5. If mimeTypeRecord is not supported by the user agent, then return false.

6. If any of the following are true:
   - destination is "audio" or "video", and mimeTypeRecord is an audio or video MIME type;
   - destination is a script-like destination and mimeTypeRecord is a JavaScript MIME type;
   - destination is "image" and mimeTypeRecord is an image MIME type;
   - destination is "font" and mimeTypeRecord is a font MIME type;
   - destination is "json" and mimeTypeRecord is a JSON MIME type;
   - destination is "style" and mimeTypeRecord’s essence is text/css;
   - destination is "track" and mimeTypeRecord’s essence is text/vtt,

   then return true.

7. Return false.

To create a preload key for a request, return a new preload key whose URL is request’s URL, destination is request’s destination, mode is request’s mode, and credentials mode is request’s credentials mode.

To translate a preload destination given a string destination:

1. If destination is not "fetch", "font", "image", "script", "style", or "track", then return null.
2. Return the result of translating destination.

To preload given a link processing options\(^{\ref{p181}}\) options and an optional processResponse, which is an algorithm accepting a response:

1. If options's type\(^{\ref{p182}}\) doesn't match\(^{\ref{p226}}\) options's destination\(^{\ref{p183}}\), then return.
2. If options's destination\(^{\ref{p182}}\) is "image" and options's source set\(^{\ref{p182}}\) is not null, then set options's href\(^{\ref{p182}}\) to the result of selecting an image source\(^{\ref{p368}}\) from options's source set\(^{\ref{p182}}\).
3. Let request be the result of creating a link request\(^{\ref{p181}}\) given options.
4. If request is null, then return.
5. Let unsafeEndTime be 0.
6. Let entry be a new preload entry\(^{\ref{p325}}\) whose integrity metadata\(^{\ref{p325}}\) is options's integrity\(^{\ref{p182}}\).
7. Let key be the result of creating a preload key\(^{\ref{p326}}\) given request.
8. If options's document\(^{\ref{p182}}\) is "pending", then set request's initiator type to "early hint".
9. Let controller be null.
10. Let reportTiming given a Document\(^{\ref{p128}}\) document be to report timing for controller given document's relevant global object\(^{\ref{p1071}}\).
11. Set controller to the result of fetching request, with processResponseConsumeBody set to the following steps given a response:
   1. If bodyBytes is a byte sequence, then set response's body to bodyBytes as a body.
   2. Otherwise, set response to a network error.
   3. Set unsafeEndTime to the unsafe shared current time.
   4. If options's document\(^{\ref{p182}}\) is not null, then call reportTiming given options's document\(^{\ref{p182}}\).
   5. If entry's on response available\(^{\ref{p325}}\) is null, then set entry's response\(^{\ref{p325}}\) to response; otherwise call entry's on response available\(^{\ref{p325}}\) given response.
   6. If processResponse is given, then call processResponse with response.
12. Let commit be the following steps given a Document\(^{\ref{p128}}\) document:
   1. If entry's response\(^{\ref{p325}}\) is not null, then call reportTiming given document.
   2. Set document's map of preloaded resources\(^{\ref{p325}}\) [key] to entry.
13. If options's document\(^{\ref{p182}}\) is null, then set options's on document ready\(^{\ref{p182}}\) to commit. Otherwise call commit with options's document\(^{\ref{p182}}\).

The fetch and process the linked resource\(^{\ref{p180}}\) steps for this type of linked resource, given a Link\(^{\ref{p174}}\) element el, are:

1. Update the source set\(^{\ref{p369}}\) for el.
2. Let options be the result of creating link options\(^{\ref{p182}}\) from el.
3. Preload\(^{\ref{p327}}\) options, with the following steps given a response response:
   1. If response is a network error, fire an event named error\(^{\ref{p1451}}\) at el. Otherwise, fire an event named load\(^{\ref{p1451}}\) at el.

---

By using processResponseConsumeBody, we have extracted the entire body. This is necessary to ensure the preloader loads the entire body from the network, regardless of whether the preload will be consumed (which is uncertain at this point). This step then resets the request's body to a new body containing the same bytes, so that other specifications can read from it at the time of actual consumption, despite us having already done so once.

2. Otherwise, set response to a network error.
3. Set unsafeEndTime to the unsafe shared current time.
4. If options's document\(^{\ref{p182}}\) is not null, then call reportTiming given options's document\(^{\ref{p182}}\).
5. If entry's on response available\(^{\ref{p325}}\) is null, then set entry's response\(^{\ref{p325}}\) to response; otherwise call entry's on response available\(^{\ref{p325}}\) given response.
6. If processResponse is given, then call processResponse with response.
12. Let commit be the following steps given a Document\(^{\ref{p128}}\) document:
   1. If entry's response\(^{\ref{p325}}\) is not null, then call reportTiming given document.
   2. Set document's map of preloaded resources\(^{\ref{p325}}\) [key] to entry.
13. If options's document\(^{\ref{p182}}\) is null, then set options's on document ready\(^{\ref{p182}}\) to commit. Otherwise call commit with options's document\(^{\ref{p182}}\).

The fetch and process the linked resource\(^{\ref{p180}}\) steps for this type of linked resource, given a Link\(^{\ref{p174}}\) element el, are:

1. Update the source set\(^{\ref{p369}}\) for el.
2. Let options be the result of creating link options\(^{\ref{p182}}\) from el.
3. Preload\(^{\ref{p327}}\) options, with the following steps given a response response:
   1. If response is a network error, fire an event named error\(^{\ref{p1451}}\) at el. Otherwise, fire an event named load\(^{\ref{p1451}}\) at el.

The actual browsers' behavior is different from the spec here, and the feasibility of changing the behavior has
The process a link header step for this type of link given a link processing options options is to preload options.

4.6.7.21 Link type "privacy-policy"

The privacy-policy keyword may be used with link, a, and area elements. This keyword creates a hyperlink.

The privacy-policy keyword indicates that the referenced document contains information about the data collection and usage practices that apply to the current document, as described in more detail in Additional Link Relation Types. The referenced document may be a standalone privacy policy, or a specific section of some more general document. [RFC6903]

4.6.7.22 Link type "search"

The search keyword may be used with link, a, area, and form elements. This keyword creates a hyperlink.

The search keyword indicates that the referenced document provides an interface specifically for searching the document and its related resources.

Note

OpenSearch description documents can be used with link elements and the search link type to enable user agents to autodiscover search interfaces. [OPENSEARCH]

4.6.7.23 Link type "stylesheet"

The stylesheet keyword may be used with link elements. This keyword creates an external resource link that contributes to the styling processing model. This keyword is body-ok.

The specified resource is a CSS style sheet that describes how to present the document.

If the alternate keyword is also specified on the link element, then the link is an alternative style sheet: in this case, the title attribute must be specified on the link element, with a non-empty value.

The default type for resources given by the stylesheet keyword is text/css.

A link element of this type is implicitly potentially render-blocking if the element was created by its node document’s parser.

When the disabled attribute of a link element with a stylesheet keyword is set, disable the associated CSS style sheet.

The appropriate times to fetch and process this type of link are:

- When the external resource link is created on a link element that is already browsing-context connected.
- When the external resource link's link element becomes browsing-context connected.
- When the href's attribute of the link element of an external resource link that is already browsing-context connected is changed.
- When the disabled attribute of the link element of an external resource link that is already browsing-context connected is set, changed, or removed.
- When the crossorigin attribute of the link element of an external resource link that is already browsing-context connected is set or changed to a value that does not or no longer matches the Content-Type metadata of the previous obtained external resource, if any.
• When the `type` attribute of the `link` element of an external resource link that is already browsing-context connected, but was previously not obtained due to the `type` attribute specifying an unsupported type, is removed or changed.

• When the external resource link that is already browsing-context connected changes from being an alternative style sheet to not being one, or vice versa.

**Quirk:** If the document has been set to quirks mode, has the same origin as the URL of the external resource, and the Content-Type metadata of the external resource is not a supported style sheet type, the user agent must instead assume it to be `text/css`.

The linked resource fetch setup steps for this type of linked resource, given a `link` element `el` and request `request`, are:

1. If `el`'s `disabled` attribute is set, then return false.
2. If `el` contributes a script-blocking style sheet, append `el` to its node document's script-blocking style sheet set.
3. If `el`'s `media` attribute's value matches the environment and `el` is potentially render-blocking, then block rendering on `el`.
4. If `el` is currently render-blocking, then set `request`'s `render-blocking` to true.
5. Return true.

See issue #968 for plans to use the CSSOM fetch a CSS style sheet algorithm instead of the default fetch and process the linked resource algorithm. In the meantime, any critical subresource request should have its `render-blocking` set to whether or not the `link` element is currently render-blocking.

To process this type of linked resource given a `link` element `el`, boolean `success`, response `response`, and byte sequence `bodyBytes`:

1. If the resource's Content-Type metadata is not `text/css`, then set `success` to false.
2. If `el` no longer creates an external resource link that contributes to the styling processing model, or if, since the resource in question was fetched, it has become appropriate to fetch it again, then:
   1. Remove `el` from `el`'s node document's script-blocking style sheet set.
   2. Return.
3. If `el` has an associated CSS style sheet, remove the CSS style sheet.
4. If `success` is true, then:
   1. Create a CSS style sheet with the following properties:
      ```
      type
      text/css
      location
      response's URL list[0]
      ```
      We provide a URL here on the assumption that w3c/csswg-drafts issue #9316 will be fixed.

**owner node**

`el`

**media**

The `media` attribute of `el`.

*Note:* This is a reference to the (possibly absent at this time) attribute, rather than a copy of the attribute's current value. CSSOM defines what happens when the attribute is dynamically set, changed, or removed.
The `title` attribute of `el`, if `el` is in a document tree, or the empty string otherwise.

**Note**
This is similarly a reference to the attribute, rather than a copy of the attribute's current value.

**alternate flag**
Set if the link is an alternative style sheet and `el`'s explicitly enabled is false; unset otherwise.

**origin-clean flag**
Set if the resource is CORS-same-origin; unset otherwise.

**parent CSS style sheet**
**owner CSS rule**
null

**disabled flag**
Left at its default value.

**CSS rules**
Left uninitialized.

This doesn't seem right. Presumably we should be using `bodyBytes`? Tracked as issue #2997.

The CSS environment encoding is the result of running the following steps: [CSSSYNTAX]

1. If `el` has a `charset` attribute, get an encoding from that attribute's value. If that succeeds, return the resulting encoding. [ENCODING]

2. Otherwise, return the document's character encoding. [DOM]

2. Fire an event named `load` at `el`.

5. Otherwise, fire an event named `error` at `el`.

6. If `el` contributes a script-blocking style sheet, then:


   2. Remove `el` from its node document's script-blocking style sheet.

7. Unblock rendering on `el`.

The process a link header steps for this type of linked resource are to do nothing.

4.6.7.24 Link type "tag" §

The `tag` keyword may be used with `a` and `area` elements. This keyword creates a hyperlink.

The `tag` keyword indicates that the tag that the referenced document represents applies to the current document.

**Note**
Since it indicates that the tag applies to the current document, it would be inappropriate to use this keyword in the markup of a tag cloud, which lists the popular tags across a set of pages.

**Example**
This document is about some gems, and so it is tagged with "https://en.wikipedia.org/wiki/Gemstone" to unambiguously categorize it as applying to the "jewel" kind of gems, and not to, say, the towns in the US, the Ruby package format, or the Swiss locomotive class:
Example

In this document, there are two articles. The "tag" link, however, applies to the whole page (and would do so wherever it was placed, including if it was within the article elements).

4.6.7.25 Link Type "terms-of-service" §

The terms-of-service keyword may be used with link, a, and area elements. This keyword creates a hyperlink.

The terms-of-service keyword indicates that the referenced document contains information about the agreements between the current document's provider and users who wish to use the current document, as described in more detail in Additional Link Relation Types. [RFC6903]
4.6.7.26 Sequential link types

Some documents form part of a sequence of documents.

A sequence of documents is one where each document can have a previous sibling and a next sibling. A document with no previous sibling is the start of its sequence, a document with no next sibling is the end of its sequence.

A document may be part of multiple sequences.

4.6.7.26.1 Link type "next"

The next keyword may be used with link, a, area, and form elements. This keyword creates a hyperlink.

The next keyword indicates that the document is part of a sequence, and that the link is leading to the document that is the next logical document in the sequence.

When the next keyword is used with a link element, user agents should process such links as if they were using one of the dns-prefetch, preconnect, or prefetch keywords. Which keyword the user agent wishes to use is implementation-dependent; for example, a user agent may wish to use the less-costly preconnect processing model when trying to conserve data, battery power, or processing power, or may wish to pick a keyword depending on heuristic analysis of past user behavior in similar scenarios.

4.6.7.26.2 Link type "prev"

The prev keyword may be used with link, a, area, and form elements. This keyword creates a hyperlink.

The prev keyword indicates that the document is part of a sequence, and that the link is leading to the document that is the previous logical document in the sequence.

Synonyms: For historical reasons, user agents must also treat the keyword "previous" like the prev keyword.

4.6.7.27 Other link types

Extensions to the predefined set of link types may be registered on the microformats page for existing rel values.

Anyone is free to edit the microformats page for existing rel values at any time to add a type. Extension types must be specified with the following information:

Keyword
The actual value being defined. The value should not be confusingly similar to any other defined value (e.g. differing only in case).

If the value contains a U+003A COLON character (:), it must also be an absolute URL.

Effect on... link
One of the following:

Not allowed
The keyword must not be specified on link elements.

Hyperlink
The keyword may be specified on a link element; it creates a hyperlink.

External Resource
The keyword may be specified on a link element; it creates an external resource link.

Effect on... a and area
One of the following:

Not allowed
The keyword must not be specified on a and area elements.
Hyperlink
The keyword may be specified on `a` and `area` elements; it creates a hyperlink.

External Resource
The keyword may be specified on `a` and `area` elements; it creates an external resource link.

Hyperlink Annotation
The keyword may be specified on `a` and `area` elements; it annotates other hyperlinks created by the element.

Effect on... form
One of the following:

Not allowed
The keyword must not be specified on `form` elements.

Hyperlink
The keyword may be specified on `form` elements; it creates a hyperlink.

External Resource
The keyword may be specified on `form` elements; it creates an external resource link.

Hyperlink Annotation
The keyword may be specified on `form` elements; it annotates other hyperlinks created by the element.

Brief description
A short non-normative description of what the keyword's meaning is.

Specification
A link to a more detailed description of the keyword's semantics and requirements. It could be another page on the wiki, or a link to an external page.

Synonyms
A list of other keyword values that have exactly the same processing requirements. Authors should not use the values defined to be synonyms, they are only intended to allow user agents to support legacy content. Anyone may remove synonyms that are not used in practice; only names that need to be processed as synonyms for compatibility with legacy content are to be registered in this way.

Status
One of the following:

Proposed
The keyword has not received wide peer review and approval. Someone has proposed it and is, or soon will be, using it.

Ratified
The keyword has received wide peer review and approval. It has a specification that unambiguously defines how to handle pages that use the keyword, including when they use it in incorrect ways.

Discontinued
The keyword has received wide peer review and it has been found wanting. Existing pages are using this keyword, but new pages should avoid it. The "brief description" and "specification" entries will give details of what authors should use instead, if anything.

If a keyword is found to be redundant with existing values, it should be removed and listed as a synonym for the existing value.

If a keyword is registered in the "proposed" state for a period of a month or more without being used or specified, then it may be removed from the registry.

If a keyword is added with the "proposed" status and found to be redundant with existing values, it should be removed and listed as a synonym for the existing value. If a keyword is added with the "proposed" status and found to be harmful, then it should be changed to "discontinued" status.

Anyone can change the status at any time, but should only do so in accordance with the definitions above.

Conformance checkers must use the information given on the microformats page for existing rel values to establish if a value is allowed or not: values defined in this specification or marked as "proposed" or "ratified" must be accepted when used on the elements for which they apply as described in the "Effect on..." field, whereas values marked as "discontinued" or not listed in either this specification or on the aforementioned page must be rejected as invalid. Conformance checkers may cache this information (e.g. for performance reasons or to avoid the use of unreliable network connectivity).

When an author uses a new type not defined by either this specification or the wiki page, conformance checkers should offer to add the value to the wiki, with the details described above, with the "proposed" status.
Types defined as extensions in the [microformats page for existing rel values](https://microformats.org/wiki/rel-extension) with the status "proposed" or "ratified" may be used with the rel attribute on [link](https://developer.mozilla.org/en-US/docs/Web/HTML/Element/link), [a](https://developer.mozilla.org/en-US/docs/Web/HTML/Element/a), and [area](https://developer.mozilla.org/en-US/docs/Web/HTML/Element/area) elements in accordance to the "Effect on..." field. [MFRel](https://developer.mozilla.org/en-US/docs/Web/HTML/Element/MFrrel)

### 4.7 Edits


#### 4.7.1 The ins element

Categories:
- Flow content
- Phrasing content
- Palpable content

Contexts in which this element can be used:
Where phrasing content is expected.

Content model:
- Transparent

Tag omission in text/html:
Neither tag is omissible.

Content attributes:
- Global attributes
  - cite — Link to the source of the quotation or more information about the edit
  - datetime — Date and (optionally) time of the change

Accessibility considerations:
- For authors.
- For implementers.

DOM interface:

The ins element represents an addition to the document.

**Example**

The following represents the addition of a single paragraph:

```html
<aside>
  <ins>
    <p> I like fruit. </p>
  </ins>
</aside>
```

As does the following, because everything in the aside element here counts as phrasing content and therefore there is just one paragraph:

```html
<aside>
  <ins>
    Apples are <em>tasty</em>.
  </ins>
  <ins>
    So are pears.
  </ins>
</aside>
```
ins elements should not cross implied paragraph boundaries.

Example

The following example represents the addition of two paragraphs, the second of which was inserted in two parts. The first ins element in this example thus crosses a paragraph boundary, which is considered poor form.

```html
<aside>
  <!-- don't do this -->
  <ins datetime="2005-03-16 00:00Z">
    <p>
      I like fruit. </p>
      Apples are <em>tasty</em>.
  </ins>
  <ins datetime="2007-12-19 00:00Z">
    So are pears.
  </ins>
</aside>

Here is a better way of marking this up. It uses more elements, but none of the elements cross implied paragraph boundaries.

```html
<aside>
  <ins datetime="2005-03-16 00:00Z">
    <p>
      I like fruit. </p>
      Apples are <em>tasty</em>.
  </ins>
  <ins datetime="2007-12-19 00:00Z">
    So are pears.
  </ins>
</aside>

4.7.2 The del element

Categories:
- Flow content.
- Phrasing content.
- Palpable content.

Contexts in which this element can be used:
Where phrasing content is expected.

Content model:
- Transparent.

Tag omission in text/html:
Neither tag is omissible.

Content attributes:
- Global attributes
  - cite:
  - datetime:

Accessibility considerations:
- For authors.
- For implementers.

DOM interface:
- Uses HTMLModElement.

The del element represents a removal from the document.
**Example**

The following shows a "to do" list where items that have been done are crossed-off with the date and time of their completion.

```html
<h1>To Do</h1>
<ul>
<li>Empty the dishwasher</li>
<li><del datetime="2009-10-11T01:25-07:00">Watch Walter Lewin's lectures</del></li>
<li><del datetime="2009-10-10T23:38-07:00">Download more tracks</del></li>
<li>Buy a printer</li>
</ul>
```

### 4.7.3 Attributes common to **ins** and **del** elements

The `cite` attribute may be used to specify the URL of a document that explains the change. When that document is long, for instance the minutes of a meeting, authors are encouraged to include a fragment pointing to the specific part of that document that discusses the change.

If the `cite` attribute is present, it must be a valid URL potentially surrounded by spaces that explains the change. To obtain the corresponding citation link, the value of the attribute must be parsed relative to the element's node document. User agents may allow users to follow such citation links, but they are primarily intended for private use (e.g., by server-side scripts collecting statistics about a site's edits), not for readers.

The `datetime` attribute may be used to specify the time and date of the change.

If present, the `datetime` attribute's value must be a valid date string with optional time.

User agents must parse the `datetime` attribute according to the parse a date or time string algorithm. If that doesn't return a date or a global date and time, then the modification has no associated timestamp (the value is non-conforming; it is not a valid date string with optional time). Otherwise, the modification is marked as having been made at the given date or global date and time. If the given value is a global date and time then user agents should use the associated time-zone offset information to determine which time zone to present the given datetime in.

This value may be shown to the user, but it is primarily intended for private use.

The `ins` and `del` elements must implement the `HTMLModElement` interface:

```idl
[Exposed=Window]
interface HTMLModElement : HTMLElement {
    [HTMLConstructor] constructor();

    [CEReactions] attribute USVString cite;
    [CEReactions] attribute DOMString dateTime;
}
```

The `cite` IDL attribute must reflect the element's `cite` content attribute. The `dateTime` IDL attribute must reflect the element's `datetime` content attribute.

### 4.7.4 Edits and paragraphs

This section is non-normative.

Since the `ins` and `del` elements do not affect paragraphing, it is possible, in some cases where paragraphs are implied (without explicit `p` elements), for an `ins` or `del` element to span both an entire paragraph or other non-phrasing content elements and part of another paragraph. For example:
By only wrapping some paragraphs in `<p>` elements, one can even get the end of one paragraph, a whole second paragraph, and the start of a third paragraph to be covered by the same `insert` or `delete` element (though this is very confusing, and not considered good practice):

```xml
<section>
  <p>This is a paragraph that was inserted.</p>
  This is another paragraph whose first sentence was inserted at the same time as the paragraph above.
  This is a second sentence, which was there all along.
</section>
```

However, due to the way implied paragraphs are defined, it is not possible to mark up the end of one paragraph and the start of the very next one using the same `insert` or `delete` element. You instead have to use one (or two) `<p>` element(s) and two `insert` or `delete` elements, as for example:

```xml
<section>
  This is the first paragraph. <ins>This sentence was inserted.</ins>
  <p>This second paragraph was inserted.</p>
  This sentence was inserted too. <ins>This is the third paragraph in this example.</ins>
  <!-- (don't do this) -->
</section>
```

Partly because of the confusion described above, authors are strongly encouraged to always mark up all paragraphs with the `<p>` element, instead of having `insert` or `delete` elements that cross implied paragraphs boundaries.

### 4.7.5 Edits and lists

This section is non-normative.

The content models of the `<ol>` and `<ul>` elements do not allow `insert` and `delete` elements as children. Lists always represent all their items, including items that would otherwise have been marked as deleted.

To indicate that an item is inserted or deleted, an `insert` or `delete` element can be wrapped around the contents of the `<li>` element. To indicate that an item has been replaced by another, a single `<li>` element can have one or more `delete` elements followed by one or more `insert` elements.

**Example**

In the following example, a list that started empty had items added and removed from it over time. The bits in the example that have been emphasized show the parts that are the "current" state of the list. The list item numbers don't take into account the edits, though.

```xml
<h1>Stop-ship bugs</h1>
<ol>
  <li><ins>datetime="2008-02-12T15:20Z">Bug 225:
      Rain detector doesn't work in snow</ins></li>
</ol>
```
The elements that form part of the table model have complicated content model requirements that do not allow for the `ins` and `del` elements, so indicating edits to a table can be difficult.

To indicate that an entire row or an entire column has been added or removed, the entire contents of each cell in that row or column can be wrapped in `ins` or `del` elements (respectively).

### 4.7.6 Edits and tables

This section is non-normative.

The elements that form part of the table model have complicated content model requirements that do not allow for the `ins` and `del` elements, so indicating edits to a table can be difficult.

To indicate that an entire row or an entire column has been added or removed, the entire contents of each cell in that row or column can be wrapped in `ins` or `del` elements (respectively).

Example

Here, a table's row has been added:

```
<table>
<thead>
<tr> <th>Game name</th> <th>Game publisher</th> <th>Verdict</th>
</thead>
<tbody>
<tr> <td>Diablo 2</td> <td>Blizzard</td> <td>8/10</td>
</tr>
<tr> <td>Portal</td> <td>Valve</td> <td>10/10</td>
</tr>
<tr> <ins>Portal 2</ins> <ins>Valve</ins> <ins>10/10</ins>
</tbody>
</table>
```

Example

Here, a column has been removed (the time at which it was removed is given also, as is a link to the page explaining why):

```
<table>
<thead>
<tr> <th>Game name</th> <th>Game publisher</th> <th><del cite="/edits/r192" datetime="2011-05-02T14:23Z">Verdict</del></th>
</thead>
<tbody>
<tr> <td>Diablo 2</td> <td>Blizzard</td> <td><del cite="/edits/r192" datetime="2011-05-02T14:23Z">8/10</del></td>
</tr>
<tr> <td>Portal</td> <td>Valve</td> <td><del cite="/edits/r192" datetime="2011-05-02T14:23Z">10/10</del></td>
</tr>
</tbody>
</table>
```
Generally speaking, there is no good way to indicate more complicated edits (e.g. that a cell was removed, moving all subsequent cells up or to the left).

### 4.8 Embedded content

#### 4.8.1 The picture element

**Categories**:
- Flow content
- Phrasing content
- Embedded content
- Palpable content

**Contexts in which this element can be used**:
Where embedded content is expected.

**Content model**:
Zero or more `source` elements, followed by one `img` element, optionally intermixed with script-supporting elements.

**Tag omission in text/html**:
Neither tag is omissible.

**Content attributes**:
- Global attributes

**Accessibility considerations**:
- For authors
- For implementers

**DOM interface**:

```idl
[Exposed=Window]
interface HTMLPictureElement : HTMLElement {
    [HTMLConstructor] constructor();
};
```

The `picture` element is a container which provides multiple sources to its contained `img` element to allow authors to declaratively control or give hints to the user agent about which image resource to use, based on the screen pixel density, viewport size, image format, and other factors. It represents its children.

**Note**
The `picture` element is somewhat different from the similar-looking `video` and `audio` elements. While all of them contain `source` elements, the `source` element's `src` attribute has no meaning when the element is nested within a `picture` element, and the resource selection algorithm is different. Also, the `picture` element itself does not display anything; it merely provides a context for its contained `img` element that enables it to choose from multiple URLs.

#### 4.8.2 The source element

**Categories**:
None.
Contexts in which this element can be used:

As a child of a `picture` element, before the `img` element.
As a child of a `media element`, before any `flow content` or `track` elements.

Content model:

Nothing.

Tag omission in text/html:

No end tag.

Content attributes:

Global attributes:
- `type` — Type of embedded resource
- `media` — Applicable media
- `src` (in `audio` or `video`) — Address of the resource
- `srcset` (in `picture`) — Images to use in different situations, e.g., high-resolution displays, small monitors, etc.
- `sizes` (in `picture`) — Image sizes for different page layouts
- `width` (in `picture`) — Horizontal dimension
- `height` (in `picture`) — Vertical dimension

Accessibility considerations:

For authors.
For implementers.

DOM interface:

```idl
[Exposed=Window]
interface HTMLSourceElement : HTMLElement {
  [HTMLConstructor] constructor();

  [CEReactions] attribute USVString src;
  [CEReactions] attribute DOMString type;
  [CEReactions] attribute USVString srcset;
  [CEReactions] attribute DOMString sizes;
  [CEReactions] attribute DOMString media;
  [CEReactions] attribute unsigned long width;
  [CEReactions] attribute unsigned long height;
};
```

The `source` element allows authors to specify multiple alternative `source sets` for `img` elements or multiple alternative `media resources` for `media elements`. It does not represent anything on its own.

The `type` attribute may be present. If present, the value must be a valid MIME type string.

The `media` attribute may also be present. If present, the value must contain a valid media query list. The user agent will skip to the next `source` element if the value does not match the environment.

**Note**

The `media` attribute is only evaluated once during the resource selection algorithm for `media elements`. In contrast, when using the `picture` element, the user agent will react to changes in the environment.

The remainder of the requirements depend on whether the parent is a `picture` element or a `media element`:

- The `source` element's parent is a `picture` element
  - The `srcset` attribute must be present, and is a `srcset attribute`.
  - The `srcset` attribute contributes the `image sources` to the `source set`, if the `source` element is selected.
    - If the `srcset` attribute has any image candidate strings using a width descriptor, the `sizes` attribute must also be present. If, additionally, the following sibling `img` element does not allow auto-sizes, the `sizes` attribute must be present. The `sizes` attribute is a `sizes attribute`, which contributes the `source size` to the `source set`, if the `source` element is selected.
The `source` element supports dimension attributes. The `img` element can use the `width` and `height` attributes of a `source` element, instead of those on the `img` element itself, to determine its rendered dimensions and aspect-ratio, as defined in the Rendering section.

The `type` attribute gives the type of the images in the `source set`, to allow the user agent to skip to the next `source` element if it does not support the given type.

When a `source` element has a following sibling `source` element or `img` element with a `srcset` attribute specified, it must have at least one of the following:

- A `media` attribute specified with a value that, after stripping leading and trailing ASCII whitespace, is not the empty string and is not an ASCII case-insensitive match for the string "all".
- A `type` attribute specified.

The `src` attribute must not be present.

The `source` element's parent is a media element. The `src` attribute gives the URL of the media resource. The value must be a valid non-empty URL potentially surrounded by spaces. This attribute must be present.

The `type` attribute gives the type of the media resource, to help the user agent determine if it can play this media resource before fetching it. The `codecs` parameter, which certain MIME types define, might be necessary to specify exactly how the resource is encoded. [RFC6381]

Note: Dynamically modifying a `source` element's `src` or `type` attribute when the element is already inserted in a video or audio element will have no effect. To change what is playing, just use the `src` attribute on the media element directly, possibly making use of the `canPlayType()` method to pick from amongst available resources. Generally, manipulating `source` elements manually after the document has been parsed is an unnecessarily complicated approach.

Example

The following list shows some examples of how to use the `codecs` MIME parameter in the `type` attribute.

H.264 Constrained baseline profile video (main and extended video compatible) level 3 and Low-Complexity AAC audio in MP4 container

```xml
<source src='video.mp4' type='video/mp4; codecs="avc1.42E01E, mp4a.40.2"'>
```

H.264 Extended profile video (baseline-compatible) level 3 and Low-Complexity AAC audio in MP4 container

```xml
<source src='video.mp4' type='video/mp4; codecs="avc1.58A01E, mp4a.40.2"'>
```

H.264 Main profile video level 3 and Low-Complexity AAC audio in MP4 container

```xml
<source src='video.mp4' type='video/mp4; codecs="avc1.4D401E, mp4a.40.2"'>
```

H.264 'High' profile video (incompatible with main, baseline, or extended profiles) level 3 and Low-Complexity AAC audio in MP4 container

```xml
<source src='video.mp4' type='video/mp4; codecs="avc1.64001E, mp4a.40.2"'>
```
The srcset and sizes attributes must not be present.

The source HTML element insertion steps, given insertedNode, are:

1. If insertedNode's parent is a media element that has no src attribute and whose networkState has the value NETWORK_EMPTY, then invoke that media element's resource selection algorithm.

2. If insertedNode's next sibling is an img element and its parent is a picture element, then, count this as a relevant mutation for the img element.

The source HTML element removing steps, given removedNode and oldParent, are:

1. If removedNode's next sibling was an img element and oldParent is a picture element, then, count this as a relevant mutation for the img element.

The IDL attributes src, type, srcset, sizes and media must reflect the respective content attributes of the same name.

Example

If the author isn't sure if user agents will all be able to render the media resources provided, the author can listen to the error event on the last source element and trigger fallback behavior:

```html
<script>
function fallback(video) {
    // replace <video> with its contents
    while (video.hasChildNodes()) {
        if (video.firstChild instanceof HTMLSourceElement) {
            video.removeChild(video.firstChild);
        } else {
            video.parentNode.insertBefore(video.firstChild, video);
        }
    }
}
</script>
```
4.8.3 The **img** element

**Categories**:
- Flow content
- Phrasing content
- Embedded content
- Form-associated element

If the element has a `usemap` attribute: Interactive content

Palpable content

**Contexts in which this element can be used**:
Where embedded content is expected.
As a child of a `picture` element, after all `source` elements.

**Content model**:
Nothing.

**Tag omission in text/html**:
No end tag.

**Content attributes**:
- Global attributes
  - `alt` — Replacement text for use when images are not available
  - `src` — Address of the resource
  - `srcset` — Images to use in different situations, e.g., high-resolution displays, small monitors, etc.
  - `sizes` — Image sizes for different page layouts
  - `crossorigin` — How the element handles crossorigin requests
  - `usemap` — Name of image map to use
  - `ismap` — Whether the image is a server-side image map
  - `width` — Horizontal dimension
  - `height` — Vertical dimension
  - `referrerpolicy` — Referrer policy for fetches initiated by the element
  - `decoding` — Decoding hint to use when processing this image for presentation
  - `loading` — Used when determining loading deferral
  - `fetchpriority` — Sets the priority for fetches initiated by the element

**Accessibility considerations**:
If the element has a non-empty `alt` attribute: for authors; for implementers.
Otherwise: for authors; for implementers.

**DOM interface**:

```idl
[Exposed=Window,
  LegacyFactoryFunction=Image(optional unsigned long width, optional unsigned long height)]
interface HTMLImageElement : HTMLElement {
  [HTMLConstructor] constructor();
  
  [CEReactions] attribute DOMString alt;
```
An `img` element represents an image.

An `img` element has a dimension attribute `source`, initially set to the element itself.

The image given by the `src` and `srcset` attributes, and any previous sibling `source` elements’ `srcset` attributes if the parent is a picture element, is the embedded content; the value of the `alt` attribute provides equivalent content for those who cannot process images or who have image loading disabled (i.e. it is the `img` element’s fallback content).

The requirements on the `alt` attribute’s value are described in a separate section.

The `src` attribute must be present, and must contain a valid non-empty URL potentially surrounded by spaces referencing a non-interactive, optionally animated, image resource that is neither paged nor scripted.

The `srcset` attribute may also be present, and is a `srcset` attribute.

The `srcset` attribute and the `src` attribute (if width descriptors are not used) contribute the image sources to the source set (if no `source` element was selected).

If the `srcset` attribute is present and has any image candidate strings using a width descriptor, the `sizes` attribute may be specified with the value "auto" (ASCII case-insensitive). The `sizes` attribute is a sizes attribute, which contributes the source size to the source set (if no `source` element was selected).

An `img` element allows auto-sizes if:

- its `loading` attribute is in the `Lazy` state, and
- its `sizes` attribute’s value is "auto" (ASCII case-insensitive), or starts with "auto," (ASCII case-insensitive).

The `crossorigin` attribute is a CORS settings attribute. Its purpose is to allow images from third-party sites that allow cross-origin access to be used with `canvas`.

The `referrerpolicy` attribute is a referer policy attribute. Its purpose is to set the referer policy used when fetching the image.
The `decoding` attribute indicates the preferred method to `decode` this image. The attribute, if present, must be an `image decoding hint`. This attribute's `missing value default` and `invalid value default` are both the `auto` state.

The `fetchpriority` attribute is a `fetch priority attribute`. Its purpose is to set the `priority` used when `fetching` the image.

The `loading` attribute is a `lazy loading attribute`. Its purpose is to indicate the policy for loading images that are outside the viewport.

When the `loading` attribute's state is changed to the `Eager` state, the user agent must run these steps:

1. Let `resumptionSteps` be the `img` element's `lazy load resumption steps`.
2. If `resumptionSteps` is null, then return.
3. Set the `img`'s `lazy load resumption steps` to null.
4. Invoke `resumptionSteps`.

Example

```html
<img src="1.jpeg" alt="1">
<img src="2.jpeg" loading=eager alt="2">
<img src="3.jpeg" loading=lazy alt="3">
<div id=very-large></div><!-- Everything after this div is below the viewport -->
<img src="4.jpeg" alt="4">
<img src="5.jpeg" loading=lazy alt="5">
```

In the example above, the images load as follows:

1. jpeg, 2.jpeg, 4.jpeg
   The images load eagerly and delay the window's load event.

3. jpeg
   The image loads when layout is known, due to being in the viewport, however it does not delay the window's load event.

5. jpeg
   The image loads only once scrolled into the viewport, and does not delay the window's load event.

Note

Developers are encouraged to specify a preferred aspect ratio via `width` and `height` attributes on lazy loaded images, even if CSS sets the image's width and height properties, to prevent the page layout from shifting around after the image loads.

The `img` HTML element insertion steps, given `insertedNode`, are:

1. If `insertedNode`'s parent is a `picture` element, then, count this as a `relevant mutation` for `insertedNode`.

The `img` HTML element removing steps, given `removedNode` and `oldParent`, are:

1. If `oldParent` is a `picture` element, then, count this as a `relevant mutation` for `removedNode`.

The `img` element must not be used as a layout tool. In particular, `img` elements should not be used to display transparent images, as such images rarely convey meaning and rarely add anything useful to the document.

What an `img` element represents depends on the `src` attribute and the `alt` attribute.

- If the `src` attribute is set and the `alt` attribute is set to the empty string
  The image is either decorative or supplemental to the rest of the content, redundant with some other information in the document.
If the image is available and the user agent is configured to display that image, then the element represents the element’s image data.

Otherwise, the element represents nothing, and may be omitted completely from the rendering. User agents may provide the user with a notification that an image is present but has been omitted from the rendering.

→ If the src attribute is set and the alt attribute is set to a value that isn’t empty

The image is a key part of the content; the alt attribute gives a textual equivalent or replacement for the image.

If the image is available and the user agent is configured to display that image, then the element represents the element’s image data.

Otherwise, the element represents the text given by the alt attribute. User agents may provide the user with a notification that an image is present but has been omitted from the rendering.

→ If the src attribute is set and the alt attribute is not

The image might be a key part of the content, and there is no textual equivalent of the image available.

NOTE

In a conforming document, the absence of the alt attribute indicates that the image is a key part of the content but that a textual replacement for the image was not available when the image was generated.

If the image is available and the user agent is configured to display that image, then the element represents the element’s image data.

If the image has a src attribute whose value is the empty string, then the element represents nothing.

Otherwise, the user agent should display some sort of indicator that there is an image that is not being rendered, and may, if requested by the user, or if so configured, or when required to provide contextual information in response to navigation, provide caption information for the image, derived as follows:

1. If the image has a title attribute whose value is not the empty string, then return the value of that attribute.
2. If the image is a descendant of a figure element that has a figcaption element, and, ignoring the figcaption element and its descendants, the figure element has no flow content descendants other than inter-element whitespace and the img element, then return the contents of the first such figcaption element.
3. Return nothing. (There is no caption information.)

→ If the src attribute is not set and either the alt attribute is set to the empty string or the alt attribute is not set at all

The element represents nothing.

→ Otherwise

The element represents the text given by the alt attribute.

The alt attribute does not represent advisory information. User agents must not present the contents of the alt attribute in the same way as content of the title attribute.

User agents may always provide the user with the option to display any image, or to prevent any image from being displayed. User agents may also apply heuristics to help the user make use of the image when the user is unable to see it, e.g. due to a visual disability or because they are using a text terminal with no graphics capabilities. Such heuristics could include, for instance, optical character recognition (OCR) of text found within the image.

⚠️ Warning!

While user agents are encouraged to repair cases of missing alt attributes, authors must not rely on such behavior. Requirements for providing text to act as an alternative for images are described in detail below.

The contents of img elements, if any, are ignored for the purposes of rendering.
The `usemap` attribute, if present, can indicate that the image has an associated `image map`. The `ismap` attribute, when used on an element that is a descendant of an `a` element with an `href` attribute, indicates by its presence that the element provides access to a server-side image map. This affects how events are handled on the corresponding `a` element.

The `ismap` attribute is a **boolean attribute**. The attribute must not be specified on an element that does not have an ancestor `a` element with an `href` attribute.

The `img` element supports **dimension attributes**.

The `alt`, `src`, `srcset` and `sizes` IDL attributes must **reflect** the respective content attributes of the same name.

The `crossOrigin` IDL attribute must **reflect** the `crossorigin` content attribute, **limited to only known values**.

The `useMap` IDL attribute must **reflect** the `usemap` content attribute.

The `referrerPolicy` IDL attribute must **reflect** the `referrerpolicy` content attribute, **limited to only known values**.

The `decoding` IDL attribute must **reflect** the `decoding` content attribute, **limited to only known values**.

The `loading` IDL attribute must **reflect** the `loading` content attribute, **limited to only known values**.

The `fetchPriority` IDL attribute must **reflect** the `fetchpriority` content attribute, **limited to only known values**.

The IDL attributes `width` and `height` must return the rendered width and height of the image, in CSS pixels, if the image is **being rendered**; or else the **density-corrected natural width and height** of the image, in CSS pixels, if the image has **density-corrected natural width and height** and is **available**, but is not **being rendered**; or else 0, if the image is not **available** or does not have **density-corrected natural width and height**, [CSS].

On setting, they must act as if they **reflected** the respective content attributes of the same name.

---

**Note:**
The `usemap` and `ismap` attributes can result in confusing behavior when used together with `source` elements with the `media` attribute specified in a `picture` element.

For web developers (non-normative)

```
image.width = value
image.height = value
```

These attributes return the actual rendered dimensions of the image, or 0 if the dimensions are not known. They can be set, to change the corresponding content attributes.

```
image.naturalWidth
image.naturalHeight
```

These attributes return the natural dimensions of the image, or 0 if the dimensions are not known.

```
image.complete
```

Returns true if the image has been completely downloaded or if no image is specified; otherwise, returns false.

```
image.currentSrc
```

Returns the image’s **absolute URL**.

```
image.decode()
```

This method causes the user agent to **decode** the image **in parallel**, returning a promise that fulfills when decoding is complete.

The promise will be rejected with an "EncodingError" **DOMException** if the image cannot be decoded.

```
image = new Image({ width, height })
```

Returns a new `img` element, with the `width` and `height` attributes set to the values passed in the relevant arguments, if applicable.
The IDL attributes `naturalWidth` and `naturalHeight` must return the density-corrected natural width and height of the image, in CSS pixels, if the image has density-corrected natural width and height and is available, or else 0. [CSS]

**Note**

Since the density-corrected natural width and height of an image take into account any orientation specified in its metadata, `naturalWidth` and `naturalHeight` reflect the dimensions after applying any rotation needed to correctly orient the image, regardless of the value of the `image-orientation` property.

The `complete` getter steps are:

1. If any of the following are true:
   - both the `src` attribute and the `srcset` attribute are omitted;
   - the `srcset` attribute is omitted and the `src` attribute's value is the empty string;
   - the `img` element's current request's state is completely available and its pending request is null; or
   - the `img` element's current request's state is broken and its pending request is null,
     then return true.
2. Return false.

The `currentSrc` IDL attribute must return the `img` element's current request's current URL.

The `decode()` method, when invoked, must perform the following steps:

1. Let `promise` be a new promise.
2. Queue a microtask to perform the following steps:
   1. If any of the following are true:
      - this's node document is not fully active; or
      - this's current request's state is broken,
        then reject `promise` with an "EncodingError" DOMException.
   2. Otherwise, in parallel, wait for one of the following cases to occur, and perform the corresponding actions:
      → This `img` element's node document stops being fully active
      → This `img` element's current request changes or is mutated
      → This `img` element's current request's state becomes broken
        Reject `promise` with an "EncodingError" DOMException.
      → This `img` element's current request's state becomes completely available
        Decode the image.
        If decoding does not need to be performed for this image (for example because it is a vector graphic), resolve `promise` with undefined.
        If decoding fails (for example due to invalid image data), reject `promise` with an "EncodingError" DOMException.

This is done because updating the image data takes place in a microtask as well. Thus, to make code such as

```javascript
img.src = "stars.jpg";
img.decode();
```

properly decode `stars.jpg`, we need to delay any processing by one microtask.
If the decoding process completes successfully, resolve `promise` with undefined.

User agents should ensure that the decoded media data stays readily available until at least the end of the next successful `update the rendering` step in the `event loop`. This is an important part of the API contract, and should not be broken if at all possible. (Typically, this would only be violated in low-memory situations that require evicting decoded image data, or when the image is too large to keep in decoded form for this period of time.)

**Note**

*Animated images will become completely available only after all their frames are loaded. Thus, even though an implementation could decode the first frame before that point, the above steps will not do so, instead waiting until all frames are available.*

3. Return `promise`.

**Example**

Without the `decode()` method, the process of loading an `img` element and then displaying it might look like the following:

```javascript
const img = new Image();
img.src = "nebula.jpg";
img.onload = () => {
  document.body.appendChild(img);
};
img.onerror = () => {
  document.body.appendChild(new Text("Could not load the nebula :(");
};
```

However, this can cause notable dropped frames, as the paint that occurs after inserting the image into the DOM causes a synchronous decode on the main thread.

This can instead be rewritten using the `decode()` method:

```javascript
const img = new Image();
img.src = "nebula.jpg";
img.decode().then(() => {
  document.body.appendChild(img);
}).catch(() => {
  document.body.appendChild(new Text("Could not load the nebula :(");
});
```

This latter form avoids the dropped frames of the original, by allowing the user agent to decode the image in parallel, and only inserting it into the DOM (and thus causing it to be painted) once the decoding process is complete.

**Example**

Because the `decode()` method attempts to ensure that the decoded image data is available for at least one frame, it can be combined with the `requestAnimationFrame()` API. This means it can be used with coding styles or frameworks that ensure that all DOM modifications are batched together as `animation frame callbacks`:

```javascript
const container = document.querySelector("#container");

const { containerWidth, containerHeight } = computeDesiredSize();
requestAnimationFrame(() => {
  container.style.width = containerWidth;
  container.style.height = containerHeight;
});

// ...

const img = new Image();
img.src = "supernova.jpg";
```
A legacy factory function is provided for creating HTMLImageElement objects (in addition to the factory methods from DOM such as createElement()): `Image(width, height)`. When invoked, the legacy factory function must perform the following steps:

1. Let `document` be the current global object's associated Document.
2. Let `img` be the result of creating an element given `document`, `img`, and the HTML namespace.
3. If `width` is given, then set an attribute value for `img` using "width" and `width`.
4. If `height` is given, then set an attribute value for `img` using "height" and `height`.
5. Return `img`.

Example

A single image can have different appropriate alternative text depending on the context.

In each of the following cases, the same image is used, yet the `alt` text is different each time. The image is the coat of arms of the Carouge municipality in the canton Geneva in Switzerland.

Here it is used as a supplementary icon:

```html
<p>I lived in <img src="carouge.svg" alt=""> Carouge.</p>
```

Here it is used as an icon representing the town:

```html
<p>Home town: <img src="carouge.svg" alt="Carouge"></p>
```

Here it is used as part of a text on the town:

```html
<p>Carouge has a coat of arms.</p>
<p><img src="carouge.svg" alt="The coat of arms depicts a lion, sitting in front of a tree."/></p>
<p>It is used as decoration all over the town.</p>
```

Here it is used as a way to support a similar text where the description is given as well as, instead of as an alternative to, the image:

```html
<p>Carouge has a coat of arms.</p>
<p><img src="carouge.svg" alt=""></p>
<p>The coat of arms depicts a lion, sitting in front of a tree. It is used as decoration all over the town.</p>
```

Here it is used as part of a story:

```html
<p>She picked up the folder and a piece of paper fell out.</p>
<p><img src="carouge.svg" alt="Shaped like a shield, the paper had a red background, a green tree, and a yellow lion with its tongue hanging out and whose tail was shaped like an S."/>
<p>She stared at the folder. S! The answer she had been looking for all this time was simply the letter S! How had she not seen that before? It all came together now. The phone call where Hector had referred to a lion's tail, the time Maria had stuck her tongue out...</p>
```

Here it is not known at the time of publication what the image will be, only that it will be a coat of arms of some kind, and thus no replacement text can be provided, and instead only a brief caption for the image is provided, in the `title` attribute:
The last user to have uploaded a coat of arms uploaded this one:

To embed an image in HTML, when there is only a single image resource, use the `img` element and its `src` attribute.

Ideally, the author would find a way to provide real replacement text even in this case, e.g. by asking the previous user. Not providing replacement text makes the document more difficult to use for people who are unable to view images, e.g. blind users, or users or very low-bandwidth connections or who pay by the byte, or users who are forced to use a text-only web browser.

Here are some more examples showing the same picture used in different contexts, with different appropriate alternate texts each time.

```html
<article>
  <h1>My cats</h1>
  <h2>Fluffy</h2>
  <p>Fluffy is my favorite.</p>
  <img src="fluffy.jpg" alt="She likes playing with a ball of yarn.">
  <p>She's just too cute.</p>
  <h2>Miles</h2>
  <p>My other cat, Miles just eats and sleeps.</p>
</article>

<article>
  <h1>Photography</h1>
  <h2>Shooting moving targets indoors</h2>
  <p>The trick here is to know how to anticipate; to know at what speed and what distance the subject will pass by.</p>
  <img src="fluffy.jpg" alt="A cat flying by, chasing a ball of yarn, can be photographed quite nicely using this technique."

  <h2>Nature by night</h2>
  <p>To achieve this, you'll need either an extremely sensitive film, or immense flash lights.</p>
</article>

<article>
  <h1>About me</h1>
  <h2>My pets</h2>
  <p>I've got a cat named Fluffy and a dog named Miles.</p>
  <img src="fluffy.jpg" alt="Fluffy, my cat, tends to keep itself busy.">
  <p>My dog Miles and I like go on long walks together.</p>
  <h2>music</h2>
  <p>After our walks, having emptied my mind, I like listening to Bach.</p>
</article>

<article>
  <h1>Fluffy and the Yarn</h1>
  <p>Fluffy was a cat who liked to play with yarn. She also liked to jump.</p>
  <aside><img src="fluffy.jpg" alt="" title="Fluffy"></aside>
  <p>She would play in the morning, she would play in the evening.</p>
</article>

4.8.4 Images

4.8.4.1 Introduction

This section is non-normative.

To embed an image in HTML, when there is only a single image resource, use the `img` element and its `src` attribute.
However, there are a number of situations for which the author might wish to use multiple image resources that the user agent can choose from:

- Different users might have different environmental characteristics:
  - The users' physical screen size might be different from one another.
  - The users' screen pixel density might be different from one another.
  - The users' zoom level might be different from one another, or might change for a single user over time.

- The users' screen orientation might be different from one another, or might change for a single user over time.

**Example**

A mobile phone's screen might be 4 inches diagonally, while a laptop's screen might be 14 inches diagonally.

**Note**

This is only relevant when an image's rendered size depends on the viewport size.

- The users' zoom level might be different from one another, or might change for a single user over time.

**Example**

A user might zoom in to a particular image to be able to get a more detailed look.

The zoom level and the screen pixel density (the previous point) can both affect the number of physical screen pixels per CSS pixel. This ratio is usually referred to as **device-pixel-ratio**.

- The users' screen orientation might be different from one another, or might change for a single user over time.
The users' network speed, network latency and bandwidth cost might be different from one another, or might change for a single user over time.

Authors might want to show the same image content but with different rendered size depending on, usually, the width of the viewport. This is usually referred to as viewport-based selection.

A tablet can be held upright or rotated 90 degrees, so that the screen is either "portrait" or "landscape".

Example
A tablet can be held upright or rotated 90 degrees, so that the screen is either "portrait" or "landscape".

Example
A user might be on a fast, low-latency and constant-cost connection while at work, on a slow, low-latency and constant-cost connection while at home, and on a variable-speed, high-latency and variable-cost connection anywhere else.

Example
A web page might have a banner at the top that always spans the entire viewport width. In this case, the rendered size of the image depends on the physical size of the screen (assuming a maximised browser window).

Example
Another web page might have images in columns, with a single column for screens with a small physical size, two columns for screens with medium physical size, and three columns for screens with big physical size, with the images varying in rendered size in each case to fill up the viewport. In this case, the rendered size of an image might be bigger in the one-column layout compared to the two-column layout, despite the screen being smaller.
• Authors might want to show different image content depending on the rendered size of the image. This is usually referred to as **art direction**.

**Example**

When a web page is viewed on a screen with a large physical size (assuming a maximised browser window), the author might wish to include some less relevant parts surrounding the critical part of the image. When the same web page is viewed on a screen with a small physical size, the author might wish to show only the critical part of the image.

• Authors might want to show the same image content but using different image formats, depending on which image formats the user agent supports. This is usually referred to as **image format-based selection**.

**Example**

A web page might have some images in the JPEG, WebP and JPEG XR image formats, with the latter two having better compression abilities compared to JPEG. Since different user agents can support different image formats, with some formats offering better compression ratios, the author would like to serve the better formats to user agents that support them, while providing JPEG fallback for user agents that don't.

The above situations are not mutually exclusive. For example, it is reasonable to combine different resources for different **device-pixel-ratio** with different resources for **art direction**.

While it is possible to solve these problems using scripting, doing so introduces some other problems:

• Some user agents aggressively download images specified in the HTML markup, before scripts have had a chance to run, so that web pages complete loading sooner. If a script changes which image to download, the user agent will potentially start two separate downloads, which can instead cause worse page loading performance.

• If the author avoids specifying any image in the HTML markup and instead instantiates a single download from script, that avoids the double download problem above but then no image will be downloaded at all for users with scripting disabled and the aggressive image downloading optimization will also be disabled.

With this in mind, this specification introduces a number of features to address the above problems in a declarative manner.

**Device-pixel-ratio-based selection when the rendered size of the image is fixed**

The `src` and `srcset` attributes on the `<img>` element can be used, using the `x` descriptor, to provide multiple images that only vary in their size (the smaller image is a scaled-down version of the bigger image).
Viewport-based selection

The srcset and sizes attributes can be used, using the w descriptor, to provide multiple images that only vary in their size (the smaller image is a scaled-down version of the bigger image).

For backwards compatibility with older user agents that don't yet understand the srcset attribute, one of the URLs is specified in the img element's src attribute. This will result in something useful (though perhaps lower-resolution than the user would like) being displayed even in older user agents. For new user agents, the src attribute participates in the resource selection, as if it was specified in srcset with a 1x descriptor.

The image's rendered size is given in the width and height attributes, which allows the user agent to allocate space for the image before it is downloaded.

Example

In this example, a banner image takes up the entire viewport width (using appropriate CSS).

```html
<h1><img sizes="(max-width: 30em) 100vw, (max-width: 50em) 50vw, calc(33vw - 100px)"
srcset="swing-200.jpg 200w, swing-400.jpg 400w, swing-800.jpg 800w, swing-1600.jpg 1600w"
src="swing-400.jpg" alt="Kettlebell Swing"></h1>
```

The user agent will calculate the effective pixel density of each image from the specified w descriptors and the specified rendered size in the sizes attribute. It can then choose any of the given resources depending on the user's screen's pixel density, zoom level, and possibly other factors such as the user's network conditions.

If the user's screen is 320 CSS pixels wide, this is equivalent to specifying wolf-400.jpg 1.25x, wolf-800.jpg 2.5x, wolf-1600.jpg 5x. On the other hand, if the user's screen is 1200 CSS pixels wide, this is equivalent to specifying wolf-400.jpg 0.33x, wolf-800.jpg 0.67x, wolf-1600.jpg 1.33x. By using the w descriptors and the sizes attribute, the user agent can choose the correct image source to download regardless of how large the user's device is.

For backwards compatibility, one of the URLs is specified in the img element's src attribute. In new user agents, the src attribute is ignored when the srcset attribute uses w descriptors.

Example

In this example, the web page has three layouts depending on the width of the viewport. The narrow layout has one column of images (the width of each image is about 100%), the middle layout has two columns of images (the width of each image is about 50%), and the widest layout has three columns of images, and some page margin (the width of each image is about 33%). It breaks between these layouts when the viewport is 30em wide and 50em wide, respectively.

```html
<img sizes="(max-width: 30em) 100vw, (max-width: 50em) 50vw, calc(33vw - 100px)"
srcset="swing-200.jpg 200w, swing-400.jpg 400w, swing-800.jpg 800w, swing-1600.jpg 1600w"
src="swing-400.jpg" alt="Kettlebell Swing">
```

The sizes attribute sets up the layout breakpoints at 30em and 50em, and declares the image sizes between these breakpoints to be 100vw, 50vw, or calc(33vw - 100px). These sizes do not necessarily have to match up exactly with the actual image width as specified in the CSS.

The user agent will pick a width from the sizes attribute, using the first item with a <media-condition> (the part in
parentheses) that evaluates to true, or using the last item (\(\text{calc}(33\text{vw} - 100\text{px})\)) if they all evaluate to false.

For example, if the \texttt{viewport} width is 29em, then (max-width: 30em) evaluates to true and 100vw is used, so the image size, for the purpose of resource selection, is 29em. If the \texttt{viewport} width is instead 32em, then (max-width: 30em) evaluates to false, but (max-width: 50em) evaluates to true and 50vw is used, so the image size, for the purpose of resource selection, is 16em (half the \texttt{viewport} width). Notice that the slightly wider \texttt{viewport} results in a smaller image because of the different layout.

The user agent can then calculate the effective pixel density and choose an appropriate resource similarly to the previous example.

\textbf{Example}

This example is the same as the previous example, but the image is \texttt{lazy-loaded}. In this case, the \texttt{sizes} attribute can use the \texttt{auto} keyword, and the user agent will use the \texttt{width} attribute (or the width specified in CSS) for the \texttt{source size}.

\begin{verbatim}
<img loading="lazy" width="200" height="200" sizes="auto"
     srcset="swing-200.jpg 200w, swing-400.jpg 400w, swing-800.jpg 800w, swing-1600.jpg 1600w"
     src="swing-400.jpg" alt="Kettlebell Swing">
\end{verbatim}

For better backwards-compatibility with legacy user agents that don’t support the \texttt{auto} keyword, fallback sizes can be specified if desired.

\begin{verbatim}
<img loading="lazy" width="200" height="200"
     sizes="auto, (max-width: 30em) 100vw, (max-width: 50em) 50vw, calc(33vw - 100px)"
     srcset="swing-200.jpg 200w, swing-400.jpg 400w, swing-800.jpg 800w, swing-1600.jpg 1600w"
     src="swing-400.jpg" alt="Kettlebell Swing">
\end{verbatim}

\textbf{Art direction-based selection}

The \texttt{picture} element and the \texttt{source} element, together with the \texttt{media} attribute, can be used to provide multiple images that vary the image content (for instance the smaller image might be a cropped version of the bigger image).

\textbf{Example}

\begin{verbatim}
<picture>
  <source media="(min-width: 45em)" srcset="large.jpg">
  <source media="(min-width: 32em)" srcset="med.jpg">
  <img src="small.jpg" alt="The wolf runs through the snow.">
</picture>
\end{verbatim}

The user agent will choose the first \texttt{source} element for which the media query in the \texttt{media} attribute matches, and then choose an appropriate URL from its \texttt{srcset} attribute.

The rendered size of the image varies depending on which resource is chosen. To specify dimensions that the user agent can use before having downloaded the image, CSS can be used.

\begin{verbatim}
CSS
  img { width: 300px; height: 300px }
  @media (min-width: 32em) { img { width: 500px; height:300px } }
  @media (min-width: 45em) { img { width: 700px; height:400px } }
\end{verbatim}

\textbf{Example}

This example combines \texttt{art direction} and \texttt{device-pixel-ratio}-based selection. A banner that takes half the \texttt{viewport} is provided in two versions, one for wide screens and one for narrow screens.

\begin{verbatim}
<h1>
  <picture>
    <source media="(max-width: 500px)" srcset="banner-phone.jpeg, banner-phone-HD.jpeg 2x">
    <img src="banner.jpeg" srcset="banner-HD.jpeg 2x" alt="The Breakfast Combo">
  </picture>
</h1>
\end{verbatim}
The **type** attribute on the `source` element can be used to provide multiple images in different formats.

### Example

```html
<h2>From today's featured article</h2>
<p>
  <picture>
    <source srcset="/uploads/100-marie-lloyd.webp" type="image/webp">
    <source srcset="/uploads/100-marie-lloyd.jxr" type="image/vnd.ms-photo">
    <img src="/uploads/100-marie-lloyd.jpg" alt="" width="100" height="150">
  </picture>

  <p><b><a href="/wiki/Marie_Lloyd">Marie Lloyd</a> (1870–1922)</b>
  was an English <a href="/wiki/Music_hall">music hall</a> singer, ...
</p>
</p>
```

In this example, the user agent will choose the first source that has a `type` attribute with a supported MIME type. If the user agent supports WebP images, the first `source` element will be chosen. If not, but the user agent does support JPEG XR images, the second `source` element will be chosen. If neither of those formats are supported, the `img` element will be chosen.

### 4.8.4.1.1 Adaptive images

This section is non-normative.

CSS and media queries can be used to construct graphical page layouts that adapt dynamically to the user's environment, in particular to different viewport dimensions and pixel densities. For content, however, CSS does not help; instead, we have the `img` element's `srcset` attribute and the `picture` element. This section walks through a sample case showing how to use these features.

Consider a situation where on wide screens (wider than 600 CSS pixels) a 300×150 image named `a-rectangle.png` is to be used, but on smaller screens (600 CSS pixels and less), a smaller 100×100 image called `a-square.png` is to be used. The markup for this would look like this:

```html
<figure>
  <picture>
    <source srcset="a-square.png" media="(max-width: 600px)"
    >
    <img src="a-rectangle.png" alt="Barney Frank wears a suit and glasses."/>
  </picture>
  <figcaption>Barney Frank, 2011</figcaption>
</figure>
```

**Note**

For details on what to put in the `alt` attribute, see the Requirements for providing text to act as an alternative for images section.

The problem with this is that the user agent does not necessarily know what dimensions to use for the image when the image is loading. To avoid the layout having to be reflowed multiple times as the page is loading, CSS and CSS media queries can be used to provide the dimensions:

```html
<style>
  #a { width: 300px; height: 150px; }
  @media (max-width: 600px) { #a { width: 100px; height: 100px; } }
</style>
<figure>
  <picture>
    <source srcset="a-square.png" media="(max-width: 600px)"
    >
    <img src="a-rectangle.png" alt="Barney Frank wears a suit and glasses." id="a">
  </picture>
  <figcaption>Barney Frank, 2011</figcaption>
</figure>
```
Alternatively, the `width` and `height` attributes can be used to provide the width and height for legacy user agents, using CSS just for the user agents that support `picture`:

```
<style media="(max-width: 600px)">
  #a { width: 100px; height: 100px; }
</style>

<figure>
  <picture>
    <source srcset="a-square.png" media="(max-width: 600px)"
    img src="a-rectangle.png" width="300" height="150"
    alt="Barney Frank wears a suit and glasses." id="a">
  </picture>
  <figcaption>Barney Frank, 2011</figcaption>
</figure>
```

The `img` element is used with the `src` attribute, which gives the URL of the image to use for legacy user agents that do not support the `picture` element. This leads to a question of which image to provide in the `src` attribute.

If the author wants the biggest image in legacy user agents, the markup could be as follows:

```
<picture>
  <source srcset="pear-mobile.jpeg" media="(max-width: 720px)"
  srcset="pear-tablet.jpeg" media="(max-width: 1280px)"
  srcset="pear-desktop.jpeg">
  <img src="pear-mobile.jpeg" alt="The pear is juicy.">
</picture>
```

However, if legacy mobile user agents are more important, one can list all three images in the `source` elements, overriding the `src` attribute entirely.

```
<picture>
  <source srcset="pear-mobile.jpeg" media="(max-width: 720px)"
  srcset="pear-tablet.jpeg" media="(max-width: 1280px)"
  srcset="pear-desktop.jpeg">
  <img src="pear-mobile.jpeg" alt="The pear is juicy.">
</picture>
```

Since at this point the `src` attribute is actually being ignored entirely by `picture`-supporting user agents, the `src` attribute can default to any image, including one that is neither the smallest nor biggest:

```
<picture>
  <source srcset="pear-mobile.jpeg" media="(max-width: 720px)"
  srcset="pear-tablet.jpeg" media="(max-width: 1280px)"
  srcset="pear-desktop.jpeg">
  <img src="pear-tablet.jpeg" alt="The pear is juicy.">
</picture>
```

Above the `max-width` media feature is used, giving the maximum (viewport) dimensions that an image is intended for. It is also possible to use `min-width` instead.

```
<picture>
  <source srcset="pear-desktop.jpeg" media="(min-width: 1281px)"
  srcset="pear-tablet.jpeg" media="(min-width: 721px)"
  srcset="pear-mobile.jpeg">
  <img src="pear-mobile.jpeg" alt="The pear is juicy.">
</picture>
```
4.8.4.2 Attributes common to `source`, `img`, and `link` elements

4.8.4.2.1 Srcset attributes

A `srcset` attribute is an attribute with requirements defined in this section.

If present, its value must consist of one or more `image candidate strings`, each separated from the next by a U+002C COMMA character (,). If an `image candidate string` contains no descriptors and no ASCII whitespace after the URL, the following `image candidate string`, if there is one, must begin with one or more ASCII whitespace.

An `image candidate string` consists of the following components, in order, with the further restrictions described below this list:

1. Zero or more ASCII whitespace.
2. A valid non-empty URL that does not start or end with a U+002C COMMA character (,), referencing a non-interactive, optionally animated, image resource that is neither paged nor scripted.
3. Zero or more ASCII whitespace.
4. Zero or one of the following:
   - A width descriptor, consisting of: ASCII whitespace, a valid non-negative integer giving a number greater than zero representing the width descriptor value, and a U+0077 LATIN SMALL LETTER W character.
   - A pixel density descriptor, consisting of: ASCII whitespace, a valid floating-point number giving a number greater than zero representing the pixel density descriptor value, and a U+0078 LATIN SMALL LETTER X character.
5. Zero or more ASCII whitespace.

There must not be an `image candidate string` for an element that has the same width descriptor value as another `image candidate string`'s width descriptor value for the same element.

There must not be an `image candidate string` for an element that has the same pixel density descriptor value as another `image candidate string`'s pixel density descriptor value for the same element. For the purpose of this requirement, an `image candidate string` with no descriptors is equivalent to an `image candidate string` with a 1x descriptor.

If an `image candidate string` for an element has the width descriptor specified, all other `image candidate strings` for that element must also have the width descriptor specified.

The specified width in an `image candidate string`'s width descriptor must match the natural width in the resource given by the `image candidate string`'s URL, if it has a natural width.

If an element has a `sizes` attribute present, all `image candidate strings` for that element must have the width descriptor specified.

4.8.4.2 Sizes attributes

A `sizes` attribute is an attribute with requirements defined in this section.

If present, the value must be a valid source size list.

A valid source size list is a string that matches the following grammar:

```
<source-size-list> = <source-size> | <source-size-list>, <source-size>
<source-size> = <media-condition> <source-size-value> | auto
<source-size-value> = <length> | auto
```

A `<source-size-value>` that is a `<length>` must not be negative, and must not use CSS functions other than the math functions.

The keyword `auto` is a width that is computed in parse a sizes attribute. If present, it must be the first entry and the entire `<source-size-list>` value must either be the string "auto" (ASCII case-insensitive) or start with the string "auto," (ASCII case-insensitive).
The `auto` keyword may be specified in the `sizes` attribute of `source` elements and `sizes` attribute of `img` elements, if the following conditions are met. Otherwise, `auto` must not be specified.

- The element is a `source` element with a following sibling `img` element.
- The element is an `img` element.
- The `img` element referenced in either condition above allows auto-sizes.

The `<source-size-value>` gives the intended layout width of the image. The author can specify different widths for different environments with `<media-condition>`s.

Note

In addition, it is strongly encouraged to specify dimensions using the `width` and `height` attributes or with CSS. Without specified dimensions, the image will likely render with 300x150 dimensions because `sizes="auto"` implies contain-intrinsic-size: 300px 150px in the Rendering section.

The `<source-size-value>` gives the intended layout width of the image. The author can specify different widths for different environments with `<media-condition>`s.

Note

Percentages are not allowed in a `<source-size-value>`, to avoid confusion about what it would be relative to. The `vw` unit can be used for sizes relative to the viewport width.

4.8.4.3 Processing model

An `img` element has a current request and a pending request. The current request is initially set to a new image request. The pending request is initially set to null.

An image request has a state, current URL, and image data.

An image request's state is one of the following:

Unavailable

The user agent hasn't obtained any image data, or has obtained some or all of the image data but hasn't yet decoded enough of the image to get the image dimensions.

Partially available

The user agent has obtained some of the image data and at least the image dimensions are available.

Completely available

The user agent has obtained all of the image data and at least the image dimensions are available.

Broken

The user agent has obtained all of the image data that it can, but it cannot even decode the image enough to get the image dimensions (e.g. the image is corrupted, or the format is not supported, or no data could be obtained).

An image request's current URL is initially the empty string.

An image request's image data is the decoded image data.

When an image request's state is either partially available or completely available, the image request is said to be available.

When an `img` element's current request's state is completely available and the user agent can decode the media data without errors, then the `img` element is said to be fully decodable.

An image request's state is initially unavailable.
When an img element's current request is available, the img element provides a paint source whose width is the image's density-corrected natural width (if any), whose height is the image's density-corrected natural height (if any), and whose appearance is the natural appearance of the image.

An img element is said to use srcset or picture if it has a srcset attribute specified or if it has a parent that is a picture element.

Each img element has a last selected source, which must initially be null.

Each image request has a current pixel density, which must initially be 1.

Each image request has preferred density-corrected dimensions, which is either a struct consisting of a width and a height or is null. It must initially be null.

To determine the density-corrected natural width and height of an img element img:

1. Let dim be img's current request's preferred density-corrected dimensions.
   
   **Note**
   
   The preferred density-corrected dimensions are set in the prepare an image for presentation algorithm based on meta information in the image.

2. If dim is null, set dim to img's natural dimensions.

3. Set dim's width to dim's width divided by img's current request's current pixel density.

4. Set dim's height to dim's height divided by img's current request's current pixel density.

5. Return dim.

**Example**

For example, if the current pixel density is 3.125, that means that there are 300 device pixels per CSS inch, and thus if the image data is 300x600, it has density-corrected natural width and height of 96 CSS pixels by 192 CSS pixels.

All img and link elements are associated with a source set.

A source set is an ordered set of zero or more image sources and a source size.

An image source is a URL, and optionally either a pixel density descriptor, or a width descriptor.

A source size is a <source-size-value>. When a source size has a unit relative to the viewport, it must be interpreted relative to the img element's node document's viewport. Other units must be interpreted the same as in Media Queries.

A parse error for algorithms in this section indicates a non-fatal mismatch between input and requirements. User agents are encouraged to expose parse error somehow.

Whether the image is fetched successfully or not (e.g. whether the response status was an ok status) must be ignored when determining the image's type and whether it is a valid image.

**Note**

This allows servers to return images with error responses, and have them displayed.

The user agent should apply the image sniffing rules to determine the type of the image, with the image's associated Content-Type headers giving the official type. If these rules are not applied, then the type of the image must be the type given by the image's associated Content-Type headers.

User agents must not support non-image resources with the img element (e.g. XML files whose document element is an HTML element). User agents must not run executable code (e.g. scripts) embedded in the image resource. User agents must only display the
first page of a multipage resource (e.g. a PDF file). User agents must not allow the resource to act in an interactive fashion, but should honour any animation in the resource.

This specification does not specify which image types are to be supported.

4.8.4.3.1 When to obtain images

By default, images are obtained immediately. User agents may provide users with the option to instead obtain them on-demand. (The on-demand option might be used by bandwidth-constrained users, for example.)

When obtaining images immediately, the user agent must synchronously update the image data of the `img` element, with the restart animation flag set if so stated, whenever that element is created or has experienced relevant mutations.

When obtaining images on demand, the user agent must update the image data of an `img` element whenever it needs the image data (i.e., on demand), but only if the `img` element's current request's state is unavailable. When an `img` element has experienced relevant mutations, if the user agent only obtains images on demand, the `img` element's current request's state must return to unavailable.

The relevant mutations for an `img` element are as follows:

- The element's `src`, `srcset`, `width`, or `sizes` attributes are set, changed, or removed.
- The element's `src` attribute is set to the same value as the previous value. This must set the restart animation flag for the update the image data algorithm.
- The element's `crossorigin` attribute's state is changed.
- The element's `referrerpolicy` attribute's state is changed.
- The `img` or `source` HTML element insertion steps or HTML element removing steps count the mutation as a relevant mutation.
- The element's parent is a `picture` element and a `source` element that is a previous sibling has its `srcset`, `sizes`, `media`, `type`, `width`, or `height` attributes set, changed, or removed.
- The element's adopting steps are run.
- If the element allows auto-sizes, the element starts or stops being rendered, or its concrete object size width changes. This must set the maybe omit events flag for the update the image data algorithm.

4.8.4.3.3 The list of available images

Each `Document` object must have a list of available images. Each image in this list is identified by a tuple consisting of an absolute URL, a CORS settings attribute mode, and, if the mode is not No CORS, an origin. Each image furthermore has an ignore higher-layer caching flag. User agents may copy entries from one `Document` object's list of available images to another at any time (e.g. when the `Document` is created, user agents can add to it all the images that are loaded in other `Document`s), but must not change the keys of entries copied in this way when doing so, and must unset the ignore higher-layer caching flag for the copied entry. User agents may also remove images from such lists at any time (e.g. to save memory). User agents must remove entries in the list of available images as appropriate given higher-layer caching semantics for the resource (e.g. the HTTP `Cache-Control` response header) when the ignore higher-layer caching flag is unset.

Note

The list of available images is intended to enable synchronous switching when changing the `src` attribute to a URL that has previously been loaded, and to avoid re-downloading images in the same document even when they don't allow caching per HTTP. It is not used to avoid re-downloading the same image while the previous image is still loading.
Image data is usually encoded in order to reduce file size. This means that in order for the user agent to present the image to the screen, the data needs to be decoded. **Decoding** is the process which converts an image’s media data into a bitmap form, suitable for presentation to the screen. Note that this process can be slow relative to other processes involved in presenting content. Thus, the user agent can choose when to perform decoding, in order to create the best user experience.

Image decoding is said to be synchronous if it prevents presentation of other content until it is finished. Typically, this has an effect of atomically presenting the image and any other content at the same time. However, this presentation is delayed by the amount of time it takes to perform the decode.

Image decoding is said to be asynchronous if it does not prevent presentation of other content. This has an effect of presenting non-image content faster. However, the image content is missing on screen until the decode finishes. Once the decode is finished, the screen is updated with the image.

In both synchronous and asynchronous decoding modes, the final content is presented to screen after the same amount of time has elapsed. The main difference is whether the user agent presents non-image content ahead of presenting the final content.

In order to aid the user agent in deciding whether to perform synchronous or asynchronous decode, the ```decoding``` attribute can be set on ```img``` elements. The possible values of the ```decoding``` attribute are the following **image decoding hint** keywords:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>sync</td>
<td>Sync</td>
<td>Indicates a preference to decode this image synchronously for atomic presentation with other content.</td>
</tr>
<tr>
<td>async</td>
<td>Async</td>
<td>Indicates a preference to decode this image asynchronously to avoid delaying presentation of other content.</td>
</tr>
<tr>
<td>auto</td>
<td>Auto</td>
<td>Indicates no preference in decoding mode (the default).</td>
</tr>
</tbody>
</table>

When ```decoding``` an image, the user agent should respect the preference indicated by the ```decoding``` attribute's state. If the state indicated is ```auto```, then the user agent is free to choose any decoding behavior.

**Note**

It is also possible to control the decoding behavior using the ```decode()``` method. Since the ```decode()``` method performs decoding independently from the process responsible for presenting content to screen, it is unaffected by the ```decoding``` attribute.

### 4.8.4.3.5 Updating the image data

**Note**

This algorithm cannot be called from steps running in parallel. If a user agent needs to call this algorithm from steps running in parallel, it needs to queue a task to do so.

When the user agent is to update the image data of an ```img``` element, optionally with the restart animations flag set, optionally with the maybe omit events flag set, it must run the following steps:

1. If the element’s ```node document``` is not fully active, then:
   1. Continue running this algorithm in parallel.
   2. Wait until the element’s ```node document``` is fully active.

   1. If the element's ```node document``` is not fully active, then:
3. If another instance of this algorithm for this `img` element was started after this instance (even if it aborted and is no longer running), then return.

4. Queue a microtask to continue this algorithm.

2. If the user agent cannot support images, or its support for images has been disabled, then abort the image request for the current request and the pending request, set current request's state to unavailable, set pending request to null, and return.

3. Let previous URL be the current request's current URL.

4. Let selected source be null and selected pixel density be undefined.

5. If the element does not use `srcset` or `picture` and it has a `src` attribute specified whose value is not the empty string, then set selected source to the value of the element's `src` attribute and set selected pixel density to 1.0.

6. Set the element's last selected source to selected source.

7. If selected source is not null, then:
   1. Let urlString be the result of encoding-parsing-and-serializing a URL given selected source, relative to the element's node document.
   2. If urlString is failure, then abort this inner set of steps.
   3. Let key be a tuple consisting of urlString, the `img` element's `crossorigin` attribute's mode, and, if that mode is not No CORS, the node document's origin.
   4. If the list of available images contains an entry for key, then:
      1. Set the ignore higher-layer caching flag for that entry.
      2. Abort the image request for the current request and the pending request.
      3. Set pending request to null.
      4. Let current request be a new image request whose image data is that of the entry and whose state is completely available.
      5. Prepare current request for presentation given img.
      6. Set current request's current pixel density to selected pixel density.
      7. Queue an element task on the DOM manipulation task source given the `img` element and following steps:
         1. If restart animation is set, then restart the animation.
         2. Set current request's current URL to urlString.
         3. If maybe omit events is not set or previousURL is not equal to urlString, then fire an event named `load` at the `img` element.
   8. Abort the update the image data algorithm.

8. Queue a microtask to perform the rest of this algorithm, allowing the task that invoked this algorithm to continue.

9. If another instance of this algorithm for this `img` element was started after this instance (even if it aborted and is no longer running), then return.

Note: Only the last instance takes effect, to avoid multiple requests when, for example, the `src`, `srcset`, and `crossorigin` attributes are all set in succession.

10. Let selected source and selected pixel density be the URL and pixel density that results from selecting an image source, respectively.

11. If selected source is null, then:
   1. Set the current request's state to broken, abort the image request for the current request and the...
pending request\(^{360}\), and set pending request\(^{360}\) to null.

2. Queue an element task\(^{1107}\) on the DOM manipulation task source\(^{1115}\) given the img element and the following steps:

1. Change the current request\(^{360}\)'s current URL\(^{360}\) to the empty string.

2. If all of the following are true:
   - the element has a src\(^{344}\) attribute or it uses srcset or picture\(^{361}\), and
   - maybe omit events is not set or previousURL is not the empty string
   then fire an event named error\(^{1451}\) at the img element.

3. Return.

12. Let urlString be the result of encoding-parsing-and-serializing a URL\(^{96}\) given selected source, relative to the element's node document.

13. If urlString is failure, then:

1. Abort the image request\(^{367}\) for the current request\(^{360}\) and the pending request\(^{360}\).

2. Set the current request\(^{360}\)'s state\(^{360}\) to broken\(^{360}\).

3. Set pending request\(^{360}\) to null.

4. Queue an element task\(^{1107}\) on the DOM manipulation task source\(^{1115}\) given the img element and the following steps:

1. Change the current request\(^{360}\)'s current URL\(^{360}\) to selected source.

2. If maybe omit events is not set or previousURL is not equal to selected source, then fire an event named error\(^{1451}\) at the img element.

5. Return.

14. If the pending request\(^{360}\) is not null and urlString is the same as the pending request\(^{360}\)'s current URL\(^{360}\), then return.

15. If urlString is the same as the current request\(^{360}\)'s current URL\(^{360}\) and current request\(^{360}\)'s state\(^{360}\) is partially available\(^{360}\), then abort the image request\(^{367}\) for the pending request\(^{360}\), queue an element task\(^{1107}\) on the DOM manipulation task source\(^{1115}\) given the img element to restart the animation\(^{1389}\) if restart animation is set, and return.

16. Abort the image request\(^{367}\) for the pending request\(^{360}\).

17. Set image request to a new image request\(^{360}\) whose current URL\(^{360}\) is urlString.

18. If current request\(^{360}\)'s state\(^{360}\) is unavailable\(^{360}\) or broken\(^{360}\), then set the current request\(^{360}\) to image request. Otherwise, set the pending request\(^{360}\) to image request.

19. Let request be the result of creating a potential-CORS request\(^{99}\) given urlString, "image", and the current state of the element's crossorigin\(^{344}\) content attribute.

20. Set request's client to the element's node document's relevant settings object\(^{1071}\).

21. If the element uses srcset or picture\(^{361}\), set request's initiator to "imageset".

22. Set request's referrer policy to the current state of the element's referrerpolicy\(^{344}\) attribute.

23. Set request's priority to the current state of the element's fetchpriority\(^{345}\) attribute.

24. Let delay load event be true if the img's lazy loading attribute\(^{100}\) is in the Eager\(^{100}\) state, or if scripting is disabled\(^{1071}\) for the img, and false otherwise.

25. If the will lazy load element steps\(^{100}\) given the img return true, then:

1. Set the img's lazy load resumption steps\(^{100}\) to the rest of this algorithm starting with the step labeled fetch the image.

2. Start intersection-observing a lazy loading element\(^{100}\) for the img element.
3. Return.

26. Fetch the image: Fetch request. Return from this algorithm, and run the remaining steps as part of the fetch's processResponse for the response response.

The resource obtained in this fashion, if any, is image request's image data. It can be either CORS-same-origin or CORS-cross-origin; this affects the image's interaction with other APIs (e.g., when used on a canvas).

When delay load event is true, fetching the image must delay the load event of the element's node document until the task that is queued by the networking task source once the resource has been fetched (defined below) has been run.

⚠ Warning! This, unfortunately, can be used to perform a rudimentary port scan of the user's local network (especially in conjunction with scripting, though scripting isn't actually necessary to carry out such an attack). User agents may implement cross-origin access control policies that are stricter than those described above to mitigate this attack, but unfortunately such policies are typically not compatible with existing web content.

27. As soon as possible, jump to the first applicable entry from the following list:

→ If the resource type is multipart/x-mixed-replace

The next task that is queued by the networking task source while the image is being fetched must run the following steps:

1. If image request is the pending request and at least one body part has been completely decoded, abort the image request for the current request, upgrade the pending request to the current request.

2. Otherwise, if image request is the pending request and the user agent is able to determine that image request's image is corrupted in some way such that the image dimensions cannot be obtained, abort the image request, upgrade the pending request to the current request, and set the current request's state to broken.

3. Otherwise, if image request is the current request, its state is unavailable, and the user agent is able to determine image request's image's width and height, set the current request's state to partially available.

4. Otherwise, if image request is the current request, its state is unavailable, and the user agent is able to determine that image request's image is corrupted in some fatal way such that the image dimensions cannot be obtained, set the current request's state to broken.

Each task that is queued by the networking task source while the image is being fetched must update the presentation of the image, but as each new body part comes in, if the user agent is able to determine the image's width and height, it must prepare the img element's current request for presentation given the img element and replace the previous image. Once one body part has been completely decoded, perform the following steps:

1. Set the img element's current request's state to completely available.

2. If maybe omit events is not set or previousURL is not equal to urlString, then queue an element task given the DOM manipulation task source given the img element to fire an event named load at the img element.

→ If the resource type and data corresponds to a supported image format, as described below

The next task that is queued by the networking task source while the image is being fetched must run the following steps:

1. If the user agent is able to determine image request's image's width and height, and image request is pending request, set image request's state to partially available.

2. Otherwise, if the user agent is able to determine image request's image's width and height, and image request is current request, prepare image request for presentation given the img element and set image request's state to partially available.

3. Otherwise, if the user agent is able to determine that image request's image is corrupted in some fatal way such that the image dimensions cannot be obtained, and image request is pending request:
1. Abort the image request for the current request and the pending request.

2. Upgrade the pending request to the current request.

3. Set current request’s state to broken.

4. Fire an event named error at the img element.

Otherwise, if the user agent is able to determine that image request’s image is corrupted in some fatal way such that the image dimensions cannot be obtained, and image request is current request:

1. Abort the image request for image request.

2. If maybe omit events is not set or previousURL is not equal to urlString, then fire an event named error at the img element.

That task, and each subsequent task, that is queued by the networking task source while the image is being fetched, if image request is the current request, must update the presentation of the image appropriately (e.g., if the image is a progressive JPEG, each packet can improve the resolution of the image).

Furthermore, the last task that is queued by the networking task source once the resource has been fetched must additionally run these steps:

1. If image request is the pending request, abort the image request for the current request, upgrade the pending request to the current request and prepare image request for presentation given the img element.

2. Set image request to the completely available state.

3. Add the image to the list of available images using the key key, with the ignore higher-layer caching flag set.

4. If maybe omit events is not set or previousURL is not equal to urlString, then fire an event named load at the img element.

Otherwise, the image data is not in a supported file format; the user agent must set image request’s state to broken, abort the image request for the current request and the pending request, upgrade the pending request to the current request if image request is the pending request, and then, if maybe omit events is not set or previousURL is not equal to urlString, queue an element task on the DOM manipulation task source given the img element to fire an event named error at the img element.

While a user agent is running the above algorithm for an element x, there must be a strong reference from the element’s node document to the element x, even if that element is not connected.

To abort the image request for an image request or null image request means to run the following steps:

1. If image request is null, then return.

2. Forget image request’s image data, if any.

3. Abort any instance of the fetching algorithm for image request, discarding any pending tasks generated by that algorithm.

To upgrade the pending request to the current request for an img element means to run the following steps:

1. Let the img element’s current request be the pending request.

2. Let the img element’s pending request be null.

4.8.4.3.6 Preparing an image for presentation

To prepare an image for presentation for an image request req given image element img:

1. Let exifTagMap be the EXIF tags obtained from req’s image data, as defined by the relevant codec. [EXIF]

2. Let physicalWidth and physicalHeight be the width and height obtained from req’s image data, as defined by the relevant
3. Let \( \text{dimX} \) be the value of \( \text{exifTagMap's tag 0xA002 (PixelXDimension)} \).
4. Let \( \text{dimY} \) be the value of \( \text{exifTagMap's tag 0xA003 (PixelYDimension)} \).
5. Let \( \text{resX} \) be the value of \( \text{exifTagMap's tag 0x011A (XResolution)} \).
6. Let \( \text{resY} \) be the value of \( \text{exifTagMap's tag 0x011B (YResolution)} \).
7. Let \( \text{resUnit} \) be the value of \( \text{exifTagMap's tag 0x0128 (ResolutionUnit)} \).
8. If either \( \text{dimX} \) or \( \text{dimY} \) is not a positive integer, then return.
9. If either \( \text{resX} \) or \( \text{resY} \) is not a positive floating-point number, then return.
10. If \( \text{resUnit} \) is not equal to 2 (Inch), then return.
11. Let \( \text{widthFromDensity} \) be the value of \( \text{physicalWidth} \), multiplied by 72 and divided by \( \text{resX} \).
12. Let \( \text{heightFromDensity} \) be the value of \( \text{physicalHeight} \), multiplied by 72 and divided by \( \text{resY} \).
13. If \( \text{widthFromDensity} \) is not equal to \( \text{dimX} \) or \( \text{heightFromDensity} \) is not equal to \( \text{dimY} \), then return.
14. If req's image data is CORS-cross-origin, then set img's natural dimensions to \( \text{dimX} \) and \( \text{dimY} \), scale img's pixel data accordingly, and return.
15. Set req's preferred density-corrected dimensions to a struct with its width set to \( \text{dimX} \) and its height set to \( \text{dimY} \).
16. Update req's img element's presentation appropriately.

Note: Resolution in EXIF is equivalent to CSS points per inch, therefore 72 is the base for computing size from resolution.

It is not yet specified what would be the case if EXIF arrives after the image is already presented. See issue #4929.

4.8.4.3.7 Selecting an image source

To select an image source given an img element el:

1. Update the source set for el.
2. If el's source set is empty, return null as the URL and undefined as the pixel density.
3. Return the result of selecting an image from el's source set.

To select an image source from a source set given a source set sourceSet:

1. If an entry b in sourceSet has the same associated pixel density descriptor as an earlier entry a in sourceSet, then remove entry b. Repeat this step until none of the entries in sourceSet have the same associated pixel density descriptor as an earlier entry.
2. In an implementation-defined manner, choose one image source from sourceSet. Let this be selectedSource.
3. Return selectedSource and its associated pixel density.

4.8.4.3.8 Creating a source set from attributes

When asked to create a source set given a string default source, a string srcset, a string sizes, and an element or null img:

1. Let source set be an empty source set.
2. If srcset is not an empty string, then set source set to the result of parsing srcset.
3. Let source size be the result of parsing sizes with img.

4. If default source is not the empty string and source set does not contain an image source with a pixel density descriptor value of 1, and no image source with a width descriptor, append default source to source set.

5. Normalize the source densities of source set.


4.8.4.3.9 Updating the source set

When asked to update the source set for a given img or link element el, user agents must do the following:

1. Set el's source set to an empty source set.

2. Let elements be « el ».

3. If el is an img element whose parent node is a picture element, then replace the contents of elements with el's parent node's child elements, retaining relative order.

4. Let img be el if el is an img element, otherwise null.

5. For each child in elements:
   1. If child is el:
      1. Let default source be the empty string.
      2. Let srcset be the empty string.
      3. Let sizes be the empty string.
      4. If el is an img element that has a srcset attribute, then set srcset to that attribute's value.
      5. Otherwise, if el is a link element that has an imagesrcset attribute, then set srcset to that attribute's value.
      6. If el is an img element that has a sizes attribute, then set sizes to that attribute's value.
      7. Otherwise, if el is a link element that has an imagesizes attribute, then set sizes to that attribute's value.
      8. If el is an img element that has a src attribute, then set default source to that attribute's value.
      9. Otherwise, if el is a link element that has an href attribute, then set default source to that attribute's value.
     10. Let el's source set be the result of creating a source set given default source, srcset, and sizes, and img.
     11. Return.

   2. If child is not a source element, then continue.

   3. If child does not have a srcset attribute, continue to the next child.

   4. Parse child's srcset attribute and let the returned source set be source set.

   5. If source set has zero image sources, continue to the next child.

   6. If child has a media attribute, and its value does not match the environment, continue to the next child.

   7. Parse child's sizes attribute with img, and let source set's source size be the returned value.
8. If child has a `type` attribute, and its value is an unknown or unsupported MIME type, continue to the next child.

9. If child has `width` or `height` attributes, set el's dimension attribute source to child. Otherwise, set el's dimension attribute source to el.

10. Normalize the source densities of source set.

11. Let el's source set be source set.

12. Return.

**Note**

Each `img` element independently considers its previous sibling `source` elements plus the `img` element itself for selecting an image source, ignoring any other (invalid) elements, including other `img` elements in the same `picture` element, or `source` elements that are following siblings of the relevant `img` element.

### 4.8.4.3.10 Parsing a `srcset` attribute

When asked to parse a `srcset` attribute from an element, parse the value of the element's `srcset` attribute as follows:

1. Let input be the value passed to this algorithm.

2. Let position be a pointer into input, initially pointing at the start of the string.

3. Let candidates be an initially empty source set.

4. Splitting loop: Collect a sequence of code points that are ASCII whitespace or U+002C COMMA characters from input given position. If any U+002C COMMA characters were collected, that is a parse error.

5. If position is past the end of input, return candidates.

6. Collect a sequence of code points that are not ASCII whitespace from input given position, and let that be url.

7. Let descriptors be a new empty list.

8. If url ends with U+002C (,), then:

   1. Remove all trailing U+002C COMMA characters from url. If this removed more than one character, that is a parse error.

Otherwise:

1. Descriptor tokenizer: Skip ASCII whitespace within input given position.

2. Let current descriptor be the empty string.

3. Let state be in descriptor.

4. Let c be the character at position. Do the following depending on the value of state. For the purpose of this step, "EOF" is a special character representing that position is past the end of input.

   → **In descriptor**

   Do the following, depending on the value of c:

   → **ASCII whitespace**

   If current descriptor is not empty, append current descriptor to descriptors and let current descriptor be the empty string. Set state to after descriptor.

   → **U+002C COMMA (,)**

   Advance position to the next character in input. If current descriptor is not empty, append current descriptor to descriptors. Jump to the step labeled descriptor parser.

   → **U+0028 LEFT PARENTHESIS (())**

   Append c to current descriptor. Set state to in parens.
If current descriptor is not empty, append current descriptor to descriptors. Jump to the step labeled descriptor parser.

Anything else
Append c to current descriptor.

In parens
Do the following, depending on the value of c:

U+0029 RIGHT PARENTHESIS ()
Append c to current descriptor. Set state to in descriptor.

EOF
Append current descriptor to descriptors. Jump to the step labeled descriptor parser.

Anything else
Append c to current descriptor.

After descriptor
Do the following, depending on the value of c:

ASCII whitespace
Stay in this state.

EOF
Jump to the step labeled descriptor parser.

Anything else
Set state to in descriptor. Set position to the previous character in input.

Advance position to the next character in input. Repeat this step.

Note
In order to be compatible with future additions, this algorithm supports multiple descriptors and descriptors with parens.

9. Descriptor parser: Let error be no.
10. Let width be absent.
11. Let density be absent.
12. Let future-compat-h be absent.
13. For each descriptor in descriptors, run the appropriate set of steps from the following list:

- If the descriptor consists of a valid non-negative integer followed by a U+0077 LATIN SMALL LETTER W character
  1. If the user agent does not support the sizes attribute, let error be yes.

  Note
  A conforming user agent will support the sizes attribute. However, user agents typically implement and ship features in an incremental manner in practice.

  2. If width and density are not both absent, then let error be yes.

  3. Apply the rules for parsing non-negative integers to the descriptor. If the result is 0, let error be yes. Otherwise, let width be the result.

- If the descriptor consists of a valid floating-point number followed by a U+0078 LATIN SMALL LETTER X character
  1. If width, density and future-compat-h are not all absent, then let error be yes.

  2. Apply the rules for parsing floating-point number values to the descriptor. If the result is less than 0, let
error be yes. Otherwise, let density be the result.

Note
If density is 0, the natural dimensions will be infinite. User agents are expected to have limits in how big images can be rendered.

→ If the descriptor consists of a valid non-negative integer\(^p75\) followed by a U+0068 LATIN SMALL LETTER H character
This is a parse error\(^p361\).

1. If future-compat-h and density are not both absent, then let error be yes.
2. Apply the rules for parsing non-negative integers\(^p75\) to the descriptor. If the result is 0, let error be yes. Otherwise, let future-compat-h be the result.

→ Anything else
Let error be yes.

14. If future-compat-h is not absent and width is absent, let error be yes.
15. If error is still no, then append a new image source\(^p361\) to candidates whose URL is \url, associated with a width width if not absent and a pixel density density if not absent. Otherwise, there is a parse error\(^p361\).
16. Return to the step labeled splitting loop.

4.8.4.3.11 Parsing a sizes attribute \(^p37\)
When asked to parse a sizes attribute from an element element, with an img\(^p343\) element or null img:

1. Let unparsed sizes list be the result of parsing a comma-separated list of component values from the value of element's sizes attribute\(^p359\) (or the empty string, if the attribute is absent). [CSSSYNTAX]\(^p1457\)
2. Let size be null.
3. For each unparsed size in unparsed sizes list:
   1. Remove all consecutive \(<\text{whitespace-token}>s from the end of unparsed size. If unparsed size is now empty, then that is a parse error\(^p361\); continue.
   2. If the last component value in unparsed size is a valid non-negative \(<\text{source-size-value}>p359\), then set size to its value and remove the component value from unparsed size. Any CSS function other than the math functions is invalid. Otherwise, there is a parse error\(^p361\); continue.
   3. If size is auto\(^p359\), and img is not null, and img is being rendered\(^p1369\), and img allows auto-sizes\(^p344\), then set size to the concrete object size width of img, in CSS pixels.
      Note
      If size is still auto\(^p359\), then it will be ignored.
   4. Remove all consecutive \(<\text{whitespace-token}>s from the end of unparsed size. If unparsed size is now empty:
      1. If this was not the last item in unparsed sizes list, that is a parse error\(^p361\).
      2. If size is not auto\(^p359\), then return size. Otherwise, continue.
   5. Parse the remaining component values in unparsed size as a <media-condition>. If it does not parse correctly, or it does parse correctly but the <media-condition> evaluates to false, continue. [MQ]\(^p1460\)
   6. If size is not auto\(^p359\), then return size. Otherwise, continue.
4. Return 100vw.

Note
It is invalid to use a bare \(<\text{source-size-value}>p359\) that is a \(<\text{length}>\) (without an accompanying <media-condition>) as an entry in
an image source can have a pixel density descriptor, a width descriptor, or no descriptor at all accompanying its URL. Normalizing a source set gives every image source a pixel density descriptor.

When asked to normalize the source densities of a source set source set, the user agent must do the following:

1. Let source size be source set's source size.
2. For each image source in source set:
   1. If the image source has a pixel density descriptor, continue to the next image source.
   2. Otherwise, if the image source has a width descriptor, replace the width descriptor with a pixel density descriptor with a value of the width descriptor value divided by the source size and a unit of x.
   3. Otherwise, give the image source a pixel density descriptor of 1x.

4.8.4.3.13 Reacting to environment changes

The user agent may at any time run the following algorithm to update an img element's image in order to react to changes in the environment. (User agents are not required to ever run this algorithm; for example, if the user is not looking at the page any more, the user agent might want to wait until the user has returned to the page before determining which image to use, in case the environment changes again in the meantime.)

1. Await a stable state. The synchronous section consists of all the remaining steps of this algorithm until the algorithm says the synchronous section has ended. (Steps in synchronous sections are marked with ⌛.)
2. If the img element does not use srcset or picture, its node document is not fully active, has image data whose resource type is multipart/x-mixed-replace, or the pending request is not null, then return.
3. Let selected source and selected pixel density be the URL and pixel density that results from selecting an image source, respectively.
4. If selected source is null, then return.
5. If selected source and selected pixel density are the same as the element's last selected source and current pixel density, then return.
6. Let urlString be the result of encoding-parsing-and-serializing a URL given selected source, relative to the element's node document.
7. If urlString is failure, then return.
8. Let corsAttributeState be the state of the element's crossorigin content attribute.
9. Let origin be the `img` element's `node document`'s `origin`.
10. Let client be the `img` element's `node document`'s `relevant settings object`.
11. Let key be a tuple consisting of `urlString`, `corsAttributeState`, and, if `corsAttributeState` is not `No CORS`, `origin`.
12. Let `image request` be a new `image request` whose `current URI` is `urlString`.
13. Let the element's `pending request` be `image request`.
14. End the `synchronous section` continuing the remaining steps in parallel.
15. If the `list of available images` contains an entry for `key`, then set `image request`'s `image data` to that of the entry. Continue to the next step.

Otherwise:

1. Let `request` be the result of creating a potential-CORS request given `urlString`, "image", and `corsAttributeState`.
2. Set `request`'s `client` to `client`, `initiator` to "imageset", and set `request`'s `synchronous flag`.
3. Set `request`'s `referrer policy` to the current state of the element's `referrerpolicy` attribute.
4. Set `request`'s `priority` to the current state of the element's `fetchpriority` attribute.
5. Let `response` be the result of fetching `request`.
6. If `response`'s `unsafe response` is a network error or if the image format is unsupported (as determined by applying the image sniffing rules, again as mentioned earlier), or if the user agent is able to determine that `image request`'s image is corrupted in some fatal way such that the image dimensions cannot be obtained, or if the resource type is `multipart/x-mixed-replace`, then let `pending request` be `null` and abort these steps.
7. Otherwise, `response`'s `unsafe response` is `image request`'s `image data`. It can be either CORS-same-origin or CORS-cross-origin; this affects the image's interaction with other APIs (e.g., when used on a `canvas`).

16. Queue an element task on the `DOM manipulation task source` given the `img` element and the following steps:

1. If the `img` element has experienced `relevant mutations` since this algorithm started, then let `pending request` be `null` and abort these steps.
2. Let the `img` element's `last selected source` be `selected source` and the `img` element's `current pixel density` be `selected pixel density`.
3. Set the `image request`'s `state` to `completely available`.
4. Add the image to the `list of available images` using the `key`, with the `ignore higher-layer caching` flag set.
5. Upgrade the pending request to the current request.
6. Prepare `image request` for presentation given the `img` element.
7. Fire an event named `load` at the `img` element.

### 4.8.4.4 Requirements for providing text to act as an alternative for images

#### 4.8.4.4.1 General guidelines

Except where otherwise specified, the `alt` attribute must be specified and its value must not be empty; the value must be an appropriate replacement for the image. The specific requirements for the `alt` attribute depend on what the image is intended to represent, as described in the following sections.

The most general rule to consider when writing alternative text is the following: the intent is that replacing every image with the text of its `alt` attribute does not change the meaning of the page.

So, in general, alternative text can be written by considering what one would have written had one not been able to include the image.

A corollary to this is that the `alt` attribute's value should never contain text that could be considered the image's `caption`, `title`, or `legend`. It is supposed to contain replacement text that could be used by users instead of the image; it is not meant to supplement the
image. The `title` attribute can be used for supplemental information.

Another corollary is that the `alt` attribute's value should not repeat information that is already provided in the prose next to the image.

**Note**

One way to think of alternative text is to think about how you would read the page containing the image to someone over the phone, without mentioning that there is an image present. Whatever you say instead of the image is typically a good start for writing the alternative text.

### 4.8.4.4.2 A link or button containing nothing but the image

When an `a` element that creates a hyperlink, or a `button` element, has no textual content but contains one or more images, the `alt` attributes must contain text that together convey the purpose of the link or button.

**Example**

In this example, a user is asked to pick their preferred color from a list of three. Each color is given by an image, but for users who have configured their user agent not to display images, the color names are used instead:

```html
<h1>Pick your color</h1>
<ul>
  <li><a href="green.html"><img src="green.jpeg" alt="Green"></a></li>
  <li><a href="blue.html"><img src="blue.jpeg" alt="Blue"></a></li>
  <li><a href="red.html"><img src="red.jpeg" alt="Red"></a></li>
</ul>
```

**Example**

In this example, each button has a set of images to indicate the kind of color output desired by the user. The first image is used in each case to give the alternative text.

```html
<button name="rgb"><img src="red" alt="RGB"><img src="green" alt=""><img src="blue" alt=""></button>
<button name="cmyk"><img src="cyan" alt="CMYK"><img src="magenta" alt=""><img src="yellow" alt=""><img src="black" alt=""></button>
```

Since each image represents one part of the text, it could also be written like this:

```html
<button name="rgb"><img src="red" alt="R"><img src="green" alt="G"><img src="blue" alt="B"></button>
<button name="cmyk"><img src="cyan" alt="C"><img src="magenta" alt="M"><img src="yellow" alt="Y"><img src="black" alt="K"></button>
```

However, with other alternative text, this might not work, and putting all the alternative text into one image in each case might make more sense:

```html
<button name="rgb"><img src="red" alt="sRGB profile"><img src="green" alt=""><img src="blue" alt=""></button>
<button name="cmyk"><img src="cyan" alt="CMYK profile"><img src="magenta" alt=""><img src="yellow" alt=""></button>
```

### 4.8.4.4.3 A phrase or paragraph with an alternative graphical representation: charts, diagrams, graphs, maps, illustrations

Sometimes something can be more clearly stated in graphical form, for example as a flowchart, a diagram, a graph, or a simple map showing directions. In such cases, an image can be given using the `img` element, but the lesser textual version must still be given,

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so that users who are unable to view the image (e.g. because they have a very slow connection, or because they are using a text-only browser, or because they are listening to the page being read out by a hands-free automobile voice web browser, or simply because they are blind) are still able to understand the message being conveyed.

The text must be given in the `alt` attribute, and must convey the same message as the image specified in the `src` attribute.

It is important to realize that the alternative text is a *replacement* for the image, not a description of the image.

Example

In the following example we have a *flowchart* in image form, with text in the `alt` attribute rephrasing the flowchart in prose form:

```html
<p>In the common case, the data handled by the tokenization stage comes from the network, but it can also come from script.</p>
<p><img src="images/parsing-model-overview.svg" alt="The Network passes data to the Input Stream Preprocessor, which passes it to the Tokenizer, which passes it to the Tree Construction stage. From there, data goes to both the DOM and to Script Execution. Script Execution is linked to the DOM, and, using document.write(), passes data to the Tokenizer."/></p>
```

Example

Here's another example, showing a good solution and a bad solution to the problem of including an image in a description.

First, here's the good solution. This sample shows how the alternative text should just be what you would have put in the prose if the image had never existed.

```html
<!-- This is the correct way to do things. -->
<p>You are standing in an open field west of a house.  
<img src="house.jpeg" alt="The house is white, with a boarded front door."/>
There is a small mailbox here.</p>
```

Second, here's the bad solution. In this incorrect way of doing things, the alternative text is simply a description of the image, instead of a textual replacement for the image. It's bad because when the image isn't shown, the text doesn't flow as well as in the first example.

```html
<!-- This is the wrong way to do things. -->
<p>You are standing in an open field west of a house.  
<img src="house.jpeg" alt="A white house, with a boarded front door."/>
There is a small mailbox here.</p>
```

Text such as "Photo of white house with boarded door" would be equally bad alternative text (though it could be suitable for the `title` attribute or in the `figcaption` element of a `figure` with this image).

4.8.4.4 A *short phrase or label with an alternative graphical representation: icons, logos*

A document can contain information in iconic form. The icon is intended to help users of visual browsers to recognize features at a glance.

In some cases, the icon is supplemental to a text label conveying the same meaning. In those cases, the `alt` attribute must be present but must be empty.

Example
In other cases, the icon has no text next to it describing what it means; the icon is supposed to be self-explanatory. In those cases, an equivalent textual label must be given in the `alt` attribute.

Many pages include logos, insignia, flags, or emblems, which stand for a particular entity such as a company, organization, project, band, software package, country, or some such.

If the logo is being used to represent the entity, e.g. as a page heading, the `alt` attribute must contain the name of the entity being represented by the logo. The `alt` attribute must not contain text like the word "logo", as it is not the fact that it is a logo that is being conveyed, it’s the entity itself.

If the logo is being used next to the name of the entity that it represents, then the logo is supplemental, and its `alt` attribute must instead be empty.

If the logo is merely used as decorative material (as branding, or, for example, as a side image in an article that mentions the entity to which the logo belongs), then the entry below on purely decorative images applies. If the logo is actually being discussed, then it is being used as a phrase or paragraph (the description of the logo) with an alternative graphical representation (the logo itself), and the first entry above applies.

Example

In the following snippets, all four of the above cases are present. First, we see a logo used to represent a company:

```
<h1><img src="XYZ.gif" alt="The XYZ company"></h1>
```

Next, we see a paragraph which uses a logo right next to the company name, and so doesn't have any alternative text:

```
<article>
  <img src="XYZ.gif" alt="The XYZ company">
</article>
```
In this third snippet, we have a logo being used in an aside, as part of the larger article discussing the acquisition:

```html
<aside>
  <p>The ΑΒΓ company has had a good quarter, and our pie chart studies of their accounts suggest a much bigger blue slice than its green and orange slices, which is always a good sign.</p>
</aside>
```

Finally, we have an opinion piece talking about a logo, and the logo is therefore described in detail in the alternative text.

```html
<p>Consider for a moment their logo:</p>
<p>How unoriginal can you get? I mean, oooooh, a question mark, how <em>revolutionary</em>, how utterly <em>ground-breaking</em>, I'm sure everyone will rush to adopt those specifications now! They could at least have tried for some sort of, I don't know, sequence of rounded squares with varying shades of green and bold white outlines, at least that would look good on the cover of a blue book.</p>
```

This example shows how the alternative text should be written such that if the image isn't available, and the text is used instead, the text flows seamlessly into the surrounding text, as if the image had never been there in the first place.

### 4.8.4.4.5 Text that has been rendered to a graphic for typographical effect

Sometimes, an image just consists of text, and the purpose of the image is not to highlight the actual typographic effects used to render the text, but just to convey the text itself.

In such cases, the `alt` attribute must be present but must consist of the same text as written in the image itself.

**Example**

Consider a graphic containing the text "Earth Day", but with the letters all decorated with flowers and plants. If the text is merely being used as a heading, to spice up the page for graphical users, then the correct alternative text is just the same text "Earth Day", and no mention need be made of the decorations:

```html
<h1><img src="earthdayheading.png" alt="Earth Day"></h1>
```

**Example**

An illuminated manuscript might use graphics for some of its images. The alternative text in such a situation is just the character that the image represents.

```html
<p><img src="initials/o.svg" alt="O">nce upon a time and a long long time ago, late at night, when it was dark, over the hills, through the woods, across a great ocean, in a land far away, in a small house, on a hill, under a full moon…</p>
```

When an image is used to represent a character that cannot otherwise be represented in Unicode, for example gaiji, itaiji, or new characters such as novel currency symbols, the alternative text should be a more conventional way of writing the same thing, e.g. using the phonetic hiragana or katakana to give the character's pronunciation.
In this example from 1997, a new-fangled currency symbol that looks like a curly E with two bars in the middle instead of one is represented using an image. The alternative text gives the character's pronunciation.

Example

In many cases, the image is actually just supplementary, and its presence merely reinforces the surrounding text. In these cases, the alt attribute must be present but its value must be the empty string.

In general, an image falls into this category if removing the image doesn't make the page any less useful, but including the image makes it a lot easier for users of visual browsers to understand the concept.

Example

A flowchart that repeats the previous paragraph in graphical form:

4.8.4.4.6 A graphical representation of some of the surrounding text

In many cases, the image is actually just supplementary, and its presence merely reinforces the surrounding text. In these cases, the alt attribute must be present but its value must be the empty string.

In general, an image falls into this category if removing the image doesn't make the page any less useful, but including the image makes it a lot easier for users of visual browsers to understand the concept.

Example

A flowchart that repeats the previous paragraph in graphical form:
Sometimes, an image is not critical to the content, but is nonetheless neither purely decorative nor entirely redundant with the text. In these cases, the `alt` attribute must be present, and its value should either be the empty string, or a textual representation of the information that the image conveys. If the image has a caption giving the image's title, then the `alt` attribute's value must not be empty (as that would be quite confusing for non-visual readers).

### Example

A graph that repeats the previous paragraph in graphical form:

```html
<p>According to a study covering several billion pages, about 62% of documents on the web in 2007 triggered the Quirks rendering mode of web browsers, about 30% triggered the Almost Standards mode, and about 9% triggered the Standards mode.</p>
```

### 4.8.4.4.7 Ancillary images

Sometimes, an image is not critical to the content, but is nonetheless neither purely decorative nor entirely redundant with the text. In these cases, the `alt` attribute must be present, and its value should either be the empty string, or a textual representation of the information that the image conveys. If the image has a caption giving the image's title, then the `alt` attribute's value must not be empty (as that would be quite confusing for non-visual readers).

### Example

Consider a news article about a political figure, in which the individual's face was shown in an image. The image is not purely decorative, as it is relevant to the story. The image is not entirely redundant with the story either, as it shows what the politician looks like. Whether any alternative text need be provided is an authoring decision, decided by whether the image influences the interpretation of the prose.

In this first variant, the image is shown without context, and no alternative text is provided:

```html
<p><img src="president.jpeg" alt=""> Ahead of today's referendum, the President wrote an open letter to all registered voters. In it, she admitted that the country was divided.</p>
```

If the picture is just a face, there might be no value in describing it. It's of no interest to the reader whether the individual has red hair or blond hair, whether the individual has white skin or black skin, whether the individual has one eye or two eyes.

However, if the picture is more dynamic, for instance showing the politician as angry, or particularly happy, or devastated, some alternative text would be useful in setting the tone of the article, a tone that might otherwise be missed:

```html
<p><img src="president.jpeg" alt="The President is sad."> Ahead of today's referendum, the President wrote an open letter to all registered voters. In it, she admitted that the country was divided.</p>

<p><img src="president.jpeg" alt="The President is happy!"></p>
```
Ahead of today's referendum, the President wrote an open letter to all registered voters. In it, she admitted that the country was divided.

Whether the individual was "sad" or "happy" makes a difference to how the rest of the paragraph is to be interpreted: is she likely saying that she is unhappy with the country being divided, or is she saying that the prospect of a divided country is good for her political career? The interpretation varies based on the image.

If the image has a caption, then including alternative text avoids leaving the non-visual user confused as to what the caption refers to.

### 4.8.4.4.8 A purely decorative image that doesn't add any information

If an image is decorative but isn't especially page-specific — for example an image that forms part of a site-wide design scheme — the image should be specified in the site's CSS, not in the markup of the document.

However, a decorative image that isn't discussed by the surrounding text but still has some relevance can be included in a page using the `img` element. Such images are decorative, but still form part of the content. In these cases, the `alt` attribute must be present but its value must be the empty string.

### Example

Examples where the image is purely decorative despite being relevant would include things like a photo of the Black Rock City landscape in a blog post about an event at Burning Man, or an image of a painting inspired by a poem, on a page reciting that poem. The following snippet shows an example of the latter case (only the first verse is included in this snippet):

```html
<h1>The Lady of Shalott</h1>
<p><img src="shalott.jpeg" alt=""></p>
<p>On either side the river lie<br>
Long fields of barley and of rye,<br>
That clothe the wold and meet the sky;<br>
And through the field the road run by<br>
To many-tower'd Camelot;<br>
And up and down the people go,<br>
Gazing where the lilies blow<br>
Round an island there below,<br>
The island of Shalott.</p>
```

### 4.8.4.4.9 A group of images that form a single larger picture with no links

When a picture has been sliced into smaller image files that are then displayed together to form the complete picture again, one of the images must have its `alt` attribute set as per the relevant rules that would be appropriate for the picture as a whole, and then all the remaining images must have their `alt` attribute set to the empty string.

### Example
Generally, image maps should be used instead of slicing an image for links. However, if an image is indeed sliced and any of the components of the sliced picture are the sole contents of links, then one image per link must have alternative text in its `alt` attribute representing the purpose of the link.

In some cases, the image is a critical part of the content. This could be the case, for instance, on a page that is part of a photo gallery. The image is the whole `point` of the page containing it.

How to provide alternative text for an image that is a key part of the content depends on the image's provenance.

**The general case**

When it is possible for detailed alternative text to be provided, for example if the image is part of a series of screenshots in a magazine review, or part of a comic strip, or is a photograph in a blog entry about that photograph, text that can serve as a substitute for the image must be given as the contents of the `alt` attribute.

**Example**

A screenshot in a gallery of screenshots for a new OS, with some alternative text:
Images that defy a complete description

In certain cases, the nature of the image might be such that providing thorough alternative text is impractical. For example, the image could be indistinct, or could be a complex fractal, or could be a detailed topographical map.

In these cases, the alt attribute must contain some suitable alternative text, but it may be somewhat brief.

Example

Sometimes there simply is no text that can do justice to an image. For example, there is little that can be said to usefully describe a Rorschach inkblot test. However, a description, even if brief, is still better than nothing:

```html
<algorithm src="/commons/a/a7/Rorschach1.jpg" alt="A shape with left-right symmetry with indistinct edges, with a small gap in the center, two larger gaps offset slightly from the center, with two similar gaps under them. The outline is wider in the top half than the bottom half, with the sides extending upwards higher than the center, and the center extending below the sides."/>
<figcaption>A black outline of the first of the ten cards in the Rorschach inkblot test.</figcaption>
</figure>
```

Note that the following would be a very bad use of alternative text:

```html
<algnot src="/commons/a/a7/Rorschach1.jpg" alt="A black outline of the first of the ten cards in the Rorschach inkblot test."/>
<figcaption>A black outline of the first of the ten cards in the Rorschach inkblot test.</figcaption>
</figure>
```

Including the caption in the alternative text like this isn't useful because it effectively duplicates the caption for users who don't have images, taunting them twice yet not helping them any more than if they had only read or heard the caption once.

Example

Another example of an image that defies full description is a fractal, which, by definition, is infinite in detail.

The following example shows one possible way of providing alternative text for the full view of an image of the Mandelbrot set.

```html
<img src="ms1.jpeg" alt="The Mandelbrot set appears as a cardioid with
```
its cusp on the real axis in the positive direction, with a smaller bulb aligned along the same center line, touching it in the negative direction, and with these two shapes being surrounded by smaller bulbs of various sizes.”>

Example

Similarly, a photograph of a person’s face, for example in a biography, can be considered quite relevant and key to the content, but it can be hard to fully substitute text for:

```html
<section class="bio">
  <h1>A Biography of Isaac Asimov</h1>
  <p>Born Isaac Yudovich Ozimov in 1920, Isaac was a prolific author.</p>
  <p><img src="headpics/asimov.jpg" alt="Isaac Asimov had dark hair, a tall forehead, and wore glasses. Later in life, he wore long white sideburns."/>
  Asimov was born in Russia, and moved to the US when he was three years old.</p>
  ...
</section>
```

In such cases it is unnecessary (and indeed discouraged) to include a reference to the presence of the image itself in the alternative text, since such text would be redundant with the browser itself reporting the presence of the image. For example, if the alternative text was “A photo of Isaac Asimov”, then a conforming user agent might read that out as ”(Image) A photo of Isaac Asimov” rather than the more useful ”(Image) Isaac Asimov had dark hair, a tall forehead, and wore glasses...”.

Images whose contents are not known

In some unfortunate cases, there might be no alternative text available at all, either because the image is obtained in some automated fashion without any associated alternative text (e.g., a webcam), or because the page is being generated by a script using user-provided images where the user did not provide suitable or usable alternative text (e.g. photograph sharing sites), or because the author does not themself know what the images represent (e.g. a blind photographer sharing an image on their blog).

In such cases, the `alt` attribute may be omitted, but one of the following conditions must be met as well:

- The `img` element is in a `figure` element that contains a `figcaption` element that contains content other than `inter-element whitespace`, and, ignoring the `figcaption` element and its descendants, the `figure` element has no `flow content` descendants other than `inter-element whitespace` and the `img` element.

- The `title` attribute is present and has a non-empty value.

Note

Relying on the `title` attribute is currently discouraged as many user agents do not expose the attribute in an accessible manner as required by this specification (e.g. requiring a pointing device such as a mouse to cause a tooltip to appear, which excludes keyboard-only users and touch-only users, such as anyone with a modern phone or tablet).

Note

Such cases are to be kept to an absolute minimum. If there is even the slightest possibility of the author having the ability to provide real alternative text, then it would not be acceptable to omit the `alt` attribute.

Example

A photo on a photo-sharing site, if the site received the image with no metadata other than the caption, could be marked up as follows:

```html
<figure>
  <img src="1100670787_6a7c664aef.jpg">
  <figcaption>Bubbles traveled everywhere with us.</figcaption>
</figure>
```

It would be better, however, if a detailed description of the important parts of the image obtained from the user and included on
A blind user’s blog in which a photo taken by the user is shown. Initially, the user might not have any idea what the photo they took shows:

```html
<article>
  <h1>I took a photo</h1>
  <p>I went out today and took a photo!</p>
  <figure>
    <img src="photo2.jpeg"/>
    <figcaption>A photograph taken blindly from my front porch.</figcaption>
  </figure>
</article>
```

Eventually though, the user might obtain a description of the image from their friends and could then include alternative text:

```html
<article>
  <h1>I took a photo</h1>
  <p>I went out today and took a photo!</p>
  <figure>
    <img src="photo2.jpeg" alt="The photograph shows my squirrel feeder hanging from the edge of my roof. It is half full, but there are no squirrels around. In the background, out-of-focus trees fill the shot. The feeder is made of wood with a metal grate, and it contains peanuts. The edge of the roof is wooden too, and is painted white with light blue streaks."/>
    <figcaption>A photograph taken blindly from my front porch.</figcaption>
  </figure>
</article>
```

Sometimes the entire point of the image is that a textual description is not available, and the user is to provide the description. For instance, the point of a CAPTCHA image is to see if the user can literally read the graphic. Here is one way to mark up a CAPTCHA (note the `title` attribute):

```html
<p><label>What does this image say?</label>
  <img src="captcha.cgi?id=8934" title="CAPTCHA" />
  <input type="text" name="captcha"></p>
(If you cannot see the image, you can use an <a href="?audio">audio</a> test instead.)
```

Another example would be software that displays images and asks for alternative text precisely for the purpose of then writing a page with correct alternative text. Such a page could have a table of images, like this:

```html
<table>
  <thead>
    <tr><th>Image</th><th>Description</th></tr>
  </thead>
  <tbody>
    <tr>
      <td><img src="2421.png" title="Image 640 by 100, filename 'banner.gif'"/></td>
      <td><input name="alt2421"></td>
    </tr>
    <tr>
      <td><img src="2422.png" title="Image 200 by 480, filename 'ad3.gif'"/></td>
      <td><input name="alt2422"></td>
    </tr>
  </tbody>
</table>
```

Notice that even in this example, as much useful information as possible is still included in the `title` attribute.
Generally authors should avoid using `img` elements for purposes other than showing images. If an `img` element is being used for purposes other than showing an image, e.g. as part of a service to count page views, then the `alt` attribute must be the empty string. In such cases, the `width` and `height` attributes should both be set to zero.

4.8.4.12 An image not intended for the user

This section does not apply to documents that are publicly accessible, or whose target audience is not necessarily personally known to the author, such as documents on a web site, emails sent to public mailing lists, or software documentation.

When an image is included in a private communication (such as an HTML email) aimed at a specific person who is known to be able to view images, the `alt` attribute may be omitted. However, even in such cases authors are strongly urged to include alternative text (as appropriate according to the kind of image involved, as described in the above entries), so that the email is still usable should the user use a mail client that does not support images, or should the document be forwarded on to other users whose abilities might not include easily seeing images.

4.8.4.14 Guidance for markup generators

Markup generators (such as WYSIWYG authoring tools) should, wherever possible, obtain alternative text from their users. However, it is recognized that in many cases, this will not be possible.

For images that are the sole contents of links, markup generators should examine the link target to determine the title of the target, or the URL of the target, and use information obtained in this manner as the alternative text.

For images that have captions, markup generators should use the `figure` and `figcaption` elements, or the `title` attribute, to provide the image's caption.

As a last resort, implementers should either set the `alt` attribute to the empty string, under the assumption that the image is a purely decorative image that doesn't add any information but is still specific to the surrounding content, or omit the `alt` attribute altogether, under the assumption that the image is a key part of the content.

Markup generators may specify a `generator-unable-to-provide-required-alt` attribute on `img` elements for which they have been unable to obtain alternative text and for which they have therefore omitted the `alt` attribute. The value of this attribute must be the empty string. Documents containing such attributes are not conforming, but conformance checkers will silently ignore this error.

Note

This is intended to avoid markup generators from being pressured into replacing the error of omitting the `alt` attribute with the even more egregious error of providing phony alternative text, because state-of-the-art automated conformance checkers cannot distinguish phony alternative text from correct alternative text.

Markup generators should generally avoid using the image's own filename as the alternative text. Similarly, markup generators should avoid generating alternative text from any content that will be equally available to presentation user agents (e.g., web browsers).
A conformance checker must report the lack of an `alt` attribute as an error unless one of the conditions listed below applies:

- The `img` element is in a `figure` element that satisfies the conditions described above.
- The `img` element has a `title` attribute with a value that is not the empty string (also as described above).
- The conformance checker has been configured to assume that the document is an email or document intended for a specific person who is known to be able to view images.
- The `img` element has a (non-conforming) `generator-unable-to-provide-required-alt` attribute whose value is the empty string. A conformance checker that is not reporting the lack of an `alt` attribute as an error must also not report the presence of the empty `generator-unable-to-provide-required-alt` attribute as an error. (This case does not represent a case where the document is conforming, only that the generator could not determine appropriate alternative text — validators are not required to show an error in this case, because such an error might encourage markup generators to include bogus alternative text purely in an attempt to silence validators. Naturally, conformance checkers may report the lack of an `alt` attribute as an error even in the presence of the `generator-unable-to-provide-required-alt` attribute; for example, there could be a user option to report all conformance errors even those that might be the more or less inevitable result of using a markup generator.)

**4.8.4.15 Guidance for conformance checkers**

A conformance checker must report the lack of an `alt` attribute as an error unless one of the conditions listed below applies:

- The `img` element is in a `figure` element that satisfies the conditions described above.
- The `img` element has a `title` attribute with a value that is not the empty string (also as described above).
- The conformance checker has been configured to assume that the document is an email or document intended for a specific person who is known to be able to view images.
- The `img` element has a (non-conforming) `generator-unable-to-provide-required-alt` attribute whose value is the empty string. A conformance checker that is not reporting the lack of an `alt` attribute as an error must also not report the presence of the empty `generator-unable-to-provide-required-alt` attribute as an error. (This case does not represent a case where the document is conforming, only that the generator could not determine appropriate alternative text — validators are not required to show an error in this case, because such an error might encourage markup generators to include bogus alternative text purely in an attempt to silence validators. Naturally, conformance checkers may report the lack of an `alt` attribute as an error even in the presence of the `generator-unable-to-provide-required-alt` attribute; for example, there could be a user option to report all conformance errors even those that might be the more or less inevitable result of using a markup generator.)

**4.8.5 The iframe element**

**Categories**: Flow content, Phrasing content, Embedded content, Interactive content, Palpable content.

**Contexts in which this element can be used**: Where embedded content is expected.

**Content model**: Nothing.

**Tag omission in text/html**: Neither tag is omissible.

**Content attributes**: `src`, `srcdoc`, `name`, `sandbox`, `allow`, `allowfullscreen`, `width`, `height`, `referrerpolicy`, `loading`.

**Accessibility considerations**:

For authors.
For implementers.
The iframe element represents its content navigable.

The src attribute gives the URL of a page that the element's content navigable is to contain. The attribute, if present, must be a valid non-empty URL potentially surrounded by spaces. If the itemprop attribute is specified on an iframe element, then the src attribute must also be specified.

The srcdoc attribute gives the content of the page that the element's content navigable is to contain. The value of the attribute is used to construct an iframe srcdoc document, which is a Document whose URL matches about:srcdoc.

The srcdoc attribute, if present, must have a value using the HTML syntax that consists of the following syntactic components, in the given order:

1. Any number of comments and ASCII whitespace.
2. Optionally, a DOCTYPE.
3. Any number of comments and ASCII whitespace.
4. The document element, in the form of an html element.
5. Any number of comments and ASCII whitespace.

Note
The above requirements apply in XML documents as well.

Example
Here a blog uses the srcdoc attribute in conjunction with the sandbox attribute described below to provide users of user agents that support this feature with an extra layer of protection from script injection in the blog post comments:

```html
<article>
  <h1>I got my own magazine!</h1>
  <p>After much effort, I’ve finally found a publisher, and so now I have my own magazine! Isn't that awesome?! The first issue will come out in September, and we have articles about getting food, and about getting in boxes, it's going to be great!</p>
<footer>
  <p>Written by <a href="/users/cap">cap</a>, 1 hour ago.</p>
</footer>
```
The iframe HTML element insertion steps, given insertedNode, are:

1. If insertedNode's shadow-including root's browsing context is null, then return.
2. Create a new child navigable for insertedNode.
3. If insertedNode has a sandbox attribute, then parse the sandboxing directive given the attribute's value and insertedNode's iframe sandboxing flag set.
4. Process the iframe attributes for insertedNode, with initialInsertion set to true.

The iframe HTML element removing steps, given removedNode, are to destroy a child navigable given removedNode.

This happens without any unload events firing (the element's content document is destroyed, not unloaded).
Although iframe's are processed while in a shadow tree, per the above, several other aspects of their behavior are not well-defined with regards to shadow trees. See issue #763 for more detail.

Whenever an iframe element with a non-null content navigable has its srcdoc attribute set, changed, or removed, the user agent must process the iframe attributes.

Similarly, whenever an iframe element with a non-null content navigable but with no srcdoc attribute specified has its src attribute set, changed, or removed, the user agent must process the iframe attributes.

To process the iframe attributes for an element element, with an optional boolean initialInsertion (default false):

1. If element's srcdoc attribute is specified, then:
   1. Set element's current navigation was lazy loaded boolean to false.
   2. If the will lazy load element steps given element return true, then:
      1. Set element's lazy load resumption steps to the rest of this algorithm starting with the step labeled navigate to the srcdoc resource.
      2. Set element's current navigation was lazy loaded boolean to true.
      3. Start intersection-observing a lazy loading element for element.
      4. Return.
   3. Navigate to the srcdoc resource: navigate an iframe or frame given element, about:srcdoc, the empty string, and the value of element's srcdoc attribute.
      The resulting Document must be considered an iframe srcdoc document.

2. Otherwise:
   1. Let url be the result of running the shared attribute processing steps for iframe and frame elements given element and initialInsertion.
   2. If url is null, then return.
   3. If url matches about:blank and initialInsertion is true, then:
      1. Run the iframe load event steps given element.
      2. Return.
   4. Let referrerPolicy be the current state of element's referrerpolicy content attribute.
   5. Set element's current navigation was lazy loaded boolean to false.
   6. If the will lazy load element steps given element return true, then:
      1. Set element's lazy load resumption steps to the rest of this algorithm starting with the step labeled navigate.
      2. Set element's current navigation was lazy loaded boolean to true.
      3. Start intersection-observing a lazy loading element for element.
      4. Return.
   7. Navigate: navigate an iframe or frame given element, url, and referrerPolicy.

The shared attribute processing steps for iframe and frame elements, given an element element and a boolean initialInsertion, are:

1. Let url be the URL record.
2. If element has a src attribute specified, and its value is not the empty string, then:
   1. Let maybeURL be the result of encoding-parsing a URL given that attribute's value, relative to element's node.
document.

2. If `maybeURL` is not failure, then set `url` to `maybeURL`.

3. If the inclusive ancestor navigables\(^{983}\) of `element`'s `node navigable`\(^{6979}\) contains a `Navigable`\(^{978}\) whose `active document`\(^{978}\)'s URL equals `url` with `exclude fragments` set to true, then return null.

4. If `url` matches `about:blank`\(^{995}\) and `initialInsertion` is true, then perform the URL and history update steps\(^{1017}\) given `element`'s `content navigable`\(^{981}\)'s `active document`\(^{978}\) and `url`.

   **Note**
   
   *This is necessary in case url is something like about:blank?foo. If url is just plain about:blank, this will do nothing.*

5. Return `url`.

To navigate an iframe or frame given an element `element`, a URL `url`, a referrer policy `referrerPolicy`, and an optional string-or-null `srcdocString` (default null):

1. Let `historyHandling` be "auto"\(^{1003}\).

2. If `element`'s `content navigable`\(^{981}\)'s `active document`\(^{978}\) is not `completely loaded`\(^{1052}\), then set `historyHandling` to "replace"\(^{1003}\).

3. If `element` is an iframe\(^{387}\), then set `element`'s `pending resource-timing start time`\(^{392}\) to the `current high resolution time` given `element`'s `node document`'s `relevant global object`\(^{1071}\).

4. Navigate\(^{1003}\) `element`'s `content navigable`\(^{981}\) to `url` using `element`'s `node document`, with `historyHandling`\(^{1003}\) set to `historyHandling`, `referrerPolicy`\(^{1003}\) set to `referrerPolicy`, and `documentResource`\(^{1003}\) set to `srcdocString`.

Each Document\(^{128}\) has an iframe load in progress flag and a mute iframe load flag. When a Document\(^{128}\) is created, these flags must be unset for that Document\(^{128}\).

To run the iframe load event steps, given an iframe\(^{387}\) element `element`:

1. **Assert**: `element`'s `content navigable`\(^{981}\) is not null.

2. Let `childDocument` be `element`'s `content navigable`\(^{981}\)'s `active document`\(^{978}\).

3. If `childDocument` has its mute iframe load\(^{391}\) flag set, then return.

4. If `element`'s `pending resource-timing start time`\(^{392}\) is not null, then:

   1. Let `global` be `element`'s `node document`'s `relevant global object`\(^{1071}\).

   2. Let `fallbackTimingInfo` be a new fetch timing info whose `start time` is `element`'s `pending resource-timing start time`\(^{392}\) and whose `response end time` is the `current high resolution time` given `global`.

   3. Mark resource timing given `fallbackTimingInfo`, url, "iframe"\(^{387}\), `global`, the empty string, a new response body info, and 0.

   4. Set `element`'s `pending resource-timing start time`\(^{392}\) to null.

5. Set `childDocument`'s iframe load in progress\(^{391}\) flag.

6. Fire an event named `load`\(^{1451}\) at `element`.


⚠ Warning!

*This, in conjunction with scripting, can be used to probe the URL space of the local network's HTTP servers. User agents may implement cross-origin access control policies that are stricter than those described above to mitigate this attack, but unfortunately such policies are typically not compatible with existing web content.*

If an element type potentially delays the load event, then for each element element of that type, the user agent must delay the load event\(^{1340}\) of `element`'s `node document` if `element`'s `content navigable`\(^{981}\) is non-null and any of the following are true:

- `element`'s `content navigable`\(^{981}\)'s `active document`\(^{978}\) is not ready for post-load tasks\(^{1340}\).
• element's `content-navigable`'s `is-delaying-load-events` is true; or

• anything is delaying the load event of element's `content-navigable`'s active document.

**Note**

If, during the handling of the `load` event, element's `content-navigable` is again navigated, that will further delay the load event.

Each `iframe` has an associated current navigation was lazy loaded boolean, initially false. It is set and unset in the process the `iframe` attributes algorithm.

An `iframe` boolean is false potentially delays the load event.

Each `iframe` element has an associated null or `DOMHighResTimeStamp` pending resource-timing start time, initially set to null.

**Note**

If, when the element is created, the `srcdoc` attribute is not set, and the `src` attribute is either also not set or set but its value cannot be parsed, the element's `content-navigable` will remain at the initial `about:blank` Document.

The `name` attribute, if present, must be a valid navigable target name. The given value is used to name the element's `content-navigable` if present when that is created.

The `sandbox` attribute, when specified, enables a set of extra restrictions on any content hosted by the `iframe`. Its value must be an unordered set of unique space-separated tokens that are ASCII case-insensitive. The allowed values are:

- `allow-downloads`
- `allow-forms`
- `allow-modal`
- `allow-orientation-lock`
- `allow-pointer-lock`
- `allow-popups`
- `allow-popups-to-escape-sandbox`
- `allow-presentation`
- `allow-same-origin`
- `allow-scripts`
- `allow-top-navigation`
- `allow-top-navigation-by-user-activation`
- `allow-top-navigation-to-custom-protocols`

When the attribute is set, the content is treated as being from a unique opaque origin, forms, scripts, and various potentially annoying APIs are disabled, and links are prevented from targeting other navigables. The `allow-same-origin` keyword causes the content to be treated as being from its real origin instead of forcing it into an opaque origin, the `allow-top-navigation` keyword allows the content to navigate its traversable navigables, the `allow-top-navigation-by-user-activation` keyword behaves similarly but allows such navigation only when the browsing context's active window has transient activation; the `allow-top-navigation-to-custom-protocols` reenables navigations toward non fetch scheme to be handed off to external software; and the `allow-forms`, `allow-modal`, `allow-orientation-lock`, `allow-pointer-lock`, `allow-popups`, `allow-presentation`, `allow-scripts`, `allow-popups-to-escape-sandbox` keywords re-enable forms, modal dialogs, screen orientation lock, the pointer lock API, popups, the presentation API, scripts, and the creation of unsandboxed auxiliary browsing contexts respectively. The `allow-downloads` keyword allows content to perform downloads. The `allow-top-navigation` and `allow-top-navigation-by-user-activation` keywords must not both be specified, as doing so is redundant; only `allow-top-navigation` will have an effect in such non-conformant markup.

Similarly, the `allow-top-navigation-to-custom-protocols` keyword must not be specified if either `allow-top-navigation` or `allow-popups` are specified, as doing so is redundant.
When an iframe element’s sandbox attribute is set or changed while it has a non-null content navigable, the user agent must parse the sandboxing directive given the attribute’s value and the iframe sandboxing flag set. When an iframe element’s sandbox attribute is removed while it has a non-null content navigable, the user agent must empty the iframe element’s iframe sandboxing flag set.

To allow alert(), confirm(), and prompt() inside sandboxed content, both the allow-modals and allow-same-origin keywords need to be specified, and the loaded URL needs to be same origin with the top-level origin. Without the allow-same-origin keyword, the content is always treated as cross-origin, and cross-origin content cannot show simple dialogs.

⚠️ Warning!

Setting both the allow-scripts and allow-same-origin keywords together when the embedded page has the same origin as the page containing the iframe allows the embedded page to simply remove the sandbox attribute and then reload itself, effectively breaking out of the sandbox altogether.

⚠️ Warning!

These flags only take effect when the content navigable of the iframe element is navigated. Removing them, or removing the entire sandbox attribute, has no effect on an already-loaded page.

⚠️ Warning!

Potentially hostile files should not be served from the same server as the file containing the iframe element. Sandboxing hostile content is of minimal help if an attacker can convince the user to just visit the hostile content directly, rather than in the iframe. To limit the damage that can be caused by hostile HTML content, it should be served from a separate dedicated domain. Using a different domain ensures that scripts in the files are unable to attack the site, even if the user is tricked into visiting those pages directly, without the protection of the sandbox attribute.

When an iframe element’s sandbox attribute is set or changed while it has a non-null content navigable, the user agent must parse the sandboxing directive given the attribute’s value and the iframe element’s iframe sandboxing flag set. When an iframe element’s sandbox attribute is removed while it has a non-null content navigable, the user agent must empty the iframe element’s iframe sandboxing flag set.

Example

In this example, some completely-unknown, potentially hostile, user-provided HTML content is embedded in a page. Because it is served from a separate domain, it is affected by all the normal cross-site restrictions. In addition, the embedded page has scripting disabled, plugins disabled, forms disabled, and it cannot navigate any frames or windows other than itself (or any frames or windows it itself embeds).

We're not scared of you! Here is your content, unedited:

It is important to use a separate domain so that if the attacker convinces the user to visit that page directly, the page doesn't run in the context of the site's origin, which would make the user vulnerable to any attack found in the page.

Example

In this example, a gadget from another site is embedded. The gadget has scripting and forms enabled, and the origin sandbox restrictions are lifted, allowing the gadget to communicate with its originating server. The sandbox is still useful, however, as it disables plugins and popups, thus reducing the risk of the user being exposed to malware and other annoyances.

Example

Suppose a file A contained the following fragment:
The allow attribute, when specified, determines the container policy that will be used when the permissions policy for a Document in the iframe's content navigable is initialized. Its value must be a serialized permissions policy.

The allowfullscreen attribute is a boolean attribute. When specified, it indicates that Document objects in the iframe's content navigable will be initialized with a permissions policy which allows the "fullscreen" feature to be used from any origin. This is enforced by the process permissions policy attributes algorithm.

Example

In this example, an iframe is used to embed a map from an online navigation service. The allow attribute is used to enable the Geolocation API within the nested context.

Example

Here, an iframe is used to embed a player from a video site. The allowfullscreen attribute is needed to enable the player to show its video fullscreen.

Note

Neither allow nor allowfullscreen can grant access to a feature in an iframe element's content navigable if the element's node document is not already allowed to use that feature.
1. If document's browsing context is null, then return false.

2. If document is not fully active, then return false.

3. If the result of running is feature enabled in document for origin on feature, document, and document's origin is "Enabled", then return true.

4. Return false.

⚠️ Warning! Because they only influence the permissions policy of the content navigable's active document, the allow and allowfullscreen attributes only take effect when the content navigable of the iframe is navigated. Adding or removing them has no effect on an already-loaded document.

The iframe element supports dimension attributes for cases where the embedded content has specific dimensions (e.g. ad units have well-defined dimensions).

An iframe element never has fallback content, as it will always create a new child navigable, regardless of whether the specified initial contents are successfully used.

The referrer policy attribute is a referrer policy attribute. Its purpose is to set the referrer policy used when processing the iframe attributes. [REFERRERPOLICY]

The loading attribute is a lazy loading attribute. Its purpose is to indicate the policy for loading iframe elements that are outside the viewport.

When the loading attribute's state is changed to the Eager state, the user agent must run these steps:

1. Let resumptionSteps be the iframe element's lazy load resumption steps.
2. If resumptionSteps is null, then return.
3. Set the iframe's lazy load resumption steps to null.
4. Invoke resumptionSteps.

Descendants of iframe elements represent nothing. (In legacy user agents that do not support iframe elements, the contents would be parsed as markup that could act as fallback content.)

Note The HTML parser treats markup inside iframe elements as text.

The IDL attributes src, srcdoc, name, sandbox, and allow must reflect the respective content attributes of the same name.

The supported tokens for sandbox vs DOMTokenList are the allowed values defined in the sandbox attribute and supported by the user agent.

The allowFullscreen IDL attribute must reflect the allowfullscreen content attribute.

The referrerPolicy IDL attribute must reflect the referrerpolicy content attribute, limited to only known values.

The loading IDL attribute must reflect the loading content attribute, limited to only known values.

The contentDocument getter steps are to return this's content document.

The contentWindow getter steps are to return this's content window.

Example
Here is an example of a page using an `<iframe>` to include advertising from an advertising broker:

```html
<iframe src="https://ads.example.com/?customerid=923513721&amp;format=banner" width="468" height="60"></iframe>
```

### 4.8.6 The `embed` element

**Categories**: Flow content, Phrasing content, Embedded content, Interactive content, Palpable content.

**Contexts in which this element can be used**: Where embedded content is expected.

**Content model**: Nothing.

**Tag omission in text/html**: No end tag.

**Content attributes**: Global attributes:
- `src` — Address of the resource
- `type` — Type of embedded resource
- `width` — Horizontal dimension
- `height` — Vertical dimension
Any other attribute that has no namespace (see prose).

**Accessibility considerations**: For authors. For implementers.

**DOM interface**:

```idl
[Exposed=Window]
interface HTMLEmbedElement : HTMLElement {
    [HTMLConstructor] constructor();

    [CEReactions] attribute USVString src;
    [CEReactions] attribute DOMString type;
    [CEReactions] attribute DOMString width;
    [CEReactions] attribute DOMString height;
    Document? getSVGDocument();

    // also has obsolete members
};
```

The `embed` element provides an integration point for an external application or interactive content.

The `src` attribute gives the URL of the resource being embedded. The attribute, if present, must contain a valid non-empty URL potentially surrounded by spaces.

If the `itemprop` attribute is specified on an `embed` element, then the `src` attribute must also be specified.

The `type` attribute, if present, gives the MIME type by which the plugin to instantiate is selected. The value must be a valid MIME type string. If both the `type` and `src` attributes are present, then the `type` attribute must specify the same type as the explicit Content-Type metadata of the resource given by the `src` attribute.
While any of the following conditions are occurring, any plugin\textsuperscript{p46} instantiated for the element must be removed, and the embed\textsuperscript{p396} element represents\textsuperscript{p398} nothing:

- The element has neither a src\textsuperscript{p396} attribute nor a type\textsuperscript{p396} attribute.
- The element has a media element\textsuperscript{p411} ancestor.
- The element has an ancestor object\textsuperscript{p398} element that is not showing its fallback content\textsuperscript{p148}.

An embed\textsuperscript{p396} element is said to be potentially active\textsuperscript{p397} when the following conditions are all met simultaneously:

- The element is in a document\textsuperscript{p396} or was in a document the last time the event loop\textsuperscript{p1104} reached step\textsuperscript{p1107} 1.
- The element's node document\textsuperscript{p992} is fully active\textsuperscript{p992}.
- The element has either a src\textsuperscript{p396} attribute set or a type\textsuperscript{p396} attribute set (or both).
- The element's src\textsuperscript{p396} attribute is either absent or its value is not the empty string.
- The element is not a descendant of a media element\textsuperscript{p411}.
- The element is not a descendant of an object\textsuperscript{p398} element that is not showing its fallback content\textsuperscript{p148}.
- The element is being rendered\textsuperscript{p1369}, or was being rendered\textsuperscript{p1369} the last time the event loop\textsuperscript{p1104} reached step\textsuperscript{p1107} 1.

Whenever an embed\textsuperscript{p396} element that was not potentially active\textsuperscript{p397} becomes potentially active\textsuperscript{p397}, and whenever a potentially active\textsuperscript{p397} embed\textsuperscript{p396} element that is remaining potentially active\textsuperscript{p397} and has its src\textsuperscript{p396} attribute set, changed, or removed or its type\textsuperscript{p396} attribute set, changed, or removed, the user agent must queue an element task\textsuperscript{p1107} on the embed task source\textsuperscript{p1107} given the element to run the embed element setup steps\textsuperscript{p397} for that element.

The embed element setup steps\textsuperscript{p397} for a given embed\textsuperscript{p396} element element\textsuperscript{p397} are as follows:

1. If another task\textsuperscript{p1105} has since been queued to run the embed element setup steps\textsuperscript{p397} for element, then return.

2. If element has a src\textsuperscript{p396} attribute set, then:
   1. Let url be the result of encoding-parsing a URL\textsuperscript{p96} given element's src\textsuperscript{p396} attribute's value, relative to element's node document\textsuperscript{p396}.
   2. If url is failure, then return.
   3. Let request be a new request whose URL is url, client is element's node document's relevant settings object\textsuperscript{p1071}, destination is "embed", credentials mode is "include", mode is "navigate", initiator type is "embed", and whose use-URL-credentials flag is set.
   4. Fetch request, with processResponse set to the following steps given response:
      1. If another task\textsuperscript{p1105} has since been queued to run the embed element setup steps\textsuperscript{p397} for element, then return.
      2. If response is a network error, then fire an event named Load\textsuperscript{p1451} at element, and return.
      3. Let type be the result of determining the type of content\textsuperscript{p398} given element and response.
      4. Switch on type:
         - null
            1. Display no plugin\textsuperscript{p398} for element.
         - Otherwise
            1. If element's content navigable\textsuperscript{p981} is null, then create a new child navigable\textsuperscript{p981} for element.
            2. Navigate\textsuperscript{p1003} element's content navigable\textsuperscript{p981} to response's URL using element's node document, with response\textsuperscript{p1008} set to response, and historyHandling\textsuperscript{p1009} set to "replace"\textsuperscript{p1883}.

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To determine the type of the content given an `embed` element `element` and a `response` response, run the following steps:

1. If `element` has a `type` attribute, and that attribute's value is a type that a `plugin` supports, then return the value of the `type` attribute.

2. If the path component of `response`'s `url` matches a pattern that a `plugin` supports, then return the type that that plugin can handle.

3. If `response` has explicit Content-Type metadata, and that value is a type that a `plugin` supports, then return that value.

4. Return null.

To display no plugin for an `embed` element `element`:

1. Destroy a child navigable given `element`.

2. Display an indication that no `plugin` could be found for `element`, as the contents of `element`.

3. `element` now represents nothing.

Whenever an `embed` element that was potentially active stops being potentially active, any `plugin` that had been instantiated for that element must be unloaded.

The `embed` element potentially delays the load event.

The `embed` element supports dimension attributes.

The IDL attributes `src` and `type` each must reflect the respective content attributes of the same name.

### 4.8.7 The object element

Categories:
- Flow content
- Phrasing content
- Embedded content
- Listed form-associated element
- Palpable content

Contexts in which this element can be used:
Where `embedded content` is expected.
Content model:

Tag omission in text/html:
Neither tag is omissible.

Content attributes:

Global attributes:
- data — Address of the resource
- type — Type of embedded resource
- name — Name of content navigable
- form — Associates the element with a form element
- width — Horizontal dimension
- height — Vertical dimension

Accessibility considerations:
- For authors.
- For implementers.

DOM interface:

IDL

```
[Exposed=Window]
interface HTMLObjectElement : HTMLElement {
    [HTMLConstructor] constructor();

    [CEReactions] attribute USVString data;
    [CEReactions] attribute DOMString type;
    [CEReactions] attribute DOMString name;
    readonly attribute HTMLFormElement? form;
    [CEReactions] attribute DOMString width;
    [CEReactions] attribute DOMString height;
    readonly attribute Document? contentDocument;
    readonly attribute WindowProxy? contentWindow;
    Document? getSVGDocument();

    readonly attribute boolean willValidate;
    readonly attribute ValidityState validity;
    readonly attribute DOMString validationMessage;
    boolean checkValidity();
    boolean reportValidity();
    undefined setCustomValidity(DOMString error);

    // also has obsolete members
}
```

Depending on the type of content instantiated by the object element, the node also supports other interfaces.

The object element can represent an external resource, which, depending on the type of the resource, will either be treated as an image or as a child navigable.

The data attribute specifies the URL of the resource. It must be present, and must contain a valid non-empty URL potentially surrounded by spaces.

The type attribute, if present, specifies the type of the resource. If present, the attribute must be a valid MIME type string.

The name attribute, if present, must be a valid navigable target name. The given value is used to name the element's content navigable, if applicable, and if present when the element's content navigable is created.

Whenever one of the following conditions occur:

- the element is created,
- the element is popped off the stack of open elements of an HTML parser or XML parser,
the element is not on the stack of open elements\(^{1267}\) of an HTML parser\(^{1252}\) or XML parser\(^{1365}\), and it is either inserted into a document\(^{446}\) or removed from a document\(^{446}\),

- the element's node document changes whether it is fully active\(^{992}\),
- one of the element's ancestor object\(^{598}\) elements changes to or from showing its fallback content\(^{148}\),
- the element's classid\(^{1409}\) attribute is set, changed, or removed,
- the element's classid\(^{1409}\) attribute is not present, and its data\(^{399}\) attribute is set, changed, or removed,
- neither the element's classid\(^{1409}\) attribute nor its data\(^{399}\) attribute are present, and its type\(^{399}\) attribute is set, changed, or removed,
- the element changes from being rendered\(^{1369}\) to not being rendered, or vice versa,

...the user agent must queue an element task\(^{1107}\) on the DOM manipulation task source\(^{9115}\) given the object\(^{598}\) element to run the following steps to (re)Determine what the object\(^{598}\) element represents. This task\(^{1105}\) being queued\(^{1106}\) or actively running must delay the load event\(^{11340}\) of the element's node document.

1. If the user has indicated a preference that this object\(^{598}\) element's fallback content\(^{148}\) be shown instead of the element's usual behavior, then jump to the step below labeled fallback.

   **Note**
   
   For example, a user could ask for the element's fallback content\(^{148}\) to be shown because that content uses a format that the user finds more accessible.

2. If the element has an ancestor media element\(^{441}\), or has an ancestor object\(^{598}\) element that is not showing its fallback content\(^{148}\), or if the element is not in a document whose browsing context\(^{998}\) is non-null, or if the element's node document is not fully active\(^{992}\), or if the element is still in the stack of open elements\(^{1267}\) of an HTML parser\(^{1252}\) or XML parser\(^{1365}\), or if the element is not being rendered\(^{1369}\), then jump to the step below labeled fallback.

3. If the data\(^{399}\) attribute is present and its value is not the empty string, then:
   1. If the type\(^{399}\) attribute is present and its value is not a type that the user agent supports, then the user agent may jump to the step below labeled fallback without fetching the content to examine its real type.
   2. Let url be the result of encoding-parsing a URL\(^{966}\) given the data\(^{399}\) attribute's value, relative to the element's node document.
   3. If url is failure, then fire an event named error\(^{91451}\) at the element and jump to the step below labeled fallback.
   4. Let request be a new request whose URL is url, client is the element's node document's relevant settings\(^{9101}\), destination is 'object', credentials mode is 'include', mode is 'navigate', initiator type is 'object', and whose use-URL-credentials flag is set.
   5. Fetch request.

      Fetching the resource must delay the load event\(^{11340}\) of the element's node document until the task\(^{1105}\) that is queued\(^{1106}\) by the networking task source\(^{9115}\) once the resource has been fetched (defined next) has been run.

6. If the resource is not yet available (e.g. because the resource was not available in the cache, so that loading the resource required making a request over the network), then jump to the step below labeled fallback. The task\(^{1105}\) that is queued\(^{1106}\) by the networking task source\(^{9115}\) once the resource is available must restart this algorithm from this step. Resources can load incrementally; user agents may opt to consider a resource "available" whenever enough data has been obtained to begin processing the resource.

7. If the load failed (e.g. there was an HTTP 404 error, there was a DNS error), fire an event named error\(^{91451}\) at the element, then jump to the step below labeled fallback.

8. Determine the resource type, as follows:
   1. Let the resource type be unknown.
   2. If the user agent is configured to strictly obey Content-Type headers for this resource, and the resource has associated Content-Type metadata\(^{997}\), then let the resource type be the type specified in the resource's Content-Type metadata\(^{997}\), and jump to the step below labeled handler.
3. Run the appropriate set of steps from the following list:

   🡣 If the resource has associated Content-Type metadata

   1. Let binary be false.
   2. If the type specified in the resource's Content-Type metadata is "text/plain", and the result of applying the rules for distinguishing if a resource is text or binary to the resource is that the resource is not text/plain, then set binary to true.
   3. If the type specified in the resource's Content-Type metadata is "application/octet-stream", then set binary to true.
   4. If binary is false, then let the resource type be the type specified in the resource's Content-Type metadata, and jump to the step below labeled handler.

   🡢 Otherwise, if the resource does not have associated Content-Type metadata

   1. If there is a type attribute present on the object element, and its value is not application/octet-stream, then let the tentative type be the type specified in that type attribute. Otherwise, let tentative type be the computed type of the resource.
   2. If tentative type is not application/octet-stream, then let resource type be tentative type and jump to the step below labeled handler.

   4. If applying the URL parser algorithm to the URL of the specified resource (after any redirects) results in a URL record whose path component matches a pattern that a plugin supports, then let resource type be the type that that plugin can handle.

   Example

   For example, a plugin might say that it can handle resources with path components that end with the four character string ".swf".

   Note

   It is possible for this step to finish, or for one of the substeps above to jump straight to the next step, with resource type still being unknown. In both cases, the next step will trigger fallback.

9. Handler: Handle the content as given by the first of the following cases that matches:

   🡣 If the resource type is an XML MIME type, or if the resource type does not start with "image/

   If the object element's content navigable is null, then create a new child navigable for the element.

   Let response be the response from fetch.

   If response's URL does not match about:blank, then navigate the element's content navigable to response's URL using the element's node document, with historyHandling set to "replace".

   Note

   The data attribute of the object element doesn't get updated if the content navigable gets
The object element represents its content navigable.

→ If the resource type starts with "image/", and support for images has not been disabled
   Destroy a child navigable element given the object element.

   Apply the image sniffing rules to determine the type of the image.

   The object element represents the specified image.

   If the image cannot be rendered, e.g. because it is malformed or in an unsupported format, jump to the step below labeled fallback.

→ Otherwise
   The given resource type is not supported. Jump to the step below labeled fallback.

Note
If the previous step ended with the resource type being unknown, this is the case that is triggered.

10. The element's contents are not part of what the object element represents.

11. If the object element does not represent its content navigable, then once the resource is completely loaded, queue an element task on the DOM manipulation task source given the object element to fire an event named load at the element.

Note
If the element does represent its content navigable, then an analogous task will be queued when the created Document is completely finished loading.

12. Return.

4. Fallback: The object element represents the element's children. This is the element's fallback content. Destroy a child navigable element given the element.

Due to the algorithm above, the contents of object elements act as fallback content, used only when referenced resources can't be shown (e.g. because it returned a 404 error). This allows multiple object elements to be nested inside each other, targeting multiple user agents with different capabilities, with the user agent picking the first one it supports.

The object element potentially delays the load event.

The form attribute is used to explicitly associate the object element with its form owner.

The object element supports dimension attributes.

The IDL attributes data, type, and name each must reflect the respective content attributes of the same name.

The contentDocument getter steps are to return this's content document.

The contentWindow getter steps are to return this's content window.

The willValidate, validity, and validationMessage attributes, and the checkValidity(), reportValidity(), and setCustomValidity() methods, are part of the constraint validation API. The form IDL attribute is part of the element's forms API.

Example
In this example, an HTML page is embedded in another using the object element.

```html
<figure>
<object data="clock.html"></object>
<figcaption>My HTML Clock</figcaption>
</figure>
```
4.8.8 The `video` element

Categories:
- Flow content
- Phrasing content
- Embedded content

If the element has a `controls` attribute: Interactive content.
- Palpable content

Contexts in which this element can be used:
- Where embedded content is expected.

Content model:
- If the element has a `src` attribute: zero or more `track` elements, then transparent, but with no `media element` descendants.
- If the element does not have a `src` attribute: zero or more `source` elements, then zero or more `track` elements, then transparent, but with no `media element` descendants.

Tag omission in text/html:
- Neither tag is omissible.

Content attributes:
- Global attributes
  - `src` — Address of the resource
  - `crossorigin` — How the element handles crossorigin requests
  - `poster` — Poster frame to show prior to video playback
  - `preload` — Hints how much buffering the `media resource` will likely need
  - `autoplay` — Hint that the `media resource` can be started automatically when the page is loaded
  - `playsinline` — Encourage the user agent to display video content within the element’s playback area
  - `loop` — Whether to loop the `media resource`
  - `muted` — Whether to mute the `media resource` by default
  - `controls` — Show user agent controls
  - `width` — Horizontal dimension
  - `height` — Vertical dimension

Accessibility considerations:
- For authors.
- For implementers.

DOM interface:

```javascript
[Exposed=Window]
interface HTMLVideoElement : HTMLElement {

  [CFReactions] attribute unsigned long width;
  [CFReactions] attribute unsigned long height;
  readonly attribute unsigned long videoWidth;
  readonly attribute unsigned long videoHeight;
  [CFReactions] attribute USVString poster;
  [CFReactions] attribute boolean playsInline;
}
```

A `video` element is used for playing videos or movies, and audio files with captions.

Content may be provided inside the `video` element. User agents should not show this content to the user; it is intended for older web browsers which do not support `video`, so that text can be shown to the users of these older browsers informing them of how to
access the video contents.

Note

In particular, this content is not intended to address accessibility concerns. To make video content accessible to the partially sighted, the blind, the hard-of-hearing, the deaf, and those with other physical or cognitive disabilities, a variety of features are available. Captions can be provided, either embedded in the video stream or as external files using the `track` element. Sign-language tracks can be embedded in the video stream. Audio descriptions can be embedded in the video stream or in text form using a WebVTT file referenced using the `track` element and synthesized into speech by the user agent. WebVTT can also be used to provide chapter titles. For users who would rather not use a media element at all, transcripts or other textual alternatives can be provided by simply linking to them in the prose near the `video` element. [WEBVTT]

The `video` element is a `media element` whose `media data` is ostensibly video data, possibly with associated audio data.

The `src`, `crossorigin`, `preload`, `autoplay`, `loop`, `muted` and `controls` attributes are the attributes common to all media elements.

The `poster` attribute gives the URL of an image file that the user agent can show while no video data is available. The attribute, if present, must contain a valid non-empty URL potentially surrounded by spaces.

If the specified resource is to be used, then, when the element is created or when the `poster` attribute is set, changed, or removed, the user agent must run the following steps to determine the element's `poster frame` (regardless of the value of the element's `show poster flag`):

1. If there is an existing instance of this algorithm running for this `video` element, abort that instance of this algorithm without changing the `poster frame`.
2. If the `poster` attribute's value is the empty string or if the attribute is absent, then there is no `poster frame`, return.
3. Let `url` be the result of encoding-parsing a URL given the `poster` attribute's value, relative to the element's `node document`.
4. If `url` is failure, then return. Note There is no `poster frame`.
5. Let request be a new `request` whose `URL` is `url`, `client` is the element's `node document`'s `relevant settings object`, `destination` is "image", `initiator type` is "video", `credentials mode` is "include", and whose `use-URL-credentials flag` is set.
6. Fetch request. This must delay the load event of the element's `node document`.
7. If an image is thus obtained, the `poster frame` is that image. Otherwise, there is no `poster frame`.

Note

The image given by the `poster` attribute, the `poster frame` is intended to be a representative frame of the video (typically one of the first non-blank frames) that gives the user an idea of what the video is like.

The `playsinline` attribute is a boolean attribute. If present, it serves as a hint to the user agent that the video ought to be displayed "inline" in the document by default, constrained to the element's playback area, instead of being displayed fullscreen or in an independent resizable window.

Note

The absence of the `playsinline` attribute does not imply that the video will display fullscreen by default. Indeed, most user agents have chosen to play all videos inline by default, and in such user agents the `playsinline` attribute has no effect.

A `video` element represents what is given for the first matching condition in the list below:

- When no video data is available (the element's `readyState` attribute is either `H ave_NOTHING`, or `H ave_METADATA` but no video data has yet been obtained at all, or the element's `readyState` attribute is any subsequent value but the `media resource` does not have a video channel)
  
  The `video` element represents its `poster frame`, if any, or else transparent black with no natural dimensions.

- When the `video` element is `paused`, the `current playback position` is the first frame of video, and the
element’s `show poster flag` is set.

The `video` element `represents` its `poster frame`, if any, or else the first frame of the video.

- **When the video element is paused**, and the frame of video corresponding to the `current playback position` is not available (e.g. because the video is seeking or buffering)

- **When the video element is neither potentially playing nor paused** (e.g. when seeking or stalled)

- **When the video element is paused**

  The `video` element `represents` the last frame of the video to have been rendered.

- **Otherwise (the video element has a video channel and is potentially playing)**

  The `video` element `represents` the frame of video corresponding to the `current playback position`. When the `current playback position` changes such that the last frame rendered is no longer the frame corresponding to the `current playback position`, in the video, the new frame must be rendered.

Frames of video must be obtained from the video track that was `selected` when the `event loop` last reached step 1.

**Note**

> Which frame in a video stream corresponds to a particular playback position is defined by the video stream’s format.

The `video` element also `represents` any `text track cues` whose `text track active flag` is set and whose `text track` is in the `showing` mode, and any audio from the `media resource`, at the `current playback position`.

Any audio associated with the `media resource` must, if played, be played synchronized with the `current playback position`, at the element’s `effective media volume`. The user agent must play the audio from audio tracks that were `enabled` when the `event loop` last reached step 1.

In addition to the above, the user agent may provide messages to the user (such as “buffering”, “no video loaded”, “error”, or more detailed information) by overlaying text or icons on the video or other areas of the element’s playback area, or in another appropriate manner.

User agents that cannot render the video may instead make the element `represent` a link to an external video playback utility or to the video data itself.

When a `video` element's `media resource` has a video channel, the element provides a `paint source` whose width is the `media resource`’s `natural width`, whose height is the `media resource`’s `natural height`, and whose appearance is the frame of video corresponding to the `current playback position`, if that is available, or else (e.g. when the video is seeking or buffering) its previous appearance, if any, or else (e.g. because the video is still loading the first frame) blackness.

**For web developers (non-normative)**

`video.videoWidth`

`video.videoHeight`

These attributes return the natural dimensions of the video, or 0 if the dimensions are not known.

The `natural width` and `natural height` of the `media resource` are the dimensions of the resource in CSS pixels after taking into account the resource’s dimensions, aspect ratio, clean aperture, resolution, and so forth, as defined for the format used by the resource. If an anamorphic format does not define how to apply the aspect ratio to the video data’s dimensions to obtain the “correct” dimensions, then the user agent must apply the ratio by increasing one dimension and leaving the other unchanged.

The `videoWidth` IDL attribute must return the `natural width` of the video in CSS pixels. The `videoHeight` IDL attribute must return the `natural height` of the video in CSS pixels. If the element’s `readyState` attribute is `HAVE NOTHING`, then the attributes must return 0.

Whenever the `natural width` or `natural height` of the video changes (including, for example, because the `selected video track` was changed), if the element’s `readyState` attribute is not `HAVE NOTHING`, the user agent must `queue a media element task` given the `media element` to `fire an event` named `resize` at the `media element`.

The `video` element supports `dimension attributes`.

In the absence of style rules to the contrary, video content should be rendered inside the element’s playback area such that the video
content is shown centered in the playback area at the largest possible size that fits completely within it, with the video content's aspect ratio being preserved. Thus, if the aspect ratio of the playback area does not match the aspect ratio of the video, the video will be shown letterboxed or pillarboxed. Areas of the element's playback area that do not contain the video represent nothing.

**Note**

In user agents that implement CSS, the above requirement can be implemented by using the style rule suggested in the Rendering section.

The natural width of a video element's playback area is the natural width of the poster frame, if that is available and the element currently represents its poster frame; otherwise, it is the natural width of the video resource, if that is available; otherwise the natural width is missing.

The natural height of a video element's playback area is the natural height of the poster frame, if that is available and the element currently represents its poster frame; otherwise it is the natural height of the video resource, if that is available; otherwise the natural height is missing.

The default object size is a width of 300 CSS pixels and a height of 150 CSS pixels.

User agents should provide controls to enable or disable the display of closed captions, audio description tracks, and other additional data associated with the video stream, though such features should, again, not interfere with the page's normal rendering.

User agents may allow users to view the video content in manners more suitable to the user, such as fullscreen or in an independent resizable window. User agents may even trigger such a viewing mode by default upon playing a video, although they should not do so when the playsinline attribute is specified. As with the other user interface features, controls to enable this should not interfere with the page's normal rendering unless the user agent is exposing a user interface. In such an independent viewing mode, however, user agents may make full user interfaces visible, even if the controls attribute is absent.

User agents may allow video playback to affect system features that could interfere with the user's experience; for example, user agents could disable screensavers while video playback is in progress.

The poster IDL attribute must reflect the poster content attribute.

The playsInline IDL attribute must reflect the playsinline content attribute.

**Example**

This example shows how to detect when a video has failed to play correctly:

```javascript
<script>
  function failed(e) {
    // video playback failed - show a message saying why
    switch (e.target.error.code) {
      case e.target.error.MEDIA_ERR_ABORTED:
        alert('You aborted the video playback.');
        break;
      case e.target.error.MEDIA_ERR_NETWORK:
        alert('A network error caused the video download to fail part-way.');
        break;
      case e.target.error.MEDIA_ERR_DECODE:
        alert('The video playback was aborted due to a corruption problem or because the video used features your browser did not support.');
        break;
      case e.target.error.MEDIA_ERR_SRC_NOT_SUPPORTED:
        alert('The video could not be loaded, either because the server or network failed or because the format is not supported.');
        break;
      default:
        alert('An unknown error occurred.');
        break;
    }
  }
</script>
```

406
4.8.9 The audio element

**Categories**: Flow content, Phrasing content, Embedded content.

If the element has a `controls` attribute: Interactive content.
If the element has a `controls` attribute: Palpable content.

**Contexts in which this element can be used**: Where embedded content is expected.

**Content model**: If the element has a `src` attribute: zero or more `track` elements, then transparent, but with no media element descendants. If the element does not have a `src` attribute: zero or more `source` elements, then zero or more `track` elements, then transparent, but with no media element descendants.

**Tag omission in text/html**: Neither tag is omissible.

**Content attributes**: Global attributes: `src` — Address of the resource, `crossorigin` — How the element handles crossorigin requests, `preload` — Hints how much buffering the media resource will likely need, `autoplay` — Hint that the media resource can be started automatically when the page is loaded, `loop` — Whether to loop the media resource, `muted` — Whether to mute the media resource by default, `controls` — Show user agent controls.

**Accessibility considerations**: For authors, For implementers.

**DOM interface**: IDL

```idl
[Exposed=Window, LegacyFactoryFunction=Audio(optional DOMString src)]
interface HTMLAudioElement : HTMLMediaElement {
    [HTMLConstructor] constructor();
};
```

An audio element represents a sound or audio stream.

Content may be provided inside the audio element. User agents should not show this content to the user; it is intended for older web browsers which do not support audio, so that text can be shown to the users of these older browsers informing them of how to access the audio contents.

**Note**: In particular, this content is not intended to address accessibility concerns. To make audio content accessible to the deaf or to those with other physical or cognitive disabilities, a variety of features are available. If captions or a sign language video are available, the video element can be used instead of the audio element to play the audio, allowing users to enable the visual...
alternatives. Chapter titles can be provided to aid navigation, using the track element and a WebVTT file. And, naturally, transcripts or other textual alternatives can be provided by simply linking to them in the prose near the audio element.

The audio element is a media element whose media data is ostensibly audio data.

The src, crossorigin, preload, autoplay, loop, muted, and controls attributes are the attributes common to all media elements.

For web developers (non-normative)

```javascript
audio = new Audio([ url ]) 
```

Returns a new audio element, with the src attribute set to the value passed in the argument, if applicable.

A legacy factory function is provided for creating HTMLAudioElement objects (in addition to the factory methods from DOM such as createElement()). When invoked, the legacy factory function must perform the following steps:

1. Let document be the current global object's associated Document.
2. Let audio be the result of creating an element given document, audio, and the HTML namespace.
3. Set an attribute value for audio using "preload" and "auto".
4. If src is given, then set an attribute value for audio using "src" and src. (This will cause the user agent to invoke the object's resource selection algorithm before returning.)
5. Return audio.

4.8.10 The track element

Categories:
None.

Contexts in which this element can be used:
As a child of a media element, before any flow content.

Content model:
Nothing.

Tag omission in text/html:
No end tag.

Content attributes:
Global attributes:
kind — The type of text track
src — Address of the resource
srclang — Language of the text track
label — User-visible label
default — Enable the track if no other text track is more suitable

Accessibility considerations:
For authors.
For implementers.

DOM interface:

```javascript
[Exposed=Window]
interface HTMLTrackElement : HTMLElement {
    [HTMLConstructor] constructor();
    [CFReactions] attribute DOMString kind;
```
The `track` element allows authors to specify explicit external timed text tracks for media elements. It does not represent anything on its own.

The `kind` attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>subtitles</td>
<td>Subtitles</td>
<td>Transcription or translation of the dialogue, suitable for when the sound is available but not understood (e.g. because the user does not understand the language of the media resource's audio track). Overlaid on the video.</td>
</tr>
<tr>
<td>captions</td>
<td>Captions</td>
<td>Transcription or translation of the dialogue, sound effects, relevant musical cues, and other relevant audio information, suitable for when sound is unavailable or not clearly audible (e.g. because it is muted, drowned-out by ambient noise, or because the user is deaf). Overlaid on the video; labeled as appropriate for the hard-of-hearing.</td>
</tr>
<tr>
<td>descriptions</td>
<td>Descriptions</td>
<td>Textual descriptions of the video component of the media resource, intended for audio synthesis when the visual component is obscured, unavailable, or not usable (e.g. because the user is interacting with the application without a screen while driving, or because the user is blind). Synthesized as audio.</td>
</tr>
<tr>
<td>chapters</td>
<td>Chapters</td>
<td>Tracks intended for use from script. Not displayed by the user agent.</td>
</tr>
<tr>
<td>metadata</td>
<td>Metadata</td>
<td></td>
</tr>
</tbody>
</table>

The attribute’s missing value default is the subtitles state, and its invalid value default is the metadata state.

The `src` attribute gives the URL of the text track data. The value must be a valid non-empty URL potentially surrounded by spaces. This attribute must be present.

The element has an associated track URL (a string), initially the empty string.

When the element’s `src` attribute is set, run these steps:

1. Let `trackURL` be failure.
2. Let `value` be the element’s `src` attribute value.
3. If `value` is not the empty string, then set `trackURL` to the result of encoding-parsing-and-serializing a URL given `value`, relative to the element’s node document.
4. Set the element’s track URL to `trackURL` if it is not failure; otherwise to the empty string.

If the element’s `track URL` identifies a WebVTT resource, and the element’s `kind` attribute is not in the chapters metadata or metadata state, then the WebVTT file must be a WebVTT file using cue text.

The `srclang` attribute gives the language of the text track data. The value must be a valid BCP 47 language tag. This attribute must be present if the element’s `kind` attribute is in the subtitles state.

If the element has a `srclang` attribute whose value is not the empty string, then the element’s track language is the value of the attribute. Otherwise, the element has no track language.

The `label` attribute gives a user-readable title for the track. This title is used by user agents when listing subtitle, caption, and audio description tracks in their user interface.

The value of the `label` attribute, if the attribute is present, must not be the empty string. Furthermore, there must not be two `track` element children of the same media element whose `kind` attributes are in the same state, whose `srclang`.
attributes are both missing or have values that represent the same language, and whose `label` attributes are again both missing or both have the same value.

If the element has a `label` attribute whose value is not the empty string, then the element's track label is the value of the attribute. Otherwise, the element's track label is an empty string.

The `default` attribute is a `boolean attribute`, which, if specified, indicates that the track is to be enabled if the user's preferences do not indicate that another track would be more appropriate.

Each `media element` must have no more than one `track` element child whose `kind` attribute is in the subtitles or captions state and whose `default` attribute is specified.

Each `media element` must have no more than one `track` element child whose `kind` attribute is in the description state and whose `default` attribute is specified.

Each `media element` must have no more than one `track` element child whose `kind` attribute is in the chapters metadata state and whose `default` attribute is specified.

### Note

There is no limit on the number of `track` elements whose `kind` attribute is in the metadata state and whose `default` attribute is specified.

For web developers (non-normative)

```javascript
track.readyState
```

Returns the `TextTrack` object corresponding to the text track of the `track` element.

The `readyState` attribute must return the numeric value corresponding to the `text track readiness state` of the `track` element's `text track`, as defined by the following list:

- **NONE** (numeric value 0)
  - The `text track not loaded` state.
- **LOADING** (numeric value 1)
  - The `text track loading` state.
- **LOADED** (numeric value 2)
  - The `text track loaded` state.
- **ERROR** (numeric value 3)
  - The `text track failed to load` state.

The `src`, `srclang`, `label`, and `default` IDL attributes must `reflect` the respective content attributes of the same name. The `kind` IDL attribute must `reflect` the content attribute of the same name, `limited to only known values`.

Example

This video has subtitles in several languages:
HTMLMediaElement objects (audio and video, in this specification) are simply known as media elements.

(IDL)

```javascript
enum CanPlayTypeResult { "" /* empty string */ , "maybe", "probably" };
typedef (MediaStream or MediaSource or Blob) MediaProvider;

[Exposed=Window]
interface HTMLMediaElement : HTMLElement {

    // error state
    readonly attribute MediaError? error;

    // network state
    [CEReactions] attribute USVString src;
    attribute MediaProvider? srcObject;
    readonly attribute USVString currentSrc;
    [CEReactions] attribute DOMString? crossOrigin;
    const unsigned short NETWORK_EMPTY = 0;
    const unsigned short NETWORK_IDLE = 1;
    const unsigned short NETWORK_LOADING = 2;
    const unsigned short NETWORK_NO_SOURCE = 3;
    readonly attribute unsigned short networkState;
    [CEReactions] attribute DOMString preload;
    readonly attribute TimeRanges buffered;
    undefined load();
    CanPlayTypeResult canPlayType(DOMString type);

    // ready state
    const unsigned short HAVE_NOTHING = 0;
    const unsigned short HAVE_METADATA = 1;
    const unsigned short HAVE_CURRENT_DATA = 2;
    const unsigned short HAVE_FUTURE_DATA = 3;
    const unsigned short HAVE_ENOUGH_DATA = 4;
    readonly attribute unsigned short readyState;
    readonly attribute boolean seeking;

    // playback state
    attribute double currentTime;
    undefined fastSeek(double time);
    readonly attribute unrestricted double duration;
    object getStartDate();
    readonly attribute boolean paused;
    attribute double defaultPlaybackRate;
    attribute double playbackRate;
    attribute boolean preservesPitch;
    readonly attribute TimeRanges played;
```

(The lang attributes on the last two describe the language of the label attribute, not the language of the subtitles themselves. The language of the subtitles is given by the srclang attribute.)
The media element attributes, `src`, `crossorigin`, `preload`, `autoplay`, `loop`, `muted`, and `controls`, apply to all media elements. They are defined in this section.

Media elements are used to present audio data, or video and audio data, to the user. This is referred to as media data in this section, since this section applies equally to media elements for audio or for video. The term media resource is used to refer to the complete set of media data, e.g. the complete video file, or complete audio file.

A media resource has an associated origin, which is either "none", "multiple", "rewritten", or an origin. It is initially set to "none".

A media resource can have multiple audio and video tracks. For the purposes of a media element, the video data of the media resource is only that of the currently selected track (if any) as given by the element's `videoTracks` attribute when the event last reached step 1, and the audio data of the media resource is the result of mixing all the currently enabled tracks (if any) given by the element's `audioTracks` attribute when the event last reached step 1.

Each media element has a unique media element event task source.

To queue a media element task with a media element element and a series of steps steps, queue an element task on the media element's media element event task source given element and steps.

4.8.11.1 Error codes

For web developers (non-normative)

media.error

Returns a MediaError object representing the current error state of the element.

Returns null if there is no error.

All media elements have an associated error status, which records the last error the element encountered since its resource selection algorithm was last invoked. The error attribute, on getting, must return the MediaError object created for this last error, or null if there has not been an error.
interface MediaError {
    const unsigned short MEDIA_ERR_ABORTED = 1;
    const unsigned short MEDIA_ERR_NETWORK = 2;
    const unsigned short MEDIA_ERR_DECODE = 3;
    const unsigned short MEDIA_ERR_SRC_NOT_SUPPORTED = 4;
    readonly attribute unsigned short code;
    readonly attribute DOMString message;
};

Every MediaError object has a message, which is a string, and a code, which is one of the following:

MEDIA_ERR_ABORTED (numeric value 1)
   The fetching process for the media resource was aborted by the user agent at the user’s request.

MEDIA_ERR_NETWORK (numeric value 2)
   A network error of some description caused the user agent to stop fetching the media resource, after the resource was established to be usable.

MEDIA_ERR_DECODE (numeric value 3)
   An error of some description occurred while decoding the media resource, after the resource was established to be usable.

MEDIA_ERR_SRC_NOT_SUPPORTED (numeric value 4)
   The media resource indicated by the src attribute or assigned media provider object was not suitable.

To create a MediaError, given an error code which is one of the above values, return a new MediaError object whose code is the given error code and whose message is a string containing any details the user agent is able to supply about the cause of the error condition, or the empty string if the user agent is unable to supply such details. This message string must not contain only the information already available via the supplied error code; for example, it must not simply be a translation of the code into a string format. If no additional information is available beyond that provided by the error code, the message must be set to the empty string.

The code getter steps are to return this’s code.

The message getter steps are to return this’s message.

4.8.11.2 Location of the media resource
   The src content attribute on media elements gives the URL of the media resource (video, audio) to show. The attribute, if present, must contain a valid non-empty URL potentially surrounded by spaces.

If the itemprop attribute is specified on the media element, then the src attribute must also be specified.

The crossorigin content attribute on media elements is a CORS settings attribute.

If a media element is created with a src attribute, the user agent must immediately invoke the media element’s resource selection algorithm.

If a src attribute of a media element is set or changed, the user agent must invoke the media element’s media element load algorithm. (Removing the src attribute does not do this, even if there are source elements present.)

The src IDL attribute on media elements must reflect the content attribute of the same name.
The `crossOrigin` IDL attribute must reflect the `crossorigin` content attribute, limited to only known values.

A media provider object is an object that can represent a media resource, separate from a URL. MediaStream objects, MediaSource objects, and Blob objects are all media provider objects.

Each media element can have an assigned media provider object, which is a media provider object. When a media element is created, it has no assigned media provider object.

For web developers (non-normative)

- `media.srcObject` *( = source )*
  
  Allows the media element to be assigned a media provider object.

- `media.currentSrc`
  
  Returns the URL of the current media resource, if any.

  Returns the empty string when there is no media resource, or it doesn't have a URL.

The `currentSrc` IDL attribute must initially be set to the empty string. Its value is changed by the resource selection algorithm defined below.

The `srcObject` IDL attribute, on getting, must return the element's assigned media provider object, if any, or null otherwise. On setting, it must set the element's assigned media provider object to the new value, and then invoke the element's media element load algorithm.

Note

There are three ways to specify a media resource: the `srcObject` IDL attribute, the `src` content attribute, and `source` elements. The IDL attribute takes priority, followed by the content attribute, followed by the elements.

4.8.11.3 MIME types

A media resource can be described in terms of its type, specifically a MIME type, in some cases with a codecs parameter. (Whether the codecs parameter is allowed or not depends on the MIME type.)

Types are usually somewhat incomplete descriptions; for example "video/mpeg" doesn't say anything except what the container type is, and even a type like "video/mp4; codecs="avc1.42E01E, mp4a.40.2"" doesn't include information like the actual bitrate (only the maximum bitrate). Thus, given a type, a user agent can often only know whether it might be able to play media of that type (with varying levels of confidence), or whether it definitely cannot play media of that type.

A type that the user agent knows it cannot render is one that describes a resource that the user agent definitely does not support, for example because it doesn't recognize the container type, or it doesn't support the listed codecs.

The MIME type "application/octet-stream" with no parameters is never a type that the user agent knows it cannot render. User agents must treat that type as equivalent to the lack of any explicit Content-Type metadata when it is used to label a potential media resource.

Note

Only the MIME type "application/octet-stream" with no parameters is special-cased here; if any parameter appears with it, it will be treated just like any other MIME type. This is a deviation from the rule that unknown MIME type parameters should be ignored.

For web developers (non-normative)

- `media.canPlayType` *( type )*
  
  Returns the empty string (a negative response), "maybe", or "probably" based on how confident the user agent is that it can play media resources of the given type.

The `canPlayType(type)` method must return the empty string if type is a type that the user agent knows it cannot render or is the type "application/octet-stream"; it must return "probably" if the user agent is confident that the type represents a media resource that it can render if used in with this `audio` or `video` element; and it must return "maybe" otherwise. Implementers are encouraged to return "maybe" unless the type can be confidently established as being supported or not. Generally, a user agent...
should never return "probably" for a type that allows the codecs parameter if that parameter is not present.

Example

This script tests to see if the user agent supports a (fictional) new format to dynamically decide whether to use a video element:

```html
<script>
  const videoSection = document.getElementById('video');
  const videoElement = document.createElement('video');
  const support = videoElement.canPlayType('video/x-new-fictional-format;codecs="kittens,bunnies"');
  if (support === "probably") {
    videoElement.setAttribute("src", "playing-cats.nfv");
    videoSection.replaceChildren(videoElement);
  }
</script>
```

Note

The type attribute of the source element allows the user agent to avoid downloading resources that use formats it cannot render.

4.8.11.4 Network states

For web developers (non-normative)

`media.networkState`

Returns the current state of network activity for the element, from the codes in the list below.

As media elements interact with the network, their current network activity is represented by the `networkState` attribute. On getting, it must return the current network state of the element, which must be one of the following values:

**NETWORK_EMPTY (numeric value 0)**

The element has not yet been initialized. All attributes are in their initial states.

**NETWORK_IDLE (numeric value 1)**

The element's resource selection algorithm is active and has selected a resource, but it is not actually using the network at this time.

**NETWORK_LOADING (numeric value 2)**

The user agent is actively trying to download data.

**NETWORK_NO_SOURCE (numeric value 3)**

The element's resource selection algorithm is active, but it has not yet found a resource to use.

The resource selection algorithm defined below describes exactly when the `networkState` attribute changes value and what events fire to indicate changes in this state.

4.8.11.5 Loading the media resource

For web developers (non-normative)

`media.load()`

Causes the element to reset and start selecting and loading a new media resource from scratch.

All media elements have a can autoplay flag, which must begin in the true state, and a delaying-the-load-event flag, which must begin in the false state. While the delaying-the-load-event flag is true, the element must delay the load event of its
When the `load()` method on a `media element` is invoked, the user agent must run the `media element load algorithm`.

A `media element` has an associated boolean `is currently stalled`, which is initially false.

The `media element load algorithm` consists of the following steps.

1. Set this element's `is currently stalled` to false.
2. Abort any already-running instance of the `resource selection algorithm` for this element.
3. Let `pending tasks` be a list of all `tasks` from the `media element`'s `media element event task source` in one of the `task queues`.
4. For each task in `pending tasks` that would `resolve pending play promises` or `reject pending play promises`, immediately resolve or reject those promises in the order the corresponding tasks were queued.
5. Remove each `task` in `pending tasks` from its `task queue`.

**Note**

Basically, pending events and callbacks are discarded and promises in-flight to be resolved/rejected are resolved/rejected immediately when the media element starts loading a new resource.

6. If the `media element`'s `networkState` is set to `NETWORK_LOADING` or `NETWORK_IDLE`, queue a media element task given the `media element` to fire an event named `abort` at the `media element`.
7. If the `media element`'s `networkState` is not set to `NETWORK_EMPTY`, then:
   1. Queue a media element task given the `media element` to fire an event named `emptied` at the `media element`.
   2. If a fetching process is in progress for the `media element`, the user agent should stop it.
   3. If the `media element`'s `assigned media provider object` is a `MediaSource` object, then detach it.
   4. Forget the media element's media-resource-specific tracks.
   5. If `readyState` is not set to `HAVE NOTHING`, then set it to that state.
   6. If the `paused` attribute is false, then:
      1. Set the `paused` attribute to true.
      2. Take pending play promises and reject pending play promises with the result and an `AbortError` `DOMException`.
   7. If `seeking` is true, set it to false.
   8. Set the `current playback position` to 0.
      Set the `official playback position` to 0.
      If this changed the `official playback position`, then queue a media element task given the `media element` to fire an event named `timeupdate` at the `media element`.
   9. Set the `timeline offset` to Not-a-Number (NaN).
10. Update the `duration` attribute to Not-a-Number (NaN).

**Note**

The user agent will not fire a `durationchange` event for this particular change of the duration.

8. Set the `playbackRate` attribute to the value of the `defaultPlaybackRate` attribute.
9. Set the `error` attribute to null and the `can autoplay flag` to true.
10. Invoke the `media element`'s `resource selection algorithm`.
The **resource selection algorithm** for a **media element** is as follows. This algorithm is always invoked as part of a **task**, but one of the first steps in the algorithm is to return and continue running the remaining steps in parallel. In addition, this algorithm interacts closely with the **event loop** mechanism; in particular, it has **synchronous sections** (which are triggered as part of the **event loop** algorithm). Steps in such sections are marked with 🕒.

1. Set the element’s `networkState` attribute to the `NETWORK_NO_SOURCE` value.
2. Set the element’s `show poster` flag to true.
3. Set the `media element`'s `delaying-the-load-event` flag to true (this delays the load event).
4. Await a stable state, allowing the `task` that invoked this algorithm to continue. The **synchronous section** consists of all the remaining steps of this algorithm until the algorithm says the **synchronous section** has ended. (Steps in **synchronous sections** are marked with 🕒.)
5. 🕒 If the `media element`'s `blocked-on-parser` flag is false, then populate the list of pending text tracks.
6. 🕒 If the `media element` has an **assigned media provider object**, then let `mode` be `object`.
   - Otherwise, if the `media element` has no **assigned media provider object** but has a `src` attribute, then let `mode` be `attribute`.
   - Otherwise, if the `media element` does not have an **assigned media provider object** and does not have a `src` attribute but does have a `source` element child, then let `mode` be `children` and let `candidate` be the first such `source` element child in tree order.
   - Otherwise the `media element` has no **assigned media provider object** and has neither a `src` attribute nor a `source` element child:
     1. 🕒 Set the `networkState` to `NETWORK_EMPTY`.
     2. 🕒 Set the element’s `delaying-the-load-event` flag to false. This stops delaying the load event.
     3. End the **synchronous section** and return.
7. 🕒 Set the `media element`'s `networkState` to `NETWORK_LOADING`.
8. 🕒 Queue a media element task given the `media element` to fire an event named `loadstart` at the `media element`.
9. Run the appropriate steps from the following list:

   → **If mode is object**
   1. 🕒 Set the `currentSrc` attribute to the empty string.
   2. End the **synchronous section**, continuing the remaining steps in parallel.
   3. Run the **resource fetch algorithm** with the **assigned media provider object**. If that algorithm returns without aborting this one, then the load failed.
   4. **Failed with media provider**: Reaching this step indicates that the media resource failed to load. Take pending play promises and queue a media element task given the `media element` to run the dedicated media source failure steps with the result.
   5. Wait for the `task` queued by the previous step to have executed.
   6. Return. The element won't attempt to load another resource until this algorithm is triggered again.

   → **If mode is attribute**
   1. 🕒 If the `src` attribute's value is the empty string, then end the **synchronous section**, and jump down to the `failed with attribute` step below.
   2. 🕒 Let `urlRecord` be the result of encoding-parsing a URL given the `src` attribute's value, relative to the `media element`'s `node document` when the `src` attribute was last changed.

---

Note: Playback of any previously playing media resource for this element stops.
3. If \( \text{urlRecord} \) is not failure, then set the \( \text{currentSrc} \) attribute to the result of applying the URL serializer to \( \text{urlRecord} \).

4. End the synchronous section, continuing the remaining steps in parallel.

5. If \( \text{urlRecord} \) is not failure, then run the resource fetch algorithm with \( \text{urlRecord} \). If that algorithm returns without aborting this one, then the load failed.

6. Failed with attribute: Reaching this step indicates that the media resource failed to load or that \( \text{urlRecord} \) is failure. Take pending play promises and queue a media element task given the media element to run the dedicated media source failure steps with the result.

7. Wait for the task queued by the previous step to have executed.

8. Return. The element won’t attempt to load another resource until this algorithm is triggered again.

\( \rightarrow \) Otherwise (\( \text{mode} \) is children)

1. Let \( \text{pointer} \) be a position defined by two adjacent nodes in the \( \text{media element} \)’s child list, treating the start of the list (before the first child in the list, if any) and end of the list (after the last child in the list, if any) as nodes in their own right. One node is the node before \( \text{pointer} \), and the other node is the node after \( \text{pointer} \). Initially, let \( \text{pointer} \) be the position between the \( \text{candidate} \) node and the next node, if there are any, or the end of the list, if it is the last node.

As nodes are inserted and removed into the \( \text{media element} \), \( \text{pointer} \) must be updated as follows:

   If a new node is inserted between the two nodes that define \( \text{pointer} \)
   Let \( \text{pointer} \) be the position between the node before \( \text{pointer} \) and the new node. In other words, insertions at \( \text{pointer} \) go after \( \text{pointer} \).

   If the node before \( \text{pointer} \) is removed
   Let \( \text{pointer} \) be the point between the node after \( \text{pointer} \) and the node before the node after \( \text{pointer} \). In other words, \( \text{pointer} \) doesn’t move relative to the remaining nodes.

   If the node after \( \text{pointer} \) is removed
   Let \( \text{pointer} \) be the point between the node before \( \text{pointer} \) and the node after the node before \( \text{pointer} \). Just as with the previous case, \( \text{pointer} \) doesn’t move relative to the remaining nodes.

   Other changes don’t affect \( \text{pointer} \).

2. Process candidate: If \( \text{candidate} \) does not have a \( \text{src} \) attribute, or if its \( \text{src} \) attribute’s value is the empty string, then end the synchronous section, and jump down to the failed with elements step below.

3. If \( \text{candidate} \) has a \( \text{media} \) attribute whose value does not match the environment, then end the synchronous section, and jump down to the failed with elements step below.

4. Let \( \text{urlRecord} \) be the result of encoding-parsing a URL given \( \text{candidate} \’s \) \( \text{src} \) attribute’s value, relative to \( \text{candidate} \’s \) node document when the \( \text{src} \) attribute was last changed.

5. If \( \text{urlRecord} \) is failure, then end the synchronous section, and jump down to the failed with elements step below.

6. If \( \text{candidate} \) has a \( \text{type} \) attribute whose value, when parsed as a MIME type (including any codecs described by the codecs parameter, for types that define that parameter), represents a type that the user agent knows it cannot render, then end the synchronous section, and jump down to the failed with elements step below.

7. Set the \( \text{currentSrc} \) attribute to the result of applying the URL serializer to \( \text{urlRecord} \).

8. End the synchronous section, continuing the remaining steps in parallel.

9. Run the resource fetch algorithm with \( \text{urlRecord} \). If that algorithm returns without aborting this one, then the load failed.

10. Failed with elements: Queue a media element task given the media element to fire an event named error at \( \text{candidate} \).

11. Await a stable state. The synchronous section consists of all the remaining steps of this algorithm until the algorithm says the synchronous section has ended. (Steps in synchronous sections are marked with \( \rightarrow \).)
12. ⌚ Forget the media element's media-resource-specific tracks.
13. ⌚ Find next candidate: Let candidate be null.
14. ⌚ Search loop: If the node after pointer is the end of the list, then jump to the waiting step below.
15. ⌚ If the node after pointer is a source element, let candidate be that element.
16. ⌚ Advance pointer so that the node before pointer is now the node that was after pointer, and the node after pointer is the node after the node that used to be after pointer, if any.
17. ⌚ If candidate is null, jump back to the search loop step. Otherwise, jump back to the process candidate step.
18. ⌚ Waiting: Set the element's networkState attribute to the NETWORK_NO_SOURCE value.
19. ⌚ Set the element's show poster flag to true.
20. ⌚ Queue a media element task given the media element to set the element's delaying-the-load-event flag to false. This stops delaying the load event.
21. End the synchronous section, continuing the remaining steps in parallel.
22. Wait until the node after pointer is a node other than the end of the list. (This step might wait forever.)
23. Await a stable state. The synchronous section consists of all the remaining steps of this algorithm until the algorithm says the synchronous section has ended. (Steps in synchronous sections are marked with ⌚.)
24. ⌚ Set the element's delaying-the-load-event flag back to true (this delays the load event again, in case it hasn't been fired yet).
25. ⌚ Set the networkState back to NETWORK_LOADING.
26. ⌚ Jump back to the find next candidate step above.

The dedicated media source failure steps with a list of promises promises are the following steps:

1. Set the error attribute to the result of creating a MediaError with MEDIA_ERR_SRC_NOT_SUPPORTED.
2. Forget the media element's media-resource-specific tracks.
3. Set the element's networkState attribute to the NETWORK_NO_SOURCE value.
4. Set the element's show poster flag to true.
5. Fire an event named error at the media element.
6. Reject pending play promises with promises and a "NotSupportedError" DOMException.
7. Set the element's delaying-the-load-event flag to false. This stops delaying the load event.

To verify a media response given a response, a media resource, and "entire resource" or a (number, number or "until end") tuple byteRange:

1. If response is a network error, then return false.
2. If byteRange is "entire resource", then return true.
3. Let internalResponse be response's unsafe response.
4. If internalResponse's status is 200, then return true.
5. If internalResponse's status is not 206, then return false.
6. If the result of extracting content-range values from internalResponse is failure, then return false.

Note

Note that the extracted values are not used, and in particular are not compared to byteRange. So this step serves as syntactic validation of the 'Content-Range' header, but if the 'Content-Range' values on the response mismatch the 'Range' values on the request, that is not considered a failure.
7. Let origin be "rewritten" if internalResponse's URL is null; otherwise internalResponse's URL's origin.

8. Let previousOrigin be resource's origin.

9. If any of the following are true:
   - previousOrigin is "none";
   - origin and previousOrigin are "rewritten";
   - origin and previousOrigin are origins, and origin is same origin with previousOrigin,
     then set resource's origin to origin.

Otherwise, if response is CORS-cross-origin, then return false.

Otherwise, set resource's origin to "multiple".

10. Return true.

The resource fetch algorithm for a media element and a given URL record or media provider object is as follows:

1. If the algorithm was invoked with media provider object or a URL record whose blob URL entry is a blob URL entry whose object is a media provider object, then let mode be local. Otherwise let mode be remote.

2. If mode is remote, then let the current media resource be the resource given by the URL record passed to this algorithm; otherwise, let the current media resource be the resource given by the media provider object. Either way, the current media resource is now the element's media resource.

3. Remove all media-resource-specific text tracks from the media element's list of pending text tracks, if any.

4. Run the appropriate steps from the following list:

   → If mode is remote

   1. Optionally, run the following substeps. This is the expected behavior if the user agent intends to not attempt to fetch the resource until the user requests it explicitly (e.g. as a way to implement the preload attribute's none keyword).

      1. Set the networkState to NETWORK_IDLE.

      2. Queue a media element task given the media element to fire an event named suspend at the element.

      3. Queue a media element task given the media element to set the element's delaying-the-load-event flag to false. This stops delaying the load event.

      4. Wait for the task to be run.

      5. Wait for an implementation-defined event (e.g., the user requesting that the media element begin playback).

      6. Set the element's delaying-the-load-event flag back to true (this delays the load event again, in case it hasn't been fired yet).

      7. Set the networkState to NETWORK_LOADING.

2. Let destination be "audio" if the media element is an audio element, or "video" otherwise.

3. Let request be the result of creating a potential-CORS request given current media resource's URL record, destination, and the current state of media element's crossorigin content attribute.

4. Set request's client to the media element's node document's relevant settings object.

5. Set request's initiator type to destination.
6. Let byteRange, which is "entire resource" or a (number, number or "until end") tuple, be the byte range required to satisfy missing data in media data\textsuperscript{p412}. This value is implementation-defined and may rely on codec, network conditions or other heuristics. The user-agent may determine to fetch the resource in full, in which case byteRange would be "entire resource", to fetch from a byte offset until the end, in which case byteRange would be (number, "until end"), or to fetch a range between two byte offsets, in which case byteRange would be a (number, number) tuple representing the two offsets.

7. If byteRange is not "entire resource", then:
   1. If byteRange[1] is "until end" then add a range header to request given byteRange[0].
   2. Otherwise, add a range header to request given byteRange[0] and byteRange[1].

8. Fetch request, with processResponse set to the following steps given response response:
   1. Let global be the media element\textsuperscript{p411}'s node document's relevant global object\textsuperscript{p1071}.
   2. Let updateMedia be to queue a media element task\textsuperscript{p412} given the media element\textsuperscript{p411} to run the first appropriate steps from the media data processing steps list\textsuperscript{p422} below. (A new task is used for this so that the work described below occurs relative to the appropriate media element event task source\textsuperscript{p412} rather than using the networking task source\textsuperscript{p1115}.)
   3. Let processEndOfMedia be the following step: If the fetching process has completes without errors, including decoding the media data, and if all of the data is available to the user agent without network access, then, the user agent must move on to the final step below. This might never happen, e.g. when streaming an infinite resource such as web radio, or if the resource is longer than the user agent's ability to cache data.
   4. If the result of verifying\textsuperscript{p419} response given the current media resource and byteRange is false, then abort these steps.
   5. Otherwise, incrementally read response's body given updateMedia, processEndOfMedia, an empty algorithm, and global.

   6. Update the media data\textsuperscript{p412} with the contents of response's unsafe response\textsuperscript{p97} obtained in this fashion. response can be CORS-same-origin\textsuperscript{p99} or CORS-cross-origin\textsuperscript{p97}; this affects whether subtitles referenced in the media data\textsuperscript{p412} are exposed in the API and, for video\textsuperscript{p463}, elements, whether a canvas\textsuperscript{p415} gets tainted when the video is drawn on it.

   The media element stall timeout is an implementation-defined length of time, which should be about three seconds. When a media element\textsuperscript{p411} that is actively attempting to obtain media data\textsuperscript{p412} has failed to receive any data for a duration equal to the media element stall timeout\textsuperscript{p421}, the user agent must queue a media element task\textsuperscript{p412} given the media element\textsuperscript{p4} to:
   1. Fire an event named stalled\textsuperscript{p44} at the element.
   2. Set the element’s is currently stalled\textsuperscript{p416} to true.

   User agents may allow users to selectively block or slow media data\textsuperscript{p412} downloads. When a media element\textsuperscript{p411}'s download has been blocked altogether, the user agent must act as if it was stalled (as opposed to acting as if the connection was closed). The rate of the download may also be throttled automatically by the user agent, e.g. to balance the download with other connections sharing the same bandwidth.

   User agents may decide to not download more content at any time, e.g. after buffering five minutes of a one hour media resource, while waiting for the user to decide whether to play the resource or not, while waiting for user input in an interactive resource, or when the user navigates away from the page. When a media element\textsuperscript{p411}'s download has been suspended, the user agent must queue a media element task\textsuperscript{p412} given the media element\textsuperscript{p41} to set the networkState\textsuperscript{p415} to NETWORK_IDLE\textsuperscript{p415} and fire an event named suspend\textsuperscript{p46} at the element. If and when downloading of the resource resumes, the user agent must queue a media element task\textsuperscript{p412} given the media element\textsuperscript{p41} to set the networkState\textsuperscript{p415} to NETWORK_LOADING\textsuperscript{p415}. Between the queuing of these tasks, the load is suspended (so progress\textsuperscript{p46} events don’t fire, as described above).

   Note

   The preload\textsuperscript{p406} attribute provides a hint regarding how much buffering the author thinks is advisable, even in the absence of the autoplay\textsuperscript{p415} attribute.
When a user agent decides to completely suspend a download, e.g., if it is waiting until the user starts playback before downloading any further content, the user agent must queue a media element task given the media element to set the element's delaying-the-load-event flag to false. This stops delaying the load event.

Although the above steps give an algorithm for issuing requests, the user agent may use other means besides those exact ones, especially in the face of error conditions. For example, the user agent may reconnect to the server or switch to a streaming protocol. The user agent must only consider the resource erroneous, and proceed into the error branches of the above steps, if the user agent has given up trying to fetch the resource.

To determine the format of the media resource, the user agent must use the rules for sniffing audio and video specifically.

While the load is not suspended (see below), every 350ms (±200ms) or for every byte received, whichever is least frequent, queue a media element task given the media element to:

1. Fire an event named progress at the element.
2. Set the element's is currently stalled to false.

While the user agent might still need network access to obtain parts of the media resource, the user agent must remain on this step.

Otherwise (mode is local)

The resource described by the current media resource, if any, contains the media data. It is CORS-same-origin.

If the current media resource is a raw data stream (e.g. from a File object), then to determine the format of the media resource, the user agent must use the rules for sniffing audio and video specifically. Otherwise, if the data stream is pre-decoded, then the format is the format given by the relevant specification.

Whenever new data for the current media resource becomes available, queue a media element task given the media element to run the first appropriate steps from the media data processing steps list below.

When the current media resource is permanently exhausted (e.g. all the bytes of a Blob have been processed), if there were no decoding errors, then the user agent must move on to the final step below. This might never happen, e.g. if the current media resource is a MediaStream.

The media data processing steps list is as follows:

1. If the media data cannot be fetched at all, due to network errors, causing the user agent to give up trying to fetch the resource
2. If the media data can be fetched but is found by inspection to be in an unsupported format, or can otherwise not be rendered at all
   DNS errors, HTTP 4xx and 5xx errors (and equivalents in other protocols), and other fatal network errors that occur before the user agent has established whether the current media resource is usable, as well as the file using an unsupported container format, or using unsupported codecs for all the data, must cause the user agent to execute the following steps:
   1. The user agent should cancel the fetching process.
   2. Abort this subalgorithm, returning to the resource selection algorithm.
3. If the media resource is found to have an audio track
   1. Create an AudioTrack object to represent the audio track.
   2. Update the media element's audioTracks attribute's AudioTrackList object with the new AudioTrack object.
3. Let enable be unknown.

4. If either the media resource or the URL of the current media resource indicate a particular set of audio tracks to enable, or if the user agent has information that would facilitate the selection of specific audio tracks to improve the user's experience, then: if this audio track is one of the ones to enable, then set enable to true, otherwise, set enable to false.

Example
This could be triggered by media fragment syntax, but it could also be triggered e.g. by the user agent selecting a 5.1 surround sound audio track over a stereo audio track.

5. If enable is still unknown, then, if the media element does not yet have an enabled audio track, then set enable to true, otherwise, set enable to false.

6. If enable is true, then enable this audio track, otherwise, do not enable this audio track.

7. Fire an event named addtrack at this AudioTrackList object, using TrackEvent, with the track attribute initialized to the new AudioTrack object.

↪ If the media resource is found to have a video track

1. Create a VideoTrack object to represent the video track.
2. Update the media element's videoTracks attribute's VideoTrackList object with the new VideoTrack object.
3. Let enable be unknown.
4. If either the media resource or the URL of the current media resource indicate a particular set of video tracks to enable, or if the user agent has information that would facilitate the selection of specific video tracks to improve the user's experience, then: if this video track is the first such video track, then set enable to true, otherwise, set enable to false.

Example
This could again be triggered by media fragment syntax.

5. If enable is still unknown, then, if the media element does not yet have a selected video track, then set enable to true, otherwise, set enable to false.

6. If enable is true, then select this track and unselect any previously selected video tracks, otherwise, do not select this video track. If other tracks are unselected, then a change event will be fired.

7. Fire an event named addtrack at this VideoTrackList object, using TrackEvent, with the track attribute initialized to the new VideoTrack object.

↪ Once enough of the media data has been fetched to determine the duration of the media resource, its dimensions, and other metadata

This indicates that the resource is usable. The user agent must follow these substeps:

1. Establish the media timeline for the purposes of the current playback position and the earliest possible position, based on the media data.
2. Update the timeline offset to the date and time that corresponds to the zero time in the media timeline, established in the previous step, if any. If no explicit time and date is given by the media resource, the timeline offset must be set to Not-a-Number (NaN).
3. Set the current playback position and the official playback position to the earliest possible position.
4. Update the duration attribute with the time of the last frame of the resource, if known, on the media timeline, established above. If it is not known (e.g. a stream that is in principle infinite), update the duration attribute to the value positive infinity.

Note
The user agent will queue a media element task given the media element to fire an event named durationchange at the element at this point.
5. For `video` elements, set the `videoWidth` and `videoHeight` attributes, and queue a media element task given the media element to fire an event named `resize` at the media element.

Note
Further `resize` events will be fired if the dimensions subsequently change.

6. Set the `readyState` attribute to `HAVE_METADATA`.

Note
A `loadedmetadata` DOM event will be fired as part of setting the `readyState` attribute to a new value.

7. Let `jumped` be false.

8. If the `media element`'s default playback start position is greater than zero, then seek to that time, and let `jumped` be true.

9. Let the `media element`'s default playback start position be zero.

10. Let the initial playback position be zero.

11. If either the `media resource` or the `URL` of the current media resource indicate a particular start time, then set the initial playback position to that time and, if `jumped` is still false, seek to that time.

Example
For example, with media formats that support media fragment syntax, the fragment can be used to indicate a start position.

12. If there is no enabled audio track, then enable an audio track. This will cause a change event to be fired.

13. If there is no selected video track, then select a video track. This will cause a change event to be fired.

Once the `readyState` attribute reaches `HAVE_CURRENT_DATA`, after the `loadeddata` event has been fired, set the element's delaying-the-load-event flag to false. This stops delaying the load event.

Note
A user agent that is attempting to reduce network usage while still fetching the metadata for each media resource would also stop buffering at this point, following the rules described previously, which involve the `networkState` attribute switching to the `NETWORK_IDLE` value and a `suspend` event firing.

Note
The user agent is required to determine the duration of the media resource and go through this step before playing.

Once the entire `media resource` has been fetched (but potentially before any of it has been decoded) Fire an event named `progress` at the media element.

Set the `networkState` to `NETWORK_IDLE` and fire an event named `suspend` at the media element.

If the user agent ever discards any `media data` and then needs to resume the network activity to obtain it again, then it must queue a media element task given the media element to set the `networkState` to `NETWORK_LOADING`.

Note
If the user agent can keep the `media resource` loaded, then the algorithm will continue to its final step below, which aborts the algorithm.

↩ If the connection is interrupted after some `media data` has been received, causing the user agent to
give up trying to fetch the resource

Fatal network errors that occur after the user agent has established whether the current media resource is usable (i.e. once the media element's `readyState` attribute is no longer `HAVE_NOTHING`) must cause the user agent to execute the following steps:

1. The user agent should cancel the fetching process.
2. Set the `error` attribute to the result of creating a `MediaError` with `MEDIA_ERR_NETWORK`.
3. Set the element's `networkState` attribute to the `NETWORK_IDLE` value.
4. Set the element's `delaying-the-load-event flag` to false. This stops delaying the load event.
5. Fire an event named `error` at the media element.
6. Abort the overall resource selection algorithm.

⇒ If the media data is corrupted

Fatal errors in decoding the media data that occur after the user agent has established whether the current media resource is usable (i.e. once the media element's `readyState` attribute is no longer `HAVE_NOTHING`) must cause the user agent to execute the following steps:

1. The user agent should cancel the fetching process.
2. Set the `error` attribute to the result of creating a `MediaError` with `MEDIA_ERR_DECODE`.
3. Set the element's `networkState` attribute to the `NETWORK_IDLE` value.
4. Set the element's `delaying-the-load-event flag` to false. This stops delaying the load event.
5. Fire an event named `error` at the media element.
6. Abort the overall resource selection algorithm.

⇒ If the media data fetching process is aborted by the user

The fetching process is aborted by the user, e.g. because the user pressed a "stop" button, the user agent must execute the following steps. These steps are not followed if the `load()` method itself is invoked while these steps are running, as the steps above handle that particular kind of abort.

1. The user agent should cancel the fetching process.
2. Set the `error` attribute to the result of creating a `MediaError` with `MEDIA_ERR_ABORTED`.
3. Fire an event named `abort` at the media element.
4. If the media element's `readyState` attribute has a value equal to `HAVE_NOTHING`, set the element's `networkState` attribute to the `NETWORK_EMPTY` value, set the element's `show poster flag` to true, and fire an event named `emptied` at the element.
   Otherwise, set the element's `networkState` attribute to the `NETWORK_IDLE` value.
5. Set the element's `delaying-the-load-event flag` to false. This stops delaying the load event.
6. Abort the overall resource selection algorithm.

⇒ If the media data can be fetched but has non-fatal errors or uses, in part, codecs that are unsupported, preventing the user agent from rendering the content completely correctly but not preventing playback altogether

The server returning data that is partially usable but cannot be optimally rendered must cause the user agent to render just the bits it can handle, and ignore the rest.

⇒ If the media resource is found to declare a media-resource-specific text track that the user agent supports

If the media data is CORS-same-origin, run the steps to expose a media-resource-specific text track with the relevant data.
5. **Final step:** If the user agent ever reaches this step (which can only happen if the entire resource gets loaded and kept available): abort the overall resource selection algorithm.

When a media element is to forget the media element’s media-resource-specific tracks, the user agent must remove from the media element’s list of text tracks all the media-resource-specific text tracks, then empty the media element’s audioTracks attribute’s AudioTrackList object, then empty the media element’s videoTracks attribute’s VideoTrackList object. No events (in particular, no removetrack events) are fired as part of this; the error and emptied events, fired by the algorithms that invoke this one, can be used instead.

The preload attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>auto</td>
<td>Automatic</td>
<td>Hints to the user agent that the user agent can put the user’s needs first without risk to the server, up to and including optimistically downloading the entire resource.</td>
</tr>
<tr>
<td>(the empty string)</td>
<td></td>
<td>Hints to the user agent that either the author does not expect the user to need the media resource, or that the server wants to minimize unnecessary traffic. This state does not provide a hint regarding how aggressively to actually download the media resource if buffering starts anyway (e.g. once the user hits “play”).</td>
</tr>
<tr>
<td>none</td>
<td>None</td>
<td>Hints to the user agent that the author does not expect the user to need the media resource, but that fetching the resource metadata (dimensions, track list, duration, etc.), and maybe even the first few frames, is reasonable. If the user agent precisely fetches no more than the metadata, then the media element will end up with its readystate attribute set to HAVE_METADATA; typically though, some frames will be obtained as well and it will probably be HAVE_CURRENT_DATA or HAVE_FUTURE_DATA. When the media resource is playing, hints to the user agent that bandwidth is to be considered scarce, e.g. suggesting throttling the download so that the media data is obtained at the slowest possible rate that still maintains consistent playback.</td>
</tr>
<tr>
<td>metadata</td>
<td>Metadata</td>
<td>Hints to the user agent that the author does not expect the user to need the media resource, but that fetching the resource metadata is reasonable.</td>
</tr>
</tbody>
</table>

The attribute’s missing value default and invalid value default are both implementation-defined, though the Metadata state is suggested as a compromise between reducing server load and providing an optimal user experience.

The attribute can be changed even once the media resource is being buffered or played; the descriptions in the table above are to be interpreted with that in mind.

**Note**

Authors might switch the attribute from “none” or “metadata” to “auto” dynamically once the user begins playback. For example, on a page with many videos this might be used to indicate that the many videos are not to be downloaded unless requested, but that once one is requested it is to be downloaded aggressively.

The preload attribute is intended to provide a hint to the user agent about what the author thinks will lead to the best user experience. The attribute may be ignored altogether, for example based on explicit user preferences or based on the available connectivity.

The preload IDL attribute must reflect the content attribute of the same name, limited to only known values.

**Note**

The autoplay attribute can override the preload attribute (since if the media plays, it naturally has to buffer first, regardless of the hint given by the preload attribute). Including both is not an error, however.

For web developers (non-normative)

`media.buffered`

Returns a TimeRanges object that represents the ranges of the media resource that the user agent has buffered.

The buffered attribute must return a new static normalized TimeRanges object that represents the ranges of the media resource, if any, that the user agent has buffered, at the time the attribute is evaluated. Users agents must accurately determine the ranges available, even for media streams where this can only be determined by tedious inspection.
User agents may discard previously buffered data.

Note
Typically this will be a single range anchored at the zero point, but if, e.g. the user agent uses HTTP range requests in response to seeking, there could be multiple ranges.

A media resource has a media timeline that maps times (in seconds) to positions in the media resource. The origin of a timeline is its earliest defined position. The duration of a timeline is its last defined position.

Establishing the media timeline: if the media resource somehow specifies an explicit timeline whose origin is not negative (i.e. gives each frame a specific time offset and gives the first frame a zero or positive offset), then the media timeline should be that timeline. (Whether the media resource can specify a timeline or not depends on the media resource's format.) If the media resource specifies an explicit start time and date, then that time and date should be considered the zero point in the media timeline; the timeline offset will be the time and date, exposed using the getStartDate() method.

If the media resource has a discontinuous timeline, the user agent must extend the timeline used at the start of the resource across the entire resource, so that the media timeline of the media resource increases linearly starting from the earliest possible position (as defined below), even if the underlying media data has out-of-order or even overlapping time codes.

For example, if two clips have been concatenated into one video file, but the video format exposes the original times for the two clips, the video data might expose a timeline that goes, say, 00:15..00:29 and then 00:05..00:38. However, the user agent would not expose those times; it would instead expose the times as 00:15..00:29 and 00:29..01:02, as a single video.

In the rare case of a media resource that does not have an explicit timeline, the zero time on the media timeline should correspond to the first frame of the media resource. In the even rarer case of a media resource with no explicit timings of any kind, not even frame durations, the user agent must itself determine the time for each frame in an implementation-defined manner.

Note
An example of a file format with no explicit timeline but with explicit frame durations is the Animated GIF format. An example of a file format with no explicit timings at all is the JPEG-push format (multipart/x-mixed-replace with JPEG frames, often used as the format for MJPEG streams).

If, in the case of a resource with no timing information, the user agent will nonetheless be able to seek to an earlier point than the first frame originally provided by the server, then the zero time should correspond to the earliest seekable time of the media resource.
otherwise, it should correspond to the first frame received from the server (the point in the media resource at which the user agent began receiving the stream).

**Note**

At the time of writing, there is no known format that lacks explicit frame time offsets yet still supports seeking to a frame before the first frame sent by the server.

---

**Example**

Consider a stream from a TV broadcaster, which begins streaming on a sunny Friday afternoon in October, and always sends connecting user agents the media data on the same media timeline, with its zero time set to the start of this stream. Months later, user agents connecting to this stream will find that the first frame they receive has a time with millions of seconds. The `getStartDate()` method would always return the date that the broadcast started; this would allow controllers to display real times in their scrubber (e.g., "2:30pm") rather than a time relative to when the broadcast began ("8 months, 4 hours, 12 minutes, and 23 seconds").

Consider a stream that carries a video with several concatenated fragments, broadcast by a server that does not allow user agents to request specific times but instead just streams the video data in a predetermined order, with the first frame delivered always being identified as the frame with time zero. If a user agent connects to this stream and receives fragments defined as covering timestamps 2010-03-20 23:15:00 UTC to 2010-03-21 00:05:00 UTC and 2010-02-12 14:25:00 UTC to 2010-02-12 14:35:00 UTC, it would expose this with a media timeline starting at 0s and extending to 3,600s (one hour). Assuming the streaming server disconnected at the end of the second clip, the `duration` attribute would then return 3,600. The `getStartDate()` method would return a Date object with a time corresponding to 2010-03-20 23:15:00 UTC. However, if a different user agent connected five minutes later, it would (presumably) receive fragments covering timestamps 2010-03-20 23:20:00 UTC to 2010-03-21 00:05:00 UTC and 2010-02-12 14:25:00 UTC to 2010-02-12 14:35:00 UTC, and would expose this with a media timeline starting at 0s and extending to 3,300s (fifty five minutes). In this case, the `getStartDate()` method would return a Date object with a time corresponding to 2010-03-20 23:20:00 UTC.

In both of these examples, the `seekable` attribute would give the ranges that the controller would want to actually display in its UI; typically, if the servers don't support seeking to arbitrary times, this would be the range of time from the moment the user agent connected to the stream up to the latest frame that the user agent has obtained; however, if the user agent starts discarding earlier information, the actual range might be shorter.

In any case, the user agent must ensure that the earliest possible position (as defined below) using the established media timeline, is greater than or equal to zero.

The media timeline also has an associated clock. Which clock is used is user-agent defined, and may be media resource dependent, but it should approximate the user's wall clock.

Media elements have a current playback position, which must initially (i.e. in the absence of media data) be zero seconds. The current playback position is a time on the media timeline.

Media elements also have an official playback position, which must initially be set to zero seconds. The official playback position is an approximation of the current playback position that is kept stable while scripts are running.

Media elements also have a default playback start position, which must initially be set to zero seconds. This time is used to allow the element to be sought even before the media is loaded.

Each media element has a show poster flag. When a media element is created, this flag must be set to true. This flag is used to control when the user agent is to show a poster frame for a video element instead of showing the video contents.

The `currentTime` attribute must, on getting, return the media element's default playback start position, unless that is zero, in which case it must return the element's official playback position. The returned value must be expressed in seconds. On setting, if the media element's `readyState` is `HAVE NOTHING`, then it must set the media element's default playback start position to the new value; otherwise, it must set the official playback position to the new value and then `seek` to the new value. The new value must be interpreted as being in seconds.

If the media resource is a streaming resource, then the user agent might be unable to obtain certain parts of the resource after it has expired from its buffer. Similarly, some media resources might have a media timeline that doesn't start at zero. The earliest possible position is the earliest position in the stream or resource that the user agent can ever obtain again. It is also a time on the media timeline.
The earliest possible position\[^{428}\] is not explicitly exposed in the API; it corresponds to the start time of the first range in the seekable\[^{441}\] attribute's TimeRanges\[^{462}\] object, if any, or the current playback position\[^{442}\] otherwise.

When the earliest possible position\[^{428}\] changes, then: if the current playback position\[^{442}\] is before the earliest possible position\[^{428}\], the user agent must seek\[^{443}\] to the earliest possible position\[^{428}\]; otherwise, if the user agent has not fired a timeupdate\[^{464}\] event at the element in the past 15 to 250ms and is not still running event handlers for such an event, then the user agent must queue a media element task\[^{412}\] given the media element\[^{411}\] to fire an event named timeupdate\[^{464}\] at the element.

Because of the above requirement and the requirement in the resource fetch algorithm\[^{426}\] that kicks in when the metadata of the clip becomes known\[^{429}\], the current playback position\[^{442}\] can never be less than the earliest possible position\[^{428}\].

If at any time the user agent learns that an audio or video track has ended and all media data\[^{442}\] relating to that track corresponds to parts of the media timeline\[^{447}\] that are before the earliest possible position\[^{428}\], the user agent may queue a media element task\[^{442}\] given the media element\[^{411}\] to run these steps:

1. Remove the track from the audioTracks\[^{441}\] attribute's AudioTrackList\[^{442}\] object or the videoTracks\[^{441}\] attribute's VideoTrackList\[^{442}\] object as appropriate.
2. Fire an event named removetrack\[^{465}\] at the media element\[^{411}\]’s aforementioned AudioTrackList\[^{442}\] or VideoTrackList\[^{442}\] object, using TrackEvent\[^{463}\], with the track\[^{463}\] attribute initialized to the AudioTrack\[^{442}\] or VideoTrack\[^{442}\] object representing the track.

The duration attribute must return the time of the end of the media resource\[^{442}\], in seconds, on the media timeline\[^{447}\]. If no media data\[^{442}\] is available, then the attributes must return the Not-a-Number (NaN) value. If the media resource\[^{442}\] is not known to be bounded (e.g. streaming radio, or a live event with no announced end time), then the attribute must return the positive Infinity value.

The user agent must determine the duration of the media resource\[^{442}\] before playing any part of the media data\[^{442}\] and before setting readyState\[^{432}\] to a value greater than or equal to HAVE_METADATA\[^{438}\], even if doing so requires fetching multiple parts of the resource.

When the length of the media resource\[^{442}\] changes to a known value (e.g. from being unknown to known, or from a previously established length to a new length) the user agent must queue a media element task\[^{442}\] given the media element\[^{411}\] to fire an event named durationchange\[^{464}\] at the media element\[^{411}\]. (The event is not fired when the duration is reset as part of loading a new media resource.) If the duration is changed such that the current playback position\[^{442}\] ends up being greater than the time of the end of the media resource\[^{442}\], then the user agent must also seek\[^{443}\] to the time of the end of the media resource\[^{442}\].

If an "infinite" stream ends for some reason, then the duration would change from positive Infinity to the time of the last frame or sample in the stream, and the durationchange\[^{464}\] event would be fired. Similarly, if the user agent initially estimated the media resource\[^{442}\]’s duration instead of determining it precisely, and later revises the estimate based on new information, then the duration would change and the durationchange\[^{464}\] event would be fired.

Some video files also have an explicit date and time corresponding to the zero time in the media timeline\[^{447}\], known as the timeline offset. Initially, the timeline offset\[^{429}\] must be set to Not-a-Number (NaN).

The getStartDate() method must return a new Date object\[^{556}\] representing the current timeline offset\[^{429}\].

The loop attribute is a boolean attribute\[^{437}\] that, if specified, indicates that the media element\[^{411}\] is to seek back to the start of the media resource\[^{442}\] upon reaching the end.

The loop IDL attribute must reflect\[^{550}\] the content attribute of the same name.

4.8.11.7 Ready states\[^{442}\]

For web developers (non-normative)
**media.readyState**

Returns a value that expresses the current state of the element with respect to rendering the current playback position, from the codes in the list below.

**Media elements** have a `ready state`, which describes to what degree they are ready to be rendered at the current playback position. The possible values are as follows; the ready state of a media element at any particular time is the greatest value describing the state of the element:

**HAVE NOTHING** (numeric value 0)

No information regarding the media resource is available. No data for the current playback position is available. Media elements whose `networkState` attribute are set to `NETWORK_EMPTY` are always in the `HAVE NOTHING` state.

**HAVE_METADATA** (numeric value 1)

Enough of the resource has been obtained that the duration of the resource is available. In the case of a `video` element, the dimensions of the video are also available. No `media data` is available for the immediate current playback position.

**HAVE_CURRENT_DATA** (numeric value 2)

Data for the immediate current playback position is available, but either not enough data is available that the user agent could successfully advance the current playback position in the direction of playback at all without immediately reverting to the HAVE_METADATA state, or there is no more data to obtain in the direction of playback. For example, in video this corresponds to the user agent having data from the current frame, but not the next frame, when the current playback position is at the end of the current frame; and to when playback has ended.

**HAVE_FUTURE_DATA** (numeric value 3)

Data for the immediate current playback position is available, as well as enough data for the user agent to advance the current playback position in the direction of playback at least a little without immediately reverting to the HAVE_METADATA state, and the text tracks are ready. For example, in video this corresponds to the user agent having data for at least the current frame and the next frame when the current playback position is at the instant in time between the two frames, or to the user agent having the video data for the current frame and audio data to keep playing at least a little when the current playback position is in the middle of a frame. The user agent cannot be in this state if playback has ended, as the current playback position can never advance in this case.

**HAVE_ENOUGH_DATA** (numeric value 4)

All the conditions described for the HAVE_FUTURE_DATA state are met, and, in addition, either of the following conditions is also true:

- The user agent estimates that data is being fetched at a rate where the current playback position, if it were to advance at the element's playbackRate, would not overtake the available data before playback reaches the end of the media resource.
- The user agent has entered a state where waiting longer will not result in further data being obtained, and therefore nothing would be gained by delaying playback any further. (For example, the buffer might be full.)

In practice, the difference between HAVE_METADATA and HAVE_CURRENT_DATA is negligible. Really the only time the difference is relevant is when painting a video element onto a canvas, where it distinguishes the case where something will be drawn (HAVE_CURRENT_DATA or greater) from the case where nothing is drawn (HAVE_METADATA or less). Similarly, the difference between HAVE_CURRENT_DATA (only the current frame) and HAVE_FUTURE_DATA (at least this frame and the next) can be negligible (in the extreme, only one frame). The only time that distinction really matters is when a page provides an interface for "frame-by-frame" navigation.

When the ready state of a media element whose `networkState` is not `NETWORK_EMPTY` changes, the user agent must follow the steps given below:

1. Apply the first applicable set of substeps from the following list:

   → If the previous ready state was HAVE NOTHING and the new ready state is HAVE_METADATA

     Queue a media element task, given the media element to fire an event named loadedmetadata at the element.
If the previous ready state was **HAVE_METADATA** and the new ready state is **HAVE_CURRENT_DATA** or greater

If this is the first time this occurs for this **media element** since the **load()** algorithm was last invoked, the user agent must **queue a media element task** given the **media element** to **fire an event** named **loadeddata** at the element.

If the new ready state is **HAVE_FUTURE_DATA** or **HAVE_ENOUGH_DATA**, then the relevant steps below must then be run also.

If the previous ready state was **HAVE_FUTURE_DATA** or more, and the new ready state is **HAVE_CURRENT_DATA** or less

If the **media element** was **potentially playing** before its **readyState** attribute changed to a value lower than **HAVE_FUTURE_DATA**, and the element has not **ended playback**, and playback has not **stopped due to errors**, **paused for user interaction**, **paused for in-band content**, the user agent must **queue a media element task** given the **media element** to **fire an event** named **timeupdate** at the element, and **queue a media element task** given the **media element** to **fire an event** named **waiting** at the element.

If the new ready state is **HAVE_CURRENT_DATA** or less, and the new ready state is **HAVE_FUTURE_DATA**

The user agent must **queue a media element task** given the **media element** to **fire an event** named **canplay** at the element.

If the element's **paused** attribute is false, the user agent must **notify about playing** for the element.

If the new ready state is **HAVE_ENOUGH_DATA**

If the previous ready state was **HAVE_CURRENT_DATA** or less, the user agent must **queue a media element task** given the **media element** to **fire an event** named **canplay** and, if the element's **paused** attribute is false, **notify about playing** for the element.

The user agent must **queue a media element task** given the **media element** to **fire an event** named **canplaythrough** at the element.

If the element is not **eligible for autoplay**, then the user agent must abort these substeps.

The user agent may run the following substeps:

1. Set the **paused** attribute to false.
2. If the element's **show poster flag** is true, set it to false and run the **time marches on** steps.
3. **Queue a media element task** given the element to **fire an event** named **play** at the element.
4. **Notify about playing** for the element.

Alternatively, if the element is a **video** element, the user agent may start observing whether the element intersects the viewport. When the element starts intersecting the viewport, if the element is still **eligible for autoplay**, run the substeps above. Optionally, when the element stops intersecting the viewport, if the **can autoplay flag** is still true and the **autoplay** attribute is still specified, run the following substeps:

1. Run the **internal pause steps** and set the **can autoplay flag** to true.
2. **Queue a media element task** given the element to **fire an event** named **pause** at the element.

**Note**

The substeps for playing and pausing can run multiple times as the element starts or stops intersecting the viewport, as long as the **can autoplay flag** is true.

**Note**

User agents do not need to support autoplay, and it is suggested that user agents honor user preferences on the...
The `readyState` IDL attribute must, on getting, return the value described above that describes the current ready state of the `media` element.

The `autoplay` attribute is a `boolean` attribute. When present, the user agent (as described in the algorithm described herein) will automatically begin playback of the `media resource` as soon as it can do so without stopping.

**Note**

Authors are urged to use the `autoplay` attribute rather than using script to trigger automatic playback, as this allows the user to override the automatic playback when it is not desired, e.g. when using a screen reader. Authors are also encouraged to consider not using the automatic playback behavior at all, and instead to let the user agent wait for the user to start playback explicitly.

The `autoplay` IDL attribute must `reflect` the content attribute of the same name.

### 4.8.11.8 Playing the media resource

**For web developers (non-normative)**

`media.paused` ➡ Returns true if playback is paused; false otherwise.

`media.ended` ➡ Returns true if playback has reached the end of the `media resource`.

`media.defaultPlaybackRate` ➡ [ = value ]

Returns the default rate of playback, for when the user is not fast-forwarding or reversing through the `media resource`.

Can be set, to change the default rate of playback.

The default rate has no direct effect on playback, but if the user switches to a fast-forward mode, when they return to the normal playback mode, it is expected that the rate of playback will be returned to the default rate of playback.

`media.playbackRate` ➡ [ = value ]

Returns the current rate playback, where 1.0 is normal speed.

Can be set, to change the rate of playback.

`media.preservesPitch` ➡ Returns true if pitch-preserving algorithms are used when the `playbackRate` is not 1.0. The default value is true.

Can be set to false to have the `media resource`’s audio pitch change up or down depending on the `playbackRate`. This is useful for aesthetic and performance reasons.

`media.played` ➡ Returns a `TimeRanges` object that represents the ranges of the `media resource` that the user agent has played.

`media.play()` ➡ Sets the `paused` attribute to false, loading the `media resource` and beginning playback if necessary. If the playback had ended, will restart it from the start.

`media.pause()` ➡ Sets the `paused` attribute to true, loading the `media resource` if necessary.

The `paused` attribute represents whether the `media element` is paused or not. The attribute must initially be true.
A media element is a blocked media element if its `readyState` attribute is in the `HAVE NOTHING` state, the `HAVE_METADATA` state, or the `HAVE_CURRENT_DATA` state, or if the element has paused for user interaction or paused for in-band content.

A media element is said to be potentially playing when its `paused` attribute is false, the element has not ended playback, playback has not stopped due to errors, and the element is not a blocked media element.

A waiting DOM event can be fired as a result of an element that is potentially playing stopping playback due to its `readyState` attribute changing to a value lower than `HAVE FUTURE DATA`.

A media element is said to be eligible for autoplay when all of the following are true:

- its `can autoplay` flag is true;
- its `paused` attribute is true;
- it has an `autoplay` attribute specified;
- its node document’s active sandboxing flag set does not have the sandboxed automatic features browsing context flag set; and
- its node document is allowed to use the “autoplay” feature.

A media element is said to be allowed to play if the user agent and the system allow media playback in the current context.

A media element is said to have ended playback when:

- The element’s `readyState` attribute is `HAVE_METADATA` or greater, and
- Either:
  - The current playback position is the end of the media resource, and
  - The direction of playback is forwards, and
  - The media element does not have a `loop` attribute specified.

Or:

- The current playback position is the earliest possible position, and
- The direction of playback is backwards.

The ended attribute must return true if, the last time the event loop reached step 1, the media element had ended playback and the direction of playback was forwards, and false otherwise.

A media element is said to have stopped due to errors when the element’s `readyState` attribute is `HAVE_METADATA` or greater, and the user agent encounters a non-fatal error during the processing of the media data, and due to that error, is not able to play the content at the current playback position.

A media element is said to have paused for user interaction when its `paused` attribute is false, the `readyState` attribute is either `HAVE FUTURE DATA` or `HAVE ENOUGH DATA` and the user agent has reached a point in the media resource where the user has to make a selection for the resource to continue.

It is possible for a media element to have both ended playback and paused for user interaction at the same time.

When a media element that is potentially playing stops playing because it has paused for user interaction, the user agent must queue a media element task given the media element to fire an event named `timeupdate` at the element.

A media element is said to have paused for in-band content when its `paused` attribute is false, the `readyState` attribute is
either HAVE_FUTURE_DATA or HAVE_ENOUGH_DATA and the user agent has suspended playback of the media resource in order to play content that is temporally anchored to the media resource and has a nonzero length, or to play content that is temporally anchored to a segment of the media resource but has a length longer than that segment.

Example

One example of when a media element would be paused for in-band content is when the user agent is playing audio descriptions from an external WebVTT file, and the synthesized speech generated for a cue is longer than the time between the text track cue start time and the text track cue end time.

When the current playback position reaches the end of the media resource when the direction of playback is forwards, then the user agent must follow these steps:

1. If the media element has a loop attribute specified, then seek to the earliest possible position of the media resource and return.
2. As defined above, the ended IDL attribute starts returning true once the event loop returns to step 1.
3. Queue a media element task given the media element and the following steps:
   1. Fire an event named timeupdate at the media element.
   2. If the media element has ended playback, the direction of playback is forwards, and paused is false, then:
      1. Set the paused attribute to true.
      2. Fire an event named pause at the media element.
      3. Take pending play promises and reject pending play promises with the result and an "AbortError" DOMException.
   3. Fire an event named ended at the media element.

When the current playback position reaches the earliest possible position of the media resource when the direction of playback is backwards, then the user agent must only queue a media element task given the media element to fire an event named timeupdate at the element.

Example

The word "reaches" here does not imply that the current playback position needs to have changed during normal playback; it could be via seeking, for instance.

The defaultPlaybackRate attribute gives the desired speed at which the media resource is to play, as a multiple of its intrinsic speed. The attribute is mutable: on getting it must return the last value it was set to, or 1.0 if it hasn't yet been set; on setting the attribute must be set to the new value.

Example

The defaultPlaybackRate is used by the user agent when it exposes a user interface to the user.

The playbackRate attribute gives the effective playback rate, which is the speed at which the media resource plays, as a multiple of its intrinsic speed. If it is not equal to the defaultPlaybackRate, then the implication is that the user is using a feature such as fast forward or slow motion playback. The attribute is mutable: on getting it must return the last value it was set to, or 1.0 if it hasn't yet been set; on setting, the user agent must follow these steps:

1. If the given value is not supported by the user agent, then throw a "NotSupportedError" DOMException.
2. Set playbackRate to the new value, and if the element is potentially playing, change the playback speed.

When the defaultPlaybackRate or playbackRate attributes change value (either by being set by script or by being changed directly by the user agent, e.g. in response to user control) the user agent must queue a media element task given the media element to fire an event named ratechange at the media element. The user agent must process attribute changes smoothly and must not introduce any perceivable gaps or muting of playback in response.
The `preservesPitch` getter steps are to return true if a pitch-preserving algorithm is in effect during playback. The setter steps are to correspondingly switch the pitch-preserving algorithm on or off, without any perceivable gaps or muting of playback. By default, such a pitch-preserving algorithm must be in effect (i.e., the getter will initially return true).

The `played` attribute must return a new static `normalized TimeRanges object` that represents the ranges of points on the `media timeline` of the `media resource` reached through the usual monotonic increase of the `current playback position` during normal playback, if any, at the time the attribute is evaluated.

⚠️ Warning! Returning a new object each time is a bad pattern for attribute getters and is only enshrined here as it would be costly to change it. It is not to be copied to new APIs.

Each `media element` has a list of pending play promises, which must initially be empty.

To take pending play promises for a `media element`, the user agent must run the following steps:

1. Let `promises` be an empty list of promises.
2. Copy the `media element`'s list of pending play promises to `promises`.
3. Clear the `media element`'s list of pending play promises.
4. Return `promises`.

To resolve pending play promises for a `media element` with a list of promises `promises`, the user agent must resolve each promise in `promises` with undefined.

To reject pending play promises for a `media element` with a list of promises `promises` and an exception name `error`, the user agent must reject each promise in `promises` with `error`.

To notify about playing for a `media element`, the user agent must run the following steps:

1. Take pending play promises and let `promises` be the result.
2. Queue a media element task given the element and the following steps:
   1. Fire an event named `playing` at the element.
   2. Resolve pending play promises with `promises`.

When the `play()` method on a `media element` is invoked, the user agent must run the following steps.

1. If the `media element` is not allowed to play, then return a promise rejected with a "NotAllowedError" DOMException.
2. If the `media element`'s `error` attribute is not null and its code is `MEDIA_ERR_SRC_NOT_SUPPORTED`, then return a promise rejected with a "NotSupportedError" DOMException.

   Note
   This means that the dedicated media source failure steps have run. Playback is not possible until the media element load algorithm clears the `error` attribute.

3. Let `promise` be a new promise and append `promise` to the list of pending play promises.
4. Run the internal play steps for the `media element`.
5. Return `promise`.

The internal play steps for a `media element` are as follows:

1. If the `media element`'s `networkState` attribute has the value `NETWORK_EMPTY`, invoke the `media element`'s resource selection algorithm.
2. If the playback has ended and the direction of playback is forwards, seek to the earliest possible position of the `media resource`.
3. If the media element\(^{411}\)’s paused\(^{412}\) attribute is true, then:
   
   1. Change the value of paused\(^{412}\) to false.
   
   2. If the show poster flag\(^{428}\) is true, set the element’s show poster flag\(^{428}\) to false and run the time marches on\(^{437}\) steps.
   
   3. Queue a media element task\(^{412}\) given the media element\(^{411}\) to fire an event named play\(^{464}\) at the element.
   
   4. If the media element\(^{411}\)’s readyState\(^{432}\) attribute has the value HAVE NOTHING\(^{430}\), HAVE_METADATA\(^{430}\), or HAVE_CURRENT_DATA\(^{430}\), queue a media element task\(^{412}\) given the media element\(^{411}\) to fire an event named waiting\(^{434}\) at the element.

   Otherwise, the media element\(^{411}\)’s readyState\(^{432}\) attribute has the value HAVE_FUTURE_DATA\(^{430}\) or HAVE_ENOUGH_DATA\(^{430}\):
   
   - Notify about playing\(^{435}\) for the element.
   
4. Otherwise, if the media element\(^{411}\)’s readyState\(^{432}\) attribute has the value HAVE_FUTURE_DATA\(^{430}\) or HAVE_ENOUGH_DATA\(^{430}\), take pending play promises\(^{435}\) and queue a media element task\(^{412}\) given the media element\(^{411}\) to resolve pending play promises\(^{435}\) with the result.

5. Set the media element\(^{411}\)’s can autoplay flag\(^{415}\) to false.

When the pause() method is invoked, and when the user agent is required to pause the media element\(^{411}\), the user agent must run the following steps:

   1. If the media element\(^{411}\)’s networkState\(^{415}\) attribute has the value NETWORK_EMPTY\(^{415}\), invoke the media element\(^{411}\)’s resource selection algorithm\(^{417}\).
   
   2. Run the internal pause steps\(^{436}\) for the media element\(^{411}\).

The internal pause steps for a media element\(^{411}\) are as follows:

   1. Set the media element\(^{411}\)’s can autoplay flag\(^{415}\) to false.
   
   2. If the media element\(^{411}\)’s paused\(^{412}\) attribute is false, run the following steps:
      
      1. Change the value of paused\(^{412}\) to true.
      
      2. Take pending play promises\(^{435}\) and let promises be the result.
      
      3. Queue a media element task\(^{412}\) given the media element\(^{411}\) and the following steps:
         
         1. Fire an event named timeupdate\(^{464}\) at the element.
         
         2. Fire an event named pause\(^{464}\) at the element.
         
         3. Reject pending play promises\(^{435}\) with promises and an “AbortError” DOMException.
      
      4. Set the official playback position\(^{428}\) to the current playback position\(^{428}\).

If the element’s playbackRate\(^{434}\) is positive or zero, then the direction of playback is forwards. Otherwise, it is backwards.

When a media element\(^{411}\) is potentially playing\(^{433}\) and its Document\(^{412}\) is a fully active Document\(^{412}\), its current playback position\(^{428}\) must increase monotonically at the element’s playbackRate\(^{434}\) units of media time per unit time of the media timeline\(^{427}\)’s clock. (This specification always refers to this as an increase, but that increase could actually be a decrease if the element’s playbackRate\(^{434}\) is negative.)
Any time the user agent provides a stable state, the official playback position must be set to the current playback position.

While the direction of playback is backwards, any corresponding audio must be muted. While the element's playbackRate is so low or so high that the user agent cannot play audio usefully, the corresponding audio must also be muted. If the element's playbackRate is not 1.0 and preservesPitch is true, the user agent must apply pitch adjustment to preserve the original pitch of the audio. Otherwise, the user agent must speed up or slow down the audio without any pitch adjustment.

When a media element is potentially playing, its audio data played must be synchronized with the current playback position at the element's effective media volume. The user agent must play the audio from audio tracks that were enabled when the event loop last reached step 31107.

When a media element is not potentially playing, audio must not play for the element.

Media elements that are potentially playing while in a document must not play any video, but should play any audio component. Media elements must not stop playing just because all references to them have been removed; only once a media element is in a state where no further audio could ever be played by that element may the element be garbage collected.

Each media element has a list of newly introduced cues, which must be initially empty. Whenever a text track cue is added to the list of cues of a text track, that is in the list of text tracks for a media element, that cue must be added to the element's list of newly introduced cues. Whenever a text track cue is added to the list of text tracks for a media element, all of the cues in that text track's list of cues must be added to the media element's list of newly introduced cues. When a media element’s list of newly introduced cues has new cues added while the media element’s show poster flag is not set, then the user agent must run the time marches on steps.

When a text track cue is removed from the list of cues of a text track that is in the list of text tracks for a media element, and whenever a text track is removed from the list of text tracks for a media element, if the media element’s show poster flag is not set, then the user agent must run the time marches on steps.

When the current playback position of a media element changes (e.g. due to playback or seeking), the user agent must run the time marches on steps. To support use cases that depend on the timing accuracy of cue event firing, such as synchronizing captions with shot changes in a video, user agents should fire cue events as close as possible to their position on the media timeline, and ideally within 20 milliseconds. If the current playback position changes while the steps are running, then the user agent must wait for the steps to complete, and then must immediately rerun the steps. These steps are thus run as often as possible or needed.

If one iteration takes a long time, this can cause short duration cues to be skipped over as the user agent rushes ahead to “catch up”, so these cues will not appear in the activeCues list.

The time marches on steps are as follows:

1. Let current cues be a list of cues, initialized to contain all the cues of all the hidden or showing text tracks of the media element (not the disabled ones) whose start times are less than or equal to the current playback position and whose end times are greater than the current playback position.
2. Let other cues be a list of cues, initialized to contain all the cues of hidden and showing text tracks of the media element that are not present in current cues.

3. Let last time be the current playback position at the time this algorithm was last run for this media element, if this is not the first time it has run.

4. If the current playback position has, since the last time this algorithm was run, only changed through its usual monotonic increase during normal playback, then let missed cues be the list of cues in other cues whose start times are greater than or equal to last time and whose end times are less than or equal to the current playback position. Otherwise, let missed cues be an empty list.

5. Remove all the cues in missed cues that are also in the media element’s list of newly introduced cues, and then empty the element’s list of newly introduced cues.

6. If the time was reached through the usual monotonic increase of the current playback position during normal playback, and if the user agent has not fired a timeupdate event at the element in the past 15 to 250ms and is not still running event handlers for such an event, then the user agent must queue a media element task given the media element to fire an event named timeupdate at the element. (In the other cases, such as explicit seeks, relevant events get fired as part of the overall process of changing the current playback position.)

Note
The event thus is not to be fired faster than about 66Hz or slower than 4Hz (assuming the event handlers don’t take longer than 250ms to run). User agents are encouraged to vary the frequency of the event based on the system load and the average cost of processing the event each time, so that the UI updates are not any more frequent than the user agent can comfortably handle while decoding the video.

7. If all of the cues in current cues have their text track cue active flag set, none of the cues in other cues have their text track cue active flag set, and missed cues is empty, then return.

8. If the time was reached through the usual monotonic increase of the current playback position during normal playback, and there are cues in other cues that have their text track cue pause-on-exit flag set and that either have their text track cue active flag set or are also in missed cues, then immediately pause the media element.

Note
In the other cases, such as explicit seeks, playback is not paused by going past the end time of a cue, even if that cue has its text track cue pause-on-exit flag set.

9. Let events be a list of tasks, initially empty. Each task in this list will be associated with a text track, a text track cue, and a time, which are used to sort the list before the tasks are queued.

Let affected tracks be a list of text tracks, initially empty.

When the steps below say to prepare an event named event for a text track cue target with a time, the user agent must run these steps:

1. Let track be the text track with which the text track cue target is associated.

2. Create a task to fire an event named event at target.

3. Add the newly created task to events, associated with the time, the text track, track, and the text track cue target.

4. Add task to affected tracks.

10. For each text track cue in missed cues, prepare an event named enter for the TextTrackCue object with the text track cue start time.

11. For each text track cue in other cues that either has its text track cue active flag set or is in missed cues, prepare an event named exit for the TextTrackCue object with the later of the text track cue end time and the text track cue start time.

12. For each text track cue in current cues that does not have its text track cue active flag set, prepare an event named enter for the TextTrackCue object with the text track cue start time.

13. Sort the tasks in events in ascending time order (tasks with earlier times first).

Further sort tasks in events that have the same time by the relative text track cue order of the text track cues.
Finally, sort tasks in events that have the same time and same text track cue order by placing tasks that fire enter events before those that fire exit events.

14. Queue a media element task for each in events, in list order.

15. Sort affected tracks in the same order as the text tracks appear in the media element’s list of text tracks, and remove duplicates.

16. For each text track in affected tracks, in the list order, queue a media element task given the media element to fire an event named cuechange at the TextTrack object, and, if the text track has a corresponding track element, to then fire an event named cuechange at the track element as well.

17. Set the text track cue active flag of all the cues in the current cues, and unset the text track cue active flag of all the cues in the other cues.

18. Run the rules for updating the text track rendering of each of the text tracks in affected tracks that are showing, providing the text track’s text track language as the fallback language if it is not the empty string. For example, for text tracks based on WebVTT, the rules for updating the display of WebVTT text tracks.

For the purposes of the algorithm above, a text track cue is considered to be part of a text track only if it is listed in the text track list of cues, not merely if it is associated with the text track.

Note

If the media element’s node document stops being a fully active document, then the playback will stop until the document is active again.

When a media element is removed from a Document, the user agent must run the following steps:

1. Await a stable state, allowing the task that removed the media element from the Document to continue. The synchronous section consists of all the remaining steps of this algorithm. (Steps in the synchronous section are marked with ⌛.)

2. ⌛ If the media element is in a document, return.

3. ⌛ Run the internal pause steps for the media element.

4.8.11.9 Seeking

For web developers (non-normative)

media.seeking

Returns true if the user agent is currently seeking.

media.seekable

Returns a TimeRanges object that represents the ranges of the media resource to which it is possible for the user agent to seek.

media.fastSeek(time)

Seeks to near the given time as fast as possible, trading precision for speed. (To seek to a precise time, use the currentTime attribute.)

This does nothing if the media resource has not been loaded.

The seeking attribute must initially have the value false.

The fastSeek(time) method must seek to the time given by time, with the approximate-for-speed flag set.

When the user agent is required to seek to a particular new playback position in the media resource, optionally with the approximate-for-speed flag set, it means that the user agent must run the following steps. This algorithm interacts closely with the event loop mechanism; in particular, it has a synchronous section (which is triggered as part of the event loop algorithm). Steps in that section are marked with ⌛.
1. Set the `media element`'s `show poster flag` to false.

2. If the `media element`'s `readyState` is `HAVE NOTHING`, return.

3. If the element's `seeking` IDL attribute is true, then another instance of this algorithm is already running. Abort that other instance of the algorithm without waiting for the step that it is running to complete.

4. Set the `seeking` IDL attribute to true.

5. If the seek was in response to a DOM method call or setting of an IDL attribute, then continue the script. The remainder of these steps must be run in parallel. With the exception of the steps marked with ⌛, they could be aborted at any time by another instance of this algorithm being invoked.

6. If the new playback position is later than the end of the `media resource`, then let it be the end of the `media resource` instead.

7. If the new playback position is less than the earliest possible position, let it be that position instead.

8. If the (possibly now changed) new playback position is not in one of the ranges given in the `seekable` attribute, then let it be the position in one of the ranges given in the `seekable` attribute that is the nearest to the new playback position. If two positions both satisfy that constraint (i.e. the new playback position is exactly in the middle between two ranges in the `seekable` attribute) then use the position that is closest to the current playback position. If there are no ranges given in the `seekable` attribute then set the `seeking` IDL attribute to false and return.

9. If the approximate-for-speed flag is set, adjust the new playback position to a value that will allow for playback to resume promptly. If new playback position before this step is before current playback position, then the adjusted new playback position must also be before the current playback position. Similarly, if the new playback position before this step is after current playback position, then the adjusted new playback position must also be after the current playback position.

Example
For example, the user agent could snap to a nearby key frame, so that it doesn't have to spend time decoding then discarding intermediate frames before resuming playback.

10. Queue a media element task given the `media element` to fire an event named `seeking` at the element.

11. Set the current playback position to the new playback position.

   Note
   If the `media element` was potentially playing immediately before it started seeking, but seeking caused its `readyState` attribute to change to a value lower than `HAVE FUTURE DATA`, then a `waiting` event will be fired at the element.

   Note
   This step sets the current playback position, and thus can immediately trigger other conditions, such as the rules regarding when playback "reaches the end of the media resource" (part of the logic that handles looping), even before the user agent is actually able to render the media data for that position (as determined in the next step).

   Note
   The `currentTime` attribute returns the official playback position, not the current playback position, and therefore gets updated before script execution, separate from this algorithm.

12. Wait until the user agent has established whether or not the `media data` for the new playback position is available, and, if it is, until it has decoded enough data to play back that position.

13. Await a stable state. The synchronous section consists of all the remaining steps of this algorithm. (Steps in the synchronous section are marked with ⌛.)

14. ⌛ Set the `seeking` IDL attribute to false.

15. ⌛ Run the `time marches on` steps.

16. ⌛ Queue a media element task given the `media element` to fire an event named `timeupdate` at the element.

17. ⌛ Queue a media element task given the `media element` to fire an event named `seeked` at the element.
The `seekable` attribute must return a new static `TimeRanges` object that represents the ranges of the media resource, if any, that the user agent is able to seek to, at the time the attribute is evaluated.

**Note**

*If the user agent can seek to anywhere in the media resource, e.g. because it is a simple movie file and the user agent and the server support HTTP Range requests, then the attribute would return an object with one range, whose start is the time of the first frame (the earliest possible position, typically zero), and whose end is the same as the time of the first frame plus the duration attribute's value (which would equal the time of the last frame, and might be positive Infinity).*

**Note**

The range might be continuously changing, e.g. if the user agent is buffering a sliding window on an infinite stream. This is the behavior seen with DVRs viewing live TV, for instance.

⚠️ Warning!  

*Returning a new object each time is a bad pattern for attribute getters and is only enshrined here as it would be costly to change it. It is not to be copied to new APIs.*

User agents should adopt a very liberal and optimistic view of what is seekable. User agents should also buffer recent content where possible to enable seeking to be fast.

**Example**

For instance, consider a large video file served on an HTTP server without support for HTTP Range requests. A browser could implement this by only buffering the current frame and data obtained for subsequent frames, never allow seeking, except for seeking to the very start by restarting the playback. However, this would be a poor implementation. A high quality implementation would buffer the last few minutes of content (or more, if sufficient storage space is available), allowing the user to jump back and rewatch something surprising without any latency, and would in addition allow arbitrary seeking by reloading the file from the start if necessary, which would be slower but still more convenient than having to literally restart the video and watch it all the way through just to get to an earlier unbuffered spot.

Media resources might be internally scripted or interactive. Thus, a media element could play in a non-linear fashion. If this happens, the user agent must act as if the algorithm for seeking was used whenever the current playback position changes in a discontinuous fashion (so that the relevant events fire).

### 4.8.11.10 Media resources with multiple media tracks

A media resource can have multiple embedded audio and video tracks. For example, in addition to the primary video and audio tracks, a media resource could have foreign-language dubbed dialogues, director's commentaries, audio descriptions, alternative angles, or sign-language overlays.

For web developers (non-normative)

`media.audioTracks` returns an `AudioTrackList` object representing the audio tracks available in the media resource.

`media.videoTracks` returns a `VideoTrackList` object representing the video tracks available in the media resource.

The `audioTracks` attribute of a media element must return a `AudioTrackList` object representing the audio tracks available in the media element and media resource.

The `videoTracks` attribute of a media element must return a `VideoTrackList` object representing the video tracks available in the media element and media resource.

**Note**

There are only ever one `AudioTrackList` object and one `VideoTrackList` object per media element, even if another media resource is loaded into the element: the objects are reused. (The `AudioTrack` and `VideoTrack` objects are not, though.)
4.8.11.10.1 **AudioTrackList** and **VideoTrackList** objects

The **AudioTrackList** and **VideoTrackList** interfaces are used by attributes defined in the previous section.

```idl
interface AudioTrackList : EventTarget {
    readonly attribute unsigned long length;
    getter AudioTrack (unsigned long index);
    AudioTrack? getTrackById(DOMString id);

    attribute EventHandler onchange;
    attribute EventHandler onaddtrack;
    attribute EventHandler onremovetrack;
};

interface AudioTrack {
    readonly attribute DOMString id;
    readonly attribute DOMString kind;
    readonly attribute DOMString label;
    readonly attribute DOMString language;
    attribute boolean enabled;
};

interface VideoTrackList : EventTarget {
    readonly attribute unsigned long length;
    getter VideoTrack (unsigned long index);
    VideoTrack? getTrackById(DOMString id);
    readonly attribute long selectedIndex;

    attribute EventHandler onchange;
    attribute EventHandler onaddtrack;
    attribute EventHandler onremovetrack;
};

interface VideoTrack {
    readonly attribute DOMString id;
    readonly attribute DOMString kind;
    readonly attribute DOMString label;
    readonly attribute DOMString language;
    attribute boolean selected;
};
```

For web developers (non-normative)

**media.audioTracks**.length

**media.videoTracks**.length

Returns the number of tracks in the list.

```
audioTrack = media.audioTracks[index]
videoTrack = media.videoTracks[index]
```

Returns the specified **AudioTrack** or **VideoTrack** object.

```
audioTrack = media.audioTracks.getTrackById(id)
videoTrack = media.videoTracks.getTrackById(id)
```

Returns the **AudioTrack** or **VideoTrack** object with the given identifier, or null if no track has that identifier.

```
audioTrack.id
videoTrack.id
```

Returns the ID of the given track. This is the ID that can be used with a fragment if the format supports media fragment syntax.
An `AudioTrackList` object represents a dynamic list of zero or more audio tracks, of which zero or more can be enabled at a time. Each audio track is represented by an `AudioTrack` object.

A `VideoTrackList` object represents a dynamic list of zero or more video tracks, of which zero or one can be selected at a time. Each video track is represented by a `VideoTrack` object.

Tracks in `AudioTrackList` and `VideoTrackList` objects must be consistently ordered. If the media resource is in a format that defines an order, then that order must be used; otherwise, the order must be the relative order in which the tracks are declared in the media resource. The order used is called the natural order of the list.

The `AudioTrackList` length and `VideoTrackList` length attribute getters must return the number of tracks represented by their objects at the time of getting.

The supported property indices of `AudioTrackList` and `VideoTrackList` objects at any instant are the numbers from zero to the number of tracks represented by the respective object minus one, if any tracks are represented. If an `AudioTrackList` or `VideoTrackList` object represents no tracks, it has no supported property indices.

To determine the value of an indexed property for a given index in an `AudioTrackList` or `VideoTrackList` object list, the user agent must return the `AudioTrack` or `VideoTrack` object that represents the index-th track in list.

The `AudioTrackList` getTrackById(id) and `VideoTrackList` getTrackById(id) methods must return the first `AudioTrack` or `VideoTrack` object (respectively) in the `AudioTrackList` or `VideoTrackList` object (respectively) whose identifier is equal to the value of the id argument (in the natural order of the list, as defined above). When no tracks match the given argument, the methods must return null.

The `AudioTrack` and `VideoTrack` objects represent specific tracks of a media resource. Each track can have an identifier, category, label, and language. These aspects of a track are permanent for the lifetime of the track; even if a track is removed from a media resource's `AudioTrackList` or `VideoTrackList` objects, those aspects do not change.

In addition, `AudioTrack` objects can each be enabled or disabled; this is the audio track's enabled state. When an `AudioTrack` is enabled, it is part of the media resource's audio output. When it is disabled, it is not part of the output, and no audio is played from it.

### property

- **audioTrack.kind**
  - Returns the category the given track falls into. The possible track categories are given below.

- **videoTrack.kind**
  - Returns the category the given track falls into. The possible track categories are given below.

- **audioTrack.label**
  - Returns the label of the given track, if known, or the empty string otherwise.

- **videoTrack.label**
  - Returns the label of the given track, if known, or the empty string otherwise.

- **audioTrack.language**
  - Returns the language of the given track, if known, or the empty string otherwise.

- **videoTrack.language**
  - Returns the language of the given track, if known, or the empty string otherwise.

- **audioTrack.enabled [ = value ]**
  - Returns true if the given track is active, and false otherwise.
  - Can be set, to change whether the track is enabled or not. If multiple audio tracks are enabled simultaneously, they are mixed.

- **media.videoTracks.selectedIndex**
  - Returns the index of the currently selected track, if any, or −1 otherwise.

- **videoTrack.selected [ = value ]**
  - Returns true if the given track is active, and false otherwise.
  - Can be set, to change whether the track is selected or not. Either zero or one video track is selected; selecting a new track while a previous one is selected will unselect the previous one.

### Note

Each track in one of these objects thus has an index; the first has the index 0, and each subsequent track is numbered one higher than the previous one. If a media resource dynamically adds or removes audio or video tracks, then the indices of the tracks will change dynamically. If the media resource changes entirely, then all the previous tracks will be removed and replaced with new tracks.
created, its enabled state must be set to false (disabled). The resource fetch algorithm can override this.

Similarly, a single VideoTrack object per VideoTrackList object can be selected, this is the video track’s selection state. When a VideoTrack is created, its selection state must be set to false (not selected). The resource fetch algorithm can override this.

The AudioTrack id and VideoTrack id attributes must return the identifier of the track, if it has one, or the empty string otherwise. If the media resource is in a format that supports media fragment syntax, the identifier returned for a particular track must be the same identifier that would enable the track if used as the name of a track in the track dimension of such a fragment.

Example

For example, in Ogg files, this would be the Name header field of the track. [OGGSKELETONHEADERS]

The AudioTrack kind and VideoTrack kind attributes must return the category of the track, if it has one, or the empty string otherwise.

The category of a track is the string given in the first column of the table below that is the most appropriate for the track based on the definitions in the table’s second and third columns, as determined by the metadata included in the track in the media resource. The cell in the third column of a row says what the category given in the cell in the first column of that row applies to; a category is only appropriate for an audio track if it applies to audio tracks, and a category is only appropriate for video tracks if it applies to video tracks. Categories must only be returned for AudioTrack objects if they are appropriate for audio, and must only be returned for VideoTrack objects if they are appropriate for video.

For Ogg files, the Role header field of the track gives the relevant metadata. For DASH media resources, the Role element conveys the information. For WebM, only the FlagDefault element currently maps to a value. Sourcing In-band Media Resource Tracks from Media Containers into HTML has further details. [OGGSKELETONHEADERS] [DASH] [WEBMCG] [INBAND]

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
<th>Applies to...</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;alternative&quot;</td>
<td>A possible alternative to the main track, e.g. a different take of a song (audio), or a different angle (video).</td>
<td>Audio and video.</td>
<td>Ogg: &quot;audio/alternate&quot; or &quot;video/alternate&quot;; DASH: &quot;alternate&quot; without &quot;main&quot; and &quot;commentary&quot; roles, and, for audio, without the &quot;dub&quot; role (other roles ignored).</td>
</tr>
<tr>
<td>&quot;captions&quot;</td>
<td>A version of the main video track with captions burnt in. (For legacy content; new content would use text tracks.)</td>
<td>Video only.</td>
<td>DASH: &quot;caption&quot; and &quot;main&quot; roles together (other roles ignored).</td>
</tr>
<tr>
<td>&quot;descriptions&quot;</td>
<td>An audio description of a video track.</td>
<td>Audio only.</td>
<td>Ogg: &quot;audio/audiodesc&quot;.</td>
</tr>
<tr>
<td>&quot;main&quot;</td>
<td>The primary audio or video track.</td>
<td>Audio and video.</td>
<td>Ogg: &quot;audio/main&quot; or &quot;video/main&quot;; WebM: the FlagDefault element is set; DASH: &quot;main&quot; role without &quot;caption&quot;, &quot;subtitle&quot;, and &quot;dub&quot; roles (other roles ignored).</td>
</tr>
<tr>
<td>&quot;main-desc&quot;</td>
<td>The primary audio track, mixed with audio descriptions.</td>
<td>Audio only.</td>
<td>AC3 audio in MPEG-2 TS: bsmod=2 and full_svc=1.</td>
</tr>
<tr>
<td>&quot;sign&quot;</td>
<td>A sign-language interpretation of an audio track.</td>
<td>Audio only.</td>
<td>Ogg: &quot;video/sign&quot;.</td>
</tr>
<tr>
<td>&quot;subtitles&quot;</td>
<td>A version of the main video track with subtitles burnt in. (For legacy content; new content would use text tracks.)</td>
<td>Video only.</td>
<td>DASH: &quot;subtitle&quot; and &quot;main&quot; roles together (other roles ignored).</td>
</tr>
<tr>
<td>&quot;translation&quot;</td>
<td>A translated version of the main audio track.</td>
<td>Audio only.</td>
<td>Ogg: &quot;audio/dub&quot;. DASH: &quot;dub&quot; and &quot;main&quot; roles together (other roles ignored).</td>
</tr>
<tr>
<td>&quot;commentary&quot;</td>
<td>Commentary on the primary audio or video track, e.g. a director's commentary.</td>
<td>Audio and video.</td>
<td>DASH: &quot;commentary&quot; role without &quot;main&quot; role (other roles ignored).</td>
</tr>
<tr>
<td>** (empty string)</td>
<td>No explicit kind, or the kind given by the track's metadata is not recognized by the user agent.</td>
<td>Audio and video.</td>
<td></td>
</tr>
</tbody>
</table>

The AudioTrack label and VideoTrack label attributes must return the label of the track, if it has one, or the empty string otherwise. [INBAND]

The AudioTrack language and VideoTrack language attributes must return the BCP 47 language tag of the language of the track, if it has one, or the empty string otherwise. If the user agent is not able to express that language as a BCP 47 language tag (for example because the language information in the media resource’s format is a free-form string without a defined interpretation), then the method must return the empty string, as if the track had no language. [INBAND]
The `AudioTrack`\(^\text{443}\) enabled attribute, on getting, must return true if the track is currently enabled, and false otherwise. On setting, it must enable the track if the new value is true, and disable it otherwise. (If the track is no longer in an `AudioTrackList`\(^\text{442}\) object, then the track being enabled or disabled has no effect beyond changing the value of the attribute on the `AudioTrack`\(^\text{442}\) object.)

Whenever an audio track in an `AudioTrackList`\(^\text{442}\) that was disabled is enabled, and whenever one that was enabled is disabled, the user agent must `queue a media element task`\(^\text{412}\) given the `media element`\(^\text{411}\) to fire an event named `change`\(^\text{465}\) at the `AudioTrackList`\(^\text{442}\) object.

An audio track that has no data for a particular position on the `media timeline`\(^\text{427}\), or that does not exist at that position, must be interpreted as being silent at that point on the timeline.

The `VideoTrackList`\(^\text{442}\) `selectedIndex` attribute must return the index of the currently selected track, if any. If the `VideoTrackList`\(^\text{442}\) object does not currently represent any tracks, or if none of the tracks are selected, it must instead return \(-1\).

The `VideoTrack`\(^\text{442}\) selected attribute, on getting, must return true if the track is currently selected, and false otherwise. On setting, it must select the track if the new value is true, and unselect it otherwise. If the track is in a `VideoTrackList`\(^\text{442}\), then all the other `VideoTrack`\(^\text{442}\) objects in that list must be unselected. (If the track is no longer in a `VideoTrackList`\(^\text{442}\) object, then the track being selected or unselected has no effect beyond changing the value of the attribute on the `VideoTrack`\(^\text{442}\) object.)

Whenever a track in a `VideoTrackList`\(^\text{442}\) that was previously not selected is selected, and whenever the selected track in a `VideoTrackList`\(^\text{442}\) is unselected without a new track being selected in its stead, the user agent must `queue a media element task`\(^\text{412}\) given the `media element`\(^\text{411}\) to fire an event named `change`\(^\text{465}\) at the `VideoTrackList`\(^\text{442}\) object. This task\(^\text{4105}\) must be `queued`\(^\text{4107}\) before the task\(^\text{4105}\) that fires the `resize`\(^\text{464}\) event, if any.

A video track that has no data for a particular position on the `media timeline`\(^\text{427}\) must be interpreted as being `transparent black` at that point on the timeline, with the same dimensions as the last frame before that position, or, if the position is before all the data for that track, the same dimensions as the first frame for that track. A track that does not exist at all at the current position must be treated as if it existed but had no data.

**Example**

For instance, if a video has a track that is only introduced after one hour of playback, and the user selects that track then goes back to the start, then the user agent will act as if that track started at the start of the `media resource`\(^\text{412}\) but was simply transparent until one hour in.

The following are the `event handlers`\(^\text{5117}\) (and their corresponding `event handler event types`\(^\text{5120}\)) that must be supported, as `event handler IDL attributes`\(^\text{5118}\), by all objects implementing the `AudioTrackList`\(^\text{442}\) and `VideoTrackList`\(^\text{442}\) interfaces:

<table>
<thead>
<tr>
<th>Event handler(^\text{5115})</th>
<th>Event handler event type(^\text{5120})</th>
</tr>
</thead>
<tbody>
<tr>
<td>onchange(^\text{5129})</td>
<td><code>change</code>(^\text{465})</td>
</tr>
<tr>
<td>onaddtrack(^\text{5129})</td>
<td><code>addtrack</code>(^\text{465})</td>
</tr>
<tr>
<td>onremovetrack(^\text{5129})</td>
<td><code>removetrack</code>(^\text{465})</td>
</tr>
</tbody>
</table>

4.8.11.10.2 Selecting specific audio and video tracks declaratively \(^\text{1946}\)

The `audioTracks`\(^\text{5441}\) and `videoTracks`\(^\text{5441}\) attributes allow scripts to select which track should play, but it is also possible to select specific tracks declaratively, by specifying particular tracks in the `fragment` of the `URL` of the `media resource`\(^\text{412}\). The format of the `fragment` depends on the `MIME type` of the `media resource`\(^\text{412}\), [RFC2046]\(^\text{1946}\) [URL]\(^\text{1942}\).

**Example**

In this example, a video that uses a format that supports `media fragment syntax` is embedded in such a way that the alternative angles labeled "Alternative" are enabled instead of the default video track.

```html
<video src="myvideo#track=Alternative"></video>
```
4.8.11 Timed text tracks

4.8.11.1 Text track model

A media element can have a group of associated text tracks, known as the media element’s list of text tracks. The text tracks are sorted as follows:

1. The text tracks corresponding to track element children of the media element, in tree order.
2. Any text tracks added using the addTextTrack() method, in the order they were added, oldest first.
3. Any media-resource-specific text tracks (text tracks corresponding to data in the media resource), in the order defined by the media resource’s format specification.

A text consists of:

The kind of text track

This decides how the track is handled by the user agent. The kind is represented by a string. The possible strings are:

- subtitles
- captions
- descriptions
- chapters
- metadata

The kind of track can change dynamically, in the case of a text corresponding to a track element.

A label

This is a human-readable string intended to identify the track for the user.

The label of a track can change dynamically, in the case of a text corresponding to a track element.

When a text label is the empty string, the user agent should automatically generate an appropriate label from the text track’s other properties (e.g. the kind of text track and the text track’s language) for use in its user interface. This automatically-generated label is not exposed in the API.

An in-band metadata track dispatch type

This is a string extracted from the media resource specifically for in-band metadata tracks to enable such tracks to be dispatched to different scripts in the document.

Example

For example, a traditional TV station broadcast streamed on the web and augmented with web-specific interactive features could include text tracks with metadata for ad targeting, trivia game data during game shows, player states during sports games, recipe information during food programs, and so forth. As each program starts and ends, new tracks might be added or removed from the stream, and as each one is added, the user agent could bind them to dedicated script modules using the value of this attribute.

Other than for in-band metadata text tracks, the in-band metadata track dispatch type is the empty string. How this value is populated for different media formats is described in steps to expose a media-resource-specific text track.

A language

This is a string (a BCP 47 language tag) representing the language of the text track’s cues. [BCP47]

The language of a text track can change dynamically, in the case of a text corresponding to a track element.

A readiness state

One of the following:

Not loaded

Indicates that the text track’s cues have not been obtained.

Loading

Indicates that the text track is loading and there have been no fatal errors encountered so far. Further cues might still be added to the track by the parser.
**Loaded**  
Indicates that the text track has been loaded with no fatal errors.

**Failed to load**  
Indicates that the text track was enabled, but when the user agent attempted to obtain it, this failed in some way (e.g., URL could not be parsed, network error, unknown text track format). Some or all of the cues are likely missing and will not be obtained.

The readiness state of a text track changes dynamically as the track is obtained.

**A mode**  
One of the following:

- **Disabled**  
Indicates that the text track is not active. Other than for the purposes of exposing the track in the DOM, the user agent is ignoring the text track. No cues are active, no events are fired, and the user agent will not attempt to obtain the track's cues.

- **Hidden**  
Indicates that the text track is active, but that the user agent is not actively displaying the cues. If no attempt has yet been made to obtain the track's cues, the user agent will perform such an attempt momentarily. The user agent is maintaining a list of which cues are active, and events are being fired accordingly.

- **Showing**  
Indicates that the text track is active. If no attempt has yet been made to obtain the track's cues, the user agent will perform such an attempt momentarily. The user agent is maintaining a list of which cues are active, and events are being fired accordingly. In addition, for text tracks whose kind is subtitles or captions, the cues are being overlaid on the video as appropriate; for text tracks whose kind is descriptions, the user agent is making the cues available to the user in a non-visual fashion; and for text tracks whose kind is chapters, the user agent is making available to the user a mechanism by which the user can navigate to any point in the media resource by selecting a cue.

**A list of zero or more cues**  
A list of text track cues, along with rules for updating the text track rendering. For example, for WebVTT, the rules for updating the display of WebVTT text tracks.

The list of cues of a text track can change dynamically, either because the text track has not yet been loaded or is still loading, or due to DOM manipulation.

Each text track has a corresponding TextTrack object.

Each media element has a list of pending text tracks, which must initially be empty, a blocked-on-parser flag, which must initially be false, and a did-perform-automatic-track-selection flag, which must also initially be false.

When the user agent is required to populate the list of pending text tracks of a media element, the user agent must add to the element's list of text tracks each text track in the element's list of text tracks whose text track mode is not disabled and whose text track readiness state is loading.

Whenever a track element's parent node changes, the user agent must remove the corresponding text track from any list of pending text tracks that it is in.

Whenever a text track's text track readiness state changes to either loaded or failed to load, the user agent must remove it from any list of pending text tracks that it is in.

When a media element is created by an HTML parser or XML parser, the user agent must set the element's blocked-on-parser flag to true. When a media element is popped off the stack of open elements of an HTML parser or XML parser, the user agent must honor user preferences for automatic text track selection, populate the list of pending text tracks, and set the element's blocked-on-parser flag to false.

The text tracks of a media element are ready when both the element's list of pending text tracks is empty and the element's blocked-on-parser flag is false.

Each media element has a pending text track change notification flag, which must initially be unset.

Whenever a text track that is in a media element's list of text tracks has its text track mode change value, the user agent...
must run the following steps for the media element:

1. If the media element’s pending text track change notification flag is set, return.
2. Set the media element’s pending text track change notification flag.
3. Queue a media element task given the media element to run these steps:
   1. Unset the media element’s pending text track change notification flag.
   2. Fire an event named change at the media element’s textTracks attribute’s TextTrackList object.
4. If the media element’s show poster flag is not set, run the time marches on steps.

The task source for the tasks listed in this section is the DOM manipulation task source.

A text track cue is the unit of time-sensitive data in a text track, corresponding for instance for subtitles and captions to the text that appears at a particular time and disappears at another time.

Each text track cue consists of:

An identifier
   An arbitrary string.

A start time
   The time, in seconds and fractions of a second, that describes the beginning of the range of the media data to which the cue applies.

An end time
   The time, in seconds and fractions of a second, that describes the end of the range of the media data to which the cue applies, or positive Infinity for an unbounded text track cue.

A pause-on-exit flag
   A boolean indicating whether playback of the media resource is to pause when the end of the range to which the cue applies is reached.

Some additional format-specific data
   Additional fields, as needed for the format, including the actual data of the cue. For example, WebVTT has a text track cue writing direction and so forth. [WEBVTT]

An unbounded text track cue is a text track cue with a text track cue end time set to positive Infinity. An active unbounded text track cue cannot become inactive through the usual monotonic increase of the current playback position during normal playback (e.g. a metadata cue for a chapter in a live event with no announced end time.)

Note
   The text track cue start time and text track cue end time can be negative. (The current playback position can never be negative, though, so cues entirely before time zero cannot be active.)

Each text track cue has a corresponding TextTrackCue object (or more specifically, an object that inherits from TextTrackCue — for example, WebVTT cues use the VTT Cue interface). A text track cue’s in-memory representation can be dynamically changed through this TextTrackCue API. [WEBVTT]

A text track cue is associated with rules for updating the text track rendering, as defined by the specification for the specific kind of text track cue. These rules are used specifically when the object representing the cue is added to a TextTrack object using the addCue() method.

In addition, each text track cue has two pieces of dynamic information:

The active flag
   This flag must be initially unset. The flag is used to ensure events are fired appropriately when the cue becomes active or inactive, and to make sure the right cues are rendered.

   The user agent must synchronously unset this flag whenever the text track cue is removed from its text track’s text track list.
of cues [p447]; whenever the text track [p446] itself is removed from its media element [p441]'s list of text tracks [p446] or has its text track mode [p447] changed to disabled [p447]; and whenever the media element [p441]'s readyState [p443] is changed back to HAVE NOTHING [p443]. When the flag is unset in this way for one or more cues in text tracks [p446] that were showing [p447] prior to the relevant incident, the user agent must, after having unset the flag for all the affected cues, apply the rules for updating the text track rendering [p447], of those text tracks [p446]. For example, for text tracks [p446] based on WebVTT, the rules for updating the display of WebVTT text tracks, [WEBVTT] [p1464]

The display state
This is used as part of the rendering model, to keep cues in a consistent position. It must initially be empty. Whenever the text track cue active flag [p446] is unset, the user agent must empty the text track cue display state [p446].

The text track cues [p448] of a media element [p441]'s text tracks [p446] are ordered relative to each other in the text track cue order, which is determined as follows: first group the cues [p448] by their text track [p446], with the groups being sorted in the same order as their text tracks [p446] appear in the media element [p441]'s list of text tracks [p446]; then, within each group, cues [p448] must be sorted by their startTime [p448], earliest first; then, any cues [p448] with the same startTime [p448] must be sorted by their endTime [p448], latest first; and finally, any cues [p448] with identical endTime [p448] must be sorted in the order they were last added to their respective text track list of cues [p447], oldest first (so e.g. for cues from a WebVTT file, that would initially be the order in which the cues were listed in the file). [WEBVTT] [p1464]

4.8.11.12 Sourcing in-band text tracks [p449]

A media-resource-specific text track is a text track [p446] that corresponds to data found in the media resource [p442].

Rules for processing and rendering such data are defined by the relevant specifications, e.g. the specification of the video format if the media resource [p442] is a video. Details for some legacy formats can be found in Sourcing In-band Media Resource Tracks from Media Containers into HTML, [INBAND] [p1460].

When a media resource [p442] contains data that the user agent recognizes and supports as being equivalent to a text track [p446], the user agent runs [p427] the steps to expose a media-resource-specific text track with the relevant data, as follows.

1. Associate the relevant data with a new text track [p446] and its corresponding new TextTrack [p451] object. The text track [p446] is a media-resource-specific text track [p449].
2. Set the new text track [p446]'s kind [p446], label [p446], and language [p446] based on the semantics of the relevant data, as defined by the relevant specification. If there is no label in that data, then the label [p446] must be set to the empty string.
3. Associate the text track list of cues [p447] with the rules for updating the text track rendering [p447] appropriate for the format in question.
4. If the new text track [p446]'s kind [p446] is chapters [p446] or metadata [p446], then set the text track in-band metadata track dispatch type [p446] as follows, based on the type of the media resource [p442]:
   - If the media resource [p442] is an Ogg file
     The text track in-band metadata track dispatch type [p446] must be set to the value of the Name header field. [OGGSKELETONHEADERS] [p1460]
   - If the media resource [p442] is a WebM file
     The text track in-band metadata track dispatch type [p446] must be set to the value of the CodecID element. [WEBMCG] [p1463]
   - If the media resource [p442] is an MPEG-2 file
     Let stream type be the value of the "stream_type" field describing the text track's type in the file's program map section, interpreted as an 8-bit unsigned integer. Let length be the value of the "ES_info_length" field for the track in the same part of the program map section, interpreted as an integer as defined by Generic coding of moving pictures and associated audio information. Let descriptor bytes be the length bytes following the "ES_info_length" field. The text track in-band metadata track dispatch type [p446] must be set to the concatenation of the stream type byte and the zero or more descriptor bytes bytes, expressed in hexadecimal using ASCII upper hex digits. [MPEG2] [p1460]
   - If the media resource [p442] is an MPEG-4 file
     Let the first stsd box of the first stbl box of the first minf box of the first metadata track box in the first moov box of the file be the stsd box, if any. If the file has no stsd box, or if the stsd box has neither a mett box nor a metx box, then the text track in-band metadata track dispatch type [p446] must be set to the empty string. Otherwise, if the stsd box has a mett box then the text track in-band metadata track dispatch type [p446] must be set to the concatenation of the string "mett", a U+0020 SPACE character, and the value of the first mime_format field of the
first `mett` box of the `stsd` box, or the empty string if that field is absent in that box. Otherwise, if the `stsd` box has no `mett` box but has a `metx` box then the `text track in-band metadata track dispatch type`[^446] must be set to the concatenation of the string "metx", a U+0020 SPACE character, and the value of the first namespace field of the first `metx` box of the `stsd` box, or the empty string if that field is absent in that box. [MPEG4]^{p1460}

5. Populate the new `text track[^446]`'s `list of cues[^447]` with the cues parsed so far, following the guidelines for exposing cues[^453], and begin updating it dynamically as necessary.


7. Set the new `text track[^446]`'s `mode[^447]` to the mode consistent with the user's preferences and the requirements of the relevant specification for the data.

Note

For instance, if there are no other active subtitles, and this is a forced subtitle track (a subtitle track giving subtitles in the audio track's primary language, but only for audio that is actually in another language), then those subtitles might be activated here.


4.8.11.11.3 Sourcing out-of-band text tracks

When a `track[^408]` element is created, it must be associated with a new `text track[^446]` (with its value set as defined below) and its corresponding new `TextTrack[^453]` object.

The `text track kind[^446]` is determined from the state of the element's `kind[^449]` attribute according to the following table; for a state given in a cell of the first column, the `kind[^446]` is the string given in the second column:

<table>
<thead>
<tr>
<th>State</th>
<th>String</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtitles[^469]</td>
<td>subtitles[^469]</td>
</tr>
<tr>
<td>Captions[^469]</td>
<td>captions[^469]</td>
</tr>
<tr>
<td>Descriptions[^469]</td>
<td>descriptions[^469]</td>
</tr>
<tr>
<td>Chapters metadata[^450]</td>
<td>chapters[^453]</td>
</tr>
<tr>
<td>Metadata[^469]</td>
<td>metadata[^469]</td>
</tr>
</tbody>
</table>

The `text track label[^446]` is the element's `track label[^410]`.

The `text track language[^446]` is the element's `track language[^409]`, if any, or the empty string otherwise.

As the `kind[^449]`, `label[^409]`, and `srclang[^409]` attributes are set, changed, or removed, the `text track[^446]` must update accordingly, as per the definitions above.

Note

Changes to the `track URL[^409]` are handled in the algorithm below.


The `text track list of cues[^447]` is initially empty. It is dynamically modified when the referenced file is parsed. Associated with the list are the rules for updating the `text track rendering[^447]`, appropriate for the format in question; for WebVTT, this is the rules for updating the display of WebVTT text tracks. [WEBVTT][p1464]


When a `track[^408]` element's parent element changes and the old parent was a `media element[^411]`, then the user agent must remove the `track[^408]` element's corresponding `text track[^446]` from the `media element[^411]`'s `list of text tracks[^446]`, and then `queue a media element task[^412]` given the `media element[^411]`. [WEBVTT][p1464]
element task\(^{447}\) given the media element\(^{411}\) to fire an event named removeTrack\(^{465}\) at the media element\(^{411}\)'s TextTrackList\(^{453}\) attribute's TextTrackList\(^{453}\) object, using TrackEvent\(^{463}\), with the track\(^{463}\) attribute initialized to the text track\(^{446}\)'s TextTrack\(^{454}\) object.

When a text track\(^{446}\) corresponding to a track\(^{408}\) element is added to a media element\(^{411}\)'s list of text tracks\(^{446}\), the user agent must queue a media element task\(^{413}\) given the media element\(^{411}\) to run the following steps for the media element\(^{411}\):

1. If the element's blocked-on-parser\(^{447}\) flag is true, then return.
2. If the element's did-perform-automatic-track-selection\(^{447}\) flag is true, then return.
3. Honor user preferences for automatic text track selection\(^{465}\) for this element.

When the user agent is required to honor user preferences for automatic text track selection\(^{451}\) for a media element\(^{411}\), the user agent must run the following steps:

1. Perform automatic text track selection\(^{451}\) for subtitles\(^{446}\) and captions\(^{446}\).
2. Perform automatic text track selection\(^{451}\) for descriptions\(^{446}\).
3. If there are any text tracks\(^{446}\) in the media element\(^{411}\)'s list of text tracks\(^{446}\) whose text track kind\(^{446}\) is chapters\(^{446}\) or metadata\(^{446}\) that correspond to track\(^{408}\) elements with a default\(^{410}\) attribute set whose text track mode\(^{444}\) is set to disabled\(^{447}\), then set the text track mode\(^{444}\) of all such tracks to hidden\(^{447}\).
4. Set the element's did-perform-automatic-track-selection\(^{447}\) flag to true.

When the steps above say to perform automatic text track selection\(^{451}\) for one or more text track kinds\(^{446}\), it means to run the following steps:

1. Let candidates be a list consisting of the text tracks\(^{446}\) in the media element\(^{411}\)'s list of text tracks\(^{446}\) whose text track kind\(^{446}\) is one of the kinds that were passed to the algorithm, if any, in the order given in the list of text tracks\(^{446}\).
2. If candidates is empty, then return.
3. If any of the text tracks\(^{446}\) in candidates have a text track mode\(^{447}\) set to showing\(^{447}\), return.
4. If the user has expressed an interest in having a track from candidates enabled based on its text track\(^{446}\), text track\(^{446}\), text track\(^{446}\), and text track label\(^{446}\), then set its text track mode\(^{444}\) to showing\(^{447}\).

**Note**

*For example, the user could have set a browser preference to the effect of "I want French captions whenever possible", or "If there is a subtitle track with 'Commentary' in the title, enable it", or "If there are audio description tracks available, enable one, ideally in Swiss German, but failing that in Standard Swiss German or Standard German".*

Otherwise, if there are any text tracks\(^{446}\) in candidates that correspond to track\(^{408}\) elements with a default\(^{410}\) attribute set whose text track mode\(^{447}\) is set to disabled\(^{447}\), then set the text track mode\(^{447}\) of the first such track to showing\(^{447}\).

When a text track\(^{446}\) corresponding to a track\(^{408}\) element experiences any of the following circumstances, the user agent must start the track processing model\(^{451}\) for that text track\(^{446}\) and its track\(^{408}\) element:

- The track\(^{408}\) element is created.
- The text track\(^{446}\) has its text track mode\(^{447}\) changed.
- The track\(^{408}\) element's parent element changes and the new parent is a media element\(^{411}\).

When a user agent is to start the track processing model\(^{451}\) for a text track\(^{446}\) and its track\(^{408}\) element, it must run the following algorithm. This algorithm interacts closely with the event loop\(^{410}\) mechanism; in particular, it has a synchronous section\(^{411}\) (which is triggered as part of the event loop\(^{110}\) algorithm). The steps in that section are marked with ⌛.

1. If another occurrence of this algorithm is already running for this text track\(^{446}\) and its track\(^{408}\) element, return, letting that other algorithm take care of this element.
2. If the text track\(^{446}\)'s text track mode\(^{447}\) is not set to one of hidden\(^{447}\) or showing\(^{447}\), then return.
3. If the text track\(^{446}\)'s track\(^{408}\) element does not have a media element\(^{411}\) as a parent, return.
4. Run the remainder of these steps \textit{in parallel}, allowing whatever caused these steps to run to continue.

5. \textit{Top: Await a stable state}. The \textit{synchronous section} consists of the following steps. (The steps in the \textit{synchronous section} are marked with \(\square\).)

6. \(\square\) Set the \textit{text track readiness state} to \textit{loading}.

7. \(\square\) Let URL be the \textit{track URL} of the \textit{track} element.

8. \(\square\) If the \textit{track} element's parent is a \textit{media element}, then let corsAttributeState be the state of the parent \textit{media element}’s \textit{crossorigin} content attribute. Otherwise, let corsAttributeState be \textit{No CORS}.

9. End the \textit{synchronous section}, continuing the remaining steps \textit{in parallel}.

10. If URL is not the empty string, then:

    1. Let request be the result of \textit{creating a potential-CORS request}, given URL, "track", and corsAttributeState, and with the same-origin fallback flag set.

    2. Set request's \textit{client} to the \textit{track} element's \textit{node document}’s \textit{relevant settings object}.

    3. Set request's \textit{initiator type} to "track".

    4. \textit{Fetch} request.

The \textit{tasks} by the fetching algorithm on the \textit{networking task source} to process the data as it is being fetched must determine the type of the resource. If the type of the resource is not a supported text track format, the load will fail, as described below. Otherwise, the resource's data must be passed to the appropriate parser (e.g., the \textit{WebVTT parser}) as it is received, with the \textit{text track list of cues} being used for that parser's output. [WEBVTT]

\textbf{Note}

The appropriate parser will incrementally update the \textit{text track list of cues} during these \textit{networking task source} \textit{tasks}, as each such task is run with whatever data has been received from the network.

This specification does not currently say whether or how to check the MIME types of text tracks, or whether or how to perform file type sniffing using the actual file data. Implementers differ in their intentions on this matter and it is therefore unclear what the right solution is. In the absence of any requirement here, the HTTP specifications' strict requirement to follow the Content-Type header prevails ("Content-Type specifies the media type of the underlying data."

"If and only if the media type is not given by a Content-Type field, the recipient MAY attempt to guess the media type via inspection of its content and/or the name extension(s) of the URI used to identify the resource.")

If fetching fails for any reason (network error, the server returns an error code, CORS fails, etc.), or if URL is the empty string, then \textit{queue an element task} on the \textit{DOM manipulation task source} given the \textit{media element} to first change the \textit{text track readiness state} to \textit{failed to load} and then \textit{fire an event} named \textit{error} at the \textit{track} element.

If fetching does not fail, but the type of the resource is not a supported text track format, or the file was not successfully processed (e.g., the format in question is an XML format and the file contained a well-formedness error that XML requires be detected and reported to the application), then the \textit{task} that is \textit{queued} on the \textit{networking task source}, in which the aforementioned problem is found must change the \textit{text track readiness state} to \textit{failed to load} and \textit{fire an event} named \textit{error} at the \textit{track} element.

If fetching does not fail, and the file was successfully processed, then the final \textit{task} that is \textit{queued} by the \textit{networking task source}, after it has finished parsing the data, must change the \textit{text track readiness state} to \textit{loaded}, and \textit{fire an event} named \textit{load} at the \textit{track} element.

If, while fetching is ongoing, either:

- the \textit{track URL} changes so that it is no longer equal to URL, while the \textit{text track mode} is set to \textit{hidden}, or showing, or
- the \textit{text track mode} changes to \textit{hidden}, or showing, while the \textit{track URL} is not equal to URL

...then the user agent must abort \textit{fetching}, discarding any pending \textit{tasks} generated by that algorithm (and in particular, not adding any cues to the \textit{text track list of cues} after the moment the URL changed), and then \textit{queue an element} on the \textit{DOM manipulation task source} given the \textit{track} element that first changes the \textit{text track readiness state} to \textit{failed to load} and then \textit{fires an event} named \textit{error} at the \textit{track} element.
11. Wait until the text track readiness state is no longer set to loading.

12. Wait until the track URL is no longer equal to URL, at the same time as the text track mode is set to hidden or showing.

13. Jump to the step labeled top.

Whenever a track element has its src attribute set, changed, or removed, the user agent must immediately empty the element’s text track’s text track list of cues. (This also causes the algorithm above to stop adding cues from the resource being obtained using the previously given URL, if any.)

4.8.11.4 Guidelines for exposing cues in various formats as text track cues

How a specific format’s text track cues are to be interpreted for the purposes of processing by an HTML user agent is defined by that format. In the absence of such a specification, this section provides some constraints within which implementations can attempt to consistently expose such formats.

To support the text model of HTML, each unit of timed data is converted to a text track cue. Where the mapping of the format’s features to the aspects of a text track cue as defined in this specification are not defined, implementations must ensure that the mapping is consistent with the definitions of the aspects of a text track cue as defined above, as well as with the following constraints:

The text track cue identifier

Should be set to the empty string if the format has no obvious analogue to a per-cue identifier.

The text track cue pause-on-exit flag

Should be set to false.

4.8.11.5 Text track API

A TextTrackList object represents a dynamically updating list of text tracks in a given order.

For web developers (non-normative)

media.textTracks.length

Returns the number of text tracks associated with the media element (e.g. from track elements). This is the number of text tracks in the media element’s list of text tracks.

media.textTracks[n]

Returns the TextTrack object representing the nth text track in the media element’s list of text tracks.

textTrack = media.textTracks.getTrackById(id)

Returns the TextTrack object with the given identifier, or null if no track has that identifier.
The supported property indices of a `TextTrackList` object at any instant are the numbers from zero to the number of text tracks in the list represented by the `TextTrackList` object minus one, if any. If there are no text tracks in the list, there are no supported property indices.

To determine the value of an indexed property of a `TextTrackList` object for a given index, the user agent must return the indexth text track in the list represented by the `TextTrackList` object.

The `getTrackById(id)` method must return the first `TextTrack` in the `TextTrackList` object whose `id` IDL attribute would return a value equal to the value of the `id` argument. When no tracks match the given argument, the method must return null.

```idl
def TextTrackMode = { "disabled", "hidden", "showing" };  
def TextTrackKind = { "subtitles", "captions", "descriptions", "chapters", "metadata" };  

[Exposed=Window]
interface TextTrack : EventTarget {  
  readonly attribute TextTrackKind kind;  
  readonly attribute DOMString label;  
  readonly attribute DOMString language;  
  readonly attribute DOMString id;  
  readonly attribute DOMString inBandMetadataTrackDispatchType;  
  attribute TextTrackMode mode;  
  readonly attribute TextTrackCueList? cues;  
  readonly attribute TextTrackCueList? activeCues;  
  undefined addCue(TextTrackCue cue);  
  undefined removeCue(TextTrackCue cue);  
  attribute EventHandler oncuechange; }
```

For web developers (non-normative)

```javascript
textTrack = media.addTextTrack(kind [, label [, language ]])

Creates and returns a new `TextTrack` object, which is also added to the media element's list of text tracks.

`textTrack.kind`

Returns the text track kind string.

`textTrack.label`

Returns the text track label, if there is one, or the empty string otherwise (indicating that a custom label probably needs to be generated from the other attributes of the object if the object is exposed to the user).

`textTrack.language`

Returns the text track language string.

`textTrack.id`

Returns the ID of the given track.

For in-band tracks, this is the ID that can be used with a fragment if the format supports media fragment syntax, and that can be used with the `getTrackById()` method.

For `TextTrack` objects corresponding to `track` elements, this is the ID of the `track` element.

`textTrack.inBandMetadataTrackDispatchType`

Returns the text track in-band metadata track dispatch type string.

`textTrack.mode [ = value ]`

Returns the text track mode, represented by a string from the following list:

```
"disabled",  
```

The text track disabled mode.
The `addTextTrack(kind, label, language)` method of media elements, when invoked, must run the following steps:

1. Create a new `TextTrack` object.
2. Create a new `TextTrack` corresponding to the new object, and set its `text track kind` to `kind`, its `text track label` to `label`, its `text track language` to `language`, its `text track readiness state` to the `text track loaded` state, its `text track mode` to the `text track hidden` mode, and its `text track list of cues` to an empty list.

Initially, the `text track list of cues` is not associated with any rules for updating the text track rendering. When a `text track cue` is added to it, the `text track list of cues` has its rules permanently set accordingly.

3. Add the new `text track` to the media element's list of text tracks.
4. Queue a media element task given the media element to fire an event named `addtrack` at the media element's `TextTrackList` object, using `TrackEvent`, with the `track` attribute initialized to the new `text track`'s `TextTrack` object.
5. Return the new `TextTrack` object.

The `kind` attribute must return the `text track kind` of the `text track` that the `TextTrack` object represents.

The `label` attribute must return the `text track label` of the `text track` that the `TextTrack` object represents.

The `language` attribute must return the `text track language` of the `text track` that the `TextTrack` object represents.

The `id` attribute returns the track's identifier, if it has one, or the empty string otherwise. For tracks that correspond to `track` elements, the track's identifier is the value of the element's `id` attribute, if any. For in-band tracks, the track's identifier is specified by the `media resource`. If the `media resource` is in a format that supports `media fragment syntax`, the identifier returned for a particular track must be the same identifier that would enable the track if used as the name of a track in the track dimension of such a fragment.

The `inBandMetadataTrackDispatchType` attribute must return the `text track in-band metadata track dispatch type` of the `text track` that the `TextTrack` object represents.

The `mode` attribute, on getting, must return the string corresponding to the `text track mode` of the `text track` that the `TextTrack` object represents, as defined by the following list:

```
"disabled"
  The `text track disabled` mode.

"hidden"
  The `text track hidden` mode.
```
"showing"

The text track showing mode.

On setting, if the new value isn't equal to what the attribute would currently return, the new value must be processed as follows:

- **If the new value is "disabled"**
  
  Set the text track mode of the text track that the TextTrack object represents to the text track disabled mode.

- **If the new value is "hidden"**
  
  Set the text track mode of the text track that the TextTrack object represents to the text track hidden mode.

- **If the new value is "showing"**
  
  Set the text track mode of the text track that the TextTrack object represents to the text track showing mode.

If the text track mode of the text track that the TextTrack object represents is not the text track disabled mode, then the cues attribute must return a live TextTrackCueList object that represents the subset of the text track list of cues of the text track that the TextTrack object represents whose end times occur at or after the earliest possible position when the script started, in text track cue order. Otherwise, it must return null. For each TextTrack object, when an object is returned, the same TextTrackCueList object must be returned each time.

The **earliest possible position when the script started** is whatever the earliest possible position was last time the event loop reached step 1.

If the text track mode of the text track that the TextTrack object represents is not the text track disabled mode, then the activeCues attribute must return a live TextTrackCueList object that represents the subset of the text track list of cues of the text track that the TextTrack object represents whose active flag was set when the script started, in text track cue order. Otherwise, it must return null. For each TextTrack object, when an object is returned, the same TextTrackCueList object must be returned each time.

A **text track cue's active flag was set when the script started** if its text track cue active flag was set last time the event loop reached step 1.

The addCue method of TextTrack objects, when invoked, must run the following steps:

1. If the text track list of cues does not yet have any associated rules for updating the text track rendering, then associate the text track list of cues with the rules for updating the text track rendering, appropriate to cue.

2. If text track list of cues associated rules for updating the text track rendering are not the same rules for updating the text track rendering, as appropriate for cue, then throw an InvalidStateError.

3. If the given cue is in the text track list of cues, then remove cue from that text track list of cues.

4. Add cue to the TextTrack's text track list of cues.

The removeCue method of TextTrack objects, when invoked, must run the following steps:

1. If the given cue is not in the TextTrack object's text track list of cues, then throw a NotFoundError.

2. Remove cue from the TextTrack object's text track list of cues.

**Example**

In this example, an audio element is used to play a specific sound-effect from a sound file containing many sound effects. A cue is used to pause the audio, so that it ends exactly at the end of the clip, even if the browser is busy running some script. If the page relied on script to pause the audio, then the start of the next clip might be heard if the browser was not able to run the script at the exact time specified.

```javascript
var sfx = new Audio('sfx.wav');
var sounds = sfx.addTextTrack('metadata');

// add sounds we care about
function addFX(start, end, name) {
  sounds.addCue(sfx, start, end, name);
}
```
var cue = new VTTCue(start, end, '');
cue.id = name;
cue.pauseOnExit = true;
sounds.add Cue(cue);
}
addFX(12.783, 13.612, 'dog bark');
addFX(13.612, 15.091, 'kitten mew');

function playSound(id) {
    sfx.currentTime = sounds.getCueById(id).startTime;
sfx.play();
}

// play a bark as soon as we can
sfx.oncanplaythrough = function () {
    playSound('dog bark');
}

// meow when the user tries to leave,
// and have the browser ask them to stay
window.onbeforeunload = function (e) {
    playSound('kitten mew');
e.preventDefault();
}

var cue = new VTTCue(start, end, '');
cue.id = name;
cue.pauseOnExit = true;
sounds.add Cue(cue);
}
addFX(12.783, 13.612, 'dog bark');
addFX(13.612, 15.091, 'kitten mew');

function playSound(id) {
    sfx.currentTime = sounds.getCueById(id).startTime;
sfx.play();
}

// play a bark as soon as we can
sfx.oncanplaythrough = function () {
    playSound('dog bark');
}

// meow when the user tries to leave,
// and have the browser ask them to stay
window.onbeforeunload = function (e) {
    playSound('kitten mew');
e.preventDefault();
}
```idl
interface TextTrackCue : EventTarget {
    readonly attribute TextTrack? track;

    attribute DOMString id;
    attribute double startTime;
    attribute unrestricted double endTime;
    attribute boolean pauseOnExit;

    attribute EventHandler onenter;
    attribute EventHandler onexit;
};
```

For web developers (non-normative)

```text
4.8.11.11.6 Event handlers for objects of the text track APIs

The `track` attribute, on getting, must return the `TextTrack` object to which this `text track cue` belongs, if any, or null otherwise.

The `id` attribute, on getting, must return the `text track cue identifier` of the `text track cue` that the `TextTrackCue` object represents. On setting, the `text track cue identifier` must be set to the new value.

The `startTime` attribute, on getting, must return the `text track cue start time`, in seconds. On setting, if the new value is negative infinity or a Not-a-Number (NaN) value, then throw a `TypeError` exception. Otherwise, the `text track cue start time` must be set to the new value, interpreted in seconds; then, if the `TextTrackCue` object's `text track cue` is in a `text track`'s `list of cues`, and that `text track` is in a `media element`'s `list of text tracks`, and the `media element`'s `show poster flag` is not set, then run the `time marches on` steps for that `media element`.

The `endTime` attribute, on getting, must return the `text track cue end time` of the `text track cue` that the `TextTrackCue` object represents, in seconds or positive infinity. On setting, if the new value is negative infinity or a Not-a-Number (NaN) value, then throw a `TypeError` exception. Otherwise, the `text track cue end time` must be set to the new value. Then, if the `TextTrackCue` object's `text track cue` is in a `text track`'s `list of cues`, and that `text track` is in a `media element`'s `list of text tracks`, and the `media element`'s `show poster flag` is not set, then run the `time marches on` steps for that `media element`.

The `pauseOnExit` attribute, on getting, must return true if the `text track cue pause-on-exit flag` of the `text track cue` that the `TextTrackCue` object represents is set; or false otherwise. On setting, the `text track cue pause-on-exit flag` must be set if the new value is true, and must be unset otherwise.

The following are the `event handlers` that (and their corresponding `event handler event types`) that must be supported, as
```
The following are the **event handlers** \(^{1117}\) that (and their corresponding **event handler event types** \(^{1120}\)) that must be supported, as **event handler IDL attributes** \(^{1118}\), by all objects implementing the **TextTrackList** \(^{453}\) interface:

<table>
<thead>
<tr>
<th>Event handler (^{1117})</th>
<th>Event handler event type (^{1120})</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>onchange</code></td>
<td><code>change</code> (^{465})</td>
</tr>
<tr>
<td><code>onaddtrack</code></td>
<td><code>addtrack</code> (^{465})</td>
</tr>
<tr>
<td><code>onremovetrack</code></td>
<td><code>removetrack</code> (^{465})</td>
</tr>
</tbody>
</table>

This section is **non-normative**.

Text tracks can be used for storing data relating to the media data, for interactive or augmented views.

For example, a page showing a sports broadcast could include information about the current score. Suppose a robotics competition was being streamed live. The image could be overlaid with the scores, as follows:

In order to make the score display render correctly whenever the user seeks to an arbitrary point in the video, the metadata text track cues need to be as long as is appropriate for the score. For example, in the frame above, there would be maybe one cue that lasts the length of the match that gives the match number, one cue that lasts until the blue alliance’s score changes, and one cue that lasts until the red alliance’s score changes. If the video is just a stream of the live event, the time in the bottom right would presumably be...
automatically derived from the current video time, rather than based on a cue. However, if the video was just the highlights, then that might be given in cues also.

The following shows what fragments of this could look like in a WebVTT file:

```
WEBVTT
...
05:10:00.000 --> 05:12:15.000
matchtype:qual
matchnumber:37
...
05:11:02.251 --> 05:11:17.198
red:78
05:11:03.672 --> 05:11:54.198
blue:66
05:11:17.198 --> 05:11:25.912
red:80
05:11:25.912 --> 05:11:26.522
red:83
05:11:26.522 --> 05:11:26.982
red:86
05:11:26.982 --> 05:11:27.499
red:89
...
```

The key here is to notice that the information is given in cues that span the length of time to which the relevant event applies. If, instead, the scores were given as zero-length (or very brief, nearly zero-length) cues when the score changes, for example saying “red+2” at 05:11:17.198, “red+3” at 05:11:25.912, etc, problems arise: primarily, seeking is much harder to implement, as the script has to walk the entire list of cues to make sure that no notifications have been missed; but also, if the cues are short it’s possible the script will never see that they are active unless it listens to them specifically.

When using cues in this manner, authors are encouraged to use the `cuechange` event to update the current annotations. (In particular, using the `timeupdate` event would be less appropriate as it would require doing work even when the cues haven’t changed, and, more importantly, would introduce a higher latency between when the metadata cues become active and when the display is updated, since `timeupdate` events are rate-limited.)

### 4.8.11.12 Identifying a track kind through a URL

Other specifications or formats that need a URL to identify the return values of the `AudioTrack` or `VideoTrack` kind IDL attributes, or identify the kind of text track, must use the `about:html-kind` URL.

### 4.8.11.13 User interface

The `controls` attribute is a boolean attribute. If present, it indicates that the author has not provided a scripted controller and would like the user agent to provide its own set of controls.

If the attribute is present, or if scripting is disabled for the media element, then the user agent should expose a user interface to the user. This user interface should include features to begin playback, pause playback, seek to an arbitrary position in the content (if the content supports arbitrary seeking), change the volume, change the display of closed captions or embedded sign-language tracks, select different audio tracks or turn on audio descriptions, and show the media content in manners more suitable to
the user (e.g. fullscreen video or in an independent resizable window). Other controls may also be made available.

Even when the attribute is absent, however, user agents may provide controls to affect playback of the media resource (e.g. play, pause, seeking, track selection, and volume controls), but such features should not interfere with the page's normal rendering. For example, such features could be exposed in the media element's context menu, platform media keys, or a remote control. The user agent may implement this simply by exposing a user interface to the user as described above (as if the controls attribute was present).

If the user agent exposes a user interface to the user by displaying controls over the media element, then the user agent should suppress any user interaction events while the user agent is interacting with this interface. (For example, if the user clicks on a video's playback control, mousedown events and so forth would not simultaneously be fired at elements on the page.)

Where possible (specifically, for starting, stopping, pausing, and unpausing playback, for seeking, for changing the rate of playback, for fast-forwarding or rewinding, for listing, enabling, and disabling text tracks, and for muting or changing the volume of the audio), user interface features exposed by the user agent must be implemented in terms of the DOM API described above, so that, e.g., all the same events fire.

Features such as fast-forward or rewind must be implemented by only changing the playbackRate attribute (and not the defaultPlaybackRate attribute).

Seeking must be implemented in terms of seeking to the requested position in the media element's media timeline. For media resources where seeking to an arbitrary position would be slow, user agents are encouraged to use the approximate-for-speed flag when seeking in response to the user manipulating an approximate position interface such as a seek bar.

The controls IDL attribute must reflect the content attribute of the same name.

### For web developers (non-normative)

```javascript
media.volume [ = value ]
```

- Returns the current playback volume, as a number in the range 0.0 to 1.0, where 0.0 is the quietest and 1.0 the loudest.
- Can be set, to change the volume.
- Throws an `IndexSizeError` DOMException if the new value is not in the range 0.0 .. 1.0.

```javascript
media.muted [ = value ]
```

- Returns true if audio is muted, overriding the volume attribute, and false if the volume attribute is being honored.
- Can be set, to change whether the audio is muted or not.

A media element has a playback volume, which is a fraction in the range 0.0 (silent) to 1.0 (loudest). Initially, the volume should be 1.0, but user agents may remember the last set value across sessions, on a per-site basis or otherwise, so the volume may start at other values.

The volume IDL attribute must return the playback volume of any audio portions of the media element. On setting, if the new value is in the range 0.0 to 1.0 inclusive, the media element's playback volume must be set to the new value. If the new value is outside the range 0.0 to 1.0 inclusive, then, on setting, an `IndexSizeError` DOMException must be thrown instead.

A media element can also be muted. If anything is muting the element, then it is muted. (For example, when the direction of playback is backwards, the element is muted.)

The muted IDL attribute must return the value to which it was last set. When a media element is created, if the element has a muted content attribute specified, then the muted IDL attribute should be set to true; otherwise, the user agents may set the value to the user's preferred value (e.g. remembering the last set value across sessions, on a per-site basis or otherwise). While the muted IDL attribute is set to true, the media element must be muted.

Whenever either of the values that would be returned by the volume and muted IDL attributes change, the user agent must queue a media element task given the media element to fire an event named volumechange at the media element. Then, if the media element is not allowed to play, the user agent must run the internal pause steps for the media element.

A user agent has an associated volume locked (a boolean). Its value is implementation-defined and determines whether the playback volume takes effect.

An element's effective media volume is determined as follows:

1. If the user has indicated that the user agent is to override the volume of the element, then return the volume desired by the
user.

2. If the user agent's `volume locked` is true, then return the system volume.

3. If the element's audio output is `muted`, then return zero.

4. Let `volume` be the `playback volume` of the audio portions of the `media element`, in range 0.0 (silent) to 1.0 (loudest).

5. Return `volume`, interpreted relative to the range 0.0 to 1.0, with 0.0 being silent, and 1.0 being the loudest setting, values in between increasing in loudness. The range need not be linear. The loudest setting may be lower than the system's loudest possible setting; for example the user could have set a maximum volume.

The `muted` content attribute on `media elements` is a boolean attribute that controls the default state of the audio output of the `media resource`, potentially overriding user preferences.

The `defaultMuted` IDL attribute must reflect the `muted` content attribute.

**Note**

This attribute has no dynamic effect (it only controls the default state of the element).

**Example**

This video (an advertisement) autoplays, but to avoid annoying users, it does so without sound, and allows the user to turn the sound on. The user agent can pause the video if it's unmuted without a user interaction.

```html
<video src="adverts.cgi?kind=video" controls autoplay loop muted></video>
```

### 4.8.11.14 Time ranges

Objects implementing the `TimeRanges` interface represent a list of ranges (periods) of time.

**IDL**

```
[Exposed=Window]
interface TimeRanges {
  readonly attribute unsigned long length;
  double start(unsigned long index);
  double end(unsigned long index);
};
```

**For web developers (non-normative)**

`media.length` returns the number of ranges in the object.

```
time = media.start(index)
```

Returns the time for the start of the range with the given index.

Throws an `IndexSizeError` if the index is out of range.

```
time = media.end(index)
```

Returns the time for the end of the range with the given index.

Throws an `IndexSizeError` if the index is out of range.

The `length` IDL attribute must return the number of ranges represented by the object.

The `start(index)` method must return the position of the start of the `index`th range represented by the object, in seconds measured from the start of the timeline that the object covers.

The `end(index)` method must return the position of the end of the `index`th range represented by the object, in seconds measured from the start of the timeline that the object covers.

These methods must throw an `IndexSizeError` if called with an `index` argument greater than or equal to the number of ranges represented by the object.
When a `TimeRanges` object is said to be a **normalized** `TimeRanges` object, the ranges it represents must obey the following criteria:

- The start of a range must be greater than the end of all earlier ranges.
- The start of a range must be less than or equal to the end of that same range.

In other words, the ranges in such an object are ordered, don't overlap, and don't touch (adjacent ranges are folded into one bigger range). A range can be empty (referencing just a single moment in time), e.g. to indicate that only one frame is currently buffered in the case that the user agent has discarded the entire media resource except for the current frame, when a media element is paused.

Ranges in a `TimeRanges` object must be inclusive.

### Example

Thus, the end of a range would be equal to the start of a following adjacent (touching but not overlapping) range. Similarly, a range covering a whole timeline anchored at zero would have a start equal to zero and an end equal to the duration of the timeline.

The timelines used by the objects returned by the `buffered`, `seekable` and `played` IDL attributes of media elements must be that element's media timeline.

---

#### 4.8.11.15 The `TrackEvent` interface

**IDL**

```idl
[Exposed=Window]
interface TrackEvent : Event {
  constructor(DOMString type, optional TrackEventInit eventInitDict = {});

  readonly attribute (VideoTrack or AudioTrack or TextTrack)? track;
}

dictionary TrackEventInit : EventInit {
  (VideoTrack or AudioTrack or TextTrack)? track = null;
}
```

**For web developers (non-normative)**

`event.track` Returns the track object (TextTrack, AudioTrack, or VideoTrack) to which the event relates.

The `track` attribute must return the value it was initialized to. It represents the context information for the event.

---

#### 4.8.11.16 Events summary

This section is non-normative.

The following events fire on media elements as part of the processing model described above:

<table>
<thead>
<tr>
<th>Event name</th>
<th>Interface</th>
<th>Fired when...</th>
<th>Preconditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>loadstart</td>
<td>Event</td>
<td>The user agent begins looking for media data, as part of the resource selection algorithm.</td>
<td><code>networkState</code> equals <code>NETWORK_LOADING</code> or <code>NETWORK_EMPTY</code>.</td>
</tr>
<tr>
<td>progress</td>
<td>Event</td>
<td>The user agent is fetching media data.</td>
<td><code>networkState</code> equals <code>NETWORK_LOADING</code> or <code>NETWORK_IDLE</code>.</td>
</tr>
<tr>
<td>suspend</td>
<td>Event</td>
<td>The user agent is intentionally not currently fetching media data.</td>
<td><code>networkState</code> equals <code>NETWORK_IDLE</code> or <code>NETWORK_EMPTY</code>.</td>
</tr>
<tr>
<td>abort</td>
<td>Event</td>
<td>The user agent stops fetching the media data before it is completely downloaded, but not due to an error.</td>
<td><code>error</code> is an object with the code <code>MEDIA_ERR_ABORTED</code>. <code>networkState</code> equals either <code>NETWORK_EMPTY</code> or <code>NETWORK_IDLE</code>, depending on when the download was aborted.</td>
</tr>
<tr>
<td>error</td>
<td>Event</td>
<td>An error occurs while fetching the media</td>
<td><code>error</code> is an object with the code <code>MEDIA_ERR_NETWORK</code> or higher.</td>
</tr>
<tr>
<td>Event name</td>
<td>Interface</td>
<td>Fired when...</td>
<td>Preconditions</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>emptied</td>
<td>Event</td>
<td>A media element[^1] whose <code>networkState</code>[^1] was previously not in the <code>NETWORK_EMPTY</code>[^1] state has just switched to that state (either because of a fatal error during load that’s about to be reported, or because the load()[^1] method was invoked while the resource selection algorithm[^1] was already running).</td>
<td><code>networkState</code>[^1] equals either <code>NETWORK_EMPTY</code>[^1] or <code>NETWORK_IDLE</code>[^1], depending on when the download was aborted.</td>
</tr>
<tr>
<td>stalled</td>
<td>Event</td>
<td>The user agent is trying to fetch media data[^2], but data is unexpectedly not forthcoming.</td>
<td><code>networkState</code>[^1] is <code>NETWORK_LOADING</code>[^1].</td>
</tr>
<tr>
<td>loadedmetadata</td>
<td>Event</td>
<td>The user agent has just determined the duration and dimensions of the media resource[^3] and the text tracks are ready[^4].</td>
<td><code>readyState</code>[^1] is newly equal to <code>HAVE_METADATA</code>[^1] or greater for the first time.</td>
</tr>
<tr>
<td>loadeddata</td>
<td>Event</td>
<td>The user agent can render the media data[^6] at the current playback position[^2] for the first time.</td>
<td><code>readyState</code>[^1] newly increased to <code>HAVE_CURRENT_DATA</code>[^1] or greater for the first time.</td>
</tr>
<tr>
<td>canplay</td>
<td>Event</td>
<td>The user agent can resume playback of the media data[^6], but estimates that if playback were to be started now, the media resource[^6] could not be rendered at the current playback rate up to its end without having to stop for further buffering of content.</td>
<td><code>readyState</code>[^1] newly increased to <code>HAVE_FUTURE_DATA</code>[^1] or greater.</td>
</tr>
<tr>
<td>canplaythrough</td>
<td>Event</td>
<td>The user agent estimates that if playback were to be started now, the media resource[^6] could be rendered at the current playback rate all the way to its end without having to stop for further buffering.</td>
<td><code>readyState</code>[^1] is newly equal to <code>HAVE_ENOUGH_DATA</code>[^1].</td>
</tr>
<tr>
<td>playing</td>
<td>Event</td>
<td>Playback is ready to start after having been paused or delayed due to lack of media data[^12].</td>
<td><code>readyState</code>[^1] is newly greater than or equal to <code>HAVE_FUTURE_DATA</code>[^1] and <code>paused</code>[^12] is false, or <code>paused</code>[^12] is newly false and <code>readyState</code>[^1] is greater than or equal to <code>HAVE_FUTURE_DATA</code>[^1]. Even if this event fires, the element might still not be potentially playing[^1], e.g. if the element is <code>paused for user interaction</code>[^13] or <code>paused for in-band content</code>[^1].</td>
</tr>
<tr>
<td>waiting</td>
<td>Event</td>
<td>Playback has stopped because the next frame is not available, but the user agent expects that frame to become available in due course.</td>
<td><code>readyState</code>[^1] is less than or equal to <code>HAVE_CURRENT_DATA</code>[^1] and <code>paused</code>[^13] is false. Either <code>seeking</code>[^1] is true, or the current playback position[^1] is not contained in any of the ranges in <code>buffered</code>[^1]. It is possible for playback to stop for other reasons without <code>paused</code>[^1] being false, but those reasons do not fire this event (and when those situations resolve, a separate playing[^1] event is not fired either): e.g., <code>playback has ended</code>[^1], or playback stopped due to errors[^1] or the element has paused for user interaction[^1] or paused for in-band content[^1].</td>
</tr>
<tr>
<td>seeking</td>
<td>Event</td>
<td>The <code>seeking</code>[^1] IDL attribute changed to true, and the user agent has started seeking to a new position.</td>
<td></td>
</tr>
<tr>
<td>sought</td>
<td>Event</td>
<td>The <code>seeking</code>[^1] IDL attribute changed to false after the current playback position[^1] was changed.</td>
<td></td>
</tr>
<tr>
<td>ended</td>
<td>Event</td>
<td>Playback has stopped because the end of the media resource[^1] was reached.</td>
<td><code>currentTime</code>[^1] equals the end of the media resource[^1]; <code>ended</code>[^1] is true.</td>
</tr>
<tr>
<td>durationchange</td>
<td>Event</td>
<td>The <code>duration</code>[^1] attribute has just been updated.</td>
<td></td>
</tr>
<tr>
<td>timeupdate</td>
<td>Event</td>
<td>The current playback position[^1] changed as part of normal playback or in an especially interesting way, for example discontinuously.</td>
<td></td>
</tr>
<tr>
<td>play</td>
<td>Event</td>
<td>The element is no longer paused. Fired after the play()[^1] method has returned, or when the autoplay[^1] attribute has caused playback to begin.</td>
<td><code>paused</code>[^1] is newly false.</td>
</tr>
<tr>
<td>pause</td>
<td>Event</td>
<td>The element has been paused. Fired after the pause()[^1] method has returned.</td>
<td><code>paused</code>[^1] is newly true.</td>
</tr>
<tr>
<td>ratechange</td>
<td>Event</td>
<td>Either the defaultPlaybackRate[^1] or the playbackRate[^1] attribute has just been updated.</td>
<td></td>
</tr>
<tr>
<td>resize</td>
<td>Event</td>
<td>One or both of the <code>videoWidth</code>[^1] and <code>videoHeight</code>[^1] attributes have just been</td>
<td><code>Media element</code>[^1] is a video[^1] element; <code>readyState</code>[^1] is not <code>HAVE NOTHING</code>[^1].</td>
</tr>
</tbody>
</table>
### Event names, Interfaces, and Preconditions

<table>
<thead>
<tr>
<th>Event name</th>
<th>Interface</th>
<th>Fired when...</th>
<th>Preconditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>volumechange</strong></td>
<td>Event</td>
<td>Either the <code>volume</code> attribute or the <code>muted</code> attribute has changed. Fired after the relevant attribute's setter has returned.</td>
<td></td>
</tr>
</tbody>
</table>

The following event fires on `source` elements:

<table>
<thead>
<tr>
<th>Event name</th>
<th>Interface</th>
<th>Fired when...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>error</strong></td>
<td>Event</td>
<td>An error occurs while fetching the <code>media data</code> or the type of the resource is not a supported media format.</td>
</tr>
</tbody>
</table>

The following events fire on `AudioTrackList`, `VideoTrackList`, and `TextTrackList` objects:

<table>
<thead>
<tr>
<th>Event name</th>
<th>Interface</th>
<th>Fired when...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>change</strong></td>
<td>Event</td>
<td>One or more tracks in the track list have been enabled or disabled.</td>
</tr>
<tr>
<td><strong>addtrack</strong></td>
<td>TrackEvent</td>
<td>A track has been added to the track list.</td>
</tr>
<tr>
<td><strong>removetrack</strong></td>
<td>TrackEvent</td>
<td>A track has been removed from the track list.</td>
</tr>
</tbody>
</table>

The following event fires on `TextTrack` objects and `track` elements:

<table>
<thead>
<tr>
<th>Event name</th>
<th>Interface</th>
<th>Fired when...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>cuechange</strong></td>
<td>Event</td>
<td>One or more cues in the track have become active or stopped being active.</td>
</tr>
</tbody>
</table>

The following events fire on `track` elements:

<table>
<thead>
<tr>
<th>Event name</th>
<th>Interface</th>
<th>Fired when...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>error</strong></td>
<td>Event</td>
<td>An error occurs while fetching the track data or the type of the resource is not supported text track format.</td>
</tr>
<tr>
<td><strong>load</strong></td>
<td>Event</td>
<td>A track data has been fetched and successfully processed.</td>
</tr>
</tbody>
</table>

The following events fire on `TextTrackCue` objects:

<table>
<thead>
<tr>
<th>Event name</th>
<th>Interface</th>
<th>Fired when...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>enter</strong></td>
<td>Event</td>
<td>The cue has become active.</td>
</tr>
<tr>
<td><strong>exit</strong></td>
<td>Event</td>
<td>The cue has stopped being active.</td>
</tr>
</tbody>
</table>

---

### 4.8.11.17 Security and privacy considerations

The main security and privacy implications of the `video` and `audio` elements come from the ability to embed media cross-origin. There are two directions that threats can flow: from hostile content to a victim page, and from a hostile page to victim content.

If a victim page embeds hostile content, the threat is that the content might contain scripted code that attempts to interact with the `Document` that embeds the content. To avoid this, user agents must ensure that there is no access from the content to the embedding page. In the case of media content that uses DOM concepts, the embedded content must be treated as if it was in its own unrelated top-level traversable.

Example

For instance, if an SVG animation was embedded in a `video` element, the user agent would not give it access to the DOM of the outer page. From the perspective of scripts in the SVG resource, the SVG file would appear to be in a lone top-level traversable with no parent.

If a hostile page embeds victim content, the threat is that the embedding page could obtain information from the content that it would not otherwise have access to. The API does expose some information: the existence of the media, its type, its duration, its size, and the performance characteristics of its host. Such information is already potentially problematic, but in practice the same information can more or less be obtained using the `img` element, and so it has been deemed acceptable.

However, significantly more sensitive information could be obtained if the user agent further exposes metadata within the content, such as subtitles. That information is therefore only exposed if the video resource uses CORS. The `crossorigin` attribute allows...
This section is non-normative.

Playing audio and video resources on small devices such as set-top boxes or mobile phones is often constrained by limited hardware resources in the device. For example, a device might only support three simultaneous videos. For this reason, it is a good practice to release resources held by media elements when they are done playing, either by being very careful about removing all references to the element and allowing it to be garbage collected, or, even better, by setting the element’s src attribute to an empty string. In cases where srcObject was set, instead set the srcObject to null.

Similarly, when the playback rate is not exactly 1.0, hardware, software, or format limitations can cause video frames to be dropped and audio to be choppy or muted.

This section is non-normative.

How accurately various aspects of the media element API are implemented is considered a quality-of-implementation issue.

For example, when implementing the buffered attribute, how precise an implementation reports the ranges that have been buffered depends on how carefully the user agent inspects the data. Since the API reports ranges as times, but the data is obtained in byte streams, a user agent receiving a variable-bitrate stream might only be able to determine precise times by actually decoding all of the data. User agents aren’t required to do this, however; they can instead return estimates (e.g. based on the average bitrate seen so far) which get revised as more information becomes available.

As a general rule, user agents are urged to be conservative rather than optimistic. For example, it would be bad to report that everything had been buffered when it had not.

Another quality-of-implementation issue would be playing a video backwards when the codec is designed only for forward playback (e.g. there aren’t many key frames, and they are far apart, and the intervening frames only have deltas from the previous frame). User agents could do a poor job, e.g. only showing key frames; however, better implementations would do more work and thus do a better job, e.g. actually decoding parts of the video forwards, storing the complete frames, and then playing the frames backwards.

Similarly, while implementations are allowed to drop buffered data at any time (there is no requirement that a user agent keep all the media data obtained for the lifetime of the media element), it is again a quality of implementation issue: user agents with sufficient resources to keep all the data around are encouraged to do so, as this allows for a better user experience. For example, if the user is watching a live stream, a user agent could allow the user only to view the live video; however, a better user agent would buffer everything and allow the user to seek through the earlier material, pause it, play it forwards and backwards, etc.

When a media element that is paused is removed from a document and not reinserted before the next time the event loop reaches step 3, implementations that are resource constrained are encouraged to take that opportunity to release all hardware resources (like video planes, networking resources, and data buffers) used by the media element. (User agents still have to keep track of the playback position and so forth, though, in case playback is later restarted.)
Contexts in which this element can be used

Where phrasing content is expected.

Content model:

Transparent.

Tag omission in text/html:

Neither tag is omissible.

Content attributes:

Global attributes

name — Name of image map to reference from the usemap attribute

Accessibility considerations:

For authors.
For implementers.

DOM interface:

IDL

```xml
[Exposed=Window]
interface HTMLMapElement : HTMLElement {
    [HTMLConstructor] constructor();

    [[Reactions]] attribute DOMString name;
    [SameObject] readonly attribute HTMLCollection areas;
};
```

The `map` element, in conjunction with an `img` element and any `area` element descendants, defines an image map. The element represents its children.

The `name` attribute gives the map a name so that it can be referenced. The attribute must be present and must have a non-empty value with no ASCII whitespace. The value of the `name` attribute must not be equal to the value of the `name` attribute of another `map` element in the same tree. If the `id` attribute is also specified, both attributes must have the same value.

For web developers (non-normative)

`map.areas`

Returns an `HTMLCollection` of the `area` elements in the `map`.

The `areas` attribute must return an `HTMLCollection` rooted at the `map` element, whose filter matches only `area` elements.

The IDL attribute `name` must reflect the content attribute of the same name.

Example

Image maps can be defined in conjunction with other content on the page, to ease maintenance. This example is of a page with an image map at the top of the page and a corresponding set of text links at the bottom.

```xml
<!DOCTYPE HTML>
<html lang="en">
  <head>
    <title>Babies™: Toys</title>
  </head>
  <body>
    <h1>Toys</h1>
    <img src="/images/menu.gif" alt="Babies™ navigation menu. Select a department to go to its page." usemap="#NAV">
    ...
  </body>
</html>
```
4.8.13 The area element

Categories:
- Flow content
- Phrasing content

Contexts in which this element can be used:
Where phrasing content is expected, but only if there is a map element ancestor.

Content model:
Nothing.

Tag omission in text/html:
No end tag.

Content attributes:
- Global attributes:
  - alt — Replacement text for use when images are not available
  - coords — Coordinates for the shape to be created in an image map
  - shape — The kind of shape to be created in an image map
  - href — Address of the hyperlink
  - target — Navigable for hyperlink navigation
  - download — Whether to download the resource instead of navigating to it, and its filename if so
  - ping — URLs to ping
  - rel — Relationship between the location in the document containing the hyperlink and the destination resource
  - referrerPolicy — Referrer policy for fetches initiated by the element

Accessibility considerations:
If the element has an href attribute: for authors; for implementers.
Otherwise: for authors; for implementers.

DOM interface:
```idl
[Exposed=Window]
interface HTMLAreaElement : HTMLElement {
  [HTMLConstructor] constructor();

  [CEReactions] attribute DOMString alt;
  [CEReactions] attribute DOMString coords;
  [CEReactions] attribute DOMString shape;
  [CEReactions] attribute DOMString target;
  [CEReactions] attribute DOMString download;
  [CEReactions] attribute USVString ping;
  [CEReactions] attribute DOMString rel;
  [SameObject, PutForwards=value] readonly attribute DOMTokenList relList;
  [CEReactions] attribute DOMString referrerPolicy;

  // also has obsolete members
```
The `area` element represents either a hyperlink with some text and a corresponding area on an `image map`, or a dead area on an image map.

An `area` element with a parent node must have a `map` element ancestor.

If the `area` element has an `href` attribute, then the `area` element represents a `hyperlink`. In this case, the `alt` attribute must be present. It specifies the text of the hyperlink. Its value must be text that, when presented with the texts specified for the other hyperlinks of the `image map`, and with the alternative text of the image, but without the image itself, provides the user with the same kind of choice as the hyperlink would when used without its text but with its shape applied to the image. The `alt` attribute may be left blank if there is another `area` element in the same `image map` that points to the same resource and has a non-blank `alt` attribute.

If the `area` element has no `href` attribute, then the area represented by the element cannot be selected, and the `alt` attribute must be omitted.

In both cases, the `shape` and `coords` attributes specify the area.

The `shape` attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Conforming</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>circle</td>
<td></td>
<td>Circle state</td>
<td>Designates a circle, using exactly three integers in the <code>coords</code> attribute.</td>
</tr>
<tr>
<td>circ</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>default</td>
<td></td>
<td>Default state</td>
<td>This area is the whole image. (The <code>coords</code> attribute is not used.)</td>
</tr>
<tr>
<td>poly</td>
<td></td>
<td>Polygon state</td>
<td>Designates a polygon, using at-least six integers in the <code>coords</code> attribute.</td>
</tr>
<tr>
<td>polygon</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rect</td>
<td></td>
<td>Rectangle state</td>
<td>Designates a rectangle, using exactly four integers in the <code>coords</code> attribute.</td>
</tr>
<tr>
<td>rectangle</td>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The attribute’s missing value default and invalid value default are both the `rectangle` state.

The `coords` attribute must, if specified, contain a valid list of floating-point numbers. This attribute gives the coordinates for the shape described by the `shape` attribute. The processing for this attribute is described as part of the `image map` processing model.

In the `circle state`, `area` elements must have a `coords` attribute present, with three integers, the last of which must be non-negative. The first integer must be the distance in CSS pixels from the left edge of the image to the center of the circle, the second integer must be the distance in CSS pixels from the top edge of the image to the center of the circle, and the third integer must be the radius of the circle, again in CSS pixels.

In the `default state`, `area` elements must not have a `coords` attribute. (The area is the whole image.)

In the `polygon state`, `area` elements must have a `coords` attribute with at least six integers, and the number of integers must be even. Each pair of integers must represent a coordinate given as the distances from the left and the top of the image in CSS pixels respectively, and all the coordinates together must represent the points of the polygon, in order.

In the `rectangle state`, `area` elements must have a `coords` attribute with exactly four integers, the first of which must be less than the third, and the second of which must be less than the fourth. The four points must represent, respectively, the distance from the left edge of the image to the left side of the rectangle, the distance from the top edge to the top side, the distance from the left edge to the right side, and the distance from the top edge to the bottom side, all in CSS pixels.

When user agents allow users to follow hyperlinks or download hyperlinks created using the `area` element, the `href`, `target`, `download`, and `ping` attributes decide how the link is followed. The `rel` attribute may be used to indicate to the user the likely nature of the target resource before the user follows the link.

The `target`, `download`, `ping`, `rel`, and `referrerpolicy` attributes must be omitted if the `href` attribute is not present.

If the `itemprop` attribute is specified on an `area` element, then the `href` attribute must also be specified.
The IDL attributes `alt`, `coords`, `shape`, `target`, `download`, `ping`, and `rel`, each must `reflect` the respective content attributes of the same name.

The IDL attribute `relList` must `reflect` the `rel` content attribute.

The IDL attribute `referrerPolicy` must `reflect` the `referrerpolicy` content attribute, limited to only known values.

### 4.8.14 Image maps

#### 4.8.14.1 Authoring

An image map allows geometric areas on an image to be associated with hyperlinks.

An image, in the form of an `img` element, may be associated with an image map (in the form of a `map` element) by specifying a `usemap` attribute on the `img` element. The `usemap` attribute, if specified, must be a valid hash-name reference to a `map` element.

**Example**

Consider an image that looks as follows:

![Image Map Example](shapes.png)

If we wanted just the colored areas to be clickable, we could do it as follows:

```html
<p>Please select a shape:

```shapes.png` usemap`="#shapes"

alt="Four shapes are available: a red hollow box, a green circle, a blue triangle, and a yellow four-pointed star."

```

```map name`="#shapes"

```rect coords`="50,50,100,100"` "-- the hole in the red box -->
`rect coords`="25,25,125,125"` href`="red.html"` alt="Red box."
```
`circle coords`="200,75,50"` href`="green.html"` alt="Green circle."` ` rect coords`="325,25,262,125,388,125"` href`="blue.html"` alt="Blue triangle."
`poly coords`="450,25,435,60,400,75,435,90,450,125,465,90,500,75,465,60"
```

```map` "Yellow star."
```

```p```

**Example**

4.8.14.2 Processing model

If an `img` element has a `usemap` attribute specified, user agents must process it as follows:

1. Parse the attribute's value using the rules for parsing a hash-name reference to a `map` element, with the element as the context node. This will return either an element (the `map`) or null.

2. If that returned null, then return. The image is not associated with an image map after all.

3. Otherwise, the user agent must collect all the `area` elements that are descendants of the `map`. Let those be the `areas`.
Having obtained the list of `area` elements that form the image map (the `areas`), interactive user agents must process the list in one of two ways.

If the user agent intends to show the text that the `img` element represents, then it must use the following steps.

1. Remove all the `area` elements in `areas` that have no `href` attribute.
2. Remove all the `area` elements in `areas` that have no `alt` attribute, or whose `alt` attribute's value is the empty string, if there is another `area` element in `areas` with the same value in the `href` attribute and with a non-empty `alt` attribute.
3. Each remaining `area` element in `areas` represents a hyperlink. Those hyperlinks should all be made available to the user in a manner associated with the text of the `img`.

   In this context, user agents may represent `area` and `img` elements with no specified `alt` attributes, or whose `alt` attributes are the empty string or some other non-visible text, in an implementation-defined fashion intended to indicate the lack of suitable author-provided text.

If the user agent intends to show the image and allow interaction with the image to select hyperlinks, then the image must be associated with a set of layered shapes, taken from the `area` elements in `areas`, in reverse tree order (so the last specified `area` element in the `map` is the bottom-most shape, and the first element in the `map`, in tree order, is the top-most shape).

Each `area` element in `areas` must be processed as follows to obtain a shape to layer onto the image:

1. Find the state that the element's `shape` attribute represents.
2. Use the rules for parsing a list of floating-point numbers to parse the element's `coords` attribute, if it is present, and let the result be the `coords` list. If the attribute is absent, let the `coords` list be the empty list.
3. If the number of items in the `coords` list is less than the minimum number given for the `area` element's current state, as per the following table, then the shape is empty; return.

<table>
<thead>
<tr>
<th>State</th>
<th>Minimum number of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circle state</td>
<td>3</td>
</tr>
<tr>
<td>Default state</td>
<td>0</td>
</tr>
<tr>
<td>Polygon state</td>
<td>6</td>
</tr>
<tr>
<td>Rectangle state</td>
<td>4</td>
</tr>
</tbody>
</table>

4. Check for excess items in the `coords` list as per the entry in the following list corresponding to the `shape` attribute's state:

   - **Circle state**
     - Drop any items in the list beyond the third.
   - **Default state**
     - Drop all items in the list.
   - **Polygon state**
     - Drop the last item if there's an odd number of items.
   - **Rectangle state**
     - Drop any items in the list beyond the fourth.

5. If the `shape` attribute represents the `rectangle` state, and the first number in the list is numerically greater than the third number in the list, then swap those two numbers around.
6. If the `shape` attribute represents the `rectangle` state, and the second number in the list is numerically greater than the fourth number in the list, then swap those two numbers around.
7. If the `shape` attribute represents the `circle` state, and the third number in the list is less than or equal to zero, then the shape is empty; return.
8. Now, the shape represented by the element is the one described for the entry in the list below corresponding to the state of the `shape` attribute:

   - **Circle state**
     - Let x be the first number in `coords`, y be the second number, and r be the third number.
The shape is a circle whose center is \(x\) CSS pixels from the left edge of the image and \(y\) CSS pixels from the top edge of the image, and whose radius is \(r\) CSS pixels.

\(\to\) **Default state**

The shape is a rectangle that exactly covers the entire image.

\(\to\) **Polygon state**

Let \(x_i\) be the \((2i)\)th entry in \(coords\), and \(y_i\) be the \((2i+1)\)th entry in \(coords\) (the first entry in \(coords\) being the one with index 0).

Let the coordinates be \((x_i, y_i)\), interpreted in CSS pixels measured from the top left of the image, for all integer values of \(i\) from 0 to \((N/2)-1\), where \(N\) is the number of items in \(coords\).

The shape is a polygon whose vertices are given by the coordinates, and whose interior is established using the even-odd rule. [GRAPHICS]

\(\to\) **Rectangle state**

Let \(x_1\) be the first number in \(coords\), \(y_1\) be the second number, \(x_2\) be the third number, and \(y_2\) be the fourth number.

The shape is a rectangle whose top-left corner is given by the coordinate \((x_1, y_1)\) and whose bottom right corner is given by the coordinate \((x_2, y_2)\), those coordinates being interpreted as CSS pixels from the top left corner of the image.

For historical reasons, the coordinates must be interpreted relative to the displayed image after any stretching caused by the CSS ‘width’ and ‘height’ properties (or, for non-CSS browsers, the image element’s width and height attributes — CSS browsers map those attributes to the aforementioned CSS properties).

**Note**

*Browser zoom features and transforms applied using CSS or SVG do not affect the coordinates.*

Pointing device interaction with an image associated with a set of layered shapes per the above algorithm must result in the relevant user interaction events being first fired to the top-most shape covering the point that the pointing device indicated, if any, or to the image element itself, if there is no shape covering that point. User agents may also allow individual area elements representing hyperlinks to be selected and activated (e.g. using a keyboard).

**Note**

*Because a map element (and its area elements) can be associated with multiple img elements, it is possible for an area element to correspond to multiple focusable areas of the document.*

Image maps are live; if the DOM is mutated, then the user agent must act as if it had rerun the algorithms for image maps.

### 4.8.15 MathML

The MathML math element falls into the embedded content, phrasing content, flow content, and palpable content categories for the purposes of the content models in this specification.

When the MathML annotation-xml element contains elements from the HTML namespace, such elements must all be flow content.

When the MathML token elements (mi, mo, mn, ms, and mtext) are descendants of HTML elements, they may contain phrasing content elements from the HTML namespace.

User agents must handle text other than inter-element whitespace found in MathML elements whose content models do not allow straight text by pretending for the purposes of MathML content models, layout, and rendering that the text is actually wrapped in a MathML mtext element. (Such text is not, however, conforming.)

User agents must act as if any MathML element whose contents does not match the element’s content model was replaced, for the purposes of MathML layout and rendering, by a MathML error element containing some appropriate error message.

The semantics of MathML elements are defined by MathML and other applicable specifications. [MATHML]
Example

Here is an example of the use of MathML in an HTML document:

```html
<!DOCTYPE html>
<html lang="en">
<head>
<title>The quadratic formula</title>
</head>
<body>
<h1>The quadratic formula</h1>
<p>
<math>
<mi>x</mi>
<mo>=</mo>
<mfrac>
<mrow>
<mo>-</mo>
<mi>b</mi>
</mrow>
<msqrt>
<mrow>
<mi>b</mi><mo>±</mo>
<msup>
<mi>b</mi><mn>2</mn>
</msup>
<mo>-</mo>
<mn>4</mn><mo>a</mo><mo>c</mo>
</mrow>
</msqrt>
</mfrac>
</math>
</p>
</body>
</html>
```

4.8.16 SVG

The SVG element falls into the embedded content, phrasing content, flow content, and palpable content categories for the purposes of the content models in this specification.

When the SVG foreignObject element contains elements from the HTML namespace, such elements must all be flow content.

The content model for the SVG title element inside HTML documents is phrasing content. (This further constrains the requirements given in SVG 2.)

The semantics of SVG elements are defined by SVG 2 and other applicable specifications.

For web developers (non-normative)

```javascript
doc = iframe.getSVGDocument();
doc = embed.getSVGDocument();
doc = object.getSVGDocument();
```

Returns the Document object, in the case of iframe, embed, or object elements being used to embed SVG.

The getSVGDocument() method steps are:

1. Let document be this's content document.
2. If document is non-null and was created by the page load processing model for XML files section because the computed type of the resource in the navigate algorithm was image/svg+xml, then return document.
3. Return null.
4.8.17 Dimension attributes

Author requirements: The `width` and `height` attributes on `img`, `iframe`, `embed`, `object`, `video`, `source` when the parent is a `picture` element and, when their `type` attribute is in the `Image Button` state, `input` elements may be specified to give the dimensions of the visual content of the element (the width and height respectively, relative to the nominal direction of the output medium), in CSS pixels. The attributes, if specified, must have values that are valid non-negative integers.

The specified dimensions given may differ from the dimensions specified in the resource itself, since the resource may have a resolution that differs from the CSS pixel resolution. (On screens, CSS pixels have a resolution of 96ppi, but in general the CSS pixel resolution depends on the reading distance.) If both attributes are specified, then one of the following statements must be true:

- specified width - 0.5 ≤ specified height * target ratio ≤ specified width + 0.5
- specified height - 0.5 ≤ specified width / target ratio ≤ specified height + 0.5
- specified height = specified width = 0

The target ratio is the ratio of the natural width to the natural height in the resource. The specified width and specified height are the values of the `width` and `height` attributes respectively.

The two attributes must be omitted if the resource in question does not have both a natural width and a natural height.

If the two attributes are both 0, it indicates that the element is not intended for the user (e.g. it might be a part of a service to count page views).

**Note**
The dimension attributes are not intended to be used to stretch the image.

User agent requirements: User agents are expected to use these attributes as hints for the rendering.

The `width` and `height` IDL attributes on the `iframe`, `embed`, `object`, `source`, and `video` elements must reflect the respective content attributes of the same name.

**Note**
For `iframe`, `embed` and `object` the IDL attributes are `DOMString`; for `video` and `source` the IDL attributes are `unsigned long`.

**Note**
The corresponding IDL attributes for `img` and `input` elements are defined in those respective elements’ sections, as they are slightly more specific to those elements’ other behaviors.

4.9 Tabular data

4.9.1 The `table` element

Categories:
- Flow content
- Palpable content

Contexts in which this element can be used:
- Where `flow content` is expected.

Content model:
In this order: optionally a `caption` element, followed by zero or more `colgroup` elements, followed optionally by a `thead` element, followed by either zero or more `tbody` elements or one or more `tr` elements, followed optionally by a `tfoot` element, optionally intermixed with one or more `script-supporting elements`.

Tag omission in `text/html`:
- Neither tag is omissible.
Accessibility considerations:

For authors.

For implementers.

DOM interface:

```plaintext
IDL  [Exposed=Window]
interface HTMLTableElement : HTMLElement {
  [HTMLConstructor] constructor();

  [CEReactions] attribute HTMLTableCaptionElement? caption;
  HTMLTableCaptionElement createCaption();
  [CEReactions] undefined deleteCaption();

  [CEReactions] attribute HTMLTableSectionElement? tHead;
  HTMLTableSectionElement createTHead();
  [CEReactions] undefined deleteTHead();

  [CEReactions] attribute HTMLTableSectionElement? tFoot;
  HTMLTableSectionElement createTFoot();
  [CEReactions] undefined deleteTFoot();

  [SameObject] readonly attribute HTMLCollection tBodies;
  HTMLTableSectionElement createTBody();

  [SameObject] readonly attribute HTMLCollection rows;
  HTMLTableRowElement insertRow(optional long index = -1);
  [CEReactions] undefined deleteRow(long index);

  // also has obsolete members
};
```

The `table` element represents data with more than one dimension, in the form of a table.

The `table` element takes part in the table model. Tables have rows, columns, and cells given by their descendants. The rows and columns form a grid; a table's cells must completely cover that grid without overlap.

**Note**

Precise rules for determining whether this conformance requirement is met are described in the description of the table model.

Authors are encouraged to provide information describing how to interpret complex tables. Guidance on how to provide such information is given below.

Tables must not be used as layout aids. Historically, some web authors have misused tables in HTML as a way to control their page layout. This usage is non-conforming, because tools attempting to extract tabular data from such documents would obtain very confusing results. In particular, users of accessibility tools like screen readers are likely to find it very difficult to navigate pages with tables used for layout.

**Note**

There are a variety of alternatives to using HTML tables for layout, such as CSS grid layout, CSS flexible box layout ("flexbox"), CSS multi-column layout, CSS positioning, and the CSS table model.

Tables can be complicated to understand and navigate. To help users with this, user agents should clearly delineate cells in a table from each other, unless the user agent has classified the table as a (non-conforming) layout table.
User agents, especially those that do table analysis on arbitrary content, are encouraged to find heuristics to determine which tables actually contain data and which are merely being used for layout. This specification does not define a precise heuristic, but the following are suggested as possible indicators:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>The use of the <code>role</code> attribute with the value <code>presentation</code></td>
<td>Probably a layout table</td>
</tr>
<tr>
<td>The use of the non-conforming <code>border</code> attribute with the non-conforming value 0</td>
<td>Probably a layout table</td>
</tr>
<tr>
<td>The use of the non-conforming <code>cellspacing</code> and <code>cellpadding</code> attributes with the value 0</td>
<td>Probably a layout table</td>
</tr>
<tr>
<td>The use of <code>caption</code>, <code>thead</code>, or <code>th</code> elements</td>
<td>Probably a non-layout table</td>
</tr>
<tr>
<td>The use of the <code>headers</code> and <code>scope</code> attributes</td>
<td>Probably a non-layout table</td>
</tr>
<tr>
<td>The use of <code>caption</code> attribute</td>
<td>Not a good indicator (both layout and non-layout tables have historically been given this attribute)</td>
</tr>
<tr>
<td>The use of the <code>summary</code> attribute</td>
<td>Probably a non-layout table</td>
</tr>
</tbody>
</table>

If a `table` element has a (non-conforming) `summary` attribute, and the user agent has not classified the table as a layout table, the user agent may report the contents of that attribute to the user.

For web developers (non-normative)

```javascript
table.caption[= value]
  Returns the table's `caption` element.
  Can be set, to replace the `caption` element.

caption = table.createCaption()
  Ensures the table has a `caption` element, and returns it.

table.deleteCaption()
  Ensures the table does not have a `caption` element.

table.thead[= value]
  Returns the table's `thead` element.
  Can be set, to replace the `thead` element. If the new value is not a `thead` element, throws a "HierarchyRequestError" DOMException.

thead = table.createThead()
  Ensures the table has a `thead` element, and returns it.

table.deleteThead()
  Ensures the table does not have a `thead` element.

table.tFoot[= value]
  Returns the table's `tFoot` element.
  Can be set, to replace the `tFoot` element. If the new value is not a `tFoot` element, throws a "HierarchyRequestError" DOMException.

tfoot = table.createTFoot()
  Ensures the table has a `tFoot` element, and returns it.

table.deleteTFoot()
  Ensures the table does not have a `tFoot` element.
```
<table>
<thead>
<tr>
<th>table.tBodies</th>
<th>Returns an HTMLCollection of the tbody elements of the table.</th>
</tr>
</thead>
<tbody>
<tr>
<td>tbody = table.createTBody()</td>
<td>Creates a tbody element, inserts it into the table, and returns it.</td>
</tr>
<tr>
<td>table.rows</td>
<td>Returns an HTMLCollection of the tr elements of the table.</td>
</tr>
<tr>
<td>tr = table.insertRow([ index ])</td>
<td>Creates a tr element, along with a tbody if required, inserts them into the table at the position given by the argument, and returns the tr. The position is relative to the rows in the table. The index −1, which is the default if the argument is omitted, is equivalent to inserting at the end of the table. If the given position is less than −1 or greater than the number of rows, throws an &quot;IndexSizeError&quot; DOMException.</td>
</tr>
<tr>
<td>table.deleteRow(index)</td>
<td>Removes the tr element with the given position in the table. The position is relative to the rows in the table. The index −1 is equivalent to deleting the last row of the table. If the given position is less than −1 or greater than the index of the last row, or if there are no rows, throws an &quot;IndexSizeError&quot; DOMException.</td>
</tr>
</tbody>
</table>

In all of the following attribute and method definitions, when an element is to be table-created, that means to create an element given the table element's node document, the given local name, and the HTML namespace.

The caption IDL attribute must return, on getting, the first caption element child of the table element, if any, or null otherwise. On setting, the first caption element child of the table element, if any, must be removed, and the new value, if not null, must be inserted as the first node of the table element.

The createCaption() method must return the first caption element child of the table element, if any; otherwise a new caption element must be table-created inserted as the first node of the table element, and then returned.

The deleteCaption() method must remove the first caption element child of the table element, if any.

The tHead IDL attribute must return, on getting, the first thead element child of the table element, if any, or null otherwise. On setting, if the new value is null or a thead element, the first thead element child of the table element, if any, must be removed, and the new value, if not null, must be inserted immediately before the first element in the table element that is neither a caption element nor a colgroup element, if any, or at the end of the table if there are no such elements. If the new value is neither null nor a thead element, then a "HierarchyRequestError" DOMException must be thrown instead.

The createTHead() method must return the first thead element child of the table element, if any; otherwise a new thead element must be table-created and inserted immediately before the first element in the table element that is neither a caption element nor a colgroup element, if any, or at the end of the table if there are no such elements, and then that new element must be returned.

The deleteTHead() method must remove the first thead element child of the table element, if any.

The tFoot IDL attribute must return, on getting, the first tfoot element child of the table element, if any, or null otherwise. On setting, if the new value is null or a tfoot element, the first tfoot element child of the table element, if any, must be removed, and the new value, if not null, must be inserted at the end of the table. If the new value is neither null nor a tfoot element, then a "HierarchyRequestError" DOMException must be thrown instead.

The createTFoot() method must return the first tfoot element child of the table element, if any; otherwise a new tfoot element must be table-created and inserted at the end of the table, and then that new element must be returned.

The deleteTFoot() method must remove the first tfoot element child of the table element, if any.

The tBodies attribute must return an HTMLCollection rooted at the table node, whose filter matches only tbody elements that are children of the table element.

The createTBody() method must table-create a new tbody element, insert it immediately after the last tbody element child.
in the `table` element, if any, or at the end of the `table` element if the `table` element has no `tbody` element children, and then must return the new `tbody` element.

The `rows` attribute must return an `HTMLCollection` rooted at the `table` node, whose filter matches only `tr` elements that are either children of the `table` element, or children of `thead`, `tbody`, or `tfoot` elements that are themselves children of the `table` element. The elements in the collection must be ordered such that those elements whose parent is a `thead` are included first, in tree order, followed by those elements whose parent is either a `table` or `tbody` element, again in tree order, followed finally by those elements whose parent is a `tfoot` element, still in tree order.

The behavior of the `insertRow(index)` method depends on the state of the table. When it is called, the method must act as required by the first item in the following list of conditions that describes the state of the table and the `index` argument:

- **If index is less than −1 or greater than the number of elements in `rows` collection:**
  The method must throw an "IndexSizeError" `DOMException`.

- **If the `rows` collection has zero elements in it, and the `table` has no `tbody` elements in it:**
  The method must `table-create` a `tbody` element, then `table-create` a `tr` element, then append the `tr` element to the `tbody` element, then append the `tbody` element to the `table` element, and finally return the `tr` element.

- **If the `rows` collection has zero elements in it:**
  The method must `table-create` a `tr` element, append it to the last `tbody` element in the table, and return the `tr` element.

- **If index is −1 or equal to the number of items in `rows` collection:**
  The method must `table-create` a `tr` element, and append it to the parent of the last `tr` element in the `rows` collection. Then, the newly created `tr` element must be returned.

- **Otherwise:**
  The method must `table-create` a `tr` element, insert it immediately before the `index`th `tr` element in the `rows` collection, in the same parent, and finally return the newly created `tr` element.

When the `deleteRow(index)` method is called, the user agent must run the following steps:

1. If `index` is less than −1 or greater than or equal to the number of elements in the `rows` collection, then throw an "IndexSizeError" `DOMException`.

2. If `index` is −1, then remove the last element in the `rows` collection from its parent, or do nothing if the `rows` collection is empty.

3. Otherwise, remove the `index`th element in the `rows` collection from its parent.

**Example**

Here is an example of a table being used to mark up a Sudoku puzzle. Observe the lack of headers, which are not necessary in such a table.

```html
<style>
  .sudoku { border-collapse: collapse; border: solid thick; }
  .sudoku table, .sudoku tbody { border: solid medium; }
  .sudoku td { border: solid medium; height: 1.4em; width: 1.4em; text-align: center; padding: 0; }
</style>

<h1>Today's Sudoku</h1>
<table id="sudoku">
  <colgroup><col><col><col>
  <colgroup><col><col><col>
  <tbody>
    <tr><td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td>
    <tr><td>7</td> <td>8</td> <td>9</td> <td>1</td> <td>2</td> <td>3</td>
    <tr><td>4</td> <td>5</td> <td>6</td> <td>7</td> <td>8</td> <td>9</td>
  </tbody>
</table>
```
For tables that consist of more than just a grid of cells with headers in the first row and headers in the first column, and for any table in general where the reader might have difficulty understanding the content, authors should include explanatory information introducing the table. This information is useful for all users, but is especially useful for users who cannot see the table, e.g. users of screen readers.

Such explanatory information should introduce the purpose of the table, outline its basic cell structure, highlight any trends or patterns, and generally teach the user how to use the table.

For instance, the following table:

<table>
<thead>
<tr>
<th>Negative</th>
<th>Characteristic</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sad</td>
<td>Mood</td>
<td>Happy</td>
</tr>
<tr>
<td>Failing</td>
<td>Grade</td>
<td>Passing</td>
</tr>
</tbody>
</table>

...might benefit from a description explaining the way the table is laid out, something like "Characteristics are given in the second column, with the negative side in the left column and the positive side in the right column".

There are a variety of ways to include this information, such as:

**In prose, surrounding the table**

Example

```html
<p>In the following table, characteristics are given in the second column, with the negative side in the left column and the positive side in the right column.</p>
<table>
  <caption>Characteristics with positive and negative sides</caption>
  <thead>
    <tr>
      <th id="n">Negative</th>
      <th id="r1">Characteristic</th>
      <th id="r2">Positive</th>
    </tr>
  </thead>
  <tbody>
    <tr>
      <td headers="n r1">Sad</td>
      <td id="r1">Mood</td>
      <td id="r2">Happy</td>
    </tr>
    <tr>
      <td headers="n r2">Failing</td>
      <td id="r2">Grade</td>
      <td id="r2">Passing</td>
    </tr>
  </tbody>
</table>
```

**In the table's caption**
<table>
  <caption><strong>Characteristics with positive and negative sides.</strong></caption>
  <p>Characteristics are given in the second column, with the negative side in the left column and the positive side in the right column.</p>
</table>

Next to the table, in the same <strong>figure</strong> element

Example

```html
<table>
  <caption><strong>Characteristics with positive and negative sides.</strong></caption>
  <details>
    <summary>Help</summary>
    <p>Characteristics are given in the second column, with the negative side in the left column and the positive side in the right column.</p>
  </details>
</table>
```

In the table's <strong>caption</strong>, in a <strong>details</strong> element

Example

```html
<figure>
  <figcaption>Characteristics with positive and negative sides</figcaption>
  <p>Characteristics are given in the second column, with the</p>
</figure>
```
Authors may also use other techniques, or combinations of the above techniques, as appropriate.

The best option, of course, rather than writing a description explaining the way the table is laid out, is to adjust the table such that no explanation is needed.

**Example**

In the case of the table used in the examples above, a simple rearrangement of the table so that the headers are on the top and left sides removes the need for an explanation as well as removing the need for the use of `headers` attributes.
4.9.1.2 Techniques for table design

Good table design is key to making tables more readable and usable.

In visual media, providing column and row borders and alternating row backgrounds can be very effective to make complicated tables more readable.

For tables with large volumes of numeric content, using monospaced fonts can help users see patterns, especially in situations where a user agent does not render the borders. (Unfortunately, for historical reasons, not rendering borders on tables is a common default.)

In speech media, table cells can be distinguished by reporting the corresponding headers before reading the cell's contents, and by allowing users to navigate the table in a grid fashion, rather than serializing the entire contents of the table in source order.

Authors are encouraged to use CSS to achieve these effects.

User agents are encouraged to render tables using these techniques whenever the page does not use CSS and the table is not classified as a layout table.

4.9.2 The caption element

Categories:
None.

Contexts in which this element can be used:
As the first element child of a table element.

Content model:
Flow content, but with no descendant table elements.

Tag omission in text/html:
A caption element's end tag can be omitted if the caption element is not immediately followed by ASCII whitespace or a comment.

Content attributes:
Global attributes

Accessibility considerations:
For authors.
For implementers.
The `caption` element represents the title of the `table` that is its parent, if it has a parent and that is a `table` element.

The `caption` element takes part in the table model.

When a `table` element is the only content in a `figure` element other than the `figcaption`, the `caption` element should be omitted in favor of the `figcaption`.

A caption can introduce context for a table, making it significantly easier to understand.

**Example**

Consider, for instance, the following table:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
</tr>
</tbody>
</table>

In the abstract, this table is not clear. However, with a caption giving the table's number (for reference in the main prose) and explaining its use, it makes more sense:

```html
<caption>
<p>Table 1. This table shows the total score obtained from rolling two six-sided dice. The first row represents the value of the first die, the first column the value of the second die. The total is given in the cell that corresponds to the values of the two dice.</p>
</caption>
```

This provides the user with more context:

**Table 1.**

This table shows the total score obtained from rolling two six-sided dice. The first row represents the value of the first die, the first column the value of the second die. The total is given in the cell that corresponds to the values of the two dice.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
</tr>
</tbody>
</table>

4.9.3 The `colgroup` element

**Categories:** None.
Contexts in which this element can be used

As a child of a `table` element, after any `caption` elements and before any `thead`, `tbody`, `tfoot`, and `tr` elements.

Content model:

- If the `span` attribute is present: Nothing.
- If the `span` attribute is absent: Zero or more `col` and `template` elements.

Tag omission in text/html:

- A `colgroup` element's start tag can be omitted if the first thing inside the `colgroup` element is a `col` element, and if the element is not immediately preceded by another `colgroup` element whose end tag has been omitted. (It can't be omitted if the element is empty.)
- A `colgroup` element's end tag can be omitted if the `colgroup` element is not immediately followed by ASCII whitespace or a comment.

Content attributes:

- `span` — Number of columns spanned by the element

Accessibility considerations:

- For authors.
- For implementers.

DOM interface:

```idl
[Exposed=Window]
interface HTMLTableColElement : HTMLElement {
    [HTMLConstructor] constructor();

    [[CEReactions]] attribute unsigned long span;

    // also has obsolete members
};
```

The `colgroup` element represents a group of one or more `columns` in the `table` that is its parent, if it has a parent and that is a `table` element.

If the `colgroup` element contains no `col` elements, then the element may have a `span` content attribute specified, whose value must be a valid non-negative integer greater than zero and less than or equal to 1000.

The `colgroup` element and its `span` attribute take part in the `table model`.

The `span` IDL attribute must reflect the content attribute of the same name. It is clamped to the range [1, 1000], and its default value is 1.

4.9.4 The `col` element

Categories:

None.

Contexts in which this element can be used:

As a child of a `colgroup` element that doesn't have a `span` attribute.

Content model:

- Nothing.

Tag omission in text/html:

No end tag.

Content attributes:

- `span` — Number of columns spanned by the element
Accessibility considerations\textsuperscript{145}:
- For authors.
- For implementers.

DOM interface\textsuperscript{145}:
Uses \texttt{HTMLTableColElement}\textsuperscript{483}, as defined for \texttt{colgroup}\textsuperscript{483} elements.

If a \texttt{col}\textsuperscript{484} element has a parent and that is a \texttt{colgroup}\textsuperscript{483} element that itself has a parent that is a \texttt{table}\textsuperscript{474} element, then the \texttt{col}\textsuperscript{484} element represents one or more \texttt{columns}\textsuperscript{484} in the \texttt{column group}\textsuperscript{494} represented by that \texttt{colgroup}\textsuperscript{483}.

The element may have a \texttt{span} content attribute specified, whose value must be a valid non-negative integer\textsuperscript{75} greater than zero and less than or equal to 1000.

The \texttt{col}\textsuperscript{484} element and its \texttt{span}\textsuperscript{485} attribute take part in the \texttt{table model}\textsuperscript{494}.

4.9.5 The \texttt{tbody} element\textsuperscript{5}\textsuperscript{48}

Categories\textsuperscript{144}:
None.

Contexts in which this element can be used\textsuperscript{144}:
As a child of a \texttt{table}\textsuperscript{474} element, after any \texttt{caption}\textsuperscript{482}, \texttt{colgroup}\textsuperscript{483}, and \texttt{thead}\textsuperscript{496} elements, but only if there are no \texttt{tr}\textsuperscript{488} elements that are children of the \texttt{table}\textsuperscript{474} element.

Content model\textsuperscript{144}:
Zero or more \texttt{tr}\textsuperscript{488} and \texttt{script-supporting}\textsuperscript{149} elements.

Tag omission in \texttt{text/html}\textsuperscript{144}:
A \texttt{tbody}\textsuperscript{485} element's \texttt{start tag}\textsuperscript{1242} can be omitted if the first thing inside the \texttt{tbody}\textsuperscript{485} element is a \texttt{tr}\textsuperscript{488} element, and if the element is not immediately preceded by a \texttt{tbody}\textsuperscript{485}, \texttt{thead}\textsuperscript{496}, or \texttt{tfoot}\textsuperscript{497} element whose \texttt{end tag}\textsuperscript{1243} has been omitted. (It can't be omitted if the element is empty.)
A \texttt{tbody}\textsuperscript{485} element's \texttt{end tag}\textsuperscript{1243} can be omitted if the \texttt{tbody}\textsuperscript{485} element is immediately followed by a \texttt{tbody}\textsuperscript{485} or \texttt{tfoot}\textsuperscript{497} element, or if there is no more content in the parent element.

Content attributes\textsuperscript{144}:

Accessibility considerations\textsuperscript{145}:
- For authors.
- For implementers.

DOM interface\textsuperscript{145}:

\begin{verbatim}
IDL [Exposed=Window]
interface HTMLTableSectionElement : HTMLElement {
    [SameObject] readonly attribute HTMLCollection rows;
    HTMLTableRowElement insertRow(optional long index = -1);
    [CFReactions] undefined deleteRow(long index);
    // also has obsolete members
};
\end{verbatim}

The \texttt{HTMLTableSectionElement}\textsuperscript{485} interface is also used for \texttt{thead}\textsuperscript{496} and \texttt{tfoot}\textsuperscript{497} elements.

The \texttt{tbody}\textsuperscript{485} element represents a block\textsuperscript{494} of \texttt{rows}\textsuperscript{494} that consist of a body of data for the parent \texttt{table}\textsuperscript{474} element, if the \texttt{tbody}\textsuperscript{485} element has a parent and it is a \texttt{table}\textsuperscript{474}.

The \texttt{tbody}\textsuperscript{485} element takes part in the \texttt{table model}\textsuperscript{494}.
For web developers (non-normative)

\texttt{tbody}\.\texttt{rows}\[\texttt{p486}\]

Returns an HTMLCollection of the tr\[\texttt{p488}\] elements of the table section.

\texttt{tr} = \texttt{tbody}\.\texttt{insertRow}\[\texttt{p486}\]([\texttt{index}])

Creates a tr\[\texttt{p488}\] element, inserts it into the table section at the position given by the argument, and returns the tr\[\texttt{p488}\].

The position is relative to the rows in the table section. The index −1, which is the default if the argument is omitted, is equivalent to inserting at the end of the table section.

If the given position is less than −1 or greater than the number of rows, throws an "IndexSizeError" DOMException.

\texttt{tbody}\.\texttt{deleteRow}\[\texttt{p486}\](\texttt{index})

Removes the tr\[\texttt{p488}\] element with the given position in the table section.

The position is relative to the rows in the table section. The index −1 is equivalent to deleting the last row of the table section.

If the given position is less than −1 or greater than the index of the last row, or if there are no rows, throws an "IndexSizeError" DOMException.

The \texttt{rows} attribute must return an HTMLCollection rooted at this element, whose filter matches only tr\[\texttt{p488}\] elements that are children of this element.

The \texttt{insertRow} (index) method must act as follows:

1. If \texttt{index} is less than −1 or greater than the number of elements in the rows\[\texttt{p486}\] collection, throw an "IndexSizeError" DOMException.

2. Let \textit{table row} be the result of creating an element given this element’s node document, tr\[\texttt{p488}\], and the HTML namespace.

3. If \texttt{index} is −1 or equal to the number of items in the rows\[\texttt{p486}\] collection, then append table row to this element.

4. Otherwise, insert table row as a child of this element, immediately before the index\textit{th} tr\[\texttt{p488}\] element in the rows\[\texttt{p486}\] collection.

5. Return table row.

The \texttt{deleteRow} (index) method must, when invoked, act as follows:

1. If \texttt{index} is less than −1 or greater than or equal to the number of elements in the rows\[\texttt{p486}\] collection, then throw an "IndexSizeError" DOMException.

2. If \texttt{index} is −1, then remove the last element in the rows\[\texttt{p486}\] collection from this element, or do nothing if the rows\[\texttt{p486}\] collection is empty.

3. Otherwise, remove the index\textit{th} element in the rows\[\texttt{p486}\] collection from this element.

\subsection{4.9.6 The \texttt{thead} element\[\texttt{p486}\]}\[\texttt{p486}\]

\textbf{Categories}\[\texttt{p144}\]:

None.

\textbf{Contexts in which this element can be used}\[\texttt{p144}\]:

As a child of a table\[\texttt{p74}\] element, after any caption\[\texttt{p482}\] and colgroup\[\texttt{p483}\] elements and before any tbody\[\texttt{p485}\], tfoot\[\texttt{p487}\], and tr\[\texttt{p488}\] elements, but only if there are no other thead\[\texttt{p486}\] elements that are children of the table\[\texttt{p74}\] element.

\textbf{Content model}\[\texttt{p144}\]:

Zero or more tr\[\texttt{p488}\] and script-supporting\[\texttt{p149}\] elements.

\textbf{Tag omission in text/html}\[\texttt{p144}\]:

A thead\[\texttt{p486}\] element’s end tag\[\texttt{p124}\] can be omitted if the thead\[\texttt{p486}\] element is immediately followed by a tbody\[\texttt{p485}\] or tfoot\[\texttt{p487}\] element.

\textbf{Content attributes}\[\texttt{p144}\]:

Global attributes\[\texttt{p52}\]
**Accessibility considerations**

For authors.
For implementers.

**DOM interface**

Uses [HTMLTableSectionElement](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement), as defined for [tbody](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#tbody) elements.

The [thead](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#thead) element represents the block of rows that consist of the column labels (headers) and any ancillary non-header cells for the parent [table](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#table) element, if the [thead](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#thead) element has a parent and it is a [table](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#table).

The [thead](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#thead) element takes part in the [table model](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#table_model).

**Categories**

None.

**Contexts in which this element can be used**:

As a child of a [table](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#table) element, after any [caption](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#caption), [colgroup](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#colgroup), [thead](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#thead), [tbody](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#tbody), and [tr](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#tr) elements, but only if there are no other [tfoot](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#tfoot) elements that are children of the [table](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#table) element.

**Content model**:

Zero or more [tr](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#tr) and [script-supporting](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#script-supporting) elements.

**Tag omission in text/html**:

A [tfoot](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#tfoot) element's end tag can be omitted if there is no more content in the parent element.

---

### Example

This example shows a [thead](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#thead) element being used. Notice the use of both [th](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#th) and [td](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#td) elements in the [thead](https://developer.mozilla.org/en-US/docs/Web/API/HTMLTableSectionElement#thead) element: the first row is the headers, and the second row is an explanation of how to fill in the table.

```html
<table>
  <caption>School auction sign-up sheet</caption>
  <thead>
    <tr>
      <th><label for=e1>Name</label></th>
      <th><label for=e2>Product</label></th>
      <th><label for=e3>Picture</label></th>
      <th><label for=e4>Price</label></th>
    </tr>
    <tr>
      <td>Your name here</td>
      <td>What are you selling?</td>
      <td>Link to a picture</td>
      <td>Your reserve price</td>
    </tr>
  </thead>
  <tbody>
    <tr>
      <td>Ms Danus</td>
      <td>Doughnuts</td>
      <td><img src="https://example.com/mydoughnuts.png" title="Doughnuts from Ms Danus">$45</td>
    </tr>
    <tr>
      <td><input id=e1 type=text name=who required form=f></td>
      <td><input id=e2 type=text name=what required form=f></td>
      <td><input id=e3 type=url name=pic form=f></td>
      <td><input id=e4 type=number step=0.01 min=0 value=0 required form=f></td>
    </tr>
  </tbody>
</table>
<form id=f action="/auction.cgi">
  <input type=button name=add value="Submit">
</form>
```
4.9.8 The `tr` element

**Categories**: None.

**Contexts in which this element can be used**: As a child of a `thead` element. As a child of a `tbody` element. As a child of a `tfoot` element. As a child of a `table` element, after any `caption`, `colgroup`, and `thead` elements, but only if there are no `tbody` elements that are children of the `table` element.

**Content model**: Zero or more `td`, `th`, and `script-supporting` elements.

**Tag omission in text/html**: A `tr` element's end tag can be omitted if the `tr` element is immediately followed by another `tr` element, or if there is no more content in the parent element.

**Content attributes**: Global attributes

**Accessibility considerations**: For authors. For implementers.

**DOM interface**: Uses `HTMLTableSectionElement`, as defined for `tbody` elements.

The `tfoot` element represents the block of rows that consist of the column summaries (footers) for the parent `table` element, if the `tfoot` element has a parent and it is a `table`.

The `tfoot` element takes part in the `table model`.

The `tr` element represents a row of cells in a `table`.

The `tr` element takes part in the `table model`.
The `rowIndex` attribute must, if this element has a parent `table` element, or a parent `tbody`, `thead`, or `tfoot` element and a grandparent `table` element, return the index of this `tr` element in that `table` element's `rows` collection. If there is no such `table` element, then the attribute must return −1.

The `sectionRowIndex` attribute must, if this element has a parent `table`, `tbody`, `thead`, or `tfoot` element, return the index of the `tr` element in the parent element's `rows` list (for tables, that's `HTMLTableElement`'s `rows` collection; for table sections, that's `HTMLTableSectionElement`'s `rows` collection). If there is no such parent element, then the attribute must return −1.

The `cells` attribute must return an `HTMLCollection` of the `td` and `th` elements of the row.

`cell = tr.insertCell([ index ])`

Creates a `td` element, inserts it into the table row at the position given by the argument, and returns the `td` element. The position is relative to the cells in the row. The index −1, which is the default if the argument is omitted, is equivalent to inserting at the end of the row.

If the given position is less than −1 or greater than the number of cells, throws an "IndexSizeError" DOMException.

The `cell` attribute must return an `HTMLCollection` rooted at this `tr` element, whose filter matches only `td` and `th` elements that are children of the `tr` element.

The `insertCell(index)` method must act as follows:

1. If `index` is less than −1 or greater than the number of elements in the `cells` collection, then throw an "IndexSizeError" DOMException.
2. Let `table cell` be the result of creating an element given this `tr` element's `node document`, `td`, and the `HTML namespace`.
3. If `index` is equal to −1 or equal to the number of items in `cells` collection, then append `table cell` to this `tr` element.
4. Otherwise, insert `table cell` as a child of this `tr` element, immediately before the `index`th `td` or `th` element in the `cells` collection.
5. Return `table cell`.

The `deleteCell(index)` method must act as follows:

1. If `index` is less than −1 or greater than or equal to the number of elements in the `cells` collection, then throw an "IndexSizeError" DOMException.
2. If `index` is −1, then remove the last element in the `cells` collection from its parent, or do nothing if the `cells` collection is empty.
3. Otherwise, remove the `index`th element in the `cells` collection from its parent.
4.9.9 The `td` element

Categories:
None.

Contexts in which this element can be used:
As a child of a `tr` element.

Content model:
Flow content.

Tag omission in text/html:
A `td` element's end tag can be omitted if the `td` element is immediately followed by a `td` or `th` element, or if there is no more content in the parent element.

Content attributes:

Global attributes:
- `colspan` — Number of columns that the cell is to span
- `rowspan` — Number of rows that the cell is to span
- `headers` — The header cells for this cell

Accessibility considerations:
For authors.
For implementers.

DOM interface:

```idl
[Exposed=Window]
interface HTMLTableCellElement : HTMLElement {
  [HTMLConstructor] constructor();

  [CEReactions] attribute unsigned long colspan;
  [CEReactions] attribute unsigned long rowspan;
  [CEReactions] attribute DOMString headers;
  readonly attribute long cellIndex;

  [CEReactions] attribute DOMString scope; // only conforming for th elements
  [CEReactions] attribute DOMString abbr;  // only conforming for th elements

  // also has obsolete members
};
```

The `HTMLTableCellElement` interface is also used for `th` elements.

The `td` element represents a data cell in a table.

The `td` element and its `colspan`, `rowspan`, and `headers` attributes take part in the table model.

User agents, especially in non-visual environments or where displaying the table as a 2D grid is impractical, may give the user context for the cell when rendering the contents of a cell; for instance, giving its position in the table model, or listing the cell's header cells (as determined by the algorithm for assigning header cells). When a cell's header cells are being listed, user agents may use the value of `abbr` attributes on those header cells, if any, instead of the contents of the header cells themselves.

Example

In this example, we see a snippet of a web application consisting of a grid of editable cells (essentially a simple spreadsheet). One of the cells has been configured to show the sum of the cells above it. Three have been marked as headings, which use `th` elements instead of `td` elements. A script would attach event handlers to these elements to maintain the total.

```html
<table>
  <tr>
    <th><input value="Name"></th>
    <th><input value="Paid ($)"></th>
    <tr>
```
4.9.10 The th element

Categories:
None.

Contexts in which this element can be used:
As a child of a tr element.

Content model:
Flow content, but with no header, footer, sectioning content, or heading content descendants.

Tag omission in text/html:
A th element's end tag can be omitted if the th element is immediately followed by a td or th element, or if there is no more content in the parent element.

Content attributes:

Global attributes:
colspan — Number of columns that the cell is to span
rowspan — Number of rows that the cell is to span
headers — The header cells for this cell
scope — Specifies which cells the header cell applies to
abbr — Alternative label to use for the header cell when referencing the cell in other contexts

Accessibility considerations:
For authors.
For implementers.

DOM interface:
Uses HTMLTableCellElement, as defined for td elements.

The th element represents a header cell in a table.

The th element may have a scope content attribute specified.

The scope attribute is an enumerated attribute, with the following keywords and states:
The attribute’s missing value default is auto. and invalid value default is auto are both the auto state.

A th element’s scope attribute must not be in the row group state if the element is not anchored in a row group, nor in the column group state if the element is not anchored in a column group.

The th element may have an abbr content attribute specified. Its value must be an alternative label for the header cell, to be used when referencing the cell in other contexts (e.g. when describing the header cells that apply to a data cell). It is typically an abbreviated form of the full header cell, but can also be an expansion, or merely a different phrasing.

The th element and its colspan, rowspan, headers, and scope attributes take part in the table model.

Example

The following example shows how the scope attribute’s rowgroup value affects which data cells a header cell applies to.

Here is a markup fragment showing a table:

```html
<table>
  <thead>
    <tr>
      <th>ID</th> <th>Measurement</th> <th>Average</th> <th>Maximum</th>
    </tr>
    <tr scope=rowgroup>
      <td>Cats</td> <td>93</td> <td>3.5</td> <td>4</td>
    </tr>
    <tr>
      <td>Tails</td> <td>10</td> <td>1</td> <td>1</td>
    </tr>
    <tr scope=rowgroup>
      <td>English speakers</td> <td>32</td> <td>2.67</td> <td>4</td>
    </tr>
    <tr>
      <td>Tails</td> <td>35</td> <td>0.33</td> <td>1</td>
    </tr>
  </thead>
</table>
```

This would result in the following table:

<table>
<thead>
<tr>
<th>ID</th>
<th>Measurement</th>
<th>Average</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cats</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>93</td>
<td>Legs</td>
<td>3.5</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>Tails</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>English speakers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Legs</td>
<td>2.67</td>
<td>4</td>
</tr>
<tr>
<td>35</td>
<td>Tails</td>
<td>0.33</td>
<td>1</td>
</tr>
</tbody>
</table>

The headers in the first row all apply directly down to the rows in their column.

The headers with a scope attribute in the rowgroup state apply to all the cells in their row group other than the cells in the first column.

The remaining headers apply just to the cells to the right of them.
4.9.11 Attributes common to \texttt{td} and \texttt{th} elements

The \texttt{td} and \texttt{th} elements may have a \texttt{colspan} content attribute specified, whose value must be a valid non-negative integer greater than zero and less than or equal to 1000.

The \texttt{td} and \texttt{th} elements may also have a \texttt{rowspan} content attribute specified, whose value must be a valid non-negative integer less than or equal to 65534. For this attribute, the value zero means that the cell is to span all the remaining rows in the row group.

These attributes give the number of columns and rows respectively that the cell is to span. These attributes must not be used to overlap cells, as described in the description of the table model.

The \texttt{colspan} and \texttt{rowspan} element may have a \texttt{headers} content attribute specified. The \texttt{headers} attribute, if specified, must contain a string consisting of an unordered set of unique space-separated tokens, none of which are identical to another token and each of which must have the value of an \texttt{ID} of a \texttt{th} element taking part in the same table as the \texttt{td} or \texttt{th} element (as defined by the table model).

A \texttt{th} element with \texttt{ID id} is said to be directly targeted by all \texttt{td} and \texttt{th} elements in the same table that have \texttt{headers} attributes whose values include as one of their tokens the \texttt{ID id}. A \texttt{th} element \texttt{A} is said to be targeted by a \texttt{th} or \texttt{td} element \texttt{B} if either \texttt{A} is directly targeted by \texttt{B} or if there exists an element \texttt{C} that is itself targeted by the element \texttt{B} and \texttt{A} is directly targeted by \texttt{C}.

A \texttt{th} element must not be targeted by itself.

The \texttt{colspan}, \texttt{rowspan}, and \texttt{headers} attributes take part in the table model.

For web developers (non-normative)

\begin{verbatim}
cell.cellIndex
\end{verbatim}

Returns the position of the cell in the row’s \texttt{cells} list. This does not necessarily correspond to the x-position of the cell in the table, since earlier cells might cover multiple rows or columns.

Returns −1 if the element isn’t in a row.

The \texttt{colSpan} IDL attribute must \texttt{reflect} the \texttt{colspan} content attribute. It is clamped to the range [1, 1000], and its default value is 1.

The \texttt{rowSpan} IDL attribute must \texttt{reflect} the \texttt{rowspan} content attribute. It is clamped to the range [0, 65534], and its default value is 1.

The \texttt{headers} IDL attribute must \texttt{reflect} the content attribute of the same name.
The `cellIndex` IDL attribute must, if the element has a parent `tr` element, return the index of the cell’s element in the parent element’s `cells` collection. If there is no such parent element, then the attribute must return −1.

The `scope` IDL attribute must `reflect` the content attribute of the same name, limited to only known values.

The `abbr` IDL attribute must `reflect` the content attribute of the same name.

### 4.9.12 Processing model

The various table elements and their content attributes together define the **table model**.

A **table** consists of cells aligned on a two-dimensional grid of **slots** with coordinates \((x, y)\). The grid is finite, and is either empty or has one or more slots. If the grid has one or more slots, then the \(x\) coordinates are always in the range \(0 \leq x < x\text{width}\), and the \(y\) coordinates are always in the range \(0 \leq y < y\text{height}\). If one or both of \(x\text{width}\) and \(y\text{height}\) are zero, then the table is empty (has no slots). Tables correspond to `table` elements.

A **cell** is a set of slots anchored at a slot \((cell_x, cell_y)\), and with a particular **width** and **height** such that the cell covers all the slots with coordinates \((x, y)\) where \(cell_x \leq x < cell_x + width\) and \(cell_y \leq y < cell_y + height\). Cells can either be data cells or header cells. Data cells correspond to `td` elements, and header cells correspond to `th` elements. Cells of both types can have zero or more associated header cells.

It is possible, in certain error cases, for two cells to occupy the same slot.

A **row** is a complete set of slots from \(x=0\) to \(x=x\text{width}-1\), for a particular value of \(y\). Rows usually correspond to `tr` elements, though a `row group` can have some implied `rows` at the end in some cases involving `cell` spanning multiple rows.

A **column** is a complete set of slots from \(y=0\) to \(y=y\text{height}-1\), for a particular value of \(x\). Columns can correspond to `col` elements. In the absence of `col` elements, columns are implied.

A **row group** is a set of `rows` anchored at a slot \((0, group_y)\) with a particular **height** such that the row group covers all the slots with coordinates \((x, y)\) where \(0 \leq x < x\text{width}\) and \(group_y \leq y < group_y + height\). Row groups correspond to `tbody`, `thead`, and `tfoot` elements. Not every row is necessarily in a row group.

A **column group** is a set of `columns` anchored at a slot \((group_x, 0)\) with a particular **width** such that the column group covers all the slots with coordinates \((x, y)\) where \(group_x \leq x < group_x + width\) and \(0 \leq y < y\text{height}\). Column groups correspond to `colgroup` elements. Not every column is necessarily in a column group.

Row groups cannot overlap each other. Similarly, column groups cannot overlap each other.

A **cell** cannot cover slots that are from two or more `row groups`. It is, however, possible for a cell to be in multiple `column groups`. All the slots that form part of one cell are part of zero or one `row groups` and zero or more `column groups`.

In addition to `cells`, `columns`, `rows`, `row groups`, and `column groups`, `table` can have a `caption` element associated with them. This gives the table a heading, or legend.

A **table model error** is an error with the data represented by `table` elements and their descendants. Documents must not have table model errors.

### 4.9.12.1 Forming a table

To determine which elements correspond to which slots in a `table` associated with a `table` element, to determine the dimensions of the table \((x\text{width} \text{ and } y\text{height})\), and to determine if there are any table model errors, user agents must use the following algorithm:

1. Let \(x\text{width}\) be zero.
2. Let \(y\text{height}\) be zero.
3. Let `pending tfoot` elements be a list of `tfoot` elements, initially empty.
4. Let the `table` be the `table` represented by the `table` element. The \(x\text{width}\) and \(y\text{height}\) variables give the table's dimensions. The `table` is initially empty.
5. If the table element has no children elements, then return the table (which will be empty).

6. Associate the first caption element child of the table element with the table. If there are no such children, then it has no associated caption element.

7. Let the current element be the first element child of the table element.

If a step in this algorithm ever requires the current element to be advanced to the next child of the table when there is no such next child, then the user agent must jump to the step labeled end, near the end of this algorithm.

8. While the current element is not one of the following elements, advance the current element to the next child of the table:
   - colgroup
   - thead
   - tbody
   - tfoot
   - tr

9. If the current element is a colgroup, follow these substeps:

   1. Column groups: Process the current element according to the appropriate case below:

      → If the current element has any col element children

      Follow these steps:

      1. Let xstart have the value of xwidth.
      2. Let the current column be the first col element child of the colgroup element.
      3. Columns: If the current column col element has a span attribute, then parse its value using the rules for parsing non-negative integers.

         If the result of parsing the value is not an error or zero, then let span be that value.
         Otherwise, if the col element has no span attribute, or if trying to parse the attribute's value resulted in an error or zero, then let span be 1.
         If span is greater than 1000, let it be 1000 instead.
      4. Increase xwidth by span.
      5. Let the last span columns in the table correspond to the current column col element.
      6. If current column is not the last col element child of the colgroup element, then let the current column be the next col element child of the colgroup element, and return to the step labeled columns.
      7. Let all the last columns in the table from x=xstart to x=xwidth-1 form a new column group, anchored at the slot (xwidth-xstart, 0), with width xwidth-xstart, corresponding to the colgroup element.

      → If the current element has no col element children

      1. If the colgroup element has a span attribute, then parse its value using the rules for parsing non-negative integers.

         If the result of parsing the value is not an error or zero, then let span be that value.
         Otherwise, if the colgroup element has no span attribute, or if trying to parse the attribute's value resulted in an error or zero, then let span be 1.
         If span is greater than 1000, let it be 1000 instead.
      2. Increase xwidth by span.
      3. Let the last span columns in the table form a new column group, anchored at the slot (xwidth-span, 0), with width span, corresponding to the colgroup element.
      4. Advance the current element to the next child of the table.
      5. While the current element is not one of the following elements, advance the current element to the next child
of the \texttt{table} element:

- \texttt{colgroup}
- \texttt{thead}
- \texttt{tbody}
- \texttt{tfoot}
- \texttt{tr}

4. If the current element is a \texttt{colgroup} element, jump to the step labeled \textit{column groups} above.

10. Let $y_{\text{current}}$ be zero.

11. Let the list of downward-growing cells be an empty list.

12. Rows: While the current element is not one of the following elements, \texttt{thead}, \texttt{tbody}, \texttt{tfoot}, \texttt{tr}, advance the current element to the next child of the \texttt{table}, and return to the step labeled rows.

13. If the current element is a \texttt{tr}, then run the \texttt{algorithm for processing rows}, advance the current element to the next child of the \texttt{table}, and return to the step labeled rows.

14. Run the \texttt{algorithm for ending a row group}.

15. If the current element is a \texttt{tfoot}, then add that element to the list of pending \texttt{tfoot} elements, advance the current element to the next child of the \texttt{table}, and return to the step labeled rows.

16. The current element is either a \texttt{thead} or a \texttt{tbody}.

Run the \texttt{algorithm for processing row groups}.

17. Advance the current element to the next child of the \texttt{table}.

18. Return to the step labeled rows.

19. End: For each \texttt{tfoot} element in the list of pending \texttt{tfoot} elements, in tree order, run the \texttt{algorithm for processing row groups}.

20. If there exists a \texttt{row} or \texttt{column} in the table containing only \texttt{slots} that do not have a \texttt{cell} anchored to them, then this is a \texttt{table model error}.

21. Return the \texttt{table}.

The \texttt{algorithm for processing row groups}, which is invoked by the set of steps above for processing \texttt{thead}, \texttt{tbody}, \texttt{tfoot} elements, is:

1. Let $y_{\text{start}}$ have the value of $y_{\text{height}}$.

2. For each \texttt{tr} element that is a child of the element being processed, in tree order, run the \texttt{algorithm for processing rows}.

3. If $y_{\text{height}} > y_{\text{start}}$, then let all the last \texttt{rows} in the table from $y=y_{\text{start}}$ to $y=y_{\text{height}}-1$ form a new \texttt{row group}, anchored at the slot with coordinate $(0, y_{\text{start}})$, with height $y_{\text{height}}-y_{\text{start}}$, corresponding to the element being processed.

4. Run the \texttt{algorithm for ending a row group}.

The \texttt{algorithm for ending a row group}, which is invoked by the set of steps above when starting and ending a block of rows, is:

1. While $y_{\text{current}}$ is less than $y_{\text{height}}$, follow these steps:
   1. Run the \texttt{algorithm for growing downward-growing cells}.
   2. Increase $y_{\text{current}}$ by 1.

2. Empty the list of downward-growing cells.

The \texttt{algorithm for processing rows}, which is invoked by the set of steps above for processing \texttt{tr} elements, is:
1. If \( y_{\text{height}} \) is equal to \( y_{\text{current}} \), then increase \( y_{\text{height}} \) by 1. (\( y_{\text{current}} \) is never greater than \( y_{\text{height}} \).)
2. Let \( x_{\text{current}} \) be 0.
3. Run the algorithm for growing downward-growing cells.
4. If the \( \text{tr}^{p488} \) element being processed has no \( \text{td}^{p489} \) or \( \text{th}^{p491} \) element children, then increase \( y_{\text{current}} \) by 1, abort this set of steps, and return to the algorithm above.
5. Let \( \text{current cell} \) be the first \( \text{td}^{p489} \) or \( \text{th}^{p491} \) element child in the \( \text{tr}^{p488} \) element being processed.
6. Cells: While \( x_{\text{current}} \) is less than \( x_{\text{width}} \) and the slot with coordinate \((x_{\text{current}}, y_{\text{current}})\) already has a cell assigned to it, increase \( x_{\text{current}} \) by 1.
7. If \( x_{\text{current}} \) is equal to \( x_{\text{width}} \), increase \( x_{\text{width}} \) by 1. (\( x_{\text{current}} \) is never greater than \( x_{\text{width}} \).)
8. If the \( \text{current cell} \) has a \( \text{colspan}^{p493} \) attribute, then parse that attribute's value, and let \( \text{colspan} \) be the result.
   If parsing that value failed, or returned zero, or if the attribute is absent, then let \( \text{colspan} \) be 1, instead.
   If \( \text{colspan} \) is greater than 1000, let it be 1000 instead.
9. If the \( \text{current cell} \) has a \( \text{rowspan}^{p493} \) attribute, then parse that attribute's value, and let \( \text{rowspan} \) be the result.
   If parsing that value failed or if the attribute is absent, then let \( \text{rowspan} \) be 1, instead.
   If \( \text{rowspan} \) is greater than 65534, let it be 65534 instead.
10. If \( \text{rowspan} \) is zero and the \( \text{table}^{p474} \) element's node document is not set to quirks mode, then let \( \text{cell grows downward} \) be true, and set \( \text{rowspan} \) to 1. Otherwise, let \( \text{cell grows downward} \) be false.
11. If \( \text{width} < x_{\text{current}} + \text{colspan} \), then let \( \text{width} \) be \( x_{\text{current}} + \text{colspan} \).
12. If \( \text{height} < y_{\text{current}} + \text{rowspan} \), then let \( \text{height} \) be \( y_{\text{current}} + \text{rowspan} \).
13. Let the slots with coordinates \((x, y)\) such that \( x_{\text{current}} \leq x < x_{\text{current}} + \text{colspan} \) and \( y_{\text{current}} \leq y < y_{\text{current}} + \text{rowspan} \) be covered by a new \( \text{cell}^{p494} \) \( c \), anchored at \((x_{\text{current}}, y_{\text{current}})\), which has width \( \text{colspan} \) and height \( \text{rowspan} \), corresponding to the \( \text{current cell} \) element.
   If the \( \text{current cell} \) element is a \( \text{th}^{p491} \) element, let this new \( c \) be a header cell; otherwise, let it be a data cell.
   To establish which header cells apply to the \( \text{current cell} \) element, use the algorithm for assigning header cells, described in the next section.
   If any of the slots involved already had a \( \text{cell}^{p494} \) covering them, then this is a table model error. Those slots now have two cells overlapping.
14. If \( \text{cell grows downward} \) is true, then add the tuple \( \{ c, x_{\text{current}}, \text{colspan} \} \) to the list of downward-growing cells.
15. Increase \( x_{\text{current}} \) by \( \text{colspan} \).
16. If \( \text{current cell} \) is the last \( \text{td}^{p499} \) or \( \text{th}^{p491} \) element child in the \( \text{tr}^{p488} \) element being processed, then increase \( y_{\text{current}} \) by 1, abort this set of steps, and return to the algorithm above.
17. Let \( \text{current cell} \) be the next \( \text{td}^{p499} \) or \( \text{th}^{p491} \) element child in the \( \text{tr}^{p488} \) element being processed.
18. Return to the step labeled \( \text{cells} \).

When the algorithms above require the user agent to run the algorithm for growing downward-growing cells, the user agent must, for each \( \{ \text{cell}, \text{cellx}, \text{width} \} \) tuple in the list of downward-growing cells, if any, extend the \( \text{cell}^{p494} \) \( \text{cell} \) so that it also covers the slots with coordinates \((x, y_{\text{current}})\), where \( \text{cellx} \leq x < \text{cellx} + \text{width} \).

### 4.9.12.2 Forming relationships between data cells and header cells

Each cell can be assigned zero or more header cells. The algorithm for assigning header cells to a cell principal cell is as follows.

1. Let header list be an empty list of cells.
2. Let \((\text{principalsx}, \text{principaly})\) be the coordinate of the slot to which the principal cell is anchored.
If the principal cell has a headers attribute specified

1. Take the value of the principal cell's headers attribute and split it on ASCII whitespace, letting id list be the list of tokens obtained.

2. For each token in the id list, if the first element in the Document with an ID equal to the token is a cell in the same table, and that cell is not the principal cell, then add that cell to header list.

If principal cell does not have a headers attribute specified

1. Let principal width be the width of the principal cell.
2. Let principal height be the height of the principal cell.
3. For each value of y from principal y to principal y + principal height - 1, run the internal algorithm for scanning and assigning header cells, with the principal cell, the header list, the initial coordinate (principal x, y), and the increments Δx = -1 and Δy = 0.
4. For each value of x from principal x to principal x + principal width - 1, run the internal algorithm for scanning and assigning header cells, with the principal cell, the header list, the initial coordinate (x, principal y), and the increments Δx = 0 and Δy = -1.
5. If the principal cell is anchored in a row group, then add all header cells that are row group headers and are anchored in the same row group with an x-coordinate less than or equal to principal x + principal width - 1 and a y-coordinate less than or equal to principal y + principal height - 1 to header list.
6. If the principal cell is anchored in a column group, then add all header cells that are column group headers and are anchored in the same column group with an x-coordinate less than or equal to principal x + principal width - 1 and a y-coordinate less than or equal to principal y + principal height - 1 to header list.
7. Assign the headers in the header list to the principal cell.

The internal algorithm for scanning and assigning header cells, given a principal cell, a header list, an initial coordinate (initial x, initial y), and Δx and Δy increments, is as follows:

1. Let x equal initial x.
2. Let y equal initial y.
3. Let opaque headers be an empty list of cells.

4. If principal cell is a header cell
   
   Let in header block be true, and let headers from current header block be a list of cells containing just the principal cell.

5. Otherwise
   
   Let in header block be false and let headers from current header block be an empty list of cells.

6. Loop: Increment x by Δx; increment y by Δy.

   **Note**
   
   For each invocation of this algorithm, one of Δx and Δy will be -1, and the other will be 0.

7. If either x or y are less than 0, then abort this internal algorithm.
8. If there is no cell covering slot (x, y), or if there is more than one cell covering slot (x, y), return to the substep labeled loop.
9. Let current cell be the cell covering slot (x, y).
If current cell is a header cell

1. Set in header block to true.
2. Add current cell to headers from current header block.
3. Let blocked be false.

4. If \( \Delta x = 0 \)
   
   If there are any cells in the opaque headers list anchored with the same x-coordinate as the current cell, and with the same width as current cell, then let blocked be true.

   If the current cell is not a column header, then let blocked be true.

   \( \Leftarrow \) If \( \Delta y = 0 \)
   
   If there are any cells in the opaque headers list anchored with the same y-coordinate as the current cell, and with the same height as current cell, then let blocked be true.

   If the current cell is not a row header, then let blocked be true.

5. If blocked is false, then add the current cell to the headers list.

\( \Leftarrow \) If current cell is a data cell and in header block is true

Set in header block to false. Add all the cells in headers from current header block to the opaque headers list, and empty the headers from current header block list.

10. Return to the step labeled loop.

A header cell anchored at the slot with coordinate \((x, y)\) with width \(\text{width}\) and height \(\text{height}\) is said to be a column header if any of the following are true:

- the cell's \text{scope} attribute is in the column state; or
- the cell's \text{scope} attribute is in the auto state, and there are no data cells in any of the cells covering slots with \(y\)-coordinates \(y .. y+\text{height}-1\).

A header cell anchored at the slot with coordinate \((x, y)\) with width \(\text{width}\) and height \(\text{height}\) is said to be a row header if any of the following are true:

- the cell's \text{scope} attribute is in the row state; or
- the cell's \text{scope} attribute is in the auto state, the cell is not a column header, and there are no data cells in any of the cells covering slots with \(x\)-coordinates \(x .. x+\text{width}-1\).

A header cell is said to be a column group header if its \text{scope} attribute is in the column group state.

A header cell is said to be a row group header if its \text{scope} attribute is in the row group state.

A cell is said to be an empty cell if it contains no elements and its child text content, if any, consists only of ASCII whitespace.

4.9.13 Examples

\( \text{This section is non-normative.} \)

The following shows how one might mark up the bottom part of table 45 of the Smithsonian physical tables, Volume 71:

\[
\begin{table}
\begin{caption}Specification values: <b>Steel</b>, <b>Castings</b>, Ann. A.S.T.M. A27-16, Class B;* P max. 0.06; S max. 0.05.</caption>
\begin{thead}
\begin{tr}
\begin{th}rowspan=2\rangle Grade.\</th>
\begin{th}rowspan=2\rangle Yield Point.\</th>
\begin{th}colspan=2\rangle Ultimate tensile strength\</th>
\end{tr}
\end{thead}
\end{table}
\]

499
<table>
<thead>
<tr>
<th>Grade</th>
<th>Yield Point</th>
<th>Ultimate tensile strength</th>
<th>Per cent elong.</th>
<th>Per cent reduct. area.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>kg/mm²</td>
<td>lb/in²</td>
<td>50.8 mm or 2 in.</td>
</tr>
<tr>
<td>Hard...</td>
<td>0.45 ultimate</td>
<td>56.2</td>
<td>80,000</td>
<td>15</td>
</tr>
<tr>
<td>Medium..</td>
<td>0.45 ultimate</td>
<td>49.2</td>
<td>70,000</td>
<td>18</td>
</tr>
<tr>
<td>Soft....</td>
<td>0.45 ultimate</td>
<td>42.2</td>
<td>60,000</td>
<td>22</td>
</tr>
</tbody>
</table>

This table could look like this:

**Specification values:** Steel, Castings, Arr. A.S.T.M. A27-16, Class B*; P max. 0.06; S max. 0.05.

The following shows how one might mark up the gross margin table on page 46 of Apple, Inc's 10-K filing for fiscal year 2008:
<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2007</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Net sales</strong></td>
<td>$32,479</td>
<td>$24,006</td>
<td>$19,315</td>
</tr>
<tr>
<td><strong>Cost of sales</strong></td>
<td>21,334</td>
<td>15,852</td>
<td>13,717</td>
</tr>
<tr>
<td><strong>Gross margin</strong></td>
<td>$11,145</td>
<td>$8,154</td>
<td>$5,598</td>
</tr>
<tr>
<td><strong>Gross margin percentage</strong></td>
<td>34.3%</td>
<td>34.0%</td>
<td>29.0%</td>
</tr>
</tbody>
</table>

This table could look like this:

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2007</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Research and development</strong></td>
<td>$1,109</td>
<td>$782</td>
<td>$712</td>
</tr>
<tr>
<td><strong>Percentage of net sales</strong></td>
<td>3.4%</td>
<td>3.3%</td>
<td>3.7%</td>
</tr>
<tr>
<td><strong>Selling, general, and administrative</strong></td>
<td>$3,761</td>
<td>$2,963</td>
<td>$2,433</td>
</tr>
<tr>
<td><strong>Percentage of net sales</strong></td>
<td>11.6%</td>
<td>12.3%</td>
<td>12.6%</td>
</tr>
</tbody>
</table>
4.10 Forms

4.10.1 Introduction

This section is non-normative.

A form is a component of a web page that has form controls, such as text, buttons, checkboxes, range, or color picker controls. A user can interact with such a form, providing data that can then be sent to the server for further processing (e.g. returning the results of a search or calculation). No client-side scripting is needed in many cases, though an API is available so that scripts can augment the user experience or use forms for purposes other than submitting data to a server.

Writing a form consists of several steps, which can be performed in any order: writing the user interface, implementing the server-side processing, and configuring the user interface to communicate with the server.

4.10.1.1 Writing a form's user interface

This section is non-normative.

For the purposes of this brief introduction, we will create a pizza ordering form.

Any form starts with a `<form>` element, inside which are placed the controls. Most controls are represented by the `<input>` element, which by default provides a text control. To label a control, the `<label>` element is used; the label text and the control itself go inside the `<label>` element. Each part of a form is considered a paragraph, and is typically separated from other parts using `<p>` elements. Putting this together, here is how one might ask for the customer's name:

```html
<form>
  <p><label>Customer name: <input></label></p>
</form>
```

To let the user select the size of the pizza, we can use a set of radio buttons. Radio buttons also use the `<input>` element, this time with a `type` attribute with the value `radio`. To make the radio buttons work as a group, they are given a common name using the `name` attribute. To group a batch of controls together, such as, in this case, the radio buttons, one can use the `<fieldset>` element. The title of such a group of controls is given by the first element in the `<fieldset>`, which has to be a `<legend>` element.

```html
<form>
  <p><label>Customer name: <input></label></p>
  <fieldset>
    <legend>Pizza Size</legend>
    <p><label><input type=radio name=size> Small</label></p>
    <p><label><input type=radio name=size> Medium</label></p>
    <p><label><input type=radio name=size> Large</label></p>
  </fieldset>
</form>
```

To pick toppings, we can use checkboxes. These use the `<input>` element with a `type` attribute with the value `checkbox`:

```html
<form>
  <p><label>Customer name: <input></label></p>
  <fieldset>
    <legend>Pizza Size</legend>
    <p><label><input type=radio name=size> Small</label></p>
    <p><label><input type=radio name=size> Medium</label></p>
    <p><label><input type=radio name=size> Large</label></p>
  </fieldset>
</form>
```
The pizzeria for which this form is being written is always making mistakes, so it needs a way to contact the customer. For this purpose, we can use form controls specifically for telephone numbers (input elements with their type attribute set to tel) and email addresses (input elements with their type attribute set to email).

We can use an input element with its type attribute set to time to ask for a delivery time. Many of these form controls have attributes to control exactly what values can be specified; in this case, three attributes of particular interest are min, max, and step. These set the minimum time, the maximum time, and the interval between allowed values (in seconds). This pizzeria only delivers between 11am and 9pm, and doesn't promise anything better than 15 minute increments, which we can mark up as follows:

The textarea element can be used to provide a multiline text control. In this instance, we are going to use it to provide a space for the customer to give delivery instructions:
Customer name: <input name="custname" type="text" />
Telephone: <input name="custtel" type="tel" />
Email address: <input name="custemail" type="email" />

Pizza Size
- Small
- Medium
- Large

Pizza Toppings
- Bacon
- Extra Cheese
- Onion
- Mushroom

Preferred delivery time: <input name="preferred_delivery_time" type="time" min="11:00" max="21:00" step="900" />

Delivery instructions: <textarea name="delivery_instructions"></textarea>

Submit order

Finally, to make the form submittable we use the <button> element:

Customer name: <input name="custname" type="text" />
Telephone: <input name="custtel" type="tel" />
Email address: <input name="custemail" type="email" />

Pizza Size
- Small
- Medium
- Large

Pizza Toppings
- Bacon
- Extra Cheese
- Onion
- Mushroom

Preferred delivery time: <input name="preferred_delivery_time" type="time" min="11:00" max="21:00" step="900" />

Delivery instructions: <textarea name="delivery_instructions"></textarea>

Submit order

4.10.1.2 Implementing the server-side processing for a form

This section is non-normative.

The exact details for writing a server-side processor are out of scope for this specification. For the purposes of this introduction, we will assume that the script at https://pizza.example.com/order.cgi is configured to accept submissions using the application/x-www-form-urlencoded format, expecting the following parameters sent in an HTTP POST body:

custname  
Customer's name

custtel  
Customer's telephone number

custemail  
Customer's email address
size
The pizza size, either small, medium, or large
topping
A topping, specified once for each selected topping, with the allowed values being bacon, cheese, onion, and mushroom
delivery
The requested delivery time
comments
The delivery instructions

4.10.1.3 Configuring a form to communicate with a server

This section is non-normative.

Form submissions are exposed to servers in a variety of ways, most commonly as HTTP GET or POST requests. To specify the exact method used, the `method` attribute is specified on the `form` element. This doesn't specify how the form data is encoded, though; to specify that, you use the `enctype` attribute. You also have to specify the URL of the service that will handle the submitted data, using the `action` attribute.

For each form control you want submitted, you then have to give a name that will be used to refer to the data in the submission. We already specified the name for the group of radio buttons; the same attribute (`name`) also specifies the submission name. Radio buttons can be distinguished from each other in the submission by giving them different values, using the `value` attribute.

Multiple controls can have the same name; for example, here we give all the checkboxes the same name, and the server distinguishes which checkbox was checked by seeing which values are submitted with that name — like the radio buttons, they are also given unique values with the `value` attribute.

Given the settings in the previous section, this all becomes:

```html
<form method="post" enctype="application/x-www-form-urlencoded"
   action="https://pizza.example.com/order.cgi">
  <p><label>Customer name: <input name="custname"></label></p>
  <p><label>Telephone: <input type="tel" name="custtel"></label></p>
  <p><label>Email address: <input type="email" name="custemail"></label></p>
  <fieldset>
    <legend>Pizza Size</legend>
    <p><label><input type="radio" name="size" value="small"> Small</label>
    </p><p><label><input type="radio" name="size" value="medium"> Medium</label>
    </p><p><label><input type="radio" name="size" value="large"> Large</label>
  </fieldset>
  <fieldset>
    <legend>Pizza Toppings</legend>
    <p><label><input type="checkbox" name="topping" value="bacon"> Bacon</label>
    </p><p><label><input type="checkbox" name="topping" value="cheese"> Extra Cheese</label>
    </p><p><label><input type="checkbox" name="topping" value="onion"> Onion</label>
    </p><p><label><input type="checkbox" name="topping" value="mushroom"> Mushroom</label>
  </fieldset>
  <p><label>Preferred delivery time: <input type="time" min="11:00" max="21:00" step="900" name="delivery"></label></p>
  <p><label>Delivery instructions: <textarea name="comments"></textarea></label></p>
  <p><button>Submit order</button></p>
</form>
```

Note
There is no particular significance to the way some of the attributes have their values quoted and others don't. The HTML syntax allows a variety of equally valid ways to specify attributes, as discussed in the syntax section.

For example, if the customer entered "Denise Lawrence" as their name, "555-321-8642" as their telephone number, did not specify an
email address, asked for a medium-sized pizza, selected the Extra Cheese and Mushroom toppings, entered a delivery time of 7pm, and left the delivery instructions text control blank, the user agent would submit the following to the online web service:

custname=Denise+Lawrence&custtel=555-321-8642&custemail=&size=medium&topping=cheese&topping=mushroom&delivery=19%3A00&comments=

### 4.10.1.4 Client-side form validation

This section is non-normative.

Forms can be annotated in such a way that the user agent will check the user's input before the form is submitted. The server still has to verify the input is valid (since hostile users can easily bypass the form validation), but it allows the user to avoid the wait incurred by having the server be the sole checker of the user's input.

The simplest annotation is the `required` attribute, which can be specified on `input` elements to indicate that the form is not to be submitted until a value is given. By adding this attribute to the customer name, pizza size, and delivery time fields, we allow the user agent to notify the user when the user submits the form without filling in those fields:

```html
<form method="post"
   enctype="application/x-www-form-urlencoded"
   action="https://pizza.example.com/order.cgi">
  <p><label>Customer name: <input name="custname" required></label></p>
  <p><label>Telephone: <input type="tel" name="custtel"></label></p>
  <p><label>Email address: <input type="email" name="custemail"></label></p>

  <fieldset>
    <legend>Pizza Size</legend>
    <p><label><input type="radio" name="size" required value="small"> Small</label></p>
    <p><label><input type="radio" name="size" required value="medium"> Medium</label></p>
    <p><label><input type="radio" name="size" required value="large"> Large</label></p>
  </fieldset>

  <fieldset>
    <legend>Pizza Toppings</legend>
    <p><label><input type="checkbox" name="topping" value="bacon"> Bacon</label></p>
    <p><label><input type="checkbox" name="topping" value="cheese"> Extra Cheese</label></p>
    <p><label><input type="checkbox" name="topping" value="onion"> Onion</label></p>
    <p><label><input type="checkbox" name="topping" value="mushroom"> Mushroom</label></p>
  </fieldset>

  <p><label>Preferred delivery time: <input type="time" min="11:00" max="21:00" step="900" name="delivery" required></label></p>
  <p><label>Delivery instructions: <textarea name="comments"></textarea></label></p>
  <p><button>Submit order</button></p>
</form>
```

It is also possible to limit the length of the input, using the `maxlength` attribute. By adding this to the `textarea` element, we can limit users to 1000 characters, preventing them from writing huge essays to the busy delivery drivers instead of staying focused and to the point:

```html
<form method="post"
   enctype="application/x-www-form-urlencoded"
   action="https://pizza.example.com/order.cgi">
  <p><label>Customer name: <input name="custname" required></label></p>
  <p><label>Telephone: <input type="tel" name="custtel"></label></p>
  <p><label>Email address: <input type="email" name="custemail"></label></p>

  <fieldset>
    <legend>Pizza Size</legend>
    <p><label><input type="radio" name="size" required value="small"> Small</label></p>
    <p><label><input type="radio" name="size" required value="medium"> Medium</label></p>
    <p><label><input type="radio" name="size" required value="large"> Large</label></p>
  </fieldset>

  <fieldset>
    <legend>Pizza Toppings</legend>
    <p><label><input type="checkbox" name="topping" value="bacon"> Bacon</label></p>
    <p><label><input type="checkbox" name="topping" value="cheese"> Extra Cheese</label></p>
    <p><label><input type="checkbox" name="topping" value="onion"> Onion</label></p>
    <p><label><input type="checkbox" name="topping" value="mushroom"> Mushroom</label></p>
  </fieldset>

  <p><label>Preferred delivery time: <input type="time" min="11:00" max="21:00" step="900" name="delivery" required></label></p>
  <p><label>Delivery instructions: <textarea name="comments"></textarea></label></p>
  <p><button>Submit order</button></p>
</form>
```
4.10.1.5 Enabling client-side automatic filling of form controls

This section is non-normative.

Some browsers attempt to aid the user by automatically filling form controls rather than having the user reenter their information each time. For example, a field asking for the user's telephone number can be automatically filled with the user's phone number.

To help the user agent with this, the `autocomplete` attribute can be used to describe the field's purpose. In the case of this form, we have three fields that can be usefully annotated in this way: the information about who the pizza is to be delivered to.

Adding this information looks like this:

```html
<form method="post" enctype="application/x-www-form-urlencoded" action="https://pizza.example.com/order.cgi">
  <p><label>Customer name: <input name="custname" required autocomplete="shipping name"></label></p>
  <p><label>Telephone: <input type="tel" name="custtel" autocomplete="shipping tel"></label></p>
  <p><label>Email address: <input type="email" name="custemail" autocomplete="shipping email"></label></p>
</form>
```

4.10.1.6 Improving the user experience on mobile devices

This section is non-normative.

Some devices, in particular those with virtual keyboards can provide the user with multiple input modalities. For example, when typing in a credit card number the user may wish to only see keys for digits 0-9, while when typing in their name they may wish to see a form
field that by default capitalizes each word.

Using the `inputmode` attribute we can select appropriate input modalities:

```html
<form method="post" enctype="application/x-www-form-urlencoded"
      action="https://pizza.example.com/order.cgi">
  <p><label>Customer name: <input name="custname" required autocomplete="shipping name" /></label></p>
  <p><label>Telephone: <input type="tel" name="custtel" autocomplete="shipping tel" /></label></p>
  <p><label>Buzzer code: <input name="custbuzz" inputmode="numeric" /></label></p>
  <p><label>Email address: <input type="email" name="customail" autocomplete="shipping email" /></label></p>

  <fieldset>
    <legend>Pizza Size</legend>
    <p><label><input type="radio" name="size" required value="small" /> Small</label></p>
    <p><label><input type="radio" name="size" required value="medium" /> Medium</label></p>
    <p><label><input type="radio" name="size" required value="large" /> Large</label></p>
  </fieldset>

  <fieldset>
    <legend>Pizza Toppings</legend>
    <p><label><input type="checkbox" name="topping" value="bacon" /> Bacon</label></p>
    <p><label><input type="checkbox" name="topping" value="cheese" /> Extra Cheese</label></p>
    <p><label><input type="checkbox" name="topping" value="onion" /> Onion</label></p>
    <p><label><input type="checkbox" name="topping" value="mushroom" /> Mushroom</label></p>
  </fieldset>

  <p><label>Preferred delivery time: <input type="time" min="11:00" max="21:00" step="900" name="delivery" required /></label></p>
  <p><label>Delivery instructions: <textarea name="comments" maxlength="1000"></textarea></label></p>
  <p><button>Submit order</button></p>
</form>

4.10.1.7 The difference between the field type, the autofill field name, and the input modality

This section is non-normative.

The `type`, `autocomplete`, and `inputmode` attributes can seem confusingly similar. For instance, in all three cases, the string "email" is a valid value. This section attempts to illustrate the difference between the three attributes and provides advice suggesting how to use them.

The `type` attribute on `<input>` elements decides what kind of control the user agent will use to expose the field. Choosing between different values of this attribute is the same choice as choosing whether to use an `<input>` element, a `<textarea>` element, a `<select>` element, etc.

The `autocomplete` attribute, in contrast, describes what the value that the user will enter actually represents. Choosing between different values of this attribute is the same choice as choosing what the label for the element will be.

First, consider telephone numbers. If a page is asking for a telephone number from the user, the right form control to use is `<input type="tel">`. However, which `autocomplete` value to use depends on which phone number the page is asking for, whether they expect a telephone number in the international format or just the local format, and so forth.

For example, a page that forms part of a checkout process on an e-commerce site for a customer buying a gift to be shipped to a friend might need both the buyer's telephone number (in case of payment issues) and the friend's telephone number (in case of delivery issues). If the site expects international phone numbers (with the country code prefix), this could thus look like this:

```html
<p><label>Your phone number: <input type="tel" name="custtel" autocomplete="billing tel" /></label></p>
<p><label>Recipient's phone number: <input type="tel" name="shiptel" autocomplete="shipping tel" /></label></p>
<p>Please enter complete phone numbers including the country code prefix, as in "+1 555 123 4567".
</p>
```

But if the site only supports British customers and recipients, it might instead look like this (notice the use of `tel-national` rather than `tel`):

```html
<p><label>Your phone number: <input type="tel" name="custtel" autocomplete="billing tel" /></label></p>
<p><label>Recipient's phone number: <input type="tel" name="shiptel" autocomplete="shipping tel" /></label></p>
```
Now, consider a person's preferred languages. The right `autocomplete` value is `language`. However, there could be a number of different form controls used for the purpose: a text control (`<input type=text>`), a drop-down list (`<select>`), radio buttons (`<input type=radio>`), etc. It only depends on what kind of interface is desired.

Finally, consider names. If a page just wants one name from the user, then the relevant control is `<input type=text>`. If the page is asking for the user's full name, then the relevant `autocomplete` value is `name`.

In this example, the "section-*" keywords in the `autocomplete` attributes' values tell the user agent that the two fields expect different names. Without them, the user agent could automatically fill the second field with the value given in the first field when the user gave a value to the first field.

Separate from the choices regarding `type` and `autocomplete`, the `inputmode` attribute decides what kind of input modality (e.g., virtual keyboard) to use, when the control is a text control.

Consider credit card numbers. The appropriate input type is not `<input type=number>`, as explained below; it is instead `<input type=text>`.

This section is non-normative.

In this pizza delivery example, the times are specified in the format "HH:MM": two digits for the hour, in 24-hour format, and two digits for the time. (Seconds could also be specified, though they are not necessary in this example.)

In some locales, however, times are often expressed differently when presented to users. For example, in the United States, it is still common to use the 12-hour clock with an am/pm indicator, as in "2pm". In France, it is common to separate the hours from the minutes using an "h" character, as in "14h00".

Similar issues exist with dates, with the added complication that even the order of the components is not always consistent — for example, in Cyprus the first of February 2003 would typically be written "1/2/03", while that same date in Japan would typically be written as "2003年02月01日" — and even with numbers, where locales differ, for example, in what punctuation is used as the decimal separator and the thousands separator.

It is therefore important to distinguish the time, date, and number formats used in HTML and in form submissions, which are always the formats defined in this specification (and based on the well-established ISO 8601 standard for computer-readable date and time formats), from the time, date, and number formats presented to the user by the browser and accepted as input from the user by the browser.

The format used "on the wire", i.e., in HTML markup and in form submissions, is intended to be computer-readable and consistent irrespective of the user's locale. Dates, for instance, are always written in the format "YYYY-MM-DD", as in "2003-02-01". While some users might see this format, others might see it as "01.02.2003" or "February 1, 2003".
The time, date, or number given by the page in the wire format is then translated to the user’s preferred presentation (based on user preferences or on the locale of the page itself), before being displayed to the user. Similarly, after the user inputs a time, date, or number using their preferred format, the user agent converts it back to the wire format before putting it in the DOM or submitting it.

This allows scripts in pages and on servers to process times, dates, and numbers in a consistent manner without needing to support dozens of different formats, while still supporting the users’ needs.

Note

See also the implementation notes regarding localization of form controls.

4.10.2 Categories

Mostly for historical reasons, elements in this section fall into several overlapping (but subtly different) categories in addition to the usual ones like flow content, phrasing content, and interactive content.

A number of the elements are form-associated elements, which means they can have a form owner.

⇒ button, fieldset, input, object, output, select, textarea, img, form-associated custom elements

The form-associated elements fall into several subcategories:

Listed elements

Denotes elements that are listed in the form.elements and fieldset.elements APIs. These elements also have a form content attribute, and a matching form IDL attribute, that allow authors to specify an explicit form owner.

⇒ button, fieldset, input, object, output, select, textarea, form-associated custom elements

Submittable elements

Denotes elements that can be used for constructing the entry list when a form element is submitted.

⇒ button, input, select, textarea, form-associated custom elements

Some submittable elements can be, depending on their attributes, buttons. The prose below defines when an element is a button. Some buttons are specifically submit buttons.

Resettable elements

Denotes elements that can be affected when a form element is reset.

⇒ input, output, select, textarea, form-associated custom elements

Autocapitalize-inheriting elements

Denotes elements that inherit the autocapitalize attribute from their form owner.

⇒ button, fieldset, input, output, select, textarea

Some elements, not all of them form-associated, are categorized as labelable elements. These are elements that can be associated with a label element.

⇒ button, input (if the type attribute is not in the Hidden state), meter, output, progress, select, textarea, form-associated custom elements

4.10.3 The form element

Categories:

Flow content, Palpable content.

Contexts in which this element can be used:

Where flow content is expected.
Content model

Flow content, but with no form element descendants.

Tag omission in text/html

Neither tag is omissible.

Content attributes:

Global attributes

- accept-charset — Character encodings to use for form submission
- action — URL to use for form submission
- autocomplete — Default setting for autofill feature for controls in the form
- enctype — Entry list encoding type to use for form submission
- method — Variant to use for form submission
- name — Name of form to use in the document.forms API
- novalidate — Bypass form control validation for form submission
- target — Navigable for form submission
- rel

Accessibility considerations:

For authors.
For implementers.

DOM interface:

```html
[Exposed=Window,
 LegacyOverrideBuiltIns,
 LegacyUnenumerableNamedProperties]

interface HTMLFormElement : HTML Element {
  [HTMLConstructor] constructor();

  [CEReactions] attribute DOMString acceptCharset;
  [CEReactions] attribute USVString action;
  [CEReactions] attribute DOMString autocomplete;
  [CEReactions] attribute DOMString enctype;
  [CEReactions] attribute DOMString encoding;
  [CEReactions] attribute DOMString method;
  [CEReactions] attribute DOMString name;
  [CEReactions] attribute boolean noValidate;
  [CEReactions] attribute DOMString target;
  [CEReactions] attribute DOMString rel;
  [SameObject, PutForwards=value] readonly attribute DOMTokenList relList;

  [SameObject] readonly attribute HTMLFormControlsCollection elements;
  readonly attribute unsigned long length;
  getter Element (unsigned long index);
  getter (RadioNodeList or Element) (DOMString name);

  undefined submit();
  undefined requestSubmit(optional HTMLElement? submitter = null);
  [CEReactions] undefined reset();
  boolean checkValidity();
  boolean reportValidity();
};
```

The form element represents a hyperlink that can be manipulated through a collection of form-associated elements, some of which can represent editable values that can be submitted to a server for processing.

The accept-charset attribute gives the character encodings that are to be used for the submission. If specified, the value must be an ASCII case-insensitive match for "UTF-8". [ENCODING]

The name attribute represents the form's name within the forms collection. The value must not be the empty string, and the value must be unique amongst the form elements in the forms collection that it is in, if any.
The **autocomplete** attribute is an enumerated attribute\(^{574}\) with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>on</td>
<td>on</td>
<td>Form controls will have their autofill field name(^{569}) set to &quot;on&quot; by default.</td>
</tr>
<tr>
<td>off</td>
<td>off</td>
<td>Form controls will have their autofill field name(^{569}) set to &quot;off&quot; by default.</td>
</tr>
</tbody>
</table>

The attribute's **missing value default**\(^{574}\) and **invalid value default**\(^{574}\) are both the **on** state.

The **action**\(^{598}\), **enctype**\(^{599}\), **method**\(^{598}\), **novalidate**\(^{599}\), and **target**\(^{599}\) attributes are **attributes for form submission**\(^{597}\).

The **rel** attribute on **form**\(^{510}\) elements controls what kinds of links the elements create. The attribute's value must be an unordered set of unique space-separated tokens\(^{93}\). The **allowed keywords and their meanings**\(^{310}\) are defined in an earlier section. **rel**\(^{512}\)’s supported tokens are the keywords defined in **HTML link types**\(^{536}\) which are allowed on **form**\(^{510}\) elements, impact the processing model, and are supported by the user agent. The possible supported tokens are **noreferrer**\(^{322}\), **noopener**\(^{321}\), and **opener**\(^{322}\). **rel**\(^{512}\)’s supported tokens must only include the tokens from this list that the user agent implements the processing model for.

---

### For web developers (non-normative)

**form.elements**\(^{513}\)

Returns an **HTMLFormControlsCollection**\(^{111}\) of the form controls in the form (excluding image buttons for historical reasons).

**form.length**\(^{513}\)

Returns the number of form controls in the form (excluding image buttons for historical reasons).

**form[index]**

Returns the index\(^{th}\) element in the form (excluding image buttons for historical reasons).

**form[name]**

Returns the form control (or, if there are several, a **RadioNodeList**\(^{111}\) of the form controls) in the form with the given ID or name\(^{595}\) (excluding image buttons for historical reasons); or, if there are none, returns the image\(^{343}\) element with the given ID.

Once an element has been referenced using a particular name, that name will continue being available as a way to reference that element in this method, even if the element's actual ID or name\(^{595}\) changes, for as long as the element remains in the tree.

If there are multiple matching items, then a **RadioNodeList**\(^{111}\) object containing all those elements is returned.

**form.submit**\(^{514}\)()

Submits the form, bypassing interactive constraint validation\(^{619}\) and without firing a submit\(^{1452}\) event.

**form.requestSubmit**\(^{514}\)([ submitter ])

Requests to submit the form. Unlike submit()\(^{514}\), this method includes interactive constraint validation\(^{619}\) and firing a submit\(^{1452}\) event, either of which can cancel submission.

The submitter argument can be used to point to a specific submit button\(^{510}\), whose formaction\(^{558}\), formenctype\(^{559}\), formmethod\(^{558}\), formnovalidate\(^{559}\), and formtarget\(^{559}\) attributes can impact submission. Additionally, the submitter will be included when constructing the entry list\(^{628}\) for submission; normally, buttons are excluded.

**form.reset**\(^{514}\)()

Resets the form.

**form.checkValidity**\(^{514}\)()

Returns true if the form’s controls are all valid; otherwise, returns false.

**form.reportValidity**\(^{514}\)()

Returns true if the form’s controls are all valid; otherwise, returns false and informs the user.

---

The **autocomplete** IDL attribute must reflect\(^{512}\) the content attribute of the same name, **limited to only known values**\(^{513}\).

The **name** and **rel** IDL attributes must reflect\(^{512}\) the content attribute of the same name.

The **acceptCharset** IDL attribute must reflect\(^{512}\) the **accept-character**\(^{511}\) content attribute.

The **relList** IDL attribute must reflect\(^{512}\) the **rel**\(^{512}\) content attribute.
The `elements` IDL attribute must return an `HTMLFormControlsCollection`¹¹¹ rooted at the `form`¹¹⁸ element's `root`, whose filter matches `listed elements`¹⁶¹, whose `form owner`¹⁹³ is the `form`¹¹⁸ element, with the exception of `input`¹⁹⁷ elements whose `type`¹⁵⁹ attribute is in the `Image Button`¹⁴³ state, which must, for historical reasons, be excluded from this particular collection.

The `length` IDL attribute must return the number of nodes represented by the `elements`¹³ collection.

The supported property indices at any instant are the indices supported by the object returned by the `elements`¹³ attribute at that instant.

To determine the value of an indexed property for a `form`¹¹⁸ element, the user agent must return the value returned by the `item` method on the `elements`¹³ collection, when invoked with the given index as its argument.

Each `form`¹¹⁸ element has a mapping of names to elements called the past names map. It is used to persist names of controls even when they change names.

The supported property names consist of the names obtained from the following algorithm, in the order obtained from this algorithm:

1. Let `sourced names` be an initially empty ordered list of tuples consisting of a string, an element, a source, where the source is either `id`, `name`, or `past`, and, if the source is `past`, an age.

2. For each `listed element` candidate whose `form owner` is the `form` element, with the exception of any `input` elements whose `type` attribute is in the `Image Button` state:
   
   i. If `candidate` has an `id` attribute, add an entry to `sourced names` with that `id` attribute's value as the string, `candidate` as the element, and `id` as the source.
   
   ii. If `candidate` has a `name` attribute, add an entry to `sourced names` with that `name` attribute's value as the string, `candidate` as the element, and `name` as the source.

3. For each `img` element candidate whose `form owner` is the `form` element:
   
   i. If `candidate` has an `id` attribute, add an entry to `sourced names` with that `id` attribute's value as the string, `candidate` as the element, and `id` as the source.
   
   ii. If `candidate` has a `name` attribute, add an entry to `sourced names` with that `name` attribute's value as the string, `candidate` as the element, and `name` as the source.

4. For each entry `past entry` in the `past names map` add an entry to `sourced names` with the `past entry`'s name as the string, `past entry`'s element as the element, `past` as the source, and the length of time `past entry` has been in the `past names map` as the age.

5. Sort `sourced names` by `tree order` of the element entry of each tuple, sorting entries with the same element by putting entries whose source is `id` first, then entries whose source is `name`, and finally entries whose source is `past`, and sorting entries with the same element and source by their age, oldest first.

6. Remove any entries in `sourced names` that have the empty string as their name.

7. Remove any entries in `sourced names` that have the same name as an earlier entry in the map.

8. Return the list of names from `sourced names`, maintaining their relative order.

To determine the value of a named property `name` for a `form` element, the user agent must run the following steps:

1. Let `candidates` be a `live` RadioNodeList object containing all the `listed elements`, whose `form owner` is the `form` element, that have either an `id` attribute or a `name` attribute equal to `name`, with the exception of `input` elements whose `type` attribute is in the `Image Button` state, in `tree order`.

2. If `candidates` is empty, let `candidates` be a `live` RadioNodeList containing all the `img` elements, whose `form owner` is the `form` element, that have either an `id` attribute or a `name` attribute equal to `name`, in `tree order`.

3. If `candidates` is empty, `name` is the name of one of the entries in the `form` element's `past names map`: return the object associated with `name` in that map.

4. If `candidates` contains more than one node, return `candidates`.

5. Otherwise, `candidates` contains exactly one node. Add a mapping from `name` to the node in `candidates` in the `form` element's `past names map`, replacing the previous entry with the same name, if any.
6. Return the node in candidates.

If an element listed in a form element's past names map changes form owner, then its entries must be removed from that map.

The submit() method steps are to submit this from this, with submitted from submit() method set to true.

The requestSubmit(submitter) method, when invoked, must run the following steps:

1. If submitter is not null, then:
   1. If submitter is not a submit button, then throw a TypeError.
   2. If submitter's form owner is not this form element, then throw a "NotFoundError" DOMException.
2. Otherwise, set submitter to this form element.
3. Submit this form element, from submitter.

The reset() method, when invoked, must run the following steps:

1. If the form element is marked as locked for reset, then return.
2. Mark the form element as locked for reset.
3. Reset the form element.
4. Unmark the form element as locked for reset.

If the checkValidity() method is invoked, the user agent must statically validate the constraints of the form element, and return true if the constraint validation return a positive result, and false if it returned a negative result.

If the reportValidity() method is invoked, the user agent must interactively validate the constraints of the form element, and return true if the constraint validation return a positive result, and false if it returned a negative result.

Example

This example shows two search forms:

```html
<form action="https://www.google.com/search" method="get">
  <label>Google: <input type="search" name="q"></label>  <input type="submit" value="Search...">  
</form>

<form action="https://www.bing.com/search" method="get">
  <label>Bing: <input type="search" name="q"></label>  <input type="submit" value="Search...">  
</form>
```

4.10.4 The label element

Categories:
- Flow content.
- Phrasing content.
- Interactive content.
- Palpable content.

Contexts in which this element can be used:
Where phrasing content is expected.

Content model:
- Phrasing content, but with no descendant labelable elements unless it is the element's labeled control, and no descendant label elements.

Tag omission in text/html:
Neither tag is omissible.
The `label` element represents a caption in a user interface. The caption can be associated with a specific form control, known as the `label` element’s labeled control, either using the `for` attribute, or by putting the form control inside the `label` element itself.

Except where otherwise specified by the following rules, a `label` element has no labeled control.

The `for` attribute may be specified to indicate a form control with which the caption is to be associated. If the attribute is specified, the attribute’s value must be the ID of a labelable element in the same tree as the `label` element. If the attribute is specified and there is an element in the tree whose ID is equal to the value of the `for` attribute, and the first such element in tree order is a labelable element, then that element is the `label` element’s labeled control.

If the `for` attribute is not specified, but the `label` element has a labelable element descendant, then the first such descendant in tree order is the `label` element’s labeled control.

The `label` element’s exact default presentation and behavior, in particular what its activation behavior might be, if anything, should match the platform’s label behavior. The activation behavior of a `label` element for events targeted at interactive content descendants of a `label` element, and any descendants of those interactive content descendants, must be to do nothing.

Note

Form-associated custom elements are labelable elements, so for user agents where the `label` element’s activation behavior impacts the labeled control, both built-in and custom elements will be impacted.

Example

For example, on platforms where clicking a label activates the form control, clicking the `label` in the following snippet could trigger the user agent to fire a click event at the `input` element, as if the element itself had been triggered by the user:

```
<label><input type=checkbox name=lost> Lost</label>
```

Similarly, assuming `my-checkbox` was declared as a form-associated custom element (like in this example), then the code

```
<label><my-checkbox name=lost/></my-checkbox> Lost</label>
```

would have the same behavior, firing a click event at the `my-checkbox` element.

On other platforms, the behavior in both cases might be just to focus the control, or to do nothing.

Example

The following example shows three form controls each with a label, two of which have small text showing the right format for users to use.
The htmlFor IDL attribute must reflect the for content attribute.

The control IDL attribute must return the label element’s labeled control, if any, or null if there isn’t one.

The form IDL attribute must run the following steps:

1. If the label element has no labeled control, then return null.
2. If the label element’s labeled control is not a form-associated element, then return null.
3. Return the label element’s labeled control’s form owner (which can still be null).

Labelable elements and all input elements have a live NodeList object associated with them that represents the list of label elements, in tree order, whose labeled control is the element in question. The labels IDL attribute of labelable elements that are not form-associated custom elements, and the labels IDL attribute of input elements, on getting, must return that NodeList object, and that same value must always be returned, unless this element is an input element whose type attribute is in the Hidden state, in which case it must instead return null.

Form-associated custom elements don’t have a labels IDL attribute. Instead, their ElementInternals object has a labels IDL attribute. On getting, it must throw a "NotSupportedError" DOMException if the target element is not a form-associated custom element. Otherwise, it must return that NodeList object, and that same value must always be returned.

Example

This (non-conforming) example shows what happens to the NodeList and what labels returns when an input element has its type attribute changed.

```html
<!doctype html>
<p><label><input></label></p>
<script>
  const input = document.querySelector('input');
  const labels = input.labels;
  console.assert(labels.length === 1);

  input.type = 'hidden';
  console.assert(labels.length === 0); // the input is no longer the label's labeled control
  console.assert(input.labels === null);
</script>
```
4.10.5 The **input** element

**Categories**

- Flow content
- Phrasing content

If the **type** attribute is *not* in the [Hidden](https://developer.mozilla.org/en-US/docs/Web/HTML/Global_attributes/hidden) state:
- Interactive content
- Listed, labelable, submittable, resettable, and autocapitalize-inheriting form-associated element

If the **type** attribute is in the [Hidden](https://developer.mozilla.org/en-US/docs/Web/HTML/Global_attributes/hidden) state:
- Listed, submittable, resettable, and autocapitalize-inheriting form-associated element

**Contexts in which this element can be used**:

Where phrasing content is expected.

**Content model**: Nothing

**Tag omission in text/html**: No end tag

**Content attributes**:

- **Global attributes**
  - `accept` — Hint for expected file type in file upload controls
  - `alt` — Replacement text for use when images are not available
  - `autocomplete` — Hint for form autofill feature
  - `checked` — Whether the control is checked
  - `dirname` — Name of form control to use for sending the element's `directionality` in form submission
  - `disabled` — Whether the form control is disabled
  - `form` — Associates the element with a form element
  - `formaction` — URL to use for form submission
  - `formenctype` — Entry list encoding type to use for form submission
  - `formmethod` — Variant to use for form submission
  - `formnovalidate` — Bypass form control validation for form submission
  - `formtarget` — Navigable for form submission
  - `height` — Vertical dimension
  - `list` — List of autocomplete options
  - `max` — Maximum value
  - `maxlength` — Maximum `length` of value
  - `min` — Minimum value
  - `minlength` — Minimum `length` of value
  - `multiple` — Whether to allow multiple values
  - `name` — Name of the element to use for form submission and in the form.elements API
  - `pattern` — Pattern to be matched by the form control's value
  - `placeholder` — User-visible label to be placed within the form control
  - `popovertarget` — Targets a popover element to toggle, show, or hide
  - `popovertargetaction` — Indicates whether a targeted popover element is to be toggled, shown, or hidden
  - `readonly` — Whether to allow the value to be edited by the user
  - `required` — Whether the control is required for form submission
  - `size` — Size of the control
  - `src` — Address of the resource
  - `step` — Granularity to be matched by the form control's value
Accessibility considerations:

- `type` attribute in the `Hidden` state: for authors; for implementers.
- `type` attribute in the `Text` state: for authors; for implementers.
- `type` attribute in the `Search` state: for authors; for implementers.
- `type` attribute in the `Telephone` state: for authors; for implementers.
- `type` attribute in the `URL` state: for authors; for implementers.
- `type` attribute in the `Email` state: for authors; for implementers.
- `type` attribute in the `Password` state: for authors; for implementers.
- `type` attribute in the `Date` state: for authors; for implementers.
- `type` attribute in the `Month` state: for authors; for implementers.
- `type` attribute in the `Week` state: for authors; for implementers.
- `type` attribute in the `Time` state: for authors; for implementers.
- `type` attribute in the `Local Date and Time` state: for authors; for implementers.
- `type` attribute in the `Number` state: for authors; for implementers.
- `type` attribute in the `Range` state: for authors; for implementers.
- `type` attribute in the `Color` state: for authors; for implementers.
- `type` attribute in the `Checkbox` state: for authors; for implementers.
- `type` attribute in the `Radio Button` state: for authors; for implementers.
- `type` attribute in the `File Upload` state: for authors; for implementers.
- `type` attribute in the `Submit Button` state: for authors; for implementers.
- `type` attribute in the `Image Button` state: for authors; for implementers.
- `type` attribute in the `Reset Button` state: for authors; for implementers.
- `type` attribute in the `Button` state: for authors; for implementers.

DOM interface:

```idl
[Exposed=Window]
interface HTMLInputElement : HTMLElement {
  [HTMLConstructor] constructor();

  [CEReactions] attribute DOMString accept;
  [CEReactions] attribute DOMString alt;
  [CEReactions] attribute DOMString autocomplete;
  [CEReactions] attribute boolean defaultChecked;
  attribute boolean checked;
  [CEReactions] attribute DOMString dirName;
  [CEReactions] attribute boolean disabled;
  readonly attribute HTMLFormElement? form;
  attribute FileList? files;
  [CEReactions] attribute USVString formAction;
  [CEReactions] attribute DOMString formEnctype;
  [CEReactions] attribute DOMString formMethod;
  [CEReactions] attribute boolean formNoValidate;
  [CEReactions] attribute DOMString formTarget;
  [CEReactions] attribute unsigned long height;
  attribute boolean indeterminate;
  readonly attribute HTMLDataListElement? list;
  [CEReactions] attribute DOMString max;
  [CEReactions] attribute long maxLength;
  [CEReactions] attribute DOMString min;
  [CEReactions] attribute long minLength;
  [CEReactions] attribute boolean multiple;
  [CEReactions] attribute DOMString name;
  [CEReactions] attribute DOMString pattern;
  [CEReactions] attribute DOMString placeholder;
  [CEReactions] attribute boolean readOnly;
  ```
The `input` element represents a typed data field, usually with a form control to allow the user to edit the data.

The `type` attribute controls the data type (and associated control) of the element. It is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Data type</th>
<th>Control type</th>
</tr>
</thead>
<tbody>
<tr>
<td>hidden</td>
<td>Hidden</td>
<td>An arbitrary string</td>
<td>n/a</td>
</tr>
<tr>
<td>text</td>
<td>Text</td>
<td>Text with no line breaks</td>
<td>A text control</td>
</tr>
<tr>
<td>search</td>
<td>Search</td>
<td>Text with no line breaks</td>
<td>Search control</td>
</tr>
<tr>
<td>tel</td>
<td>Telephone</td>
<td>Text with no line breaks</td>
<td>A text control</td>
</tr>
<tr>
<td>url</td>
<td>URL</td>
<td>An absolute URL</td>
<td>A text control</td>
</tr>
<tr>
<td>email</td>
<td>Email</td>
<td>An email address or list of email addresses</td>
<td>A text control</td>
</tr>
<tr>
<td>password</td>
<td>Password</td>
<td>Text with no line breaks (sensitive information)</td>
<td>A text control that obscures data entry</td>
</tr>
<tr>
<td>date</td>
<td>Date</td>
<td>A date (year, month, day) with no time zone</td>
<td>A date control</td>
</tr>
<tr>
<td>month</td>
<td>Month</td>
<td>A date consisting of a year and a month with no time zone</td>
<td>A month control</td>
</tr>
<tr>
<td>week</td>
<td>Week</td>
<td>A date consisting of a week-year number and a week number with no time zone</td>
<td>A week control</td>
</tr>
<tr>
<td>time</td>
<td>Time</td>
<td>A time (hour, minute, seconds, fractional seconds) with no time zone</td>
<td>A time control</td>
</tr>
<tr>
<td>datetime-</td>
<td>Local Date</td>
<td>A date and time (year, month, day, hour, minute, second, fraction of a second) with no time zone</td>
<td>A date and time control</td>
</tr>
<tr>
<td>local</td>
<td>Time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>number</td>
<td>Number</td>
<td>A numerical value</td>
<td>A text control or spinner</td>
</tr>
</tbody>
</table>
The attribute’s missing value default\(^{524}\) and invalid value default\(^{574}\) are both the Text\(^{524}\) state.

Which of the accept\(^{540}\), alt\(^{543}\), autocaply\(^{500}\), checked\(^{522}\), dirname\(^{596}\), formaction\(^{598}\), formenctype\(^{599}\), formmethod\(^{598}\), formnovalidate\(^{599}\), formtargets\(^{599}\), height\(^{547}\), list\(^{553}\), max\(^{551}\), maxlength\(^{546}\), min\(^{551}\), minlength\(^{546}\), multiple\(^{549}\), pattern\(^{549}\), placeholder\(^{555}\), required\(^{548}\), size\(^{547}\), src\(^{543}\), step\(^{552}\), and width\(^{547}\) content attributes, the checked\(^{557}\), files\(^{557}\), valueAsDate\(^{557}\), valueAsNumber\(^{558}\), and list\(^{559}\) IDL attributes, the select()\(^{565}\) method, the selectionStart\(^{565}\), selectionEnd\(^{565}\), and selectionDirection\(^{565}\) IDL attributes, the setRangeText()\(^{516}\) and setSelectionRange()\(^{515}\) methods, the stepUp()\(^{558}\) and stepDown()\(^{558}\) methods, and the input and change\(^{551}\) events apply to an input\(^{557}\) element depends on the state of its type\(^{551}\) attribute. The subsections that define each type also clearly define in normative “bookkeeping” sections which of these feature apply, and which do not apply, to each type. The behavior of these features depends on whether they apply or not, as defined in their various sections (q.v. for content attributes\(^{546}\), for APIs\(^{556}\), for events\(^{560}\)).

The following table is non-normative and summarizes which of those content attributes, IDL attributes, methods, and events apply\(^{520}\) to each state:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Data type</th>
<th>Control type</th>
</tr>
</thead>
<tbody>
<tr>
<td>range</td>
<td>Range(^{538})</td>
<td>A numerical value, with the extra semantic that the exact value is not important</td>
<td>A slider control or similar</td>
</tr>
<tr>
<td>color</td>
<td>Color(^{533})</td>
<td>An sRGB color with 8-bit red, green, and blue components</td>
<td>A color picker</td>
</tr>
<tr>
<td>checkbox</td>
<td>Checkbox(^{538})</td>
<td>A set of zero or more values from a predefined list</td>
<td>A checkbox</td>
</tr>
<tr>
<td>radio</td>
<td>Radio Button(^{538})</td>
<td>An enumerated value</td>
<td>A radio button</td>
</tr>
<tr>
<td>file</td>
<td>File Upload(^{542})</td>
<td>Zero or more files each with a MIME type and optionally a filename</td>
<td>A label and a button</td>
</tr>
<tr>
<td>submit</td>
<td>Submit Button(^{542})</td>
<td>An enumerated value, with the extra semantic that it must be the last value selected and initiates form submission</td>
<td>A button</td>
</tr>
<tr>
<td>image</td>
<td>Image Button(^{542})</td>
<td>A coordinate, relative to a particular image’s size, with the extra semantic that it must be the last value selected and initiates form submission</td>
<td>Either a clickable image, or a button</td>
</tr>
<tr>
<td>reset</td>
<td>Reset Button(^{545})</td>
<td>n/a</td>
<td>A button</td>
</tr>
<tr>
<td>button</td>
<td>Button(^{544})</td>
<td>n/a</td>
<td>A button</td>
</tr>
</tbody>
</table>

The attributes’ missing value default\(^{524}\) and invalid value default\(^{574}\) are both the Text\(^{524}\) state.

Which of the accept\(^{540}\), alt\(^{543}\), autocaply\(^{500}\), checked\(^{522}\), dirname\(^{596}\), formaction\(^{598}\), formenctype\(^{599}\), formmethod\(^{598}\), formnovalidate\(^{599}\), formtargets\(^{599}\), height\(^{547}\), list\(^{553}\), max\(^{551}\), maxlength\(^{546}\), min\(^{551}\), minlength\(^{546}\), multiple\(^{549}\), pattern\(^{549}\), placeholder\(^{555}\), required\(^{548}\), size\(^{547}\), src\(^{543}\), step\(^{552}\), and width\(^{547}\) content attributes, the checked\(^{557}\), files\(^{557}\), valueAsDate\(^{557}\), valueAsNumber\(^{558}\), and list\(^{559}\) IDL attributes, the select()\(^{565}\) method, the selectionStart\(^{565}\), selectionEnd\(^{565}\), and selectionDirection\(^{565}\) IDL attributes, the setRangeText()\(^{516}\) and setSelectionRange()\(^{515}\) methods, the stepUp()\(^{558}\) and stepDown()\(^{558}\) methods, and the input and change\(^{551}\) events apply to an input\(^{557}\) element depends on the state of its type\(^{551}\) attribute. The subsections that define each type also clearly define in normative “bookkeeping” sections which of these feature apply, and which do not apply, to each type. The behavior of these features depends on whether they apply or not, as defined in their various sections (q.v. for content attributes\(^{546}\), for APIs\(^{556}\), for events\(^{560}\)).

The following table is non-normative and summarizes which of those content attributes, IDL attributes, methods, and events apply\(^{520}\) to each state:

<table>
<thead>
<tr>
<th>Keyword</th>
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</thead>
<tbody>
<tr>
<td>range</td>
<td>Range(^{538})</td>
<td>A numerical value, with the extra semantic that the exact value is not important</td>
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</tr>
<tr>
<td>color</td>
<td>Color(^{533})</td>
<td>An sRGB color with 8-bit red, green, and blue components</td>
<td>A color picker</td>
</tr>
<tr>
<td>checkbox</td>
<td>Checkbox(^{538})</td>
<td>A set of zero or more values from a predefined list</td>
<td>A checkbox</td>
</tr>
<tr>
<td>radio</td>
<td>Radio Button(^{538})</td>
<td>An enumerated value</td>
<td>A radio button</td>
</tr>
<tr>
<td>file</td>
<td>File Upload(^{542})</td>
<td>Zero or more files each with a MIME type and optionally a filename</td>
<td>A label and a button</td>
</tr>
<tr>
<td>submit</td>
<td>Submit Button(^{542})</td>
<td>An enumerated value, with the extra semantic that it must be the last value selected and initiates form submission</td>
<td>A button</td>
</tr>
<tr>
<td>image</td>
<td>Image Button(^{542})</td>
<td>A coordinate, relative to a particular image’s size, with the extra semantic that it must be the last value selected and initiates form submission</td>
<td>Either a clickable image, or a button</td>
</tr>
<tr>
<td>reset</td>
<td>Reset Button(^{545})</td>
<td>n/a</td>
<td>A button</td>
</tr>
<tr>
<td>button</td>
<td>Button(^{544})</td>
<td>n/a</td>
<td>A button</td>
</tr>
</tbody>
</table>
Some states of the type IDL attribute define a value sanitation algorithm.

Each input element has a value, which is exposed by the value IDL attribute. Some states define an algorithm to convert a string to a number, an algorithm to convert a number to a string, an algorithm to convert a string to a Date object, and an algorithm to convert a Date object to a string, which are used by max, min, step, valueAsDate, valueAsNumber, valueAsDate, and stepUp.

An input element's dirty value flag must be set to true whenever the user interacts with the control in a way that changes the value. (It is also set to true when the value is programmatically changed, as described in the definition of the value IDL attribute.)

The value content attribute gives the default value of the input element. When the value content attribute is added, set, or removed, if the control's dirty value flag is false, the user agent must set the value of the element to the value of the value content attribute, if there is one, or the empty string otherwise, and then run the current value sanitation algorithm, if one is defined.

Each input element has a checkedness, which is exposed by the checked IDL attribute.

Each input element has a boolean dirty checkedness flag. When it is true, the element is said to have a dirty checkedness. The dirty checkedness flag must be initially set to false when the element is created, and must be set to true whenever the user interacts with the control in a way that changes the checkedness.

The checked content attribute is a boolean attribute that gives the default checkedness of the input element. When the checked content attribute is added, if the control does not have dirty checkedness, the user agent must set the checkedness of the element to true; when the checked content attribute is removed, if the control does not have dirty checkedness, the user agent must set the checkedness of the element to false.

The reset algorithm for input elements is to set its user validity, dirty value flag, and dirty checkedness flag back to false, set the value of the element to the value of the value content attribute, if there is one, or the empty string otherwise, set the checkedness of the element to true if the element has a checked content attribute and false if it does not, empty the list of selected files, and then invoke the value sanitation algorithm, if the type attribute's current state defines one.

Each input element can be mutable. Except where otherwise specified, an input element is always mutable. Similarly, except where otherwise specified, the user agent should not allow the user to modify the element's value or checkedness.
When an `<input>` element is `disabled`, it is not `mutable`.

Note

The `readonly` attribute can also in some cases (e.g. for the `Date` state, but not the `Checkbox` state) stop an `<input>` element from being `mutable`.

The cloning steps for `<input>` elements must propagate the `value`, `dirty value flag`, `checkedness`, and `dirty checkedness flag` from the node being cloned to the copy.

The activation behavior for `<input>` elements `element`, given event, are these steps:

1. If `element` is not `mutable` and is not in the `Checkbox` state and is not in the `Radio` state, then return.
2. Run `element`'s input activation behavior, if any, and do nothing otherwise.
3. Run the popover target attribute activation behavior on `element`.

Note

Recall that an element's activation behavior runs for both user-initiated activations and for synthetic activations (e.g., via `el.click()`). User agents might also have behaviors for a given control — not specified here — that are triggered only by true user-initiated activations. A common choice is to show the picker, if applicable, for the control. In contrast, the input activation behavior, only shows pickers for the special historical cases of the `File Upload` and `Color` states.

The legacy-pre-activation behavior for `<input>` elements are these steps:

1. If this element's `type` attribute is in the `Checkbox state`, then set this element's `checkedness` to its opposite value (i.e. true if it is false, false if it is true) and set this element's `indeterminate` IDL attribute to false.
2. If this element's `type` attribute is in the `Radio Button state` that has its `checkedness` set to true, if any, and then set this element's `checkedness` to true.

The legacy-canceled-activation behavior for `<input>` elements are these steps:

1. If the element's `type` attribute is in the `Checkbox state`, then set the element's `checkedness` and the element's `indeterminate` IDL attribute back to the values they had before the legacy-pre-activation behavior was run.
2. If this element's `type` attribute is in the `Radio Button state`, then if the element to which a reference was obtained in the legacy-pre-activation behavior, if any, is still in what is now this element's `radio button group` that has its `checkedness` set to true, or else, if there was no such element, or that element is no longer in this element's `radio button group`, or if this element no longer has a `radio button group`, setting this element's `checkedness` to false.

When an `<input>` element is first created, the element's rendering and behavior must be set to the rendering and behavior defined for the `type` attribute's state, and the value sanitization algorithm, if one is defined for the `type` attribute's state, must be invoked.

When an `<input>` element's `type` attribute changes state, the user agent must run the following steps:

1. If the previous state of the element's `type` attribute put the `value` IDL attribute in the `value` mode, and the element's `value` is not the empty string, and the new state of the element's `type` attribute puts the `value` IDL attribute in either the `default` mode or the `default/on` mode, then set the element's `value` content attribute to the element's `value`.
2. Otherwise, if the previous state of the element's `type` attribute put the `value` IDL attribute in any mode other than the `value` mode, and the new state of the element's `type` attribute puts the `value` IDL attribute in the `value` mode, then set the `value` of the element to the value of the `value` content attribute, if there is one, or the empty string otherwise, and then set the control's `dirty value flag` to false.
3. Otherwise, if the previous state of the element's `type` attribute put the `value` IDL attribute in any mode other than the `filename` mode, and the new state of the element's `type` attribute puts the `value` IDL attribute in the `filename` mode, then set the `value` of the element to the empty string.
4. Update the element's rendering and behavior to the new state's.

5. **Signal a type change** for the element. (The Radio Button attribute uses this, in particular.)

6. Invoke the value sanitization algorithm, if one is defined for the type attribute's new state.

7. Let previouslySelectable be true if setRangeText previously applied to the element, and false otherwise.

8. Let nowSelectable be true if setRangeText now applies to the element, and false otherwise.

9. If previouslySelectable is false and nowSelectable is true, set the element's text entry cursor position to the beginning of the text control, and set its selection direction to "none".

The name attribute represents the element's name. The dirname attribute controls how the element's directionality is submitted. The disabled attribute is used to make the control non-interactive and to prevent its value from being submitted. The form attribute is used to explicitly associate the input element with its form owner. The autocomplete attribute controls how the user agent provides autofill behavior.

The indeterminate IDL attribute must initially be set to false. On getting, it must return the last value it was set to. On setting, it must be set to the new value. It has no effect except for changing the appearance of checkbox controls.

The accept, alt, max, min, multiple, pattern, placeholder, required, size, src, and step IDL attributes must reflect the respective content attributes of the same name. The dirName IDL attribute must reflect the dirname content attribute. The readOnly IDL attribute must reflect the readonly content attribute. The defaultChecked IDL attribute must reflect the checked content attribute. The defaultValue IDL attribute must reflect the value content attribute.

The type IDL attribute must reflect the respective content attribute of the same name, limited to only known values. The maxLength IDL attribute must reflect the maxlen content attribute, limited to only non-negative numbers. The minLength IDL attribute must reflect the minLen content attribute, limited to only non-negative numbers.

The IDL attributes width and height must return the rendered width and height of the image, in CSS pixels, if an image is being rendered; or else the natural width and height of the image, in CSS pixels, if an image is available, but not being rendered; or else 0, if no image is available. When the input element's type attribute is not in the Image Button state, then no image is available. The IDL attributes are part of the element's forms API.

4.10.5.1 States of the type attribute

4.10.5.1.1 Hidden state (type=hidden)

When an input element's type attribute is in the Hidden state, the rules in this section apply.

The input element represents a value that is not intended to be examined or manipulated by the user.

**Constraint validation**: If an input element's type attribute is in the Hidden state, it is barred from constraint validation.

If the name attribute is present and has a value that is an ASCII case-insensitive match for "\_charset\_", then the element's value attribute must be omitted.

**Bookkeeping details**

- The autocomplete and dirname content attributes apply to this element.
- The value attribute applies to this element and is in mode default.
- The following content attributes must not be specified and do not apply to the element: accept, alt, checked, formaction, formenctype, formmethod, formnovalidate, formtarget, height, list, max, maxlength, min, minlength, multiple, pattern, placeholder, popoptarget, popoptargetaction, readonly, required, size, src, step, width.
- The following IDL attributes and methods do not apply to the element: checked, files, list, selectionStart, selectionEnd.
4.10.5.1.2 **Text (type=text) state and Search state (type=search)**

When an *input* element's *type* attribute is in the *Text* state or the *Search* state, the rules in this section apply.

The *input* element represents a one line plain text edit control for the element's *value*.

**Note**

The difference between the *Text* state and the *Search* state is primarily stylistic: on platforms where search controls are distinguished from regular text controls, the *Search* state might result in an appearance consistent with the platform's search controls rather than appearing like a regular text control.

If the element is *mutable*, its *value* should be editable by the user. User agents must not allow users to insert U+000A LINE FEED (LF) or U+000D CARRIAGE RETURN (CR) characters into the element's *value*.

If the element is *mutable*, the user agent should allow the user to change the writing direction of the element, setting it either to a left-to-right or right-to-left writing direction. If the user does so, the user agent must then run the following steps:

1. Set the element's *dir* attribute to "ltr" if the user selected a left-to-right writing direction, and "rtl" if the user selected a right-to-left writing direction.

2. Queue an element task given the user interaction task source, given the element to fire an event named *input* at the element, with the *bubbles* and *composed* attributes initialized to true.

The *value*, if specified, must have a value that contains no U+000A LINE FEED (LF) or U+000D CARRIAGE RETURN (CR) characters.

The *value sanitization algorithm* is as follows: Strip newlines from the *value*.

**Bookkeeping details**

The following common *input* element content attributes, IDL attributes, and methods apply to the element: *autocomplete*, *dir*, *dirname*, *dirname*, *list*, *maxlength*, *minlength*, *pattern*, *placeholder*, *readonly*, *required*, *size*, *content attributes; list, selectionStart*, *selectionEnd*, *selectionDirection*, and *value* IDL attributes; *select*, *setRangeText*, and *setSelectionRange* methods.

The *value* IDL attribute is in mode *value*.

The *input* and *change* events apply.

The following content attributes must not be specified and do not apply to the element: *accept*, *alt*, *checked*, *formaction*, *formenctype*, *formmethod*, *formnovalidate*, *formtarget*, *height*, *max*, *min*, *multiple*, *popovertarget*, *popovertargetaction*, *src*, *step*, and *width*.

The following IDL attributes and methods do not apply to the element: *checked*, *files*, *valueAsDate*, and *valueAsNumber* IDL attributes; *stepDown* and *stepUp* methods.

4.10.5.1.3 **Telephone state (type=tel)**

When an *input* element's *type* attribute is in the *Telephone* state, the rules in this section apply.

The *input* element represents a control for editing a telephone number given in the element's *value*.

If the element is *mutable*, its *value* should be editable by the user. User agents may change the spacing and, with care, the punctuation of the *value* that the user enters. User agents must not allow users to insert U+000A LINE FEED (LF) or U+000D CARRIAGE RETURN (CR) characters into the element's *value*.

The *value*, if specified, must have a value that contains no U+000A LINE FEED (LF) or U+000D CARRIAGE RETURN (CR) characters.

The *value sanitization algorithm* is as follows: Strip newlines from the *value*. 

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Bookkeeping details

- The following common `input` element content attributes, IDL attributes, and methods apply to the element: `autocomplete`, `dirname`, `list`, `maxlength`, `minlength`, `pattern`, `placeholder`, `readonly`, `required`, and `size` content attributes; `list`, `selectionStart`, `selectionEnd`, `selectionDirection`, and `value` IDL attributes; `select()`, `setRangeText()`, and `setSelectionRange()` methods.

- The `value` IDL attribute is in mode `value`.

- The `input` and `change` events apply.

- The following content attributes must not be specified and do not apply to the element: `accept`, `alt`, `checked`, `formaction`, `formenctype`, `formmethod`, `formnovalidate`, `formtarget`, `height`, `max`, `min`, `multiple`, `popovertarget`, `popovertargetaction`, `src`, `step`, and `width`.

- The following IDL attributes and methods do not apply to the element: `checked`, `files`, `valueAsDate`, and `valueAsNumber` IDL attributes; `stepDown()` and `stepUp()` methods.

4.10.5.1.4 URL state (type=url) 525

When an `input` element's `type` attribute is in the `URL` state, the rules in this section apply.

The `input` element represents a control for editing a single absolute URL given in the element's `value`.

If the element is `mutable`, the user agent should allow the user to change the URL represented by its `value`. User agents may allow the user to set the `value` to a string that is not a valid absolute URL, but may also or instead automatically escape characters entered by the user so that the `value` is always a valid absolute URL (even if that isn't the actual value seen and edited by the user in the interface). User agents should allow the user to set the `value` to the empty string. User agents must not allow users to insert U+000A LINE FEED (LF) or U+000D CARRIAGE RETURN (CR) characters into the interface. User agents should allow the user to set the `value`.

The `value` attribute, if specified and not empty, must have a value that is a valid URL potentially surrounded by spaces that is also an absolute URL.

The `value sanitization algorithm` is as follows: Strip newlines from the `value`, then strip leading and trailing ASCII whitespace from the `value`.

Constraint validation: While the `value` of the element is neither the empty string nor a valid absolute URL, the element is suffering from a type mismatch.

Example

If a document contained the following markup:

```xml
<input type="url" name="location" list="urls" />
<datalist id="urls">
    <option label="MIME: Format of Internet Message Bodies" value="https://www.rfc-editor.org/rfc/rfc2045"/>
    <option label="HTML" value="https://html.spec.whatwg.org"/>
    <option label="DOM" value="https://dom.spec.whatwg.org"/>
```
When an \input\ element's \type\ attribute is in the \Email\ state, the rules in this section apply. How the \Email\ state operates depends on whether the \multiple\ attribute is specified or not.

↪ When the \multiple\ attribute is not specified on the element

The \input\ element represents a control for editing an email address given in the element's value.

If the element is mutable, the user agent should allow the user to change the email address represented by its value. User agents may allow the user to set the value to a string that is not a valid email address. User agents should allow the user to set the value to the empty string. User agents must not allow users to insert U+000A LINE FEED (LF) or U+000D CARRIAGE RETURN (CR) characters into the value. User agents may transform the value for display and editing; in particular, user agents should convert punycode in the domain labels of the value to IDN in the display and vice versa.

Constraint validation: While the user interface is representing input that the user agent cannot convert to punycode, the control is suffering from bad input.

The value attribute, if specified and not empty, must have a value that is a single valid email address.

The value sanitization algorithm is as follows: Strip newlines from the value, then strip leading and trailing ASCII whitespace from the value.

Constraint validation: While the value of the element is neither the empty string nor a single valid email address, the element is suffering from a type mismatch.

↪ When the \multiple\ attribute is specified on the element

The \input\ element represents a control for adding, removing, and editing the email addresses given in the element's values.
If the element is mutable, the user agent should allow the user to add, remove, and edit the email addresses represented by its values. User agents may allow the user to set any individual value in the list of values to a string that is not a valid email address, but must not allow users to set any individual value to a string containing U+002C COMMA (,), U+00A LINE FEED (LF), or U+00D CARRIAGE RETURN (CR) characters. User agents should allow the user to remove all the addresses in the element's values. User agents may transform the values for display and editing; in particular, user agents should convert punycode in the domain labels of the value to IDN in the display and vice versa.

**Constraint validation:** While the user interface describes a situation where an individual value contains a U+002C COMMA (,) or is representing input that the user agent cannot convert to punycode, the control is suffering from bad input.

Whenever the user changes the element's values, the user agent must run the following steps:

1. Let latest values be a copy of the element's values.
2. Strip leading and trailing ASCII whitespace from each value in latest values.
3. Let the element's value be the result of concatenating all the values in latest values, separating each value from the next by a single U+002C COMMA character (,), maintaining the list's order.

The value attribute, if specified, must have a value that is a valid email address.

The value sanitization algorithm is as follows:

1. Split on commas the element's value, strip leading and trailing ASCII whitespace from each resulting token, if any, and let the element's values be the (possibly empty) resulting list of (possibly empty) tokens, maintaining the original order.
2. Let the element's value be the result of concatenating the element's values, separating each value from the next by a single U+002C COMMA character (,), maintaining the list's order.

**Constraint validation:** While the value of the element is not a valid email address, the element is suffering from a type mismatch.

When the multiple attribute is set or removed, the user agent must run the value sanitization algorithm.

A valid email address is a string that matches the email production of the following ABNF, the character set for which is Unicode. This ABNF implements the extensions described in RFC 1123. [RFC1034] [RFC5322] [RFC1123] [RFC1034]

```
email = 1*( atext / "." ) "@" label *( "." label )
label = let-dig [ [ ldh-str ] let-dig ] ; limited to a length of 63 characters by RFC 1034
section 3.5
atext = < as defined in RFC 5322 section 3.2.3 >
let-dig = < as defined in RFC 1034 section 3.5 >
ldh-str = < as defined in RFC 1034 section 3.5 >
```

**Note**

This requirement is a willful violation of RFC 5322, which defines a syntax for email addresses that is simultaneously too strict (before the "@" character), too vague (after the "@" character), and too lax (allowing comments, whitespace characters, and quoted strings in manners unfamiliar to most users) to be of practical use here.

**Note**

The following JavaScript- and Perl-compatible regular expression is an implementation of the above definition.

```
/^[a-zA-Z0-9#!$%&'*+\-\./;\?\[\]^\`\{}\-\]\]@[a-zA-Z0-9](\?\:[a-zA-Z0-9\-\.]\{0,61\}[a-zA-Z0-9])\?\:[\.:\:\\;\?\[\]^\`\{}\-\]\]@[a-zA-Z0-9\-\.]\{0,61\}[a-zA-Z0-9])\?$/
```

A valid email address list is a set of comma-separated tokens, where each token is itself a valid email address. To obtain the list of tokens from a valid email address list, an implementation must split the string on commas.

**Bookkeeping details**

- The following common input element content attributes, IDL attributes, and methods apply to the element: autocomplete, dirname, list, maxlength, minlength, multiple, pattern, placeholder, readonly, required, and size content attributes; list and value IDL attributes; select method.
4.10.5.1.6 Password state (type=password)

When an input element's type attribute is in the Password state, the rules in this section apply.

The input element represents a one line plain text edit control for the element's value. The user agent should obscure the value so that people other than the user cannot see it.

If the element is mutable, its value should be editable by the user. User agents must not allow users to insert U+000A LINE FEED (LF) or U+000D CARRIAGE RETURN (CR) characters into the value.

The value, if specified, must have a value that contains no U+000A LINE FEED (LF) or U+000D CARRIAGE RETURN (CR) characters.

The value sanitization algorithm is as follows: Strip newlines from the value.

Bookkeeping details

The following common input element content attributes, IDL attributes, and methods apply to the element: autocomplete, dirname, maxlength, minlength, pattern, placeholder, readonly, required, and size content attributes; selectionStart, selectionEnd, selectionDirection, and value IDL attributes; select, setRangeText, and setSelectionRange methods.

The value IDL attribute is in mode.

The input and change events apply.

The following content attributes must not be specified and do not apply to the element: accept, alt, checked, formaction, formenctype, formmethod, formnovalidate, formtarget, height, max, min, multiple, popupTarget, popupTargetAction, src, step, and width.

The following IDL attributes and methods do not apply to the element: checked, files, list, valueAsDate, and valueAsNumber IDL attributes; setRangeText, setSelectionRange, stepDown, and stepUp methods.

4.10.5.1.7 Date state (type=date)

When an input element's type attribute is in the Date state, the rules in this section apply.

The input element represents a control for setting the element's value to a string representing a specific date.

If the element is mutable, the user agent should allow the user to change the date represented by its value, as obtained by parsing a date from it. User agents must not allow the user to set the value to a non-empty string that is not a valid date string. If the user agent provides a user interface for selecting a date, then the value must be set to a valid date string representing the user's selection. User agents should allow the user to set the value to the empty string.

Constraint validation: While the user interface describes input that the user agent cannot convert to a valid date string, the control is suffering from bad input.

The value attribute, if specified and not empty, must have a value that is a valid date string.

The value sanitization algorithm is as follows: If the value of the element is not a valid date string, then set it to the empty string instead.

The min attribute, if specified, must have a value that is a valid date string. The max attribute, if specified, must have a value that is a valid date string.
The step attribute is expressed in days. The step scale factor is 86,400,000 (which converts the days to milliseconds, as used in the other algorithms). The default step is 1 day.

When the element is suffering from a step mismatch, the user agent may round the element's value to the nearest date for which the element would not suffer from a step mismatch.

The algorithm to convert a string to a number, given a string input, is as follows: If parsing a date from input results in an error, then return an error; otherwise, return the number of milliseconds elapsed from midnight UTC on the morning of 1970-01-01 (the time represented by the value "1970-01-01T00:00:00.0Z") to midnight UTC on the morning of the parsed date, ignoring leap seconds.

The algorithm to convert a number to a string, given a number input, is as follows: Return a valid date string that represents the date that, in UTC, is current input milliseconds after midnight UTC on the morning of 1970-01-01 (the time represented by the value "1970-01-01T00:00:00.0Z").

The algorithm to convert a string to a Date object, given a string input, is as follows: If parsing a date from input results in an error, then return an error; otherwise, return a new Date object representing midnight UTC on the morning of the parsed date.

The algorithm to convert a Date object to a string, given a Date object input, is as follows: Return a valid date string that represents the date current at the time represented by input in the UTC time zone.

Note

The Date state (and other date- and time-related states described in subsequent sections) is not intended for the entry of values for which a precise date and time relative to the contemporary calendar cannot be established. For example, it would be inappropriate for the entry of times like “one millisecond after the big bang”, “the early part of the Jurassic period”, or “a winter around 250 BCE”.

For the input of dates before the introduction of the Gregorian calendar, authors are encouraged to not use the Date state (and other date- and time-related states described in subsequent sections), as user agents are not required to support converting dates and times from earlier periods to the Gregorian calendar, and asking users to do so manually puts an undue burden on users. (This is complicated by the manner in which the Gregorian calendar was phased in, which occurred at different times in different countries, ranging from partway through the 16th century all the way to early in the 20th.) Instead, authors are encouraged to provide fine-grained input controls using the select element and input elements with the Number state.

Bookkeeping details

- The following common input element content attributes, IDL attributes, and methods apply to the element: autocomplete, list, max, min, readonly, required, and step, content attributes; list, value, valueAsDate, and valueAsNumber IDL attributes; select; valueAsNumber, stepDown(), and stepUp() methods.
- The value IDL attribute is in mode value.
- The Input and change events apply.
- The following content attributes must not be specified and do not apply to the element: accept, alt, checked, dir, lang, multiple, pattern, placeholder, popovertarget, popovertargetaction, size, src, and width.
- The following IDL attributes and methods do not apply to the element: checked, selectionStart, selectionEnd, and selectionDirection IDL attributes; setRangeText(), and setSelectionRange() methods.

4.10.5.1.8 Month state (type=month)

If an input element's type attribute is in the Month state, the rules in this section apply.

The input element represents a control for setting the element's value to a string representing a specific month.

If the element is mutable, the user agent should allow the user to change the month represented by its value, as obtained by parsing a month from it. User agents must not allow the user to set the value to a non-empty string that is not a valid month string. If the user agent provides a user interface for selecting a month, then the value must be set to a valid month string representing the user's selection. User agents should allow the user to set the value to the empty string.

Constraint validation: While the user interface describes input that the user agent cannot convert to a valid month string, the control is suffering from bad input.
See the introduction section for a discussion of the difference between the input format and submission format for date, time, and number form controls, and the implementation notes regarding localization of form controls.

The `value` attribute, if specified and not empty, must have a value that is a valid month string.

The value sanitization algorithm is as follows: If the `value` of the element is not a valid month string, then set it to the empty string instead.

The `min` attribute, if specified, must have a value that is a valid month string. The `max` attribute, if specified, must have a value that is a valid month string.

The `step` attribute is expressed in months. The step scale factor is 1 (there is no conversion needed as the algorithms use months). The default step is 1 month.

When the element is suffering from a step mismatch, the user agent may round the element's `value` to the nearest month for which the element would not suffer from a step mismatch.

The algorithm to convert a string to a number, given a string input, is as follows: If parsing a month from input results in an error, then return an error; otherwise, return the number of months between January 1970 and the parsed month for which the element would not suffer from a step mismatch.

The algorithm to convert a month to a string, given a number input, is as follows: Return a valid month string that represents the month that has input months between it and January 1970.

When a control for setting the element's value is as follows: If parsing a month from input results in an error, then return an error; otherwise, return a new Date object representing midnight UTC on the morning of the first day of the parsed month.

The algorithm to convert a Date object to a string, given a Date object input, is as follows: Return a valid month string that represents the month current at the time represented by input in the UTC time zone.

**Bookkeeping details**

- The following common input element content attributes, IDL attributes, and methods apply to the element: `autocomplete`, `list`, `max`, `min`, `readonly`, `required`, and `step` content attributes; `list`, `value`, `valueAsDate`, and `valueAsNumber` IDL attributes; `select()`, `stepDown()`, and `stepUp()` methods.
- The `value` IDL attribute is in mode.
- The `input` and `change` events apply.
- The following content attributes must not be specified and do not apply to the element: `accept`, `alt`, `checked`, `dir`, `language`, `formaction`, `formmethod`, `formnovalidate`, `formtarget`, `height`, `maxlength`, `minlength`, `multiple`, `pattern`, `placeholder`, `popovertarget`, `popovertargetaction`, `size`, `src`, and `width`.
- The following IDL attributes and methods do not apply to the element: `checked`, `files`, `selectionStart`, `selectionEnd`, and `selectionDirection` IDL attributes; `setRangeText()`, and `setSelectionRange()` methods.

4.10.5.1.9 Week state (type=week)

When an element's type is `type` attribute is in the `Week` state, the rules in this section apply.

The `input` element represents a control for setting the element's `value` to a string representing a specific week.

If the element is `mutable`, the user agent should allow the user to change the `week` represented by its `value`, as obtained by parsing a week from it. User agents must not allow the user to set the `value` to a non-empty string that is not a valid week string. If the user agent provides a user interface for selecting a `week`, then the `value` must be set to a valid week string representing the user's selection. User agents should allow the user to set the `value` to the empty string.

**Constraint validation:** While the user interface describes input that the user agent cannot convert to a valid week string, the control is suffering from bad input.

See the introduction section for a discussion of the difference between the input format and submission format for date, time, and number form controls, and the implementation notes regarding localization of form controls.
The **value** attribute, if specified and not empty, must have a value that is a **valid week string**.

The **value sanitization algorithm** is as follows: If the **value** of the element is not a **valid week string**, then set it to the empty string instead.

The **min** attribute, if specified, must have a value that is a **valid week string**. The **max** attribute, if specified, must have a value that is a **valid week string**.

The **step** attribute is expressed in weeks. The **step scale factor** is 604,800,000 (which converts the weeks to milliseconds, as used in the other algorithms). The **default step** is 1 week. The **default step base** is −259,200,000 (the start of week 1970-W01).

When the element is **suffering from a step mismatch**, the user agent may round the element’s **value** to the nearest week for which the element would not **suffer from a step mismatch**.

The **algorithm to convert a string to a number**, given a **string input**, is as follows: If parsing a **week string** from input results in an error, then return an error; otherwise, return the number of milliseconds elapsed from midnight UTC on the morning of 1970-01-01 (the time represented by the value "1970-01-01T00:00:00.0Z") to midnight UTC on the morning of the Monday of the parsed **week**, ignoring leap seconds.

The **algorithm to convert a number to a string**, given a **number input**, is as follows: Return a **valid week string** that represents the **week** that, in UTC, is current input milliseconds after midnight UTC on the morning of 1970-01-01 (the time represented by the value "1970-01-01T00:00:00.0Z").

The **algorithm to convert a string to a Date object**, given a **string input**, is as follows: If parsing a **week** from input results in an error, then return an error; otherwise, return a **new Date object** representing midnight UTC on the morning of the Monday of the parsed **week**.

The **algorithm to convert a Date object to a string**, given a **Date object input**, is as follows: Return a **valid week string** that represents the **week** current at the time represented by **input** in the UTC time zone.

**Bookkeeping details**

- The following common **input** element content attributes, IDL attributes, and methods **apply** to the element: **autocomplete**, **list**, **max**, **min**, **readonly**, **required**, and **step** content attributes; **list**, **value**, **valueAsDate**, and **valueAsNumber** IDL attributes; **select()**, **stepDown()**, and **stepUp()** methods.
- The **value** IDL attribute is in mode **value**.
- The **input** and **change** events **apply**.
- The following IDL attributes and methods do **not apply** to the element: **checked**, **files**, **selectionStart**, **selectionEnd**, and **selectionDirection** IDL attributes; **setRangeText()**, and **setSelectionRange()** methods.

4.10.5.1.10 **Time state (type=time)**

When an **input** element’s **type** attribute is in the **Time** state, the rules in this section apply.

The **input** element **represents** a control for setting the element’s **value** to a string representing a specific **time**.

If the element is **mutable**, the user agent should allow the user to change the **time** represented by its **value**, as obtained by parsing a **time** from it. User agents must not allow the user to set the **value** to a non-empty string that is not a **valid time string**. If the user agent provides a user interface for selecting a **time**, then the **value** must be set to a **valid time string** representing the user’s selection. User agents should allow the user to set the **value** to the empty string.

**Constraint validation**: While the user interface describes input that the user agent cannot convert to a **valid time string**, the control is **suffering from bad input**.

**Note**

See the **introduction section** for a discussion of the difference between the input format and submission format for date, time, and number form controls, and the **implementation notes** regarding localization of form controls.

The **value** attribute, if specified and not empty, must have a value that is a **valid time string**.
The value sanitization algorithm\(^{521}\) is as follows: If the value\(^{593}\) of the element is not a valid time string\(^{582}\), then set it to the empty string instead.

The form control has a periodic domain\(^{551}\).

The min\(^{551}\) attribute, if specified, must have a value that is a valid time string\(^{582}\). The max\(^{551}\) attribute, if specified, must have a value that is a valid time string\(^{582}\).

The step\(^{552}\) attribute is expressed in seconds. The step scale factor\(^{552}\) is 1000 (which converts the seconds to milliseconds, as used in the other algorithms). The default step\(^{552}\) is 60 seconds. When the element is suffering from a step mismatch\(^{618}\), the user agent may round the element's value\(^{593}\) to the nearest time\(^{582}\) for which the element would not suffer from a step mismatch\(^{618}\).

The algorithm to convert a string to a number\(^{521}\), given a string input, is as follows: If parsing a time\(^{583}\) from input results in an error, then return an error; otherwise, return the number of milliseconds elapsed from midnight to the parsed time\(^{582}\) on a day with no time changes.

The algorithm to convert a string to a number\(^{521}\), given a string input, is as follows: Return a valid time string\(^{582}\) that represents the time\(^{582}\) that is input milliseconds after midnight on a day with no time changes.

The algorithm to convert a string to a Date object\(^{521}\), given a string input, is as follows: If parsing a time\(^{583}\) from input results in an error, then return an error; otherwise, return a new Date object\(^{556}\) representing the parsed time\(^{582}\) in UTC on 1970-01-01.

The algorithm to convert a Date object to a string\(^{521}\), given a Date object input, is as follows: Return a valid time string\(^{582}\) that represents the UTC time\(^{582}\) component that is represented by input.

**Bookkeeping details**

- The following common input\(^{517}\) element content attributes, IDL attributes, and methods apply\(^{522}\) to the element: autocomplete\(^{580}\), list\(^{555}\), max\(^{551}\), min\(^{551}\), readonly\(^{557}\), required\(^{546}\), and step\(^{511}\) content attributes; list\(^{558}\), value\(^{595}\), valueAsDate\(^{515}\), and valueAsNumber\(^{515}\) IDL attributes; select\(^{461}\), stepDown()\(^{506}\), and stepUp()\(^{506}\) methods.
- The value\(^{552}\) IDL attribute is in mode value\(^{516}\).
- The Input and change\(^{414}\) events apply\(^{522}\).
- The following content attributes must not be specified and do not apply\(^{522}\) to the element: accept\(^{550}\), alt\(^{524}\), checked\(^{521}\), dirname\(^{526}\), form\(^{138}\), formAction\(^{138}\), formMethod\(^{138}\), formNoValidate\(^{138}\), formTarget\(^{138}\), height\(^{551}\), maxLength\(^{551}\), minLength\(^{551}\), multiple\(^{556}\), pattern\(^{138}\), placeholder\(^{555}\), popovertargetAction\(^{547}\), popovertargetact\(^{547}\), size\(^{551}\), src\(^{545}\), and width\(^{551}\).
- The following IDL attributes and methods do not apply\(^{586}\) to the element: checked\(^{517}\), files\(^{507}\), selectionStart\(^{413}\), selectionEnd\(^{415}\), and selectionDirection\(^{541}\) IDL attributes; setRangeText()\(^{549}\), and setSelectionRange()\(^{549}\) methods.

#### 4.10.5.1.1 Local Date and Time state (type= datetime-local) \(^{513}\)

When an Input\(^{517}\) element's type\(^{519}\) attribute is in the Local Date and Time\(^{532}\) state, the rules in this section apply.

The Input\(^{517}\) element represents\(^{639}\) a control for setting the element's value\(^{593}\) to a string representing a local date and time\(^{583}\), with no time-zone offset information.

If the element is mutable\(^{693}\), the user agent should allow the user to change the date and time\(^{583}\) represented by its value\(^{593}\), as obtained by parsing a date and time\(^{583}\) from it. User agents must not allow the user to set the value\(^{593}\) to a non-empty string that is not a valid normalized local date and time string\(^{584}\). If the user agent provides a user interface for selecting a local date and time\(^{583}\), then the value\(^{593}\) must be set to a valid normalized local date and time string\(^{584}\) representing the user's selection. User agents should allow the user to set the value\(^{593}\) to the empty string.

**Constraint validation:** While the user interface describes input that the user agent cannot convert to a valid normalized local date and time string\(^{584}\), the control is suffering from bad input\(^{618}\).

**Note**

See the introduction section\(^{508}\) for a discussion of the difference between the input format and submission format for date, time, and number form controls, and the implementation notes\(^{546}\) regarding localization of form controls.

The value\(^{521}\) attribute, if specified and not empty, must have a value that is a valid local date and time string\(^{483}\).

**The value sanitization algorithm**\(^{521}\) is as follows: If the value\(^{593}\) of the element is a valid local date and time string\(^{483}\), then set it...
to a valid normalized local date and time string representing the same date and time; otherwise, set it to the empty string instead.

The \texttt{min} attribute, if specified, must have a value that is a valid local date and time string. The \texttt{max} attribute, if specified, must have a value that is a valid local date and time string.

The \texttt{step} attribute is expressed in seconds. The \texttt{step scale factor} is 1000 (which converts the seconds to milliseconds, as used in the other algorithms). The \texttt{default step} is 60 seconds.

When the element is suffering from a step mismatch, the user agent may round the element's \texttt{value} to the nearest local date and time for which the element would not suffer from a step mismatch.

The \texttt{algorithm to convert a string to a number}, given a string \textit{input}, is as follows: If parsing a date and time from input results in an error, then return an error; otherwise, return the number of milliseconds elapsed from midnight on the morning of 1970-01-01 (the time represented by the value "1970-01-01T00:00:00.0") to the parsed \texttt{local date and time}, ignoring leap seconds.

The \texttt{algorithm to convert a number to a string}, given a number \textit{input}, is as follows: Return a valid normalized local date and time string that represents the date and time that is \textit{input} milliseconds after midnight on the morning of 1970-01-01 (the time represented by the value "1970-01-01T00:00:00.0").

\begin{mdnote}
See the note on historical dates in the Date state section.
\end{mdnote}

\begin{bookkeepingdetails}
\begin{itemize}
  \item The following common \texttt{input} element content attributes, IDL attributes, and methods apply to the element: \texttt{autocomplete}, \texttt{list}, \texttt{max}, \texttt{min}, \texttt{readonly}, \texttt{required}, and \texttt{step} content attributes; \texttt{list}, \texttt{value}, and \texttt{valuesNumber} IDL attributes; \texttt{select()}, \texttt{stepDown()}, and \texttt{stepUp()} methods.
  \item The \texttt{value} IDL attribute is in mode \texttt{value}.
  \item The \texttt{input} and \texttt{change} events apply.
  \item The following content attributes must not be specified and do not apply to the element: \texttt{accept}, \texttt{alt}, \texttt{checked}, \texttt{dirname}, \texttt{formaction}, \texttt{formenctype}, \texttt{formmethod}, \texttt{formnovalidate}, \texttt{formtarget}, \texttt{height}, \texttt{max}, \texttt{maxlength}, \texttt{min}, \texttt{minlength}, \texttt{multiple}, \texttt{pattern}, \texttt{placeholder}, \texttt{popovertarget}, \texttt{popovertargetaction}, \texttt{size}, \texttt{src}, and \texttt{width}.
  \item The following IDL attributes and methods do not apply to the element: \texttt{checked}, \texttt{files}, \texttt{selectionStart}, \texttt{selectionEnd}, \texttt{selectionDirection}, and \texttt{valueAsDate} IDL attributes; \texttt{setRangeText()}, and \texttt{setSelectionRange()} methods.
\end{itemize}
\end{bookkeepingdetails}

\begin{example}
The following example shows part of a flight booking application. The application uses an \texttt{input} element with its \texttt{type} attribute set to \texttt{datetime-local}, and it then interprets the given date and time in the time zone of the selected airport.

\begin{verbatim}
<fieldset>
  <legend>Destination</legend>
  <p><label>Destination: <input type=text name=to list=airports></label></p>
  <p><label>Departure time: <input type=number name=fromtime step=3600></label></p>
</fieldset>

<option value=ATL label="Atlanta">
  <option value=MEM label="Memphis">
    <option value=LAX label="Los Angeles">
      <option value=FRA label="Frankfurt">
\end{verbatim}
\end{example}

4.10.5.1.12 Number state (type=number)

When an \texttt{input} element's \texttt{type} attribute is in the Number state, the rules in this section apply.

The \texttt{input} element represents a control for setting the element's \texttt{value} to a string representing a number.

If the element is \texttt{mutable}, the user agent should allow the user to change the number represented by its \texttt{value}, as obtained from applying the rules for parsing floating-point number values to it. User agents must not allow the user to set the \texttt{value} to a non-
empty string that is not a valid floating-point number. If the user agent provides a user interface for selecting a number, then the value of the element is set to the best representation of the number representing the user’s selection as a floating-point number. User agents should allow the user to set the value to the empty string.

**Constraint validation:** While the user interface describes input that the user agent cannot convert to a valid floating-point number, the control is suffering from bad input.

The value attribute, if specified and not empty, must have a value that is a valid floating-point number.

**The value sanitization algorithm** is as follows: If the value of the element is not a valid floating-point number, then set it to the empty string instead.

The min attribute, if specified, must have a value that is a valid floating-point number. The max attribute, if specified, must have a value that is a valid floating-point number.

The step scale factor is 1. The default step is 1 (allowing only integers to be selected by the user, unless the step base has a non-integer value).

When the element is suffering from a step mismatch, the user agent may round the element’s value to the nearest number for which the element would not suffer from a step mismatch. If there are two such numbers, user agents are encouraged to pick the one nearest positive infinity.

**The algorithm to convert a string to a number**, given a string input, is as follows: If applying the rules for parsing floating-point number values to input results in an error, then return an error; otherwise, return the resulting number.

**The algorithm to convert a number to a string**, given a number input, is as follows: Return a valid floating-point number that represents input.

**Bookkeeping details**:
- The following common input element content attributes, IDL attributes, and methods apply to the element: `autocomplete`, `list`, `max`, `min`, `placeholder`, `readonly`, `required`, and `step` content attributes; `list`, `value`, and `valueAsNumber` IDL attributes; `select()`, `stepDown()`, and `stepUp()` methods.
- The value IDL attribute is in mode value.
- The input and change events apply.
- The following content attributes must not be specified and do not apply to the element: accept, all, checked, dirname, formaction, formenctype, formmethod, formnovalidate, height, max, maxlength, min, minlength, multiple, pattern, popovertargetaction, size, src, and width.
- The following IDL attributes and methods do not apply to the element: checked, files, selectionStart, selectionEnd, selectionDirection, and valueAsDate IDL attributes; `setRangeText()`, and `setSelectionRange()` methods.

**Example**

Here is an example of using a numeric input control:

```html
<label>How much do you want to charge? $<input type=number min=0 step=0.01 name=price></label>
```

As described above, a user agent might support numeric input in the user's local format, converting it to the format required for submission as described above. This might include handling grouping separators (as in "872,000,000,000") and various decimal separators (such as "3,99" vs "3.99") or using local digits (such as those in Arabic, Devanagari, Persian, and Thai).

**Note**
The type=number state is not appropriate for input that happens to only consist of numbers but isn't strictly speaking a number. For example, it would be inappropriate for credit card numbers or US postal codes. A simple way of determining whether to use type=number is to consider whether it would make sense for the input control to have a spinbox interface (e.g. with "up" and "down" buttons) to allow the user to select values within the range.

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4.10.5.1.13 Range state (type=range)

When an `input` element's `type` attribute is in the `Range` state, the rules in this section apply.

The `input` element represents a control for setting the element's `value` to a string representing a number, but with the caveat that the exact value is not important, letting UAs provide a simpler interface than they do for the `Number` state. If the element is `mutable`, the user agent should allow the user to change the number represented by its `value`, as obtained from applying the rules for parsing floating-point number values to it. User agents must not allow the user to set the `value` to a string that is not a valid floating-point number. If the user agent provides a user interface for selecting a number, then the `value` must be set to a best representation of the number representing the user's selection as a floating-point number. User agents must not allow the user to set the `value` to the empty string.

Constraint validation: While the user interface describes input that the user agent cannot convert to a valid floating-point number, the control is suffering from bad input.

The `value` attribute, if specified, must have a value that is a valid floating-point number.

The value sanitization algorithm is as follows: If the `value` of the element is not a valid floating-point number, then set it to the best representation as a floating-point number, of the default value.

The default value is the minimum plus half the difference between the minimum and the maximum, unless the maximum is less than the minimum, in which case the default value is the minimum.

When the element is suffering from an underflow, the user agent must set the element's `value` to the best representation as a floating-point number, of the minimum.

When the element is suffering from an overflow, if the maximum is not less than the minimum, the user agent must set the element's `value` to a valid floating-point number that represents the maximum.

When the element is suffering from a step mismatch, the user agent must round the element's `value` to the nearest number for which the element would not suffer from a step mismatch, and which is greater than or equal to the minimum, and, if the maximum is not less than the minimum, which is less than or equal to the maximum, if there is a number that matches these constraints. If two numbers match these constraints, then user agents must use the one nearest to positive infinity.

Example

For example, the markup `<input type="range" min=0 max=100 step=20 value=50>` results in a range control whose initial value is 60.

Example

Here is an example of a range control using an autocomplete list with the `list` attribute. This could be useful if there are values along the full range of the control that are especially important, such as preconfigured light levels or typical speed limits in a range control used as a speed control. The following markup fragment:

```html
<input type="range" min="-100" max="100" value="0" step="10" name="power" list="powers">
<datalist id="powers">
  <option value="0">
  <option value="-30">
  <option value="30">
  <option value="+50">
</datalist>
```

...with the following style sheet applied:
Note how the UA determined the orientation of the control from the ratio of the style-sheet-specified height and width properties. The colors were similarly derived from the style sheet. The tick marks, however, were derived from the markup. In particular, the `step` attribute has not affected the placement of tick marks, the UA deciding to only use the author-specified completion values and then adding longer tick marks at the extremes.

Note also how the invalid value `++50` was ignored.

For another example, consider the following markup fragment:

```html
<input name="x" type="range" min="100" max="700" step="9.09090909" value="509.090909">
```

A user agent could display in a variety of ways, for instance:

![Example](image1)

Or, alternatively, for instance:

![Example](image2)

The user agent could pick which one to display based on the dimensions given in the style sheet. This would allow it to maintain the same resolution for the tick marks, despite the differences in width.

Finally, here is an example of a range control with two labeled values:

```html
<input type="range" name="a" list="a-values">
<datalist id="a-values">
<option value="10" label="Low">
<option value="90" label="High">
</datalist>
```

With styles that make the control draw vertically, it might look as follows:
Note

In this state, the range and step constraints are enforced even during user input, and there is no way to set the value to the empty string.

The `min` attribute, if specified, must have a value that is a valid floating-point number. The default minimum is 0. The `max` attribute, if specified, must have a value that is a valid floating-point number. The default maximum is 100.

The `step scale factor` is 1. The default step is 1 (allowing only integers, unless the `min` attribute has a non-integer value).

The algorithm to convert a string to a number, given a string input, is as follows: If applying the rules for parsing floating-point number values to input results in an error, then return an error; otherwise, return the resulting number.

The algorithm to convert a number to a string, given a number input, is as follows: Return the best representation as a floating-point number, of input.

Bookkeeping details

- The following common `input` element content attributes, IDL attributes, and methods apply to the element: `autocomplete`, `list`, `max`, `min`, `value`, and `valueAsNumber` IDL attributes; `stepDown()` and `stepUp()` methods.
- The `value` IDL attribute is in mode `valueAsNumber`.
- The `input` and `change` events apply.
- The following content attributes must not be specified and do not apply to the element: `accept`, `alt`, `checked`, `dir`, `dirname`, `formaction`, `form enctype`, `formmethod`, `formnovalidate`, `formtarget`, `height`, `max`, `maxlength`, `minlength`, `multiple`, `pattern`, `placeholder`, `popovertarget`, `popovertargetaction`, `readonly`, `required`, `size`, `src`, and `width`.
- The following IDL attributes and methods do not apply to the element: `checked`, `files`, `selectionStart`, `selectionEnd`, `selectionDirection`, and `valueAsDate` IDL attributes; `select()`, `setRangeText()`, and `setSelectionRange()` methods.

4.10.5.14 Color state (`type=color`)

When an `input` element's type attribute is in the Color state, the rules in this section apply.

The `input` element represents a color well control, for setting the element’s value to a string representing a simple color.

Note

In this state, there is always a color picked, and there is no way to set the value to the empty string.

If the element is mutable, the user agent should allow the user to change the color represented by its value, as obtained from applying the rules for parsing simple color values to it. User agents must not allow the user to set the value to a string that is not a valid lowercase simple color.

If the user agent provides a user interface for selecting a color, then the value must be set to the result of using the rules for serializing simple color values to the user's selection. User agents must not allow the user to set the value to the empty string.

The `input activation behavior` for such an element is to show the picker, if applicable, for element.

Constraint validation: While the user interface describes input that the user agent cannot convert to a valid lowercase simple color, the control is suffering from bad input.
The value\(^{531}\) attribute, if specified and not empty, must have a value that is a valid simple color\(^{562}\).

The value sanitization algorithm\(^{531}\) is as follows: If the value\(^{559}\) of the element is a valid simple color\(^{562}\), then set it to the value\(^{559}\); otherwise, set it to the string "\#000000".

**Bookkeeping details**
- The following common input\(^{411}\) element content attributes and IDL attributes apply\(^{529}\) to the element: autocomplete\(^{530}\) and list\(^{555}\) content attributes; list\(^{555}\) and value\(^{555}\) IDL attributes; select\(^{565}\) method.
- The value\(^{555}\) IDL attribute is in mode value\(^{555}\).
- The input and change\(^{1451}\) events apply\(^{529}\).

The following common content attributes must not be specified and do not apply\(^{529}\) to the element: accept\(^{550}\), alt\(^{544}\), checked\(^{531}\), dirname\(^{550}\), formaction\(^{535}\), formenctype\(^{535}\), formmethod\(^{535}\), formnovalidate\(^{535}\), formtarget\(^{535}\), height\(^{535}\), max\(^{535}\), maxlength\(^{535}\), min\(^{535}\), minlength\(^{535}\), multiple\(^{535}\), pattern\(^{535}\), placeholder\(^{535}\), popovertarget\(^{538}\), popovertargetaction\(^{538}\), readonly\(^{538}\), required\(^{538}\), size\(^{538}\), src\(^{538}\), step\(^{538}\), and width\(^{538}\).

The following IDL attributes and methods do not apply\(^{529}\) to the element: checked\(^{537}\), files\(^{537}\), selectionStart\(^{531}\), selectionEnd\(^{531}\), selectionDirection\(^{531}\), valueAsDate\(^{537}\), and valueAsNumber\(^{537}\) IDL attributes; setRangeText\(^{539}\), setSelectionRange\(^{539}\), stepDown\(^{538}\), and stepUp\(^{538}\) methods.

4.10.5.1.15 **Checkbox state** (type=checkbox)\(^{542}\)

When an input\(^{517}\) element's type\(^{519}\) attribute is in the Checkbox\(^{538}\) state, the rules in this section apply.

The input\(^{517}\) element represents\(^{519}\) a two-state control that represents the element's checked\(^{559}\) state. If the element's checked\(^{559}\) state is true, the control represents a positive selection, and if it is false, a negative selection. If the element's indeterminate\(^{523}\) IDL attribute is set to true, then the control's selection should be obscured as if the control was in a third, indeterminate, state.

**Note**

The control is never a true tri-state control, even if the element's indeterminate\(^{523}\) IDL attribute is set to true. The indeterminate\(^{523}\) IDL attribute only gives the appearance of a third state.

The input activation behavior\(^{552}\) is run the following steps:

1. If the element is not connected, then return.
2. Fire an event named input at the element with the bubbles and composed attributes initialized to true.
3. Fire an event named change\(^{1451}\) at the element with the bubbles attribute initialized to true.

**Constraint validation:** If the element is required\(^{548}\) and its checked\(^{559}\) is false, then the element is suffering from being missing\(^{616}\).

**For web developers (non-normative)**

\[
input.indeterminate [ = value ]
\]

When set, overrides the rendering of checkbox\(^{538}\) controls so that the current value is not visible.

**Bookkeeping details**
- The following common input\(^{411}\) element content attributes and IDL attributes apply\(^{529}\) to the element: checked\(^{537}\), and required\(^{556}\) content attributes; hovered\(^{537}\) and value\(^{555}\) IDL attributes.
- The value\(^{555}\) IDL attribute is in mode default\(^{557}\).
- The input and change\(^{1451}\) events apply\(^{529}\).

The following common content attributes must not be specified and do not apply\(^{529}\) to the element: accept\(^{550}\), alt\(^{544}\), autocomplete\(^{530}\), dirname\(^{550}\), formaction\(^{535}\), formenctype\(^{535}\), formmethod\(^{535}\), formnovalidate\(^{535}\), formtarget\(^{535}\), height\(^{535}\), max\(^{535}\), maxlength\(^{535}\), min\(^{535}\), minlength\(^{535}\), multiple\(^{535}\), pattern\(^{535}\), placeholder\(^{535}\), popovertarget\(^{538}\), popovertargetaction\(^{538}\), readonly\(^{538}\), required\(^{538}\), size\(^{538}\), src\(^{538}\), step\(^{538}\), and width\(^{538}\).

The following IDL attributes and methods do not apply\(^{529}\) to the element: files\(^{537}\), list\(^{555}\), selectionStart\(^{531}\), selectionEnd\(^{531}\), selectionDirection\(^{531}\), valueAsDate\(^{537}\), and valueAsNumber\(^{537}\) IDL attributes; select\(^{565}\), setRangeText\(^{539}\), setSelectionRange\(^{539}\), stepDown\(^{538}\), and stepUp\(^{538}\) methods.
When an `input` element's `type` attribute is in the Radio Button state, the rules in this section apply.

The `input` element represents a control that, when used in conjunction with other `input` elements, forms a radio button group in which only one control can have its checkedness state set to true. If the element's checkedness state is true, the control represents the selected control in the group, and if it is false, it indicates a control in the group that is not selected.

The radio button group that contains an `input` element also contains all the other `input` elements that fulfill all of the following conditions:

- The `input` element b's `type` attribute is in the Radio Button state.
- Either a and b have the same form owner, or they both have no form owner.
- Both a and b are in the same tree.
- They both have a `name` attribute, their `name` attributes are not empty, and the value of a's `name` attribute equals the value of b's `name` attribute.

A tree must not contain an `input` element whose radio button group contains only that element.

When any of the following phenomena occur, if the element's checkedness state is true after the occurrence, the checkedness state of all the other elements in the same radio button group must be set to false:

- The element's checkedness state is set to true (for whatever reason).
- The element's `name` attribute is set, changed, or removed.
- The element's form owner changes.
- A type change is signalled for the element.

The input activation behavior is to run the following steps:

1. If the element is not connected, then return.
2. Fire an event named `input` at the element with the bubbles and composed attributes initialized to true.
3. Fire an event named `change` at the element with the bubbles attribute initialized to true.

Constraint validation: If an element in the radio button group is required, and all of the `input` elements in the radio button group have a checkedness that is false, then the element is suffering from being missing.

Example

The following example, for some reason, has specified that puppers are both required and disabled:

```html
<form>
  <p><label><input type="radio" name="dog-type" value="pupper" required disabled> Pupper</label></p>
  <p><label><input type="radio" name="dog-type" value="doggo"> Doggo</label></p>
  <p><button>Make your choice</button></p>
</form>
```

If the user tries to submit this form without first selecting "Doggo", then both `input` elements will be suffering from being missing, since an element in the radio button group is required (viz. the first element), and both of the elements in the radio button group have a false checkedness.

On the other hand, if the user selects "Doggo" and then submits the form, then neither `input` element will be suffering from being missing, since while one of them is required, not all of them have a false checkedness.

Note

If none of the radio buttons in a radio button group are checked, then they will all be initially unchecked in the interface, until such time as one of them is checked (either by the user or by script).
The following common `input` element content attributes and IDL attributes apply to the element: `checked` and `required` content attributes; `value` and `valueAsNumber` IDL attributes.

The `value` IDL attribute is in mode `default/on`.

The `input` and `change` events do not apply.

The following content attributes must not be specified and do not apply to the element: `accept`, `autocomplete`, `dirname`, `formaction`, `formenctype`, `formmethod`, `formnovalidate`, `formtarget`, `height`, `list`, `max`, `maxlength`, `min`, `multiple`, `pattern`, `placeholder`, `popovertarget`, `popovertargetaction`, `readonly`, `size`, `src`, `step`, and `width`.

The following IDL attributes and methods do not apply to the element: `files`, `list`, `selectionStart`, `selectionEnd`, `selectionDirection`, `valueAsDate`, and `valueAsNumber` IDL attributes; `select()`, `setRangeText()`, `setSelectionRange()`, `stepDown()`, and `stepUp()` methods.

### 4.10.5.1.17 File Upload state (type=file)

When an `input` element's `type` attribute is in the File Upload state, the rules in this section apply.

The `input` element represents a list of selected files, each file consisting of a filename, a file type, and a file body (the contents of the file).

Filenames must not contain path components, even in the case that a user has selected an entire directory hierarchy or multiple files with the same name from different directories. Path components, for the purposes of the File Upload state, are those parts of filenames that are separated by U+005C REVERSE SOLIDUS character (\) characters.

Unless the `multiple` attribute is set, there must be no more than one file in the list of selected files.

The input activation behavior for such an element is to show the picker, if applicable, for element.

If the element is mutable, the user agent should allow the user to change the files on the list in other ways also, e.g., adding or removing files by drag-and-drop. When the user does so, the user agent must update the file selection for the element.

If the element is not mutable, the user agent must not allow the user to change the element's selection.

To update the file selection for an element:

1. Queue an element task on the user interaction task source given element and the following steps:
   1. Update element's selected files so that it represents the user's selection.
   2. Fire an event named input at the input element, with the bubbles and composed attributes initialized to true.
   3. Fire an event named change at the input element, with the bubbles attribute initialized to true.

Constraint validation: If the element is required and the list of selected files is empty, then the element is suffering from being missing.

The accept attribute may be specified to provide user agents with a hint of what file types will be accepted.

If specified, the attribute must consist of a set of comma-separated tokens, each of which must be an ASCII case-insensitive match for one of the following:

- The string "audio/*"
  Indicates that sound files are accepted.

- The string "video/*"
  Indicates that video files are accepted.

- The string "image/*"
  Indicates that image files are accepted.

A valid MIME type string with no parameters
  Indicates that files of the specified type are accepted.

A string whose first character is a U+002E FULL STOP character (.)
  Indicates that files with the specified file extension are accepted.
The tokens must not be ASCII case-insensitive matches for any of the other tokens (i.e. duplicates are not allowed). To obtain the list of tokens from the attribute, the user agent must split the attribute value on commas.

User agents may use the value of this attribute to display a more appropriate user interface than a generic file picker. For instance, given the value `image/*`, a user agent could offer the user the option of using a local camera or selecting a photograph from their photo collection; given the value `audio/*`, a user agent could offer the user the option of recording a clip using a headset microphone.

User agents should prevent the user from selecting files that are not accepted by one (or more) of these tokens.

**Note**

Authors are encouraged to specify both any MIME types and any corresponding extensions when looking for data in a specific format.

**Example**

For example, consider an application that converts Microsoft Word documents to Open Document Format files. Since Microsoft Word documents are described with a wide variety of MIME types and extensions, the site can list several, as follows:

```
<input type="file" accept=".doc,.docx,.xml,application/msword,application/vnd.openxmlformats-officedocument.wordprocessingml.document">
```

On platforms that only use file extensions to describe file types, the extensions listed here can be used to filter the allowed documents, while the MIME types can be used with the system's type registration table (mapping MIME types to extensions used by the system), if any, to determine any other extensions to allow. Similarly, on a system that does not have filenames or extensions but labels documents with MIME types internally, the MIME types can be used to pick the allowed files, while the extensions can be used if the system has an extension registration table that maps known extensions to MIME types used by the system.

**⚠ Warning!**

Extensions tend to be ambiguous (e.g. there are an untold number of formats that use the ".dat" extension, and users can typically quite easily rename their files to have a ".doc" extension even if they are not Microsoft Word documents), and MIME types tend to be unreliable (e.g. many formats have no formally registered types, and many formats are in practice labeled using a number of different MIME types). Authors are reminded that, as usual, data received from a client should be treated with caution, as it may not be in an expected format even if the user is not hostile and the user agent fully obeyed the `accept` attribute's requirements.

**Example**

For historical reasons, the `value` IDL attribute prefixes the filename with the string "C:\fakepath\". Some legacy user agents actually included the full path (which was a security vulnerability). As a result of this, obtaining the filename from the `value` IDL attribute in a backwards-compatible way is non-trivial. The following function extracts the filename in a suitably compatible manner:

```javascript
function extractFilename(path) {
  if (path.substr(0, 12) == "C:\\fakepath\\")
    return path.substr(12); // modern browser
  var x;
  x = path.lastIndexOf('/');
  if (x >= 0) // Unix-based path
    return path.substr(x+1);
  x = path.lastIndexOf('\');
  if (x >= 0) // Windows-based path
    return path.substr(x+1);
  return path; // just the filename
}
```

This can be used as follows:

```
<p><input type="file" name="image" onchange="updateFilename(this.value)"/>
</p>
<p>The name of the file you picked is: <span id="filename">(none)</span></p>
<script>
```
Bookkeeping details

- The following common `input` element content attributes and IDL attributes apply to the element: `accept`, `multiple`, and `required` content attributes; `files`, and `value` IDL attributes; `select` method.
- The `value` IDL attribute is in mode.
- The `input` and `change` events apply.
- The following content attributes must not be specified and do not apply to the element: `alt`, `autocomplete`, `checked`, `dirname`, `formaction`, `form enctype`, `formmethod`, `form novalidate`, `form target`, `form target text`, `form target text action`, `placeholder`, `read only`, `select`, `src`, `step`, and `width` attributes.
- The element's `value` attribute must be omitted.
- The following IDL attributes and methods do not apply to the element: `checked`, `list`, `selection start`, `selection end`, `selection direction`, `value as date`, and `value as number` IDL attributes; `set Range Text`, `set Selection Range`, `step Down`, and `step Up` methods.

4.10.5.1.18 Submit Button state (type=submit)

When an `input` element's `type` attribute is in the `Submit Button` state, the rules in this section apply.

The `input` element represents a button that, when activated, submits the form. If the element has a `value` attribute, the button's label must be the value of that attribute; otherwise, it must be an `implementation-defined` string that means "Submit" or some such. The element is a `button`, specifically a `submit button`.

Note

Since the default label is `implementation-defined`, and the width of the button typically depends on the button's label, the button's width can leak a few bits of fingerprintable information. These bits are likely to be strongly correlated to the identity of the user agent and the user's locale.

The element's `input activation behavior` given event is as follows:

1. If the element does not have a `form owner`, then return.
2. If the element's `node document` is not `fully active`, then return.
3. Submit the element's `form owner` from the element with `userInvolvement` set to event's `user navigation involvement`.

The `form action`, `form enctype`, `form method`, `form novalidate`, and `form target` attributes are `attributes for form submission`.

Note

The `form no validate` attribute can be used to make submit buttons that do not trigger the constraint validation.

Bookkeeping details

- The following common `input` element content attributes and IDL attributes apply to the element: `dirname`, `form action`, `form enctype`, `form method`, `form no validate`, `form target`, `form target text`, `form target text action`, `placeholder`, `read only`, `select`, `src`, `step`, and `width` attributes.
- The `value` IDL attribute is in mode.
- The following content attributes must not be specified and do not apply to the element: `alt`, `autocomplete`, `checked`, `form enctype`, `form method`, `form no validate`, `form target`, `form target text`, `form target text action`, `placeholder`, `read only`, `step`, and `width` attributes.
- The following IDL attributes and methods do not apply to the element: `checked`, `files`, `list`, `selection start`, `selection end`, `selection direction`, `value as date`, and `value as number` IDL attributes; `select`, `set Range Text`, `set Selection Range`, `step Down`, and `step Up` methods.
- The `input` and `change` events do not apply.
4.10.5.1.19 Image Button state (type=image) §543

When an input element's type attribute is in the Image Button state, the rules in this section apply.

The input element represents either an image from which a user can select a coordinate and submit the form, or alternatively a button from which the user can submit the form. The element is a button, specifically a submit button.

Note

The coordinate is sent to the server during form submission by sending two entries for the element, derived from the name of the control but with ".x" and ".y" appended to the name with the x and y components of the coordinate respectively.

The image is given by the src attribute. The src attribute must be present, and must contain a valid non-empty URL potentially surrounded by spaces referencing a non-interactive, optionally animated, image resource that is neither paged nor scripted.

When any of these events occur

- the input element's type attribute is first set to the Image Button state (possibly when the element is first created), and the src attribute is present
- the input element's type attribute is changed back to the Image Button state, and the src attribute is present, and its value has changed since the last time the type attribute was in the Image Button state
- the input element's type attribute is in the Image Button state, and the src attribute is set or changed

then unless the user agent cannot support images, or its support for images has been disabled, or the user agent only fetches images on demand, or the src attribute's value is the empty string, run these steps:

1. Let url be the result of encoding-parsing a URL given the src attribute's value, relative to the element's node document.
2. If url is failure, then return.
3. Let request be a new request whose URL is url, client is the element's node document's relevant settings object, destination is "image", initiator type is "input", credentials mode is "include", and whose use-URL-credentials flag is set.
4. Fetch request, with processResponseEndOfBody set to the following step given response:
   1. If the download was successful and the image is available, queue an element task on the user interaction task source given the input element to fire an event named load at the input element.
   2. Otherwise, if the fetching process fails without a response from the remote server, or completes but the image is not a valid or supported image, then queue an element task on the user interaction task source given the input element to fire an event named error on the input element.

Fetching the image must delay the load event of the element's node document until the task that is queued by the networking task source once the resource has been fetched (defined below) has been run.

If the image was successfully obtained, with no network errors, and the image's type is a supported image type, and the image is a valid image of that type, then the image is said to be available. If this is true before the image is completely downloaded, each task that is queued by the networking task source while the image is being fetched must update the presentation of the image appropriately.

The user agent should apply the image sniffing rules to determine the type of the image, with the image's associated Content-Type headers giving the official type. If these rules are not applied, then the type of the image must be the type given by the image's associated Content-Type headers.

User agents must not support non-image resources with the input element. User agents must not run executable code embedded in the image resource. User agents must only display the first page of a multipage resource. User agents must not allow the resource to act in an interactive fashion, but should honor any animation in the resource.

The alt attribute provides the textual label for the button for users and user agents who cannot use the image. The alt attribute must be present, and must contain a non-empty string giving the label that would be appropriate for an equivalent button if the image was unavailable.
The `input` element supports dimension attributes.

If the `src` attribute is set, and the image is available and the user agent is configured to display that image, then the element represents a control for selecting a coordinate from the image specified by the `src` attribute. In that case, if the element is mutable, the user agent should allow the user to select this coordinate.

Otherwise, the element represents a submit button whose label is given by the value of the `alt` attribute.

The element's input activation behavior given event is as follows:

1. If the element does not have a form owner, then return.
2. If the element's node document is not fully active, then return.
3. If the user activated the control while explicitly selecting a coordinate, then set the element's selected coordinate to that coordinate.

Note

This is only possible under the conditions outlined above, when the element represents a control for selecting such a coordinate. Even then, the user might activate the control without explicitly selecting a coordinate.

4. Submit the element's form owner from the element with `userInvolvement` set to event's user navigation involvement.

The element's selected coordinate consists of an x-component and a y-component. It is initially (0, 0). The coordinates represent the position relative to the edge of the element's image, with the coordinate space having the positive x direction to the right, and the positive y direction downwards.

The x-component must be a valid integer representing a number x in the range $-(borderleft + paddingleft) \leq x \leq width + borderright + paddingright$, where `width` is the rendered width of the image, `borderleft` is the width of the border on the left of the image, `paddingleft` is the width of the padding on the left of the image, `borderright` is the width of the border on the right of the image, and `paddingright` is the width of the padding on the right of the image, with all dimensions given in CSS pixels.

The y-component must be a valid integer representing a number y in the range $-(bordertop + paddingtop) \leq y \leq height + borderbottom + paddingbottom$, where `height` is the rendered height of the image, `bordertop` is the width of the border above the image, `paddingtop` is the width of the padding above the image, `borderbottom` is the width of the border below the image, and `paddingbottom` is the width of the padding below the image, with all dimensions given in CSS pixels.

Where a border or padding is missing, its width is zero CSS pixels.

The `formaction`, `formenctype`, `formmethod`, `formnovalidate`, and `formtarget` attributes are attributes for form submission.

For web developers (non-normative)

```javascript
image.width = value
image.height = value
```

These attributes return the actual rendered dimensions of the image, or 0 if the dimensions are not known.

They can be set, to change the corresponding content attributes.

Bookkeeping details

- The following common `input` element content attributes and IDL attributes apply to the element: `alt`, `formaction`, `formenctype`, `formmethod`, `formnovalidate`, `formtarget`, `height`, `max`, `maxlength`, `min`, `multiple`, `pattern`, `placeholder`, `readonly`, `required`, `size`, and `step`
- The `value` IDL attribute is in mode default.
- The following content attributes must not be specified and do not apply to the element: `accept`, `autocomplete`, `checked`, `dirname`, `list`, `max`, `maxlength`, `min`, `minlength`, `multiple`, `pattern`, `placeholder`, `readonly`, `required`, `size`, and `step`
- The element's `value` attribute must be omitted.
- The following IDL attributes and methods do not apply to the element: `checked`, `files`, `list`, `selectionStart`, `selectionEnd`, `tagName`, valueAsDate, and `valueAsNumber` IDL attributes; `select`, `setRangeText`, `setSelectionRange`, `stepDown`, and `stepUp` methods.
- The input and change events do not apply.
Many aspects of this state's behavior are similar to the behavior of the \texttt{img} element. Readers are encouraged to read that section, where many of the same requirements are described in more detail.

Example

Take the following form:

\begin{verbatim}
<form action="process.cgi">
<input type=image src=map.png name=where alt="Show location list">
</form>
\end{verbatim}

If the user clicked on the image at coordinate (127,40) then the URL used to submit the form would be "process.cgi?where.x=127&where.y=40".

(In this example, it’s assumed that for users who don’t see the map, and who instead just see a button labeled "Show location list", clicking the button will cause the server to show a list of locations to pick from instead of the map.)

4.10.5.1.20 Reset Button state (\texttt{type=reset})

When an \texttt{input} element's \texttt{type} attribute is in the Reset Button state, the rules in this section apply.

The \texttt{input} element represents a button that, when activated, resets the form. If the element has a \texttt{value} attribute, the button's label must be the value of that attribute; otherwise, it must be an \texttt{implementation-defined} string that means "Reset" or some such. The element is a button.

Since the default label is \texttt{implementation-defined}, and the width of the button typically depends on the button's label, the button's width can leak a few bits of fingerprintable information. These bits are likely to be strongly correlated to the identity of the user agent and the user's locale.

The element's \texttt{input activation behavior} is as follows:

1. If the element does not have a \texttt{form owner} in this state, then return.
2. If the element's \texttt{node document} is not \texttt{fully active}, then return.
3. \texttt{Reset} the \texttt{form owner} from the element.

Constraint validation: The element is barred from constraint validation.

\textbf{Bookkeeping details}

- The \texttt{value} IDL attribute applies to this element and is in mode default.
- The following \texttt{input} element content attributes: \texttt{apply} to the element: \texttt{popoverTarget} and \texttt{popoverTargetAction}.
- The following content attributes must not be specified and do not apply to the element: \texttt{accept}, \texttt{autocomplete}, \texttt{checked}, \texttt{dirname}, \texttt{formaction}, \texttt{formenctype}, \texttt{formmethod}, \texttt{formnovalidate}, \texttt{formtarget}, \texttt{height}, \texttt{list}, \texttt{max}, \texttt{maxlength}, \texttt{min}, \texttt{minlength}, \texttt{multiple}, \texttt{pattern}, \texttt{placeholder}, \texttt{readonly}, \texttt{size}, \texttt{src}, \texttt{step}, and \texttt{width}.
- The following IDL attributes and methods do not apply to the element: \texttt{checked}, \texttt{files}, \texttt{list}, \texttt{selectionStart}, \texttt{selectionEnd}, \texttt{selectionDirection}, \texttt{valueAsDate}, and \texttt{valueAsNumber} IDL attributes; \texttt{select()}, \texttt{setRangeText()}, \texttt{setSelectionRange()}, \texttt{stepDown()}, \texttt{stepUp()} methods.
- The \texttt{input} and \texttt{change} events do not apply.

4.10.5.1.21 Button state (\texttt{type=button})

When an \texttt{input} element's \texttt{type} attribute is in the Button state, the rules in this section apply.

The \texttt{input} element represents a button with no default behavior. A label for the button must be provided in the \texttt{value} attribute, though it may be the empty string. If the element has a \texttt{value} attribute, the button's label must be the value of that attribute; otherwise, it must be the empty string. The element is a button.
The element has no input activation behavior.

**Constraint validation:** The element is barred from constraint validation.

**Bookkeeping details**
- The value element content attributes apply to this element and is in mode default.
- The following common input element content attributes apply to the element: popovertarget and popovertargetaction.
- The following common content attributes must not be specified and do not apply to the element: accept, alt, autocomplete, checked, dir, formaction, formmethod, formnovalidate, formtarget, formvalidate, form, height, list, max, maxsize, min, minlength, multiple, pattern, placeholder, readonly, required, requiredsize, src, step, title, width, x, xref.
- The following IDL attributes and methods do not apply to the element: checked, files, list, selectionStart, selectionEnd, selectionDirection, valueAsNumber, and valueAsDate. IDL attributes: select, setRangeText, setSelectionRange, stepDown, stepUp methods.
- The input and change events do not apply.

### 4.10.5.2 Implementation notes regarding localization of form controls

This section is non-normative.

The formats shown to the user in date, time, and number controls is independent of the format used for form submission.

Browsers are encouraged to use user interfaces that present dates, times, and numbers according to the conventions of either the locale implied by the input element's language or the user's preferred locale. Using the page's locale will ensure consistency with page-provided data.

**Example**

For example, it would be confusing to users if an American English page claimed that a Cirque De Soleil show was going to be showing on 02/03, but their browser, configured to use the British English locale, only showed the date 03/02 in the ticket purchase date picker. Using the page's locale would at least ensure that the date was presented in the same format everywhere. (There's still a risk that the user would end up arriving a month late, of course, but there's only so much that can be done about such cultural differences.)

### 4.10.5.3 Common input element attributes

These attributes only apply to an input element if its type attribute is in a state whose definition declares that the attribute applies. When an attribute doesn't apply to an input element, user agents must ignore the attribute, regardless of the requirements and definitions below.

#### 4.10.5.3.1 The maxlen and minlen attributes

The maxlen attribute, when it applies, is a form control maxlen attribute.

The minlen attribute, when it applies, is a form control minlen attribute.

If the input element has a maximum allowed value, then the length of the value of the element's value attribute must be less than or equal to the element's maximum allowed value.
4.10.5.3.2 The size attribute

The size attribute gives the number of characters that, in a visual rendering, the user agent is to allow the user to see while editing the element's value.

The size attribute, if specified, must have a value that is a valid non-negative integer greater than zero.

If the attribute is present, then its value must be parsed using the rules for parsing non-negative integers, and if the result is a number greater than zero, then the user agent should ensure that at least that many characters are visible.

The size IDL attribute is limited to only positive numbers and has a default value of 20.

4.10.5.3.3 The readonly attribute

The readonly attribute is a boolean attribute that controls whether or not the user can edit the form control. When specified, the element is not mutable.

Constraint validation: If the readonly attribute is specified on an input element, the element is barred from constraint validation.

Note

The difference between disabled and readonly is that read-only controls can still function, whereas disabled controls generally do not function as controls until they are enabled. This is spelled out in more detail elsewhere in this specification with normative requirements that refer to the disabled concept (for example, the element's activation behavior, whether or not it is a focusable area, or when constructing the entry list). Any other behavior related to user interaction with disabled controls, such as whether text can be selected or copied, is not defined in this standard.

Only text controls can be made read-only, since for other controls (such as checkboxes and buttons) there is no useful distinction between being read-only and being disabled, so the readonly attribute does not apply.

Example

In the following example, the existing product identifiers cannot be modified, but they are still displayed as part of the form, for consistency with the row representing a new product (where the identifier is not yet filled in).

```
<form action="products.cgi" method="post" enctype="multipart/form-data">
  <table>
    <tr>
      <th>Product ID</th> <th>Product name</th> <th>Price</th> <th>Action</th>
    </tr>
    <tr>
      <td><input readonly="readonly" name="1.pid" value="H412"></td>
      <td><input required="required" name="1.pname" value="Floor lamp Ulke"></td>
      <td>$49.99</td>
      <td><button formnovalidate="formnovalidate" name="action" value="delete:1">Delete</button></td>
    </tr>
    <tr>
      <td><input readonly="readonly" name="2.pid" value="FG28"></td>
      <td><input required="required" name="2.pname" value="Table lamp Ulke"></td>
      <td>$24.99</td>
      <td><button formnovalidate="formnovalidate" name="action" value="delete:2">Delete</button></td>
    </tr>
  </table>
</form>
```
4.10.5.3.4 The `required` attribute

The `required` attribute is a boolean attribute. When specified, the element is `required`.

**Constraint validation:** If the element is `required`, and its `value` `IDL attribute` `applies` and is in the mode `value`, and the element is `mutable`, and the element’s `value` is the empty string, then the element is `suffering from being missing`.

**Example**

The following form has two required fields, one for an email address and one for a password. It also has a third field that is only considered valid if the user types the same password in the password field and this third field.

```html
<html>
  <form action="/newaccount" method="post"
       oninput="up2.setCustomValidity(up2.value != up.value ? 'Passwords do not match.' : '')">
    <p>
      <label for="username">Email address:</label>
      <input id="username" type="email" required name="un">
    </p>
    <p>
      <label for="password1">Password:</label>
      <input id="password1" type="password" required name="up">
    </p>
    <p>
      <label for="password2">Confirm password:</label>
      <input id="password2" type="password" name="up2">
    </p>
    <p>
      <input type="submit" value="Create account"/>
    </p>
  </form>
</html>
```

**Example**

For radio buttons, the `required` attribute is satisfied if any of the radio buttons in the `group` is selected. Thus, in the following example, any of the radio buttons can be checked, not just the one marked as required:

```html
<fieldset>
  <legend>Did the movie pass the Bechdel test?</legend>
  <p>
    <label>
      <input type="radio" name="bechdel" value="no-characters"> No, there are not even two female characters in the movie. </label>
  </p>
  <p>
    <label>
      <input type="radio" name="bechdel" value="no-names"> No, the female characters never talk to each other. </label>
  </p>
  <p>
    <label>
      <input type="radio" name="bechdel" value="no-topic"> No, when female characters talk to each other it’s always about a male character. </label>
  </p>
  <p>
    <label>
      <input type="radio" name="bechdel" value="yes" required> Yes. </label>
  </p>
  <p>
    <label>
      <input type="radio" name="bechdel" value="unknown"> I don’t know. </label>
  </p>
</fieldset>
```

To avoid confusion as to whether a `radio button group` is required or not, authors are encouraged to specify the attribute on all the radio buttons in a group. Indeed, in general, authors are encouraged to avoid having radio button groups that do not have any initially checked controls in the first place, as this is a state that the user cannot return to, and is therefore generally considered a poor user interface.
The **multiple** attribute is a [boolean attribute](#) that indicates whether the user is to be allowed to specify more than one value.

The pattern attribute specifies a regular expression against which the control's value, or, when the multiple attribute applies and is set, the control's values, are to be checked. If specified, the attribute's value must match the JavaScript `Pattern` production.

The compiled pattern regular expression of an `input` element, if it exists, is a JavaScript `RegExp` object. It is determined as
follows:

1. If the element does not have a pattern attribute specified, then return nothing. The element has no compiled pattern regular expression.

2. Let pattern be the value of the pattern attribute of the element.

3. Let regexpCompletion be RegExpCreate(pattern, "v").

4. If regexpCompletion is an abrupt completion, then return nothing. The element has no compiled pattern regular expression.

5. Let anchoredPattern be the string "^(?:", followed by pattern, followed by ")$".

6. Return !RegExpCreate(anchoredPattern, "v").

Note
User agents are encouraged to log this error in a developer console, to aid debugging.

A RegExp object regexp matches a string input, if !RegExpBuiltinExec(regexp, input) is not null.

Constraint validation: If the element's value is not the empty string, and either the element's multiple attribute is not specified or it does not apply to the input element given its type attribute's current state, and the element has a compiled pattern regular expression but that regular expression does not match the element's value, then the element is suffering from a pattern mismatch.

Constraint validation: If the element's value is not the empty string, and the element's multiple attribute is specified and applies to the input element, and the element has a compiled pattern regular expression but that regular expression does not match each of the element's values, then the element is suffering from a pattern mismatch.

When an input element has a pattern attribute specified, authors should include a title attribute to give a description of the pattern. User agents may use the contents of this attribute, if it is present, when informing the user that the pattern is not matched, or at any other suitable time, such as in a tooltip or read out by assistive technology when the control gains focus.

Example
For example, the following snippet:

```html
<label> Part number:  
<input pattern="[0-9][A-Z]{3}" name="part" title="A part number is a digit followed by three uppercase letters."/>
</label>
```

...could cause the UA to display an alert such as:

A part number is a digit followed by three uppercase letters.  
You cannot submit this form when the field is incorrect.

When a control has a pattern attribute, the title attribute, if used, must describe the pattern. Additional information could also be included, so long as it assists the user in filling in the control. Otherwise, assistive technology would be impaired.

Example
For instance, if the title attribute contained the caption of the control, assistive technology could end up saying something like The text you have entered does not match the required pattern. Birthday, which is not useful.

UAs may still show the title in non-error situations (for example, as a tooltip when hovering over the control), so authors should be careful not to word title as if an error has necessarily occurred.
Some form controls can have explicit constraints applied limiting the allowed range of values that the user can provide. Normally, such a range would be linear and continuous. A form control can have a periodic domain, however, in which case the form control's broadest possible range is finite, and authors can specify explicit ranges within it that span the boundaries.

The \texttt{min} and \texttt{max} attributes indicate the allowed range of values for the element.

Their syntax is defined by the section that defines the \texttt{type} attribute's current state.

If the element has a \texttt{min} attribute, and the result of applying the \textit{algorithm to convert a string to a number} to the value of the \texttt{min} attribute is a number, then that number is the element's \texttt{minimum}; otherwise, if the \texttt{type} attribute's current state defines a default minimum, then that is the \texttt{minimum}; otherwise, the element has no \texttt{minimum}.

The \texttt{min} attribute also defines the \texttt{step base}.

If the element has a \texttt{max} attribute, and the result of applying the \textit{algorithm to convert a string to a number} to the value of the \texttt{max} attribute is a number, then that number is the element's \texttt{maximum}; otherwise, if the \texttt{type} attribute's current state defines a default maximum, then that is the \texttt{maximum}; otherwise, the element has no \texttt{maximum}.

If the element does not have a periodic domain, the \texttt{max} attribute's value (the \texttt{maximum}) must not be less than the \texttt{min} attribute's value (its \texttt{minimum}).

An element has a reversed range if it has a periodic domain and its \texttt{maximum} is less than its \texttt{minimum}.

An element has range limitations if it has a defined \texttt{minimum} or a defined \texttt{maximum}.

### Constraint validation:

When the element has a \texttt{minimum} and does not have a reversed range, and the result of applying the \textit{algorithm to convert a string to a number} to the string given by the element's \texttt{value} is a number, and the number obtained from that algorithm is less than the \texttt{minimum}, the element is suffering from an underflow.

When the element has a \texttt{maximum} and does not have a reversed range, and the result of applying the \textit{algorithm to convert a string to a number} to the string given by the element's \texttt{value} is a number, and the number obtained from that algorithm is more than the \texttt{maximum}, the element is suffering from an overflow.

When an element has a reversed range, and the result of applying the \textit{algorithm to convert a string to a number} to the string given by the element's \texttt{value} is a number, and the number obtained from that algorithm is more than the \texttt{maximum} and less than the \texttt{minimum}, the element is simultaneously suffering from an underflow and suffering from an overflow.

### Example

Specifically, the broadest range of a \texttt{type=time} control is midnight to midnight (24 hours), and authors can set both continuous linear ranges (such as 9pm to 11pm) and discontinuous ranges spanning midnight (such as 11pm to 1am).

The following date control limits input to dates that are before the 1980s:

\begin{verbatim}
<input name=bday type=date max="1979-12-31">
\end{verbatim}

The following number control limits input to whole numbers greater than zero:

\begin{verbatim}
<input name=quantity required="" type="number" min="1" value="1">
\end{verbatim}
The step attribute indicates the granularity that is expected (and required) of the value, by limiting the allowed values. The section that defines the type attribute's current state also defines the default step, the step scale factor, and in some cases the default step base, which are used in processing the attribute as described below.

The step attribute, if specified, must either have a value that is a valid floating-point number that parses to a number that is greater than zero, or must have a value that is an ASCII case-insensitive match for the string "any".

The attribute provides the allowed value step for the element, as follows:

1. If the attribute does not apply, then there is no allowed value step.
2. Otherwise, if the attribute is absent, then the allowed value step is the default step multiplied by the step scale factor.
3. Otherwise, if the attribute's value is an ASCII case-insensitive match for the string "any", then there is no allowed value step.
4. Otherwise, if the rules for parsing floating-point number values, when they are applied to the attribute's value, return an error, zero, or a number less than zero, then the allowed value step is the default step multiplied by the step scale factor.
5. Otherwise, the allowed value step is the number returned by the rules for parsing floating-point number values when they are applied to the attribute's value, multiplied by the step scale factor.

The step base is the value returned by the following algorithm:

1. If the element has a min content attribute, and the result of applying the algorithm to convert a string to a number to the value of the min content attribute is not an error, then return that result.
2. If the element has a value content attribute, and the result of applying the algorithm to convert a string to a number to the value of the value content attribute is not an error, then return that result.
3. If a default step base is defined for this element given its type attribute's state, then return it.
4. Return zero.

Constraint validation: When the element has an allowed value step, and the result of applying the algorithm to convert a string to a number to the string given by the element's value is a number, and that number subtracted from the step base is not an integral multiple of the allowed value step, the element is suffering from a step mismatch.

Example

The following time control limits input to those minutes that occur between 9pm and 6am, defaulting to midnight:

```
<input name="sleepStart" type=time min="21:00" max="06:00" step="60" value="00:00"/>
```

4.10.5.3.8 The step attribute

The step attribute indicates the granularity that is expected (and required) of the value, or values, by limiting the allowed values. The section that defines the type attribute's current state also defines the default step, the step scale factor, and in some cases the default step base, which are used in processing the attribute as described above.

The step attribute, if specified, must either have a value that is a valid floating-point number that parses to a number that is greater than zero, or must have a value that is an ASCII case-insensitive match for the string "any".

The attribute provides the allowed value step for the element, as follows:

1. If the attribute does not apply, then there is no allowed value step.
2. Otherwise, if the attribute is absent, then the allowed value step is the default step multiplied by the step scale factor.
3. Otherwise, if the attribute's value is an ASCII case-insensitive match for the string "any", then there is no allowed value step.
4. Otherwise, if the rules for parsing floating-point number values, when they are applied to the attribute's value, return an error, zero, or a number less than zero, then the allowed value step is the default step multiplied by the step scale factor.
5. Otherwise, the allowed value step is the number returned by the rules for parsing floating-point number values when they are applied to the attribute's value, multiplied by the step scale factor.

The step base is the value returned by the following algorithm:

1. If the element has a min content attribute, and the result of applying the algorithm to convert a string to a number to the value of the min content attribute is not an error, then return that result.
2. If the element has a value content attribute, and the result of applying the algorithm to convert a string to a number to the value of the value content attribute is not an error, then return that result.
3. If a default step base is defined for this element given its type attribute's state, then return it.
4. Return zero.

Constraint validation: When the element has an allowed value step, and the result of applying the algorithm to convert a string to a number to the string given by the element's value is a number, and that number subtracted from the step base is not an integral multiple of the allowed value step, the element is suffering from a step mismatch.

Example

The following range control only accepts values in the range 0..1, and allows 256 steps in that range:

```
<input name="opacity" type=range min=0 max=1 step=0.00392156863>
```

Example

The following control allows any time in the day to be selected, with any accuracy (e.g. thousandth-of-a-second accuracy or more):

```
<input name="favtime" type=time step=any>
```

Normally, time controls are limited to an accuracy of one minute.
4.10.5.3.9 The `list` attribute

The `list` attribute is used to identify an element that lists predefined options suggested to the user.

If present, its value must be the `ID` of a `datalist` element in the same `tree`.

The `suggestions source element` is the first element in the `tree` in `tree order` to have an `ID` equal to the value of the `list` attribute, if that element is a `datalist` element. If there is no `list` attribute, or if there is no element with that `ID`, or if the first element with that `ID` is not a `datalist` element, then there is no `suggestions source element`.

If there is a `suggestions source element`, then, when the user agent is allowing the user to edit the `input` element's `value`, the user agent should offer the suggestions represented by the `suggestions source element` to the user in a manner suitable for the type of control used. If appropriate, the user agent should use the suggestion's `label` and `value` to identify the suggestion to the user.

User agents are encouraged to filter the suggestions represented by the `suggestions source element` when the number of suggestions is large, including only the most relevant ones. If filtering based on the user's input, user agents should search within both the `label` and `value` of the suggestions for matches. Case variations should be ignored, which may require language-specific case mapping. For examples of these, see Character Model for the World Wide Web: String Matching. User agents may also provide other matching features: for illustration, a few examples include matching different forms of kana to each other (or to kanji), ignoring accents, or applying spelling correction.

Unicode normalization should be applied so that different underlying Unicode code point sequences, caused by different keyboard- or input-specific mechanisms, do not interfere with the matching process. Case variations should be ignored, which may require language-specific case mapping. For examples of these, see Character Model for the World Wide Web: String Matching. User agents may also provide other matching features: for illustration, a few examples include matching different forms of kana to each other (or to kanji), ignoring accents, or applying spelling correction.

How user selections of suggestions are handled depends on whether the element is a control accepting a single value only, or whether it accepts multiple values:

```html
<input type="text" list="function-types">
<datalist id="function-types">
  <option value="function">function</option>
  <option value="async function">async function</option>
  <option value="function*">generator function</option>
  <option value="=>">arrow function</option>
  <option value="async =>">async arrow function</option>
  <option value="async function*">async generator function</option>
</datalist>
```

For user agents that follow the above suggestions, both the `label` and `value` would be shown:

```
▼
function
async function
generator function
arrow function
async arrow function
async generator function
```

Then, typing "arrow" or "=>" would filter the list to the entries with labels "arrow function" and "async arrow function". Typing "generator" or "*" would filter the list to the entries with labels "generator function" and "async generator function".

As always, user agents are free to make user interface decisions which are appropriate for their particular requirements and for the user's particular circumstances. However, this has historically been an area of confusion for implementers, web developers, and users alike, so we've given some "should" suggestions above.
If the element does not have a `multiple` attribute specified or if the `multiple` attribute does not apply, when the user selects a suggestion, the `input` element's `value` must be set to the selected suggestion's `value`, as if the user had written that value themself.

If the element's `type` attribute is in the `Email` state and the element has a `multiple` attribute specified, when the user selects a suggestion, the user agent must either add a new entry to the `input` element's `values`, whose value is the selected suggestion's `value`, or change an existing entry in the `input` element's `values` to have the value given by the selected suggestion's `value`, as if the user had themself added an entry with that value, or edited an existing entry to be that value. Which behavior is to be applied depends on the user interface in an implementation-defined manner.

If the `list` attribute does not apply, there is no suggestions source element.

**Example**
This URL field offers some suggestions.

```html
<label>Homepage: <input name=hp type=url list=hpurls></label>
</datalist>
<datalist id=hpurls>
<option value="https://www.google.com" label="Google">
<option value="https://www.reddit.com" label="Reddit">
</datalist>
</label>
</p>
Other URLs from the user's history might show also; this is up to the user agent.

**Example**
This example demonstrates how to design a form that uses the autocompletion list feature while still degrading usefully in legacy user agents.

If the autocompletion list is merely an aid, and is not important to the content, then simply using a `datalist` element with children `option` elements is enough. To prevent the values from being rendered in legacy user agents, they need to be placed inside the `value` attribute instead of inline.

```html
<p>
<label>
 Enter a breed:
 <input type="text" name="breed" list="breeds">
 <datalist id="breeds">
 <option value="Abyssinian">
 <option value="Alpaca">
 </option>
 </datalist>
 </label>
</p>
</label>
</p>
```

However, if the values need to be shown in legacy UAs, then fallback content can be placed inside the `datalist` element, as follows:

```html
<p>
<label>
 Enter a breed:
 <input type="text" name="breed" list="breeds">
 </label>
 <datalist id="breeds">
 <label>or select one from the list:
 <select name="breed">
 <option value="1">(none selected)
 <option>Abyssinian
 <option>Alpaca
 </option>
 </select>
 </label>
 </p>
```
The fallback content will only be shown in UAs that don’t support `datalist`\(^{578}\). The options, on the other hand, will be detected by all UAs, even though they are not children of the `datalist`\(^{578}\) element.

Note that if an `option`\(^{572}\) element used in a `datalist`\(^{578}\) is `selected`\(^{573}\), it will be selected by default by legacy UAs (because it affects the `select`\(^{564}\) element), but it will not have any effect on the `input`\(^{517}\) element in UAs that support `datalist`\(^{578}\).

### 4.10.5.3.10 The `placeholder`\(^{555}\) attribute \(^5^{55}\)

The `placeholder`\(^{555}\) attribute represents a short hint (a word or short phrase) intended to aid the user with data entry when the control has no value. A hint could be a sample value or a brief description of the expected format. The attribute, if specified, must have a value that contains no U+000A LINE FEED (LF) or U+000D CARRIAGE RETURN (CR) characters.

The `placeholder`\(^{555}\) attribute should not be used as an alternative to a `label`\(^{514}\). For a longer hint or other advisory text, the `title`\(^{155}\) attribute is more appropriate.

**Note**

These mechanisms are very similar but subtly different: the hint given by the control’s `label`\(^{514}\) is shown at all times; the short hint given in the `placeholder`\(^{555}\) attribute is shown before the user enters a value; and the hint in the `title`\(^{155}\) attribute is shown when the user requests further help.

User agents should present this hint to the user, after having stripped newlines from it, when the element’s `value`\(^{593}\) is the empty string, especially if the control is not `focused`\(^{830}\).

If a user agent normally doesn't show this hint to the user when the control is `focused`\(^{830}\), then the user agent should nonetheless show the hint for the control if it was focused as a result of the `autofocus`\(^{842}\) attribute, since in that case the user will not have had an opportunity to examine the control before focusing it.

**Example**

Here is an example of a mail configuration user interface that uses the `placeholder`\(^{555}\) attribute:

```html
<fieldset>
  <legend>Mail Account</legend>
  <p><label>Name: <input type="text" name="fullname" placeholder="John Ratzenberger"></label></p>
  <p><label>Address: <input type="email" name="address" placeholder="john@example.net"></label></p>
  <p><label>Password: <input type="password" name="password"></label></p>
  <p><label>Description: <input type="text" name="desc" placeholder="My Email Account"></label></p>
</fieldset>
```

**Example**

In situations where the control’s content has one directionality but the placeholder needs to have a different directionality, Unicode’s bidirectional-algorithm formatting characters can be used in the attribute value:

```html
<input name="t1" type="tel" placeholder="\&#x202B;\&#x202B; رقم الها تف 1">
<input name="t2" type="tel" placeholder="\&#x202B;\&#x202B; رقم الها تف 2">  
```

For slightly more clarity, here’s the same example using numeric character references instead of inline Arabic:

```html
<input name="t1" type="tel" placeholder="\&#x202B;\&#x202B;\&#x202B;\&#x202B;\&#1585;\&#1602;\&#1605;\&#1575;\&#1604;\&#1607;\&#1575;\&#1578;\&#1601;\&#x202E;">  
```

555
4.10.5.4 Common input\(^557\) element APIs \(^556\)

For web developers (non-normative)

- **input.value**\(^556\) \([=\ value]\)
  - Returns the current \(value\)\(^593\) of the form control.
  - Can be set, to change the value.
  - Throws an "InvalidStateError" DOMException if it is set to any value other than the empty string when the control is a file upload control.

- **input.checked**\(^557\) \([=\ value]\)
  - Returns the current \(checked\)\(^593\) of the form control.
  - Can be set, to change the \(checked\)\(^593\).

- **input.files**\(^557\) \([=\ files]\)
  - Returns a FileList object listing the \(selected\) files\(^540\) of the form control.
  - Returns null if the control isn't a file control.
  - Can be set to a FileList object to change the \(selected\) files\(^540\) of the form control. For instance, as the result of a drag-and-drop operation.

- **input.valueAsDate**\(^557\) \([=\ value]\)
  - Returns a Date object representing the form control's \(value\)\(^593\), if applicable; otherwise, returns null.
  - Can be set, to change the value.
  - Throws an "InvalidStateError" DOMException if the control isn't date- or time-based.

- **input.valueAsNumber**\(^558\) \([=\ value]\)
  - Returns a number representing the form control's \(value\)\(^593\), if applicable; otherwise, returns NaN.
  - Can be set, to change the value. Setting this to NaN will set the underlying value to the empty string.
  - Throws an "InvalidStateError" DOMException if the control is neither date- or time-based nor numeric.

- **input.stepUp**\(^558\)(\([n]\))
- **input.stepDown**\(^558\)(\([n]\))
  - Changes the form control's \(value\)\(^593\) by the value given in the \(step\)\(^552\) attribute, multiplied by \(n\). The default value for \(n\) is 1.
  - Throws an "InvalidStateError" DOMException if the control is neither date- or time-based nor numeric, or if the \(step\)\(^552\) attribute's value is "any".

- **input.list**\(^559\)
  - Returns the datalist\(^570\) element indicated by the list\(^553\) attribute.

- **input.showPicker**\(^559\)()
  - Shows any applicable picker UI for input, so that the user can select a value. (If no picker UI is implemented for the given control, then this method does nothing.)
  - Throws an "InvalidStateError" DOMException if input is not mutable\(^593\).
  - Throws a "NotAllowedError" DOMException if called without transient user activation\(^824\).
  - Throws a "SecurityError" DOMException if input is inside a cross-origin iframe\(^687\), unless input is in the File Upload\(^540\) or Color\(^537\) states.

The value IDL attribute allows scripts to manipulate the value\(^593\) of an input\(^517\) element. The attribute is in one of the following modes, which define its behavior:

- **value**
  - On getting, return the current \(value\)\(^593\) of the element.
On setting:

1. Let `oldValue` be the element's `value`.
2. Set the element's `value` to the new value.
3. Set the element's `dirty value flag` to true.
4. Invoke the `value sanitization algorithm`, if the element's `type` attribute's current state defines one.
5. If the element's `value` (after applying the `value sanitization algorithm`) is different from `oldValue`, and the element has a `text entry cursor position`, move the `text entry cursor position` to the end of the text control, unselecting any selected text and resetting the selection direction to "none".

`default`

On setting, if the element has a `value` content attribute, return that attribute's value; otherwise, return the empty string.

On setting, set the value of the element's `value` content attribute to the new value.

`default/on`

On getting, if the element has a `value` content attribute, return that attribute's value; otherwise, return the string "on".

On setting, set the value of the element's `value` content attribute to the new value.

`filename`

On getting, return the string "C:\fakepath\" followed by the name of the first file in the list of `selected files`, if any, or the empty string if the list is empty.

On setting, if the new value is the empty string, empty the list of `selected files`; otherwise, throw an "InvalidStateError" `DOMException`.

**Note**

This "fakepath" requirement is a sad accident of history. See the example in the File Upload state section for more information.

**Note**

Since path components are not permitted in filenames in the list of `selected files`, the "\fakepath\" cannot be mistaken for a path component.

The `checked` IDL attribute allows scripts to manipulate the `checkedness` of an `input` element. On getting, it must return the current `checkedness` of the element; and on setting, it must set the element's `checkedness` to the new value and set the element's `dirty checkedness flag` to true.

The `files` IDL attribute allows scripts to access the element's `selected files`.

On getting, if the IDL attribute `applies`, it must return a `FileList` object that represents the current `selected files`. The same object must be returned until the list of `selected files` changes. If the IDL attribute `does not apply`, then it must instead return null.

On setting, it must run these steps:

1. If the IDL attribute `does not apply` or the given value is null, then return.
2. Replace the element's `selected files` with the given value.

The `valueAsDate` IDL attribute represents the `value` of the element, interpreted as a date.

On getting, if the `valueAsDate` attribute `does not apply`, as defined for the `input` element's `type` attribute's current state, then return null. Otherwise, run the `algorithm to convert a string to a Date object` defined for that state to the element's `value`; if the algorithm returned a `date` object, then return it, otherwise, return null.

557
On setting, if the `valueAsDate` attribute does not apply, as defined for the `input` element's `type` attribute's current state, then throw an "InvalidStateError" DOMException; otherwise, if the new value is not null and not a `Date` object throw a `TypeError` exception; otherwise, if the new value is null or a `Date` object representing the NaN time value, then set the `value` of the element to the empty string; otherwise, run the algorithm to convert a `Date` object to a string, as defined for that state, on the new value, and set the `value` of the element to the resulting string.

The `valueAsNumber` IDL attribute represents the `value` of the element, interpreted as a number.

On getting, if the `valueAsNumber` attribute does not apply, as defined for the `input` element's `type` attribute's current state, then return a Not-a-Number (NaN) value. Otherwise, run the algorithm to convert a number to a string, as defined for that state to the element's `value`; if the algorithm returned a number, then return it, otherwise, return a Not-A-Number (NaN) value.

On setting, if the new value is infinite, then throw a `TypeError` exception. Otherwise, if the `valueAsNumber` attribute does not apply, as defined for the `input` element's `type` attribute's current state, then throw an "InvalidStateError" DOMException. Otherwise, if the new value is a Not-a-Number (NaN) value, then set the `value` of the element to the empty string. Otherwise, run the algorithm to convert a number to a string, as defined for that state, on the new value, and set the `value` of the element to the resulting string.

The `stepDown(n)` and `stepUp(n)` methods, when invoked, must run the following algorithm:

1. If the `stepDown()` and `stepUp()` methods do not apply, as defined for the `input` element's `type` attribute's current state, then throw an "InvalidStateError" DOMException.
2. If the element has no allowed value step, then throw an "InvalidStateError" DOMException.
3. If the element has a `minimum` and a `maximum` and the `minimum` is greater than the `maximum`, then return.
4. If the element has a `minimum` and a `maximum` and there is no value greater than or equal to the element's `minimum` and less than or equal to the element's `maximum` that, when subtracted from the `step base`, is an integral multiple of the `allowed value step`, then return.
5. If applying the algorithm to convert a string to a number to the string given by the element's `value` does not result in an error, then let `value` be the result of that algorithm. Otherwise, let `value` be zero.
6. Let `valueBeforeStepping` be `value`.
7. If `value` subtracted from the `step base` is not an integral multiple of the `allowed value step`, then set `value` to the nearest value that, when subtracted from the `step base`, is an integral multiple of the `allowed value step`, and that is less than `value` if the method invoked was the `stepDown()` method, and more than `value` otherwise.

Otherwise (`value` subtracted from the `step base` is an integral multiple of the `allowed value step`):

1. Let `n` be the argument.
2. Let `delta` be the `allowed value step` multiplied by `n`.
3. If the method invoked was the `stepDown()` method, negate `delta`.
4. Let `value` be the result of adding `delta` to `value`.
8. If the element has a `minimum`, and `value` is less than that `minimum`, then set `value` to the smallest value that, when subtracted from the `step base`, is an integral multiple of the `allowed value step`, and that is more than or equal to `minimum`.
9. If the element has a `maximum`, and `value` is greater than that `maximum`, then set `value` to the largest value that, when subtracted from the `step base`, is an integral multiple of the `allowed value step`, and that is less than or equal to `maximum`.
10. If either the method invoked was the `stepDown()` method and `value` is greater than `valueBeforeStepping`, or the method invoked was the `stepUp()` method and `value` is less than `valueBeforeStepping`, then return.

**Example**

This ensures that invoking the `stepUp()` method on the `input` element in the following example does not change...
11. Let `value as string` be the result of running the `algorithm to convert a number to a string`\(^{521}\), as defined for the `input`\(^{517}\) element's `type`\(^{519}\) attribute's current state, on `value`.

12. Set the `value`\(^{593}\) of the element to `value as string`.

The `list` IDL attribute must return the current `suggestions source element`\(^{553}\), if any, or null otherwise.

The `HTMLInputElement`\(^{518}\) `showPicker()` and `HTMLSelectElement`\(^{564}\) `showPicker()` method steps are:

1. If `this` is not `mutable`\(^{593}\), then throw an "`InvalidStateError`" DOMException.

2. If `this`'s relevant settings object\(^{1071}\)'s `origin`\(^{1064}\) is not `same origin`\(^{891}\) with `this`'s relevant settings object\(^{1071}\)'s top-level `origin`\(^{1064}\), and `this` is a `select`\(^{564}\) element, or `this`'s `type`\(^{519}\) attribute is not in the `File Upload`\(^{540}\) state or `Color`\(^{537}\) state, then throw a "`SecurityError`" DOMException.

3. If `this`'s relevant global object\(^{1071}\) does not have `transient activation`\(^{824}\), then throw a "`NotAllowedError`" DOMException.

4. If `this` is a `select`\(^{564}\) element, and `this` is not `being rendered`\(^{1369}\), then throw a "`NotSupportedError`" DOMException.

5. Show the picker, if applicable\(^{559}\), for `this`.

To show the picker, if applicable for an `input`\(^{517}\) or `select`\(^{564}\) element `element`:

1. If `element`'s relevant global object\(^{1071}\) does not have `transient activation`\(^{824}\), then return.

2. If `element` is not `mutable`\(^{593}\), then return.

3. `Consume user activation`\(^{825}\) given `element`'s relevant global object\(^{1071}\).

4. If `element` is an `input`\(^{517}\) element and `element`'s `type`\(^{519}\) attribute is in the `File Upload`\(^{540}\) state, then run these steps in parallel\(^{43}\):
   
   1. Optionally, wait until any prior execution of this algorithm has terminated.
   
   2. Display a prompt to the user requesting that the user specify some files. If the `multiple`\(^{549}\) attribute is not set on `element`, there must be no more than one file selected; otherwise, any number may be selected. Files can be from the filesystem or created on the fly, e.g., a picture taken from a camera connected to the user's device.

   3. Wait for the user to have made their selection.

   4. If the user dismissed the prompt without changing their selection, then queue an element task\(^{1107}\) on the `user interaction task source`\(^{1115}\) given `element` to `fire an event` named `cancel`\(^{1451}\) at `element`, with the `bubbles` attribute initialized to true.

   5. Otherwise, update the file selection\(^{540}\) for `element`.

**Note**

As with all user interface specifications, user agents have a good deal of freedom in how they interpret these requirements. The above text implies that a user either dismisses the prompt or changes their selection; exactly one of these will be true. But the mapping of these possibilities to specific user interface elements is not mandated by the standard. For example, a user agent might interpret clicking the "Cancel" button when files were previously selected as a change of selection to select zero files, thus firing `input` and `change`\(^{1451}\). Or it might interpret such a click as a dismissal that leaves the selection unchanged, thus firing `cancel`\(^{1451}\). Similarly, it's up to the user agent whether re-selecting the same files counts as were previously selected counts as a dismissal, or as a change of selection.
5. Otherwise, the user agent should show any relevant user interface for selecting a value for element, in the way it normally would when the user interacts with the control. (If no such UI applies to element, then this step does nothing.)

If such a user interface is shown, it must respect the requirements stated in the relevant parts of the specification for how element behaves given its type attribute state. (For example, various sections describe restrictions on the resulting value string.)

This step can have side effects, such as closing other pickers that were previously shown by this algorithm. (If this closes a file selection picker, then per the above that will lead to firing either input and change events, or a cancel event.)

**Note**

As of the time of this writing, typical browser implementations show such picker UI for:

- input elements whose type attributes are in the Date, Month, Week, Time, Local Date and Time, and Color states;
- input elements in various states that have a suggestions source element;
- input elements whose type attribute is in the File Upload state (although those are handled via the special case above, instead of by this step); and
- select elements.

However, the intent of this step is to trigger any picker UI implementation. So for example, if a user agent implemented a password picker UI for the Password state, then this method would be expected to show that picker UI when called on a password input.

### 4.10.5.5 Common event behaviors

When the input and change events apply (which is the case for all input controls other than buttons and those with the type attribute in the Hidden state), the events are fired to indicate that the user has interacted with the control. The input event fires whenever the user has modified the data of the control. The change event fires when the value is committed, if that makes sense for the control, or else when the control loses focus. In all cases, the input event comes before the corresponding change event (if any).

When an input element has a defined input activation behavior, the rules for dispatching these events, if they apply, are given in the section above that defines the type attribute's state. (This is the case for all input controls with the type attribute in the Checkbox state, the Radio Button state, or the File Upload state.)

For input elements without a defined input activation behavior, but to which these events apply, and for which the user interface involves both interactive manipulation and an explicit commit action, then when the user changes the element's value, the user agent must queue an element task on the user interaction task source given the input element to fire an event named input at the input element, with the bubbles and composed attributes initialized to true, and any time the user commits the change, the user agent must queue an element task on the user interaction task source given the input element to set its user validity true and fire an event named change at the input element, with the bubbles attribute initialized to true.

**Example**

An example of a user interface involving both interactive manipulation and a commit action would be a Range controls that use a slider, when manipulated using a pointing device. While the user is dragging the control's knob, input events would fire whenever the position changed, whereas the change event would only fire when the user lets go of the knob, committing to a specific value.

For input elements without a defined input activation behavior, but to which these events apply, and for which the user interface involves an explicit commit action but no intermediate manipulation, then any time the user commits a change to the element's value, the user agent must queue an element task on the user interaction task source given the input element to first fire an event named input at the input element, with the bubbles and composed attributes initialized to true, and then fire an event named change at the input element, with the bubbles attribute initialized to true.

**Example**

An example of a user interface with a commit action would be a Color control that consists of a single button that brings up a
For input elements without a defined input activation behavior, but to which these events apply, any time the user causes the element's value to change without an explicit commit step, selecting a date from the drop down calendar and then dismissing the drop down would be a commit action.

For input elements without a defined input activation behavior, but to which these events apply, any time the user causes the element's value to change without an explicit commit step, the user agent must queue an element task on the user interaction task source given the input element to fire an event named input at the input element, with the bubbles and composed attributes initialized to true. The corresponding change event, if any, will be fired when the control loses focus.

In the case of tasks that just fire an input event, user agents may wait for a suitable break in the user's interaction before queuing the tasks; for example, a user agent could wait for the user to have not hit a key for 100ms, so as to only fire the event when the user pauses, instead of continuously for each keystroke.

When the user agent is to change an input element's value on behalf of the user (e.g. as part of a form prefilling feature), the user agent must queue an element task on the user interaction task source given the input element to first update the value accordingly, then fire an event named input at the input element, with the bubbles and composed attributes initialized to true, then fire an event named change at the input element, with the bubbles attribute initialized to true.

These events are not fired in response to changes made to the values of form controls by scripts. (This is to make it easier to update the values of form controls in response to the user manipulating the controls, without having to then filter out the script's own changes to avoid an infinite loop.)

These events are also not fired when the browser changes the values of form controls as part of state restoration during navigation.

4.10.6 The button element

Categories:
- Flow content
- Phrasing content
- Interactive content
- Listed
- Labelable
- Submittable, and autocapitalize-inheriting form-associated element.
- Palpable content.

Contexts in which this element can be used:
Where phrasing content is expected.

Content model:
- Phrasing content, but there must be no interactive content descendant and no descendant with the tabindex attribute.

Example:
Another example of a user interface with a commit action would be a Date control that allows both text-based user input and user selection from a drop-down calendar: while text input might not have an explicit commit step, selecting a date from the drop down calendar and then dismissing the drop down would be a commit action.

Examples of a user changing the element's value would include the user typing into a text control, pasting a new value into the control, or undoing an edit in that control. Some user interactions do not cause changes to the value, e.g., hitting the “delete” key in an empty text control, or replacing some text in the control with text from the clipboard that happens to be exactly the same text.

Examples:
A Range control in the form of a slider that the user has focused and is interacting with using a keyboard would be another example of the user changing the element's value without a commit step.

In the case of tasks that just fire an input event, user agents may wait for a suitable break in the user's interaction before queuing the tasks; for example, a user agent could wait for the user to have not hit a key for 100ms, so as to only fire the event when the user pauses, instead of continuously for each keystroke.

Another example of a user interface with a commit action would be a Date control that allows both text-based user input and user selection from a drop-down calendar: while text input might not have an explicit commit step, selecting a date from the drop down calendar and then dismissing the drop down would be a commit action.

Example:
These events are not fired in response to changes made to the values of form controls by scripts. (This is to make it easier to update the values of form controls in response to the user manipulating the controls, without having to then filter out the script's own changes to avoid an infinite loop.)

Example:
These events are also not fired when the browser changes the values of form controls as part of state restoration during navigation.

Note:

Note:

4.10.6 The button element

Categories:
- Flow content
- Phrasing content
- Interactive content
- Listed
- Labelable
- Submittable, and autocapitalize-inheriting form-associated element.
- Palpable content.

Contexts in which this element can be used:
Where phrasing content is expected.

Content model:
- Phrasing content, but there must be no interactive content descendant and no descendant with the tabindex attribute.
Tag omission in text/html[^144]:
Neither tag is omissible.

Content attributes[^144]:

**Global attributes[^152]**

- `disabled[^597]` — Whether the form control is disabled
- `form[^593]` — Associates the element with a `form[^510]` element
- `formaction[^598]` — URL to use for `form submission[^623]`
- `formenctype[^599]` — Entry list[^627] encoding type to use for `form submission[^623]`
- `formmethod[^598]` — Variant to use for `form submission[^623]`
- `formnovalidate[^599]` — Bypass form control validation for `form submission[^623]`

- `name[^595]` — Name of the element to use for `form submission[^623]` and in the `form.elements[^513]` API
- `popovertarget[^886]` — Targets a popover element to toggle, show, or hide
- `popovertargetaction[^887]` — Indicates whether a targeted popover element is to be toggled, shown, or hidden
- `type[^562]` — Type of button
- `value[^563]` — Value to be used for `form submission[^623]`

Accessibility considerations[^145]:
For authors.
For implementers.

**DOM interface[^145]:**

```idl
[Exposed=Window]
interface HTMLButtonElement : HTMLElement {

    [HTMLConstructor] constructor();

    [CEReactions] attribute boolean disabled;
    readonly attribute HTMLFormElement? form;
    [CEReactions] attribute USVString formAction;
    [CEReactions] attribute DOMString formEnctype;
    [CEReactions] attribute DOMString formMethod;
    [CEReactions] attribute boolean formNoValidate;
    [CEReactions] attribute DOMString formTarget;
    [CEReactions] attribute DOMString name;
    [CEReactions] attribute DOMString type;
    [CEReactions] attribute DOMString value;

    readonly attribute boolean willValidate;
    readonly attributeValidityState validity;
    readonly attribute DOMString validationMessage;
    boolean checkValidity();
    boolean reportValidity();
    undefined setCustomValidity(DOMString error);

    readonly attribute NodeList labels;
};
```

The **button[^561]** element represents[^139] a button labeled by its contents.

The element is a **button[^610]**.

The **type** attribute controls the behavior of the button when it is activated. It is an enumerated attribute[^74] with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>submit</td>
<td>Submit Button[^561]</td>
<td>Submits the form.</td>
</tr>
<tr>
<td>reset</td>
<td>Reset Button[^562]</td>
<td>Resets the form.</td>
</tr>
<tr>
<td>button</td>
<td>Button[^563]</td>
<td>Does nothing.</td>
</tr>
</tbody>
</table>
The attribute’s missing value default and invalid value default are both the Submit Button state. If the type attribute is in the Submit Button state, the element is specifically a submit button.

Constraint validation: If the type attribute is in the Reset Button state or the Button state, the element is barred from constraint validation.

A button element’s activation behavior given event is:

1. If element is disabled, then return.
2. If element’s node document is not fully active, then return.
3. If element has a form owner then switch on element’s type attribute’s state, then:
   
   **Submit Button**
   
   Submit element’s form owner from element with userInvolvement set to event’s user navigation involvement.

   **Reset Button**
   
   Reset element’s form owner.

   **Button**
   
   Do nothing.

4. Run the popover target attribute activation behavior given element.

The form attribute is used to explicitly associate the button element with its form owner. The name attribute represents the element’s name. The disabled attribute is used to make the control non-interactive and to prevent its value from being submitted. The formaction, formenctype, formmethod, formnovalidate, and formtarget attributes are attributes for form submission.

The formnovalidate attribute can be used to make submit buttons that do not trigger the constraint validation.

The formaction, formenctype, formmethod, formnovalidate, and formtarget attributes must not be specified if the element’s type attribute is not in the Submit Button state.

The value attribute gives the element’s value for the purposes of form submission. The element’s value is the value of the element’s value attribute, if there is one, or the empty string otherwise.

A button (and its value) is only included in the form submission if the button itself was used to initiate the form submission.

The value IDL attribute must reflect the content attribute of the same name.

The type IDL attribute must reflect the content attribute of the same name, limited to only known values.

The willValidate, validity, and validationMessage IDL attributes, and the checkValidity(), reportValidity(), and setCustomValidity() methods, are part of the constraint validation API. The labels IDL attribute provides a list of the element’s label’s. The disabled, form, and name IDL attributes are part of the element’s forms API.

Example

The following button is labeled "Show hint" and pops up a dialog box when activated:

```html
<button type=button onclick="alert('This 15-20 minute piece was composed by George Gershwin.')}">
  Show hint
</button>
```
4.10.7 The `select` element

Categories:
- Flow content
- Phrasing content
- Interactive content
- Listed, labelable, submittable, resettable, and autocapitalize-inheriting form-associated element
- Palpable content

Contexts in which this element can be used:
Where phrasing content is expected.

Content model:
Zero or more `option`, `optgroup`, `hr`, and script-supporting elements.

Tag omission in text/html:
Neither tag is omissible.

Content attributes:
- `autocomplete` — Hint for form autofill feature
- `disabled` — Whether the form control is disabled
- `form` — Associates the element with a form element
- `multiple` — Whether to allow multiple values
- `name` — Name of the element to use for form submission and in the `form.elements` API
- `required` — Whether the control is required for form submission
- `size` — Size of the control

Accessibility considerations:
If the element has a `multiple` attribute or a `size` attribute with a value > 1:
for authors; for implementers.
Otherwise:
for authors; for implementers.

DOM interface:

```idl
[Exposed=Window]
interface HTMLSelectElement : HTMLElement {
    [HTMLConstructor] constructor();

    // CEReactions
    attribute DOMString autocomplete;
    attribute boolean disabled;
    readonly attribute HTMLFormElement? form;
    attribute boolean multiple;
    attribute DOMString name;
    attribute boolean required;
    attribute unsigned long size;

    readonly attribute DOMString type;

    [SameObject] readonly attribute HTMLOptionsCollection options;
    [CEReactions] attribute unsigned long length;
    getter HTMLOptionElement? item(unsigned long index);
    HTMLOptionElement? namedItem(DOMString name);

    [CEReactions] undefined add((HTMLOptionElement or HTMLOptGroupElement) element, optional
    (HTMLElement or long)? before = null);

    [CEReactions] undefined remove(); // ChildNode overload
    [CEReactions] undefined remove(long index);
    [CEReactions] setter undefined (unsigned long index, HTMLOptionElement? option);

    [SameObject]readonly attribute HTMLCollection selectedOptions;
    attribute long selectedIndex;
    attribute DOMString value;

    readonly attribute boolean willValidate;
```
The `select` element represents a control for selecting amongst a set of options.

The `multiple` attribute is a boolean attribute. If the attribute is present, then the `select` element represents a control for selecting zero or more options from the list of options. If the attribute is absent, then the `select` element represents a control for selecting a single option from the list of options.

The `size` attribute gives the number of options to show to the user. The `size` attribute, if specified, must have a value that is a valid non-negative integer greater than zero.

The display size of a `select` element is the result of applying the rules for parsing non-negative integers to the value of element's `size` attribute, if it has one and parsing it is successful. If applying those rules to the attribute's value is not successful, or if the `size` attribute is absent, then the element's display size is 4 if the element's `multiple` content attribute is present, and 1 otherwise.

The list of options for a `select` element consists of all the `option` element children of the `select` element, and all the `option` element children of all the `optgroup` element children of the `select` element, in tree order.

The `required` attribute is a boolean attribute. When specified, the user will be required to select a value before submitting the form.

If a `select` element has a `required` attribute specified, does not have a `multiple` attribute specified, and has a display size of 1; and if the value of the first `option` element in the `select` element's list of options (if any) is the empty string, and that `option` element's parent node is the `select` element (and not an `optgroup` element), then that `option` is the `select` element's placeholder label option.

If a `select` element has a `required` attribute specified, does not have a `multiple` attribute specified, and has a display size of 1, then the `select` element must have a placeholder label option.

**Note**

In practice, the requirement stated in the paragraph above can only apply when a `select` element does not have a `size` attribute with a value greater than 1.

**Constraint validation:** If the element has its `required` attribute specified, and either none of the `option` elements in the `select` element's list of options have their `selectedness` set to true, or the only `option` element in the `select` element's list of options with its `selectedness` set to true is the placeholder label option, then the element is suffering from being missing.

If the `multiple` attribute is absent, and the element is not disabled, then the user agent should allow the user to pick an `option` element in its list of options that is itself not disabled. Upon this `option` element being picked (either through a click, or through unfocusing the element after changing its value, or through a menu command, or through any other mechanism), and before the relevant user interaction event is queued (e.g. before the click event), the user agent must set the `selectedness` of the picked `option` element to true, set its `dirtiness` to true, and then send select update notifications.

If the `multiple` attribute is absent, whenever an `option` element in the `select` element's list of options has its `selectedness` set to true, and whenever an `option` element with its `selectedness` set to true is added to the `select` element's list of options, the user agent must set the `selectedness` of all the other `option` elements in its list of options to false.

If the `multiple` attribute is absent and the element's display size is greater than 1, then the user agent should also allow the user to request that the `option` whose `selectedness` is true, if any, be unselected. Upon this request being conveyed to the user agent, and before the relevant user interaction event is queued (e.g. before the click event), the user agent must set the
selectedness\(^{574}\) of that \texttt{option}\(^{577}\) element to false, set its dirtiness\(^{571}\) to true, and then send select update notifications\(^{566}\).

The selectedness setting algorithm, given a select\(^{564}\) element element, is to run the following steps:

1. If element's multiple\(^{565}\) attribute is absent, and element's display size\(^{565}\) is 1, and no \texttt{option}\(^{577}\) elements in the element's list of options\(^{565}\) have their selectedness\(^{574}\) set to true, then set the selectedness\(^{574}\) of the first \texttt{option}\(^{577}\) element in the list of options\(^{565}\) in tree order that is not disabled\(^{571}\), if any, to true, and return.

2. If element's multiple\(^{565}\) attribute is absent, and two or more \texttt{option}\(^{577}\) elements in element's list of options\(^{565}\) have their selectedness\(^{574}\) set to true, then set the selectedness\(^{574}\) of all but the last \texttt{option}\(^{577}\) element with its selectedness\(^{574}\) set to true in the list of options\(^{565}\) in tree order to false.

The option\(^{572}\) HTML element insertion steps\(^{45}\), given insertedNode, are:

1. If insertedNode's parent is a select\(^{564}\) element, or insertedNode's parent is an optgroup\(^{571}\) element whose parent is a select\(^{564}\) element, then run that select\(^{564}\) element's selectedness setting algorithm\(^{566}\).

The option\(^{572}\) HTML element removing steps\(^{45}\), given removedNode and oldParent, are:

1. If oldParent is a select\(^{564}\) element, or oldParent is an optgroup\(^{571}\) element whose parent is a select\(^{564}\) element, then run that select\(^{564}\) element's selectedness setting algorithm\(^{566}\).

The optgroup\(^{571}\) HTML element removing steps\(^{45}\), given removedNode and oldParent, are:

1. If oldParent is a select\(^{564}\) element and removedNode has an option child, then run oldParent's selectedness setting algorithm\(^{566}\).

If an option\(^{577}\) element in the list of options\(^{565}\) asks for a reset, then run that select\(^{564}\) element's selectedness setting algorithm\(^{566}\).

If the multiple\(^{565}\) attribute is present, and the element is not disabled\(^{571}\), then the user agent should allow the user to toggle the selectedness\(^{574}\) of the option\(^{577}\) elements in its list of options\(^{565}\) that are themselves not disabled\(^{571}\). Upon such an element being toggled\(^{566}\) (either through a click, or through a menu command\(^{564}\)), or any other mechanism), and before the relevant user interaction event is queued (e.g. before a related click event), the selectedness\(^{574}\) of the option\(^{577}\) element must be changed (from true to false or false to true), the dirtiness\(^{571}\) of the element must be set to true, and the user agent must send select update notifications\(^{566}\).

When the user agent is to send select update notifications, queue an element task\(^{1107}\) on the user interaction task source\(^{1115}\) given the select\(^{564}\) element to run these steps:

1. Set the select\(^{564}\) element's user validity\(^{593}\) to true.
2. Fire an event named input at the select\(^{564}\) element, with the bubbles and composed attributes initialized to true.
3. Fire an event named change\(^{1151}\) at the select\(^{564}\) element, with the bubbles attribute initialized to true.

The reset algorithm\(^{5632}\) for a select\(^{564}\) element selectElement is:

1. Set selectElement's user validity\(^{593}\) to false.
2. For each optionElement of selectElement's list of options\(^{565}\):
   1. If optionElement has a selected\(^{573}\) attribute, then set optionElement's selectedness\(^{574}\) to true; otherwise set it to false.
   2. Set optionElement's dirtiness\(^{571}\) to false.
3. Run the selectedness setting algorithm\(^{566}\) given selectElement.

The form\(^{593}\) attribute is used to explicitly associate the select\(^{564}\) element with its form owner\(^{593}\). The name\(^{591}\) attribute represents the element's name. The disabled\(^{597}\) attribute is used to make the control non-interactive and to prevent its value from being submitted. The autocomplete\(^{566}\) attribute controls how the user agent provides autofill behavior.

A select\(^{564}\) element that is not disabled\(^{597}\) is mutable\(^{593}\).
The **select.type**\[567\]
Returns "select-multiple" if the element has a **multiple**\[565\] attribute, and "select-one" otherwise.

The **select.options**\[567\]
Returns an **HTMLOptionsCollection**\[511\] of the **list of options**\[565\].

The **select.length**\[ = value \]
Returns the number of elements in the **list of options**\[565\].
When set to a smaller number, truncates the number of **option**\[572\] elements in the **select**\[564\].
When set to a greater number, adds new blank **option**\[572\] elements to the **select**\[564\].

The **select.item(index)**
Returns the item with index \[index\] from the **list of options**\[565\]. The items are sorted in tree order.

The **select.namedItem(name)**
Returns the first item with **ID** or **name**\[1407\] name from the **list of options**\[565\].
Returns null if no element with that **ID** could be found.

The **select.add(element [, before ])**
Inserts **element** before the node given by **before**.
The **before** argument can be a number, in which case **element** is inserted before the item with that number, or an element from the **list of options**\[565\], in which case **element** is inserted before that element.
If **before** is omitted, null, or a number out of range, then element will be added at the end of the list.
This method will throw a **"HierarchyRequestError" DOMException** if **element** is an ancestor of the element into which it is to be inserted.

The **select.selectedIndex**\[ = value \]
Returns the index of the first selected item, if any, or −1 if there is no selected item.
Can be set, to change the selection.

The **select.value**\[ = value \]
Returns the **value**\[573\] of the first selected item, if any, or the empty string if there is no selected item.
Can be set, to change the selection.

The **select.showPicker()**
Shows any applicable picker UI for **select**, so that the user can select a value.
Throws an **"InvalidStateError" DOMException** if **select** is not **mutable**\[593\].
Throws a **"NotAllowedError" DOMException** if called without **transient user activation**\[824\].
Throws a **"SecurityError" DOMException** if **select** is inside a cross-origin **iframe**\[387\].
Throws a **"NotSupportedError" DOMException** if **select** is not **being rendered**\[1369\].

The **type** IDL attribute, on getting, must return the string "select-one" if the **multiple**\[565\] attribute is absent, and the string "select-multiple" if the **multiple**\[565\] attribute is present.

The **options** IDL attribute must return an **HTMLOptionsCollection**\[511\] rooted at the **select**\[564\] node, whose filter matches the elements in the **list of options**\[565\].

The **options**\[567\] collection is also mirrored on the **HTMLSelectElement**\[564\] object. The **supported property indices** at any instant are the indices supported by the object returned by the **options**\[567\] attribute at that instant.

The **length** IDL attribute must return the number of nodes **represented** by the **options**\[567\] collection. On setting, it must act like the attribute of the same name on the **options**\[567\] collection.

The **item(index)** method must return the value returned by the **method of the same name** on the **options**\[567\] collection, when invoked with the same argument.
The `namedItem(name)` method must return the value returned by the method of the same name on the `options` collection, when invoked with the same argument.

When the user agent is to set the value of a new indexed property or set the value of an existing indexed property for a `select` element, it must instead run the corresponding algorithm on the `select` element's `options` collection.

Similarly, the `add(element, before)` method must act like its namesake method on that same `options` collection.

The `remove()` method must act like its namesake method on that same `options` collection when it has arguments, and like its namesake method on the `ChildNode` interface implemented by the `HTMLSelectElement` ancestor interface `Element` when it has no arguments.

The `selectedOptions` IDL attribute must return an `HTMLCollection` rooted at the `select` node, whose filter matches the elements in the `list of options` that have their `selectedness` set to true.

The `selectedIndex` IDL attribute, on getting, must return the `index` of the first `option` element in the `list of options` in `tree order` that has its `selectedness` set to true, if any. If there isn’t one, then it must return −1.

On setting, the `selectedIndex` attribute must set the `selectedness` of all the `option` elements in the `list of options` to false, and then the `option` element in the `list of options` whose `index` is the given new value, if any, must have its `selectedness` set to true and its `dirtiness` set to true.

---

**Note**

This can result in no element having a `selectedness` set to true even in the case of the `select` element having no `multiple` attribute and a `display size` of 1.

The `value` IDL attribute, on getting, must return the `value` of the first `option` element in the `list of options` in `tree order` that has its `selectedness` set to true, if any. If there isn’t one, then it must return the empty string.

On setting, the `value` attribute must set the `selectedness` of all the `option` elements in the `list of options` to false, and then the first `option` element in the `list of options` in `tree order` whose `value` is equal to the given new value, if any, must have its `selectedness` set to true and its `dirtiness` set to true.

---

**Note**

This can result in no element having a `selectedness` set to true even in the case of the `select` element having no `multiple` attribute and a `display size` of 1.

The `multiple`, `required`, and `size` IDL attributes must `reflect` the respective content attributes of the same name. The `size` IDL attribute has a `default value` of 0.

---

**Note**

For historical reasons, the default value of the `size` IDL attribute does not return the actual size used, which, in the absence of the `size` content attribute, is either 1 or 4 depending on the presence of the `multiple` attribute.

The `willValidate`, `validity`, and `validationMessage` IDL attributes, and the `checkValidity()`, `reportValidity()`, and `setCustomValidity()` methods, are part of the constraint validation API. The `labels` IDL attribute provides a list of the element's `label`'s. The `disabled`, `form`, and `name` IDL attributes are part of the element's forms API.

---

**Example**

The following example shows how a `select` element can be used to offer the user with a set of options from which the user can select a single option. The default option is preselected.

```html
<p>
  <label for="unittype">Select unit type:</label>
  <select id="unittype" name="unittype">
    <option value="1">Miner </option>
    <option value="2">Puffer </option>
    <option value="3" selected> Snipey </option>
    <option value="4"> Max </option>
  </select>
</p>
```
When there is no default option, a placeholder can be used instead:

```html
<select name="unittype" required>
  <option value="" selected> Select unit type </option>
  <option value="1"> Miner </option>
  <option value="2"> Puffer </option>
  <option value="3"> Snipey </option>
  <option value="4"> Max </option>
  <option value="5"> Firebot </option>
</select>
```

**Example**

Here, the user is offered a set of options from which they can select any number. By default, all five options are selected.

```html
<p>
  <label for="allowedunits">Select unit types to enable on this map:</label>
  <select id="allowedunits" name="allowedunits" multiple>
    <option value="1" selected> Miner </option>
    <option value="2" selected> Puffer </option>
    <option value="3" selected> Snipey </option>
    <option value="4" selected> Max </option>
    <option value="5" selected> Firebot </option>
  </select>
</p>
```

**Example**

Sometimes, a user has to select one or more items. This example shows such an interface.

```html
<label>
  Select the songs from that you would like on your Act II Mix Tape:
  <select multiple required name="act2">
    <option value="s1">It Sucks to Be Me (Reprise) </option>
    <option value="s2">There is Life Outside Your Apartment </option>
    <option value="s3">The More You Ruv Someone </option>
    <option value="s4">Schadenfreude </option>
    <option value="s5">I Wish I Could Go Back to College </option>
    <option value="s6">The Money Song </option>
    <option value="s7">School for Monsters </option>
    <option value="s8">The Money Song (Reprise) </option>
    <option value="s9">There's a Fine, Fine Line (Reprise) </option>
    <option value="s10">What Do You Do With a B.A. in English? (Reprise) </option>
    <option value="s11">For Now </option>
  </select>
</label>
```

**Example**

Occasionally it can be useful to have a separator:

```html
<label>
  Select the song to play next:
  <select required name="next">
    <option value="sr">Random </option>
  </select>
</label>
```
4.10.8 The `datalist` element

**Categories**
- Flow content
- Phrasing content

**Contexts in which this element can be used**:
Where phrasing content is expected.

**Content model**:
Either: phrasing content.
Or: Zero or more option and script-supporting elements.

**Tag omission in text/html**:
Neither tag is omissible.

**Content attributes**:
Global attributes

**Accessibility considerations**:
For authors.
For implementers.

**DOM interface**:

```html
[Exposed=Window]
interface HTMLDataListElement : HTMLElement {
    [HTMLConstructor] constructor();
    [SameObject] readonly attribute HTMLCollection options;
};
```

The `datalist` element represents a set of option elements that represent predefined options for other controls. In the rendering, the `datalist` element represents nothing and it, along with its children, should be hidden.

The `datalist` element can be used in two ways. In the simplest case, the `datalist` element has just option element children.

**Example**

```html
<label>
  Animal:
  <input name=animal list=animals>
  <datalist id=animals>
    <option value="Cat">
    <option value="Dog">
  </datalist>
</label>
```

In the more elaborate case, the `datalist` element can be given contents that are to be displayed for down-level clients that don't support `datalist`. In this case, the option elements are provided inside a `select` element inside the `datalist` element.
The `datalist` element is hooked up to an `input` element using the `list` attribute on the `input` element.

Each `option` element that is a descendant of the `datalist` element, that is not `disabled`, and whose `value` is a string that isn't the empty string, represents a suggestion. Each suggestion has a `value` and a `label`.

### For web developers (non-normative)

`datalist.options` Returns an `HTMLCollection` of the `option` elements of the `datalist` element.

The `options` IDL attribute must return an `HTMLCollection` rooted at the `datalist` node, whose filter matches `option` elements.

**Constraint validation:** If an element has a `datalist` element ancestor, it is barred from constraint validation.

### 4.10.9 The optgroup element

#### Categories:
None.

#### Contexts in which this element can be used:
As a child of a `select` element.

#### Content model:
Zero or more `option` and `script-supporting` elements.

#### Tag omission in text/html:
An `optgroup` element's end tag can be omitted if the `optgroup` element is immediately followed by another `optgroup` element, if it is immediately followed by an `hr` element, or if there is no more content in the parent element.

#### Content attributes:
- `Global attributes`
  - `disabled` — Whether the form control is disabled
  - `label` — User-visible label

#### Accessibility considerations:
For authors.
For implementers.

#### DOM interface:

```javascript
[Exposed=Window]
interface HTMLOptGroupElement : HTMLElement {
    [HTMLConstructor] constructor();
    [CFReactions] attribute boolean disabled;
```
The `optgroup` element represents a group of `option` elements with a common label.

The element's group of `option` elements consists of the `option` elements that are children of the `optgroup` element.

When showing `option` elements in `select` elements, user agents should show the `option` elements of such groups as being related to each other and separate from other `option` elements.

The `disabled` attribute is a boolean attribute and can be used to disable a group of `option` elements together.

The `label` attribute must be specified. Its value gives the name of the group, for the purposes of the user interface. User agents should use this attribute's value when labeling the group of `option` elements in a `select` element.

The `disabled` and `label` attributes must reflect the respective content attributes of the same name.

**Note**

There is no way to select an `optgroup` element. Only `option` elements can be selected. An `optgroup` element merely provides a label for a group of `option` elements.

**Example**

The following snippet shows how a set of lessons from three courses could be offered in a `select` drop-down widget:

```html
<form action="courseselector.dll" method="get">
<p>Which course would you like to watch today?</p>
<p><label>Course:
	<select name="c">
		<optgroup label="8.01 Physics I: Classical Mechanics">
			<option value="8.01.1">Lecture 01: Powers of Ten</option>
			<option value="8.01.2">Lecture 02: 1D Kinematics</option>
			<option value="8.01.3">Lecture 03: Vectors</option>
		</optgroup>
		<optgroup label="8.02 Electricity and Magnetism">
			<option value="8.02.1">Lecture 01: What holds our world together?</option>
			<option value="8.02.2">Lecture 02: Electric Field</option>
			<option value="8.02.3">Lecture 03: Electric Flux</option>
		</optgroup>
		<optgroup label="8.03 Physics III: Vibrations and Waves">
			<option value="8.03.1">Lecture 01: Periodic Phenomenon</option>
			<option value="8.03.2">Lecture 02: Beats</option>
			<option value="8.03.3">Lecture 03: Forced Oscillations with Damping</option>
		</optgroup>
	</select>
	</label>

<p><input type=submit value="▶ Play"></p>
</form>
```
If the element has no `label` attribute and is not a child of a `datalist` element: Text that is not inter-element whitespace.

If the element has no `label` attribute and is a child of a `datalist` element: Text.

**Tag omission in text/html**: An `option` element's end tag can be omitted if the `option` element is immediately followed by another `option` element, if it is immediately followed by an `optgroup` element, if it is immediately followed by an `hr` element, or if there is no more content in the parent element.

**Content attributes**:

- **Global attributes**
  - `disabled` — Whether the form control is disabled
  - `label` — User-visible label
  - `selected` — Whether the option is selected by default
  - `value` — Value to be used for form submission

**Accessibility considerations**:

- **For authors**
- **For implementers**

**DOM interface**:

```javascript
IDL [Exposed=Window, LegacyFactoryFunction=Option] (optional DOMString text = "", optional DOMString value, optional boolean defaultSelected = false, optional boolean selected = false)
interface HTMLOptionElement : HTMLElement {
  [HTMLConstructor] constructor();

  [CEReactions] attribute boolean disabled;
  readonly attribute HTMLFormElement? form;
  [CEReactions] attribute DOMString label;
  [CEReactions] attribute boolean defaultSelected;
  attribute boolean selected;
  [CEReactions] attribute DOMString value;
  [CEReactions] attribute DOMString text;
  readonly attribute long index;
};
```

The `option` element represents an option in a `select` element or as part of a list of suggestions in a `datalist` element.

In certain circumstances described in the definition of the `select` element, an `option` element can be a `select` element's placeholder label option. A placeholder label option does not represent an actual option, but instead represents a label for the `select` control.

The `disabled` attribute is a boolean attribute. An `option` element is `disabled` if its `disabled` attribute is present or if it is a child of an `optgroup` element whose `disabled` attribute is present.

An `option` element that is `disabled` must prevent any `click` events that are queued on the user interaction task source from being dispatched on the element.

The `label` attribute provides a label for element. The `label` of an `option` element is the value of the `label` content attribute, if there is one and its value is not the empty string, or, otherwise, the value of the element's `text` IDL attribute.

The `label` content attribute, if specified, must not be empty.

The `value` attribute provides a value for element. The `value` of an `option` element is the value of the `value` content attribute, if there is one, or, if there is not, the value of the element's `text` IDL attribute.

The `selected` attribute is a boolean attribute. It represents the default selectedness of the element.

The `dirtiness` of an `option` element is a boolean state, initially false. It controls whether adding or removing the `selected` content attribute has any effect.
The selectedness of an option element is a boolean state, initially false. Except where otherwise specified, when the element is created, its selected attribute must be set to true if the element has a selected attribute. Whenever an option element’s selected attribute is added, if its dirtiness is false, its selected attribute must be set to true. Whenever an option element’s selected attribute is removed, if its dirtiness is false, its selected attribute must be set to false.

Note

The Option() constructor, when called with three or fewer arguments, overrides the initial state of the selected state to always be false even if the third argument is true (implying that a selected attribute is to be set). The fourth argument can be used to explicitly set the initial selected state when using the constructor.

A select element whose multiple attribute is not specified must not have more than one descendant option element with its selected attribute set.

An option element’s index is the number of option elements that are in the same list of options but that come before it in tree order. If the option element is not in a list of options, then the option element’s index is zero.

For web developers (non-normative)

\[
\text{option.selected}\]

Returns true if the element is selected, and false otherwise.

Can be set, to override the current state of the element.

\[
\text{option.index}\]

Returns the index of the element in its select element’s options list.

\[
\text{option.form}\]

Returns the element’s form element, if any, or null otherwise.

\[
\text{option.text}\]

Same as textContent, except that spaces are collapsed and script elements are skipped.

\[
\text{option = new Option([ text [, value [, defaultSelected [, selected ] ] ] ] )}\]

Returns a new option element.

The text argument sets the contents of the element.

The value argument sets the value attribute.

The defaultSelected argument sets the selected attribute.

The selected argument sets whether or not the element is selected. If it is omitted, even if the defaultSelected argument is true, the element is not selected.

The disabled IDL attribute must reflect the content attribute of the same name. The defaultSelected IDL attribute must reflect the selected content attribute.

The label IDL attribute, on getting, if there is a label content attribute, must return that attribute’s value; otherwise, it must return the element’s label. On setting, the element’s label content attribute must be set to the new value.

The value IDL attribute, on getting, must return the element’s value. On setting, the element’s value content attribute must be set to the new value.

The selected IDL attribute, on getting, must return true if the element’s selected attribute is true, and false otherwise. On setting, it must set the element’s selected attribute to the new value, set its dirtiness to true, and then cause the element to ask for a reset.

The index IDL attribute must return the element’s index.

The text IDL attribute, on getting, must return the result of stripping and collapsing ASCII whitespace from the concatenation of data of all the Text node descendants of the option element, in tree order, excluding any that are descendants of descendants of the option element that are themselves script or SVG script elements.

The text attribute’s setter must string replace all with the given value within this element.

The form IDL attribute’s behavior depends on whether the option element is in a select element or not. If the option has a select element as its parent, or has anoptgroup element as its parent and thatoptgroup element has a select element as its parent, then the form IDL attribute must return the same value as the form IDL attribute on that select element.
Otherwise, it must return null.

A legacy factory function is provided for creating HTMLOptionElement objects (in addition to the factory methods from DOM such as createElement()). Option(text, value, defaultSelected, selected). When invoked, the legacy factory function must perform the following steps:

1. Let document be the current global object’s associated Document.
2. Let option be the result of creating an element given document, option, and the HTML namespace.
3. If text is not the empty string, then append to option a new Text node whose data is text.
4. If value is given, then set an attribute value for option using \"value\" and value.
5. If defaultSelected is true, then set an attribute value for option using \"selected\" and the empty string.
6. If selected is true, then set option’s selectedness to true; otherwise set its selectedness to false (even if defaultSelected is true).
7. Return option.

4.10.11 The textarea element

Categories:
- Flow content
- Phrasing content
- Interactive content
- Listed, labelable, submittable, resettable, and autocapitalize-inheriting form-associated element
- Palpable content

Contexts in which this element can be used:
Where phrasing content is expected.

Content model:
Text.

Tag omission in text/html:
Neither tag is omissible.

Content attributes:
- Global attributes
  - autocomplete — Hint for form autofill feature
  - cols — Maximum number of characters per line
  - dirname — Name of form control to use for sending the element's directionality in form submission
  - disabled — Whether the form control is disabled
  - form — Associates the element with a form element
  - maxlength — Maximum length of value
  - minlength — Minimum length of value
  - name — Name of the element to use for form submission and in the form.elements API
  - placeholder — User-visible label to be placed within the form control
  - readonly — Whether to allow the value to be edited by the user
  - required — Whether the control is required for form submission
  - rows — Number of lines to show
  - wrap — How the value of the form control is to be wrapped for form submission

Accessibility considerations:
- For authors.
- For implementers.

DOM interface:

```idl
[Exposed=Window]
interface HTMLTextAreaElement : HTMLElement {
```
The `textarea` element represents a multiline plain text edit control for the element's raw value. The contents of the control represent the control's default value.

The raw value of a `textarea` control must be initially the empty string.

**Note**

This element has rendering requirements involving the bidirectional algorithm.

The `readonly` attribute is a boolean attribute used to control whether the text can be edited by the user or not.

**Example**

In this example, a text control is marked read-only because it represents a read-only file:

```html
<code>
Filename: /etc/bash.bashrc
<textarea name="buffer" readonly>
# System-wide .bashrc file for interactive bash(1) shells.
# To enable the settings / commands in this file for login shells as well,
</textarea>
</code>
```
Constraint validation: If the `readonly` attribute is specified on a `textarea` element, the element is barred from constraint validation. A `textarea` element is mutable if it is neither disabled nor has a `readonly` attribute specified. When a `textarea` is mutable, its raw value should be editable by the user: the user agent should allow the user to edit, insert, and remove text, and to insert and remove line breaks in the form of U+000A LINE FEED (LF) characters. Any time the user causes the element’s raw value to change, the user agent must queue an element task on the user interaction task source given the `textarea` element to fire an event named input at the `textarea` element, with the bubbles and composed attributes initialized to true. User agents may wait for a suitable break in the user’s interaction before queuing the task; for example, a user agent could wait for a suitable break in the user’s interaction before queuing the task; for example, a user agent could wait for the user to have not hit a key for 100ms, so as to only fire the event when the user pauses, instead of continuously for each keystroke.

A `textarea` element’s dirty value flag must be set to true whenever the user interacts with the control in a way that changes the raw value.

The cloning steps for `textarea` elements must propagate the raw value and dirty value from the node being cloned to the copy.

The children changed steps for `textarea` elements must, if the element’s dirty value flag is false, set the element’s raw value to its child text content.

The reset algorithm for `textarea` elements is to set the user validity to false, dirty value flag back to false, and set the raw value of element to its child text content.

When a `textarea` element is popped off the stack of open elements of an HTML parser or XML parser, then the user agent must invoke the element’s reset algorithm.

If the element is mutable, the user agent should allow the user to change the writing direction of the element, setting it either to a left-to-right writing direction or a right-to-left writing direction. If the user does so, the user agent must then run the following steps:

1. Set the element’s dir attribute to “ltr” if the user selected a left-to-right writing direction, and “rtl” if the user selected a right-to-left writing direction.

2. Queue an element task on the user interaction task source given the `textarea` element to fire an event named input at the `textarea` element, with the bubbles and composed attributes initialized to true.

The cols attribute specifies the expected maximum number of characters per line. If the cols attribute is specified, its value must be a valid non-negative integer greater than zero. If applying the rules for parsing non-negative integers to the attribute’s value results in a number greater than zero, then the element’s character width is that value; otherwise, it is 20.

The user agent may use the `textarea` element’s character width as a hint to the user as to how many characters the server prefers per line (e.g. for visual user agents by making the width of the control be that many characters). In visual renderings, the user agent should wrap the user’s input in the rendering so that each line is no wider than this number of characters.

The rows attribute specifies the number of lines to show. If the rows attribute is specified, its value must be a valid non-negative integer greater than zero. If applying the rules for parsing non-negative integers to the attribute’s value results in a number greater than zero, then the element’s character height is that value; otherwise, it is 2.

Visual user agents should set the height of the control to the number of lines given by character height.

The wrap attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>soft</strong></td>
<td>Soft</td>
<td>Text is not to be wrapped when submitted (though can still be wrapped in the rendering).</td>
</tr>
</tbody>
</table>
The attribute’s missing value default\(^{574}\) and invalid value default\(^{574}\) are both the Soft\(^{577}\) state. If the element’s wrap\(^{577}\) attribute is in the Hard\(^{578}\) state, the cols\(^{577}\) attribute must be specified.

For historical reasons, the element’s value is normalized in three different ways for three different purposes. The raw value\(^{576}\) is the value as it was originally set. It is not normalized. The API value\(^{579}\) is the value used in the value\(^{579}\) IDL attribute, textarea wrapping transformation\(^{578}\) IDL attribute, and by the maxlength\(^{596}\) and minlength\(^{596}\) content attributes. It is normalized so that line breaks use U+000A LINE FEED (LF) characters. Finally, there is the value\(^{599}\), as used in form submission and other processing models in this specification. It is normalized as for the API value\(^{579}\), and in addition, if necessary given the element’s wrap\(^{577}\) attribute, additional line breaks are inserted to wrap the text at the given width.

The algorithm for obtaining the element’s API value\(^{592}\) is to return the element’s raw value\(^{576}\), with newlines normalized.

The element’s value\(^{593}\) is defined to be the element’s API value\(^{576}\) with the textarea wrapping transformation\(^{578}\) applied. The textarea wrapping transformation is the following algorithm, as applied to a string:

1. If the element’s wrap\(^{577}\) attribute is in the Hard\(^{578}\) state, insert U+000A LINE FEED (LF) characters into the string using an implementation-defined algorithm so that each line has no more than character width\(^{577}\) characters. For the purposes of this requirement, lines are delimited by the start of the string, the end of the string, and U+000A LINE FEED (LF) characters.

The maxlength attribute is a form control maxlength attribute\(^{596}\).

If the textarea\(^{575}\) element has a maximum allowed value length\(^{596}\), then the element’s children must be such that the length of the value of the element’s descendant text content with newlines normalized is less than or equal to the element’s maximum allowed value length\(^{596}\).

The minlength attribute is a form control minlength attribute\(^{596}\).

The required attribute is a boolean attribute\(^{593}\). When specified, the user will be required to enter a value before submitting the form.

Constraint validation: If the element has its required\(^{578}\) attribute specified, and the element is mutable\(^{593}\), and the element’s value\(^{592}\) is the empty string, then the element is suffering from being missing\(^{618}\).

The placeholder attribute represents a short hint (a word or short phrase) intended to aid the user with data entry when the control has no value. A hint could be a sample value or a brief description of the expected format.

The placeholder\(^{578}\) attribute should not be used as an alternative to a label\(^{534}\). For a longer hint or other advisory text, the title\(^{595}\) attribute is more appropriate.

**Note**

These mechanisms are very similar but subtly different: the hint given by the control’s label\(^{534}\) is shown at all times; the short hint given in the placeholder\(^{578}\) attribute is shown before the user enters a value; and the hint in the title\(^{595}\) attribute is shown when the user requests further help.

User agents should present this hint to the user when the element’s value\(^{593}\) is the empty string and the control is not focused\(^{630}\) (e.g. by displaying it inside a blank unfocused control). All U+000D CARRIAGE RETURN U+000A LINE FEED character pairs (CRLF) in the hint, as well as all other U+000D CARRIAGE RETURN (CR) and U+000A LINE FEED (LF) characters in the hint, must be treated as line breaks when rendering the hint.

If a user agent normally doesn’t show this hint to the user when the control is focused\(^{630}\), then the user agent should nonetheless show the hint for the control if it was focused as a result of the autofocus\(^{682}\) attribute, since in that case the user will not have had an opportunity to examine the control before focusing it.

The name\(^{595}\) attribute represents the element’s name. The dirname\(^{596}\) attribute controls how the element’s directionality\(^{518}\) is submitted. The disabled\(^{597}\) attribute is used to make the control non-interactive and to prevent its value from being submitted. The form\(^{593}\) attribute is used to explicitly associate the textarea\(^{575}\) element with its form owner\(^{593}\). The autocomplete\(^{660}\) attribute controls how the user agent provides autofill behavior.

**For web developers (non-normative)**
The `cols`, `placeholder`, `required`, `rows`, and `wrap` IDL attributes must reflect the respective content attributes of the same name. The `cols` and `rows` attributes are limited to only positive numbers with fallback. The `cols` IDL attribute's default value is 20. The `rows` IDL attribute's default value is 2. The `dirName` IDL attribute must reflect the `dirname` content attribute.

The `maxLength` IDL attribute must reflect the `maxlength` content attribute, limited to only non-negative numbers. The `minLength` IDL attribute must reflect the `minlength` content attribute, limited to only non-negative numbers. The `readOnly` IDL attribute must reflect the `readonly` content attribute.

The `type` IDL attribute must return the value "textarea". The `defaultValue` attribute's getter must return the element's `child text content`. The `defaultValue` attribute's setter must `string replace all` with the given value within this element.

The `value` IDL attribute must, on getting, return the element's `API value`. On setting, it must perform the following steps:

1. Let `oldAPIValue` be this element's `API value`.
2. Set this element's `raw value` to the new value.
3. Set this element's `dirty value flag` to true.
4. If the new `API value` is different from `oldAPIValue`, then move the `text entry cursor position` to the end of the text control, unselecting any selected text and resetting the `selection direction` to "none".

The `textLength` IDL attribute must return the `length` of the element's `API value`.

The `willValidate`, `validity`, and `validationMessage` IDL attributes, and the `checkValidity()`, `reportValidity()`, and `setCustomValidity()` methods, are part of the constraint validation API. The `labels` IDL attribute provides a list of the element's `label`'s. The `select()`, `selectionStart`, `selectionEnd`, `selectionDirection`, `setText()`, and `setSelectionRange()` methods and IDL attributes expose the element's text selection. The `disabled`, `form`, and `name` IDL attributes are part of the element's forms API.

**Example**

Here is an example of a `textarea` being used for unrestricted free-form text input in a form:

```html
<p> If you have any comments, please let us know: <textarea cols=80 name=comments></textarea></p>
```

To specify a maximum length for the comments, one can use the `maxlength` attribute:

```html
<p> If you have any short comments, please let us know: <textarea cols=80 name=comments maxLength=200></textarea></p>
```

To give a default value, text can be included inside the element:

```html
<p> If you have any comments, please let us know: <textarea cols=80 name=comments> You rock!</textarea></p>
```

You can also give a minimum length. Here, a letter needs to be filled out by the user; a template (which is shorter than the minimum length) is provided, but is insufficient to submit the form:

```html
<textarea required minlength="500"> Dear Madam Speaker,
Regarding your letter dated ...
</textarea>
```
A placeholder can be given as well, to suggest the basic form to the user, without providing an explicit template:

```
<textarea placeholder="Dear Francine,
They closed the parks this week, so we won't be able to
meet your there. Should we just have dinner?
Love,
Daddy"></textarea>
```

To have the browser submit the directionality of the element along with the value, the `dirname` attribute can be specified:

```
<p>If you have any comments, please let us know (you may use either English or Hebrew for your comments):
<textarea cols=80 name=comments dirname=comments.dir></textarea></p>
```

### 4.10.12 The output element

**Categories**: Flow content, Phrasing content, Listed, labelable, resettable, and autocapitalize-inheriting form-associated element.

**Contexts in which this element can be used**: Where phrasing content is expected.

**Content model**: Phrasing content.

**Tag omission in text/html**: Neither tag is omissible.

**Content attributes**: Global attributes

- `for`: Specifies controls from which the output was calculated
- `form`: Associates the element with a form element
- `name`: Name of the element to use in the `form.elements` API.

**Accessibility considerations**: For authors, For implementers.

**DOM interface**: IDL

```
[Exposed=Window]
interface HTMLOutputElement : HTMLElement {
    [HTMConstructor] constructor();

    [SameObject, PutForwards=value] readonly attribute DOMTokenList htmlFor;
    readonly attribute HTMLFormElement? form;
}
```
The `output` element represents the result of a calculation performed by the application, or the result of a user action.

**Note**
This element can be contrasted with the `samp` element, which is the appropriate element for quoting the output of other programs run previously.

The `for` content attribute allows an explicit relationship to be made between the result of a calculation and the elements that represent the values that went into the calculation or that otherwise influenced the calculation. The `for` attribute, if specified, must contain a string consisting of an unordered set of unique space-separated tokens, none of which are identical to another token and each of which must have the value of an ID of an element in the same tree.

The `form` attribute is used to explicitly associate the `output` element with its form owner. The `name` attribute represents the element's name. The `output` element is associated with a form so that it can be easily referenced from the event handlers of form controls; the element's value itself is not submitted when the form is submitted.

The element has a default value override (null or a string). Initially it must be null.

The element's default value is determined by the following steps:

1. If this element's default value override is non-null, then return it.
2. Return this element's descendant text content.

The reset algorithm for `output` elements is to run these steps:

1. **String replace all** with this element's default value within this element.
2. Set this element's default value override to null.

**For web developers (non-normative)**

`output.value` [ = value ]

- Returns the element's current value.
- Can be set, to change the value.

`output.defaultValue` [ = value ]

- Returns the element's current default value.
- Can be set, to change the default value.

`output.type`

- Returns the string "output".

The `value` getter steps are to return this's descendant text content.

The `value` setter steps are:
1. Set this's default value override to its default value.

2. String replace all with the given value within this.

The defaultValue getter steps are to return the result of running this's default value.

The defaultValue setter steps are:

1. If this's default value override is null, then string replace all with the given value within this and return.

2. Set this's default value override to the given value.

The type getter steps are to return "output".

The htmlFor IDL attribute must reflect the for content attribute.

The willValidate, validity, and validationMessage IDL attributes, and the checkValidity(), reportValidity(), and setCustomValidity() methods, are part of the constraint validation API. The labels and name IDL attributes are part of the element's forms API.

Example

A simple calculator could use output for its display of calculated results:

```html
<form onsubmit="return false" oninput="o.value = a.valueAsNumber + b.valueAsNumber">
  <input id=a type=number step=any> +
  <input id=b type=number step=any> =
  <output id=o for="a b"></output>
</form>
```

Example

In this example, an output element is used to report the results of a calculation performed by a remote server, as they come in:

```html
<output id="result"></output>
<script>
  var primeSource = new WebSocket('ws://primes.example.net/');
  primeSource.onmessage = function (event) {
    document.getElementById('result').value = event.data;
  }
</script>
```

4.10.13 The progress element

Categories:

- Flow content
- Phrasing content
- Labelable element
- Palpable content

Contexts in which this element can be used:

Where phrasing content is expected.

Content model:

- Phrasing content, but there must be no progress element descendants.

Tag omission in text/html:

Neither tag is omissible.

Content attributes:

- Global attributes
- value — Current value of the element
Accessibility considerations:

For authors.
For implementers.

DOM interface:

```
[Exposed=Window]
interface HTMLProgressElement : HTMLElement {
  [HTMLConstructor] constructor();

  [CFReactions] attribute double value;
  [CFReactions] attribute double max;
  readonly attribute double position;
  readonly attribute NodeList labels;
};
```

The `progress` element represents the completion progress of a task. The progress is either indeterminate, indicating that progress is being made but it is not clear how much more work remains to be done before the task is complete (e.g. because the task is waiting for a remote host to respond), or the progress is a number in the range zero to a maximum, giving the fraction of work that has so far been completed.

There are two attributes that determine the current task completion represented by the element. The `value` attribute specifies how much of the task has been completed, and the `max` attribute specifies how much work the task requires in total. The units are arbitrary and not specified.

**Note**

To make a determinate progress bar, add a `value` attribute with the current progress (either a number from 0.0 to 1.0, or, if the `max` attribute is specified, a number from 0 to the value of the `max` attribute). To make an indeterminate progress bar, remove the `value` attribute.

Authors are encouraged to also include the current value and the maximum value inline as text inside the element, so that the progress is made available to users of legacy user agents.

**Example**

Here is a snippet of a web application that shows the progress of some automated task:

```html
<section>
  <h2>Task Progress</h2>
  <p>Progress: <progress id=p max=100><span>0</span>%</progress></p>
  
  <script>
    var progressBar = document.getElementById('p');
    function updateProgress(newValue) {
      progressBar.value = newValue;
      progressBar.getElementsByTagName('span')[0].textContent = newValue;
    }
  </script>
</section>
```

(The `updateProgress()` method in this example would be called by some other code on the page to update the actual progress bar as the task progressed.)

The `value` and `max` attributes, when present, must have values that are valid floating-point numbers. The `value` attribute, if present, must have a value greater than or equal to zero, and less than or equal to the value of the `max` attribute, if present, or 1.0, otherwise. The `max` attribute, if present, must have a value greater than zero.

**Note**

The `progress` element is the wrong element to use for something that is just a gauge, as opposed to task progress. For instance, indicating disk space usage using `progress` would be inappropriate. Instead, the `meter` element is available for...
**User agent requirements:** If the `value` attribute is omitted, then the progress bar is an indeterminate progress bar. Otherwise, it is a determinate progress bar.

If the progress bar is a determinate progress bar and the element has a `max` attribute, the user agent must parse the `max` attribute's value according to the rules for parsing floating-point number values. If this does not result in an error, and if the parsed value is greater than zero, then the maximum value of the progress bar is that value. Otherwise, if the element has no `max` attribute, or if it has one but parsing it resulted in an error, or if the parsed value was less than or equal to zero, then the maximum value of the progress bar is 1.0.

If the progress bar is a determinate progress bar, user agents must parse the `value` attribute's value according to the rules for parsing floating-point number values. If this does not result in an error and the parsed value is greater than zero, then the value of the progress bar is that parsed value. Otherwise, if parsing the `value` attribute's value resulted in an error or a number less than or equal to zero, then the value of the progress bar is zero.

If the progress bar is a determinate progress bar, then the current value is the maximum value, if value is greater than the maximum value, and value otherwise.

**UA requirements for showing the progress bar:** When representing a `progress` element to the user, the UA should indicate whether it is a determinate or indeterminate progress bar, and in the former case, should indicate the relative position of the current value relative to the maximum value.

For web developers (non-normative)

`progress.position`

For a determinate progress bar (one with known current and maximum values), returns the result of dividing the current value by the maximum value.

For an indeterminate progress bar, returns −1.

If the progress bar is an indeterminate progress bar, then the current value attribute must return −1. Otherwise, it must return the result of dividing the current value by the maximum value.

If the progress bar is an indeterminate progress bar, then the `value` attribute on getting, must return 0. Otherwise, it must return the current value. On setting, the given value must be converted to the best representation of the number as a floating-point number and then the `value` content attribute must be set to that string.

**Note**

Setting the `value` IDL attribute to itself when the corresponding content attribute is absent would change the progress bar from an indeterminate progress bar to a determinate progress bar with no progress.

The `max` IDL attribute must reflect the content attribute of the same name, limited to only positive numbers. The default value is 1.0.

The `labels` IDL attribute provides a list of the element's `label`'s.

### 4.10.14 The `meter` element

**Categories:**
- Flow content.
- Phrasing content.
- Labelable element.
- Palpable content.

**Contexts in which this element can be used:** Where phrasing content is expected.

**Content model:**
- Phrasing content, but there must be no `meter` element descendants.
Tag omission in text/html:
Neither tag is omissible.

Content attributes:

Global attributes
- `value` — Current value of the element
- `min` — Lower bound of range
- `max` — Upper bound of range
- `low` — High limit of low range
- `high` — Low limit of high range
- `optimum` — Optimum value in gauge

Accessibility considerations:

For authors.
For implementers.

DOM interface:

```idl
[Exposed=Window] interface HTMLMeterElement : HTMLElement {
[HTMLConstructor] constructor();

[CFReactions] attribute double value;
[CFReactions] attribute double min;
[CFReactions] attribute double max;
[CFReactions] attribute double low;
[CFReactions] attribute double high;
[CFReactions] attribute double optimum;
readonly attribute NodeList labels;
};
```

The `meter` element represents a scalar measurement within a known range, or a fractional value; for example disk usage, the relevance of a query result, or the fraction of a voting population to have selected a particular candidate.

This is also known as a gauge.

The `meter` element should not be used to indicate progress (as in a progress bar). For that role, HTML provides a separate `progress` element.

**Note**

The `meter` element also does not represent a scalar value of arbitrary range — for example, it would be wrong to use this to report a weight, or height, unless there is a known maximum value.

There are six attributes that determine the semantics of the gauge represented by the element.

The `min` attribute specifies the lower bound of the range, and the `max` attribute specifies the upper bound. The `value` attribute specifies the value to have the gauge indicate as the "measured" value.

The other three attributes can be used to segment the gauge's range into "low", "medium", and "high" parts, and to indicate which part of the gauge is the "optimum" part. The `low` attribute specifies the range that is considered to be the "low" part, and the `high` attribute specifies the range that is considered to be the "high" part. The `optimum` attribute gives the position that is "optimum"; if that is higher than the "high" value then this indicates that the higher the value, the better; if it's lower than the "low" mark then it indicates that lower values are better, and naturally if it is in between then it indicates that neither high nor low values are good.

**Authoring requirements:** The `value` attribute must be specified. The `value`, `min`, `low`, `high`, `max`, and `optimum` attributes, when present, must have values that are valid floating-point numbers.

In addition, the attributes' values are further constrained:

Let `value` be the `value` attribute's number.

If the `min` attribute is specified, then let minimum be that attribute's value; otherwise, let it be zero.
If the \texttt{max} attribute is specified, then let \textit{maximum} be that attribute's value; otherwise, let it be 1.0.

The following inequalities must hold, as applicable:

- \( \text{minimum} \leq \text{value} \leq \text{maximum} \)
- \( \text{minimum} \leq \text{low} \leq \text{maximum} \) (if \texttt{low} is specified)
- \( \text{minimum} \leq \text{high} \leq \text{maximum} \) (if \texttt{high} is specified)
- \( \text{minimum} \leq \text{optimum} \leq \text{maximum} \) (if \texttt{optimum} is specified)
- \( \text{low} \leq \text{high} \) (if both \texttt{low} and \texttt{high} are specified)

\textbf{Note}

\begin{quote}
If no minimum or maximum is specified, then the range is assumed to be 0..1, and the value thus has to be within that range.
\end{quote}

Authors are encouraged to include a textual representation of the gauge's state in the element's contents, for users of user agents that do not support the \texttt{meter} element.

When used with \texttt{microdata}, the \texttt{meter} element's \texttt{value} attribute provides the element's machine-readable value.

\textbf{Example}

The following examples show three gauges that would all be three-quarters full:

Storage space usage: <meter value=6 max=8>6 blocks used (out of 8 total)</meter>

Voter turnout: <meter value=0.75><img alt="75%" src="graph75.png"></meter>

Tickets sold: <meter min="0" max="100" value="75"></meter>

The following example is incorrect use of the element, because it doesn't give a range (and since the default maximum is 1, both of the gauges would end up looking maxed out):

\begin{quote}
<p>The grapefruit pie had a radius of <meter value=12>12cm</meter>
and a height of <meter value=2>2cm</meter>.</p> <!-- BAD! -->
\end{quote}

Instead, one would either not include the meter element, or use the meter element with a defined range to give the dimensions in context compared to other pies:

\begin{quote}
<p>The grapefruit pie had a radius of 12cm and a height of 2cm.</p>
<dl>
  <dt>Radius: </dt> <dd> <meter min=0 max=20 value=12 title="centimeters">12cm</meter> 
  <dt>Height: </dt> <dd> <meter min=0 max=10 value=2 title="centimeters">2cm</meter>
</dl>
\end{quote}

There is no explicit way to specify units in the \texttt{meter} element, but the units may be specified in the \texttt{title} attribute in free-form text.

\textbf{Example}

The example above could be extended to mention the units:

\begin{quote}
<dl>
  <dt>Radius: </dt> <dd> <meter min=0 max=20 value=12 title="centimeters">12cm</meter>
  <dt>Height: </dt> <dd> <meter min=0 max=10 value=2 title="centimeters">2cm</meter>
</dl>
\end{quote}

\textbf{User agent requirements}: User agents must parse the \texttt{min}, \texttt{max}, \texttt{value}, \texttt{low}, \texttt{high}, and \texttt{optimum} attributes using the \texttt{rules for parsing floating-point number values}.
User agents must then use all these numbers to obtain values for six points on the gauge, as follows. (The order in which these are evaluated is important, as some of the values refer to earlier ones.)

**The minimum value**

If the \texttt{min} attribute is specified and a value could be parsed out of it, then the minimum value is that value. Otherwise, the minimum value is zero.

**The maximum value**

If the \texttt{max} attribute is specified and a value could be parsed out of it, then the candidate maximum value is that value. Otherwise, the candidate maximum value is 1.0.

If the candidate maximum value is greater than or equal to the minimum value, then the maximum value is the candidate maximum value. Otherwise, the maximum value is the same as the minimum value.

**The actual value**

If the \texttt{value} attribute is specified and a value could be parsed out of it, then that value is the candidate actual value. Otherwise, the candidate actual value is zero.

If the candidate actual value is less than the minimum value, then the actual value is the minimum value.

Otherwise, if the candidate actual value is greater than the maximum value, then the actual value is the maximum value.

Otherwise, the actual value is the candidate actual value.

**The low boundary**

If the \texttt{low} attribute is specified and a value could be parsed out of it, then the candidate low boundary is that value. Otherwise, the candidate low boundary is the same as the minimum value.

If the candidate low boundary is less than the minimum value, then the low boundary is the minimum value.

Otherwise, if the candidate low boundary is greater than the maximum value, then the low boundary is the maximum value.

Otherwise, the low boundary is the candidate low boundary.

**The high boundary**

If the \texttt{high} attribute is specified and a value could be parsed out of it, then the candidate high boundary is that value. Otherwise, the candidate high boundary is the same as the maximum value.

If the candidate high boundary is less than the low boundary, then the high boundary is the low boundary.

Otherwise, if the candidate high boundary is greater than the maximum value, then the high boundary is the maximum value.

Otherwise, the high boundary is the candidate high boundary.

**The optimum point**

If the \texttt{optimum} attribute is specified and a value could be parsed out of it, then the candidate optimum point is that value. Otherwise, the candidate optimum point is the midpoint between the minimum value and the maximum value.

If the candidate optimum point is less than the minimum value, then the optimum point is the minimum value.

Otherwise, if the candidate optimum point is greater than the maximum value, then the optimum point is the maximum value.

Otherwise, the optimum point is the candidate optimum point.

All of which will result in the following inequalities all being true:

- \( \text{minimum value} \leq \text{actual value} \leq \text{maximum value} \)
- \( \text{minimum value} \leq \text{low boundary} \leq \text{high boundary} \leq \text{maximum value} \)
- \( \text{minimum value} \leq \text{optimum point} \leq \text{maximum value} \)

**UA requirements for regions of the gauge**: If the optimum point is equal to the low boundary or the high boundary, or anywhere in between them, then the region between the low and high boundaries of the gauge must be treated as the optimum region, and the low and high parts, if any, must be treated as suboptimal. Otherwise, if the optimum point is less than the low boundary, then the region
between the minimum value and the low boundary must be treated as the optimum region, the region from the low boundary up to the
high boundary must be treated as a suboptimal region, and the remaining region must be treated as an even less good region. Finally,
if the optimum point is higher than the high boundary, then the situation is reversed; the region between the high boundary and the
maximum value must be treated as the optimum region, the region from the high boundary down to the low boundary must be treated
as a suboptimal region, and the remaining region must be treated as an even less good region.
UA requirements for showing the gauge: When representing a meter p584 element to the user, the UA should indicate the relative
position of the actual value to the minimum and maximum values, and the relationship between the actual value and the three regions
of the gauge.
Example
The following markup:
<h3>Suggested groups</h3>
<menu>
<li><a href="?cmd=hsg" onclick="hideSuggestedGroups()">Hide suggested groups</a></li>
</menu>
<ul>
<li>
<p><a href="/group/comp.infosystems.www.authoring.stylesheets/
<p>Group description: <strong>Layout/presentation on the WWW.</strong></p>
<p><meter value="0.5">Moderate activity,</meter> Usenet, 618 subscribers</p>
</li>
<li>
<p><a href="/group/netscape.public.mozilla.xpinstall/view">netscape.public.mozilla.xpinstall</a>
<a href="/group/netscape.public.mozilla.xpinstall/subscribe">join</a></p>
<p>Group description: <strong>Mozilla XPInstall discussion.</strong></p>
<p><meter value="0.25">Low activity,</meter> Usenet, 22 subscribers</p>
</li>
<li>
<p><a href="/group/mozilla.dev.general/view">mozilla.dev.general</a> <a href="/group/mozilla.dev.general/subscribe">join</a></p>
<p><meter value="0.25">Low activity,</meter> Usenet, 66 subscribers</p>
</li>
</ul>
Might be rendered as follows:

User agents may combine the value of the title p155 attribute and the other attributes to provide context-sensitive help or inline text
detailing the actual values.
Example
For example, the following snippet:

588


The `value` IDL attribute, on getting, must return the actual value\(^587\). On setting, the given value must be converted to the best representation of the number as a floating-point number\(^576\) and then the `value` content attribute must be set to that string.

The `min` IDL attribute, on getting, must return the minimum value\(^587\). On setting, the given value must be converted to the best representation of the number as a floating-point number\(^576\) and then the `min` content attribute must be set to that string.

The `max` IDL attribute, on getting, must return the maximum value\(^587\). On setting, the given value must be converted to the best representation of the number as a floating-point number\(^576\) and then the `max` content attribute must be set to that string.

The `low` IDL attribute, on getting, must return the low boundary\(^587\). On setting, the given value must be converted to the best representation of the number as a floating-point number\(^576\) and then the `low` content attribute must be set to that string.

The `high` IDL attribute, on getting, must return the high boundary\(^587\). On setting, the given value must be converted to the best representation of the number as a floating-point number\(^576\) and then the `high` content attribute must be set to that string.

The `optimum` IDL attribute, on getting, must return the optimum value\(^587\). On setting, the given value must be converted to the best representation of the number as a floating-point number\(^576\) and then the `optimum` content attribute must be set to that string.

The `labels` IDL attribute provides a list of the element's `label`\(^514\)s.

Example

The following example shows how a gauge could fall back to localized or pretty-printed text.

```html
<p>Disk usage: <meter min=0 value=170261928 max=233257824>170261928 bytes used out of 233257824 bytes available</meter></p>
```

4.10.15 The `fieldset` element\(^558\)

**Categories**\(^p144\):
- **Flow content**\(^p147\)
- **Listed**\(^p510\) and **autocapitalize-inheriting**\(^p510\), **form-associated element**\(^p510\).
- **Palpable content**\(^p148\).

**Contexts in which this element can be used**\(^p144\):
Where **flow content**\(^p147\) is expected.

**Content model**\(^p144\):
- Optionally a `legend` element, followed by **flow content**\(^p147\).

**Tag omission in text/html**\(^p144\):
- Neither tag is omissible.

**Content attributes**\(^p144\):
- **Global attributes**\(^p152\)
  - `disabled`\(^p590\) — Whether the descendant form controls, except any inside `legend`\(^p592\), are disabled
  - `form`\(^p593\) — Associates the element with a `form`\(^p593\) element
  - `name`\(^p595\) — Name of the element to use in the `form.elements`\(^p513\) API.

**Accessibility considerations**\(^p145\):
- For **authors**.
- For **implementers**.
DOM interface

```idl
[Exposed=Window]
interface HTMLFieldSetElement : HTMLElement {
    [HTMLConstructor] constructor();

    [CEReactions] attribute boolean disabled;
    readonly attribute HTMLFormElement? form;
    [CEReactions] attribute DOMString name;

    readonly attribute DOMString type;

    [SameObject] readonly attribute HTMLCollection elements;

    readonly attribute boolean willValidate;
    [SameObject] readonly attribute ValidityState validity;
    readonly attribute DOMString validationMessage;

    boolean checkValidity();
    boolean reportValidity();
    undefined setCustomValidity(DOMString error);
};
```

The `fieldset` element represents a set of form controls (or other content) grouped together, optionally with a caption. The caption is given by the first `legend` element that is a child of the `fieldset` element, if any. The remainder of the descendants form the group.

The `disabled` attribute, when specified, causes all the form control descendants of the `fieldset` element, excluding those that are descendants of the `fieldset` element's first `legend` element child, if any, to be `disabled`.

A `fieldset` element is a `disabled fieldset` if it matches any of the following conditions:

- Its `disabled` attribute is specified
- It is a descendant of another `fieldset` element whose `disabled` attribute is specified, and is not a descendant of that `fieldset` element's first `legend` element child, if any.

The `form` attribute is used to explicitly associate the `fieldset` element with its `form owner`. The `name` attribute represents the element's name.

For web developers (non-normative)

- `fieldset.type` returns the string "fieldset".
- `fieldset.elements` returns an `HTMLCollection` of the form controls in the element.

The `disabled` IDL attribute must reflect the content attribute of the same name.

The `type` IDL attribute must return the string "fieldset".

The `elements` IDL attribute must return an `HTMLCollection` rooted at the `fieldset` element, whose filter matches listed elements.

The `willValidate`, `validity`, and `validationMessage` attributes, and the `checkValidity()`, `reportValidity()`, and `setCustomValidity()` methods, are part of the `constraint validation API`. The `form` and `name` IDL attributes are part of the element's forms API.

Example

This example shows a `fieldset` element being used to group a set of related controls:

```html
<fieldset>
  
</fieldset>
```
The following snippet shows a fieldset with a checkbox in the legend that controls whether or not the fieldset is enabled. The contents of the fieldset consist of two required text controls and an optional year/month control.

```html
<fieldset name="clubfields" disabled>
  <legend>
    <input type=checkbox name=club onchange="form.clubfields.disabled = !checked"> Use Club Card
  </legend>
  <p><label>Name on card: <input name=clubname required></label></p>
  <p><label>Card number: <input name=clubnum required pattern="[-0-9]+"></label></p>
  <p><label>Expiry date: <input name=clubexp type=month></label></p>
</fieldset>
```

Example

You can also nest `<fieldset>` elements. Here is an example expanding on the previous one that does so:

```html
<fieldset name="clubfields" disabled>
  <legend>
    <input type=checkbox name=club onchange="form.clubfields.disabled = !checked"> Use Club Card
  </legend>
  <p><label>Name on card: <input name=clubname required></label></p>
  <fieldset name="numfields">
    <legend>
      <input type=radio checked name=clubtype onchange="form.numfields.disabled = !checked"> My card has numbers on it
    </legend>
    <p><label>Card number: <input name=clubnum required pattern="[-0-9]+"></label></p>
  </fieldset>
  <fieldset name="letfields" disabled>
    <legend>
      <input type=radio name=clubtype onchange="form.letfields.disabled = !checked"> My card has letters on it
    </legend>
    <p><label>Card code: <input name=clublet required pattern="[A-Za-z]+"></label></p>
  </fieldset>
</fieldset>
```

In this example, if the outer "Use Club Card" checkbox is not checked, everything inside the outer `<fieldset>`, including the two radio buttons in the legends of the two nested `<fieldset>`s, will be disabled. However, if the checkbox is checked, then the radio buttons will both be enabled and will let you select which of the two inner `<fieldset>`s is to be enabled.
This example shows a grouping of controls where the `legend` element both labels the grouping, and the nested heading element surfaces the grouping in the document outline:

```html
<fieldset>
  <legend><h2>How can we best reach you?</h2></legend>
  <p><label><input type=radio checked name=contact_pref> Phone</label></p>
  <p><label><input type=radio name=contact_pref> Text</label></p>
  <p><label><input type=radio name=contact_pref> Email</label></p>
</fieldset>
```

### 4.10.16 The `legend` element

**Categories:** None.

**Contexts in which this element can be used:**
As the first child of a `fieldset` element.

**Content model:**
Phrasing content, optionally intermixed with heading content.

**Tag omission in text/html:**
Neither tag is omissible.

**Content attributes:**
Global attributes

**Accessibility considerations:**
For authors.
For implementers.

**DOM interface:**

```javascript
[Exposed=Window]
interface HTMLLegendElement : HTMLElement {
  [HTMLConstructor] constructor();

  // readonly attribute HTMLFormElement? form;
  // also has obsolete members
};
```

The `legend` element represents a caption for the rest of the contents of the `legend` element's parent `fieldset` element, if any.

**For web developers (non-normative)**

`legend.form` Returns the element's `form` element, if any, or null otherwise.
The `form` IDL attribute's behavior depends on whether the `legend` element is in a `fieldset` element or not. If the `legend` has a `fieldset` element as its parent, then the `form` IDL attribute must return the same value as the `form` IDL attribute on that `fieldset` element. Otherwise, it must return null.

### 4.10.17 Form control infrastructure

#### 4.10.17.1 A form control's value

Most form controls have a `value` and a `checkedness`. (The latter is only used by `input` elements.) These are used to describe how the user interacts with the control.

A control's `value` is its internal state. As such, it might not match the user's current input.

Example

For instance, if a user enters the word "three" into a numeric field that expects digits, the user's input would be the string "three" but the control's `value` would remain unchanged. Or, if a user enters the email address "awesome@example.com" (with leading whitespace) into an email field, the user's input would be the string "awesome@example.com" but the browser's UI for email fields might translate that into a `value` of "awesome@example.com" (without the leading whitespace).

`input` and `textarea` elements have a **dirty value flag**. This is used to track the interaction between the `value` and default value. If it is false, `value` mirrors the default value. If it is true, the default value is ignored.

`input`, `textarea` and `select` elements have a **user validity** boolean. It is initially set to false.

To define the behavior of constraint validation in the face of the `input` element's `multiple` attribute, `input` elements can also have separately defined `values`.

To define the behavior of the `maxlength` and `minlength` attributes, as well as other APIs specific to the `textarea` element, all form control with a `value` also have an algorithm for obtaining an **API value**. By default this algorithm is to simply return the control's `value`.

The `select` element does not have a `value`; the `selectedness` of its `option` elements is what is used instead.

#### 4.10.17.2 Mutability

A form control can be designated as `mutable`.

**Note**

This determines (by means of definitions and requirements in this specification that rely on whether an element is so designated) whether or not the user can modify the `value` or `checkedness` of a form control, or whether or not a control can be automatically prefilled.

#### 4.10.17.3 Association of controls and forms

A `form-associated element` can have a relationship with a `form` element, which is called the element's `form owner`. If a `form-associated element` is not associated with a `form` element, its `form owner` is said to be null.

A `form-associated element` has an associated `parser inserted flag`.

A `form-associated element` is, by default, associated with its nearest ancestor `form` element (as described below), but, if it is `listed`, may have a `form` attribute specified to override this.

**Note**

This feature allows authors to work around the lack of support for nested `form` elements.

If a `listed` `form-associated element` has a `form` attribute specified, then that attribute's value must be the ID of a `form`
element in the element's tree.

Note

The rules in this section are complicated by the fact that although conforming documents or trees will never contain nested form elements, it is quite possible (e.g., using a script that performs DOM manipulation) to generate trees that have such nested elements. They are also complicated by rules in the HTML parser that, for historical reasons, can result in a form-associated element being associated with a form element that is not its ancestor.

When a form-associated element is created, its form owner must be initialized to null (no owner).

When a form-associated element is to be associated with a form, its form owner must be set to that form.

When a listed form-associated element's form attribute is set, changed, or removed, then the user agent must reset the form owner of that element.

When a listed form-associated element has a form attribute and the ID of any of the elements in the tree changes, then the user agent must reset the form owner of that form-associated element.

When a listed form-associated element has a form attribute and an element with an ID is inserted into or removed from the Document, then the user agent must reset the form owner of that form-associated element.

Note

The form owner is also reset by the HTML Standard's insertion steps and removing steps.

To reset the form owner of a form-associated element element:

1. Unset element's parser inserted flag.

2. If all of the following are true:
   - element's form owner is not null;
   - element is not listed or its form content attribute is not present; and
   - element's form owner is its nearest form element ancestor after the change to the ancestor chain,
     then return.

3. Set element's form owner to null.

4. If element is listed, has a form content attribute, and is connected, then:

   1. If the first element in element's tree, in tree order, to have an ID that is identical to element's form content attribute's value, is a form element, then associate the element with that form element.

5. Otherwise, if element has an ancestor form element, then associate element with the nearest such ancestor form element.

Example

In the following non-conforming snippet

```html
...<form id="a">
  <div id="b"></div>
</form>
<script>
  document.getElementById('b').innerHTML = 
    '<table><tr><td></td></form><form id="c"><input id="d"></table>' + 
    '<input id="e">';
</script>
...`
the form owner of "d" would be the inner nested form "c", while the form owner of "e" would be the outer form "a".

This happens as follows: First, the "e" node gets associated with "c" in the HTML parser. Then, the innerHTML algorithm moves the nodes from the temporary document to the "b" element. At this point, the nodes see their ancestor chain change, and thus all the "magic" associations done by the parser are reset to normal ancestor associations.

This example is a non-conforming document, though, as it is a violation of the content models to nest form elements, and there is a parse error for the </form> tag.

For web developers (non-normative)

```javascript
let form = document.createElement("form");
let input = document.createElement("input");
form.appendChild(input);
form.method; // => "get"
input.name = "method"; // DOM clobbering occurs here
form.method === input; // => true
```

Since the input name takes precedence over built-in form properties, the JavaScript reference form.method will point to the input element named "method" instead of the built-in method property.

4.10.18 Attributes common to form controls

4.10.18.1 Naming form controls: the name attribute

The name content attribute gives the name of the form control, as used in form submission and in the form element’s elements object. If the attribute is specified, its value must not be the empty string or isindex.

Note

A number of user agents historically implemented special support for first-in-form text controls with the name isindex, and this specification previously defined related user agent requirements for it. However, some user agents subsequently dropped that special support, and the related requirements were removed from this specification. So, to avoid problematic reinterpretations in legacy user agents, the name isindex is no longer allowed.

Other than isindex, any non-empty value for name is allowed. An ASCII case-insensitive match for the name _charset_ is special: if used as the name of a Hidden control with no value attribute, then during submission the value attribute is automatically given a value consisting of the submission character encoding.

The name IDL attribute must reflect the name content attribute.

Note

DOM clobbering is a common cause of security issues. Avoid using the names of built-in form properties with the name content attribute.

In this example, the input element overrides the built-in method property:
4.10.18.2 Submitting element directionality: the `dirname` attribute

The `dirname` attribute on a form control element enables the submission of the directionality of the element, and gives the name of the control that contains this value during form submission. If such an attribute is specified, its value must not be the empty string.

**Example**

In this example, a form contains a text control and a submission button:

```html
<form action="addcomment.cgi" method=post>
  <p><label>Comment: <input type=text name="comment" dirname="comment.dir" required></label></p>
  <p><button name="mode" type=submit value="add">Post Comment</button></p>
</form>
```

When the user submits the form, the user agent includes three fields, one called "comment", one called "comment.dir", and one called "mode"; so if the user types "Hello", the submission body might be something like:

`comment=Hello&comment.dir=ltr&mode=add`

If the user manually switches to a right-to-left writing direction and enters "مرحبا", the submission body might be something like:

`comment=%D9%85%D8%B1%D8%AD%D8%A8%D8%A7&comment.dir=rtl&mode=add`

4.10.18.3 Limiting user input length: the `maxlength` attribute

A form control `maxlength` attribute, controlled by the `dirty value flag`, declares a limit on the number of characters a user can input. The number of characters is measured using `length` and, in the case of `textarea` elements, with all newlines normalized to a single character (as opposed to CRLF pairs).

If an element has its form control `maxlength` attribute specified, the attribute's value must be a valid non-negative integer. If the attribute is specified and applying the rules for parsing non-negative integers to its value results in a number, then that number is the element's maximum allowed value length. If the attribute is omitted or parsing its value results in an error, then there is no maximum allowed value length.

**Constraint validation**: If an element has a maximum allowed value length, its `dirty value flag` is true, its `value` was last changed by a user edit (as opposed to a change made by a script), and the `length` of the element's `API value` is greater than the element's maximum allowed value length, then the element is suffering from being too long.

User agents may prevent the user from causing the element's `API value` to be set to a value whose `length` is greater than the element's maximum allowed value length.

**Note**

In the case of `textarea` elements, the `API value` and `value` differ. In particular, newline normalization is applied before the maximum allowed value length is checked (whereas the textarea wrapping transformation is not applied).

4.10.18.4 Setting minimum input length requirements: the `minlength` attribute

A form control `minlength` attribute, controlled by the `dirty value flag`, declares a lower bound on the number of characters a user can input. The "number of characters" is measured using `length` and, in the case of `textarea` elements, with all newlines normalized to a single character (as opposed to CRLF pairs).

The `minlength` attribute does not imply the `required` attribute. If the form control has no `required` attribute, then the value can still be omitted; the `minlength` attribute only kicks in once the user has entered a value at all. If the empty string is not allowed, then the `required` attribute also needs to be set.

If an element has its form control `minlength` attribute specified, the attribute's value must be a valid non-negative integer. If the attribute is specified and applying the rules for parsing non-negative integers to its value results in a number, then that number is
the element’s minimum allowed value length. If the attribute is omitted or parsing its value results in an error, then there is no minimum allowed value length\(^597\).

If an element has both a maximum allowed value length\(^596\) and a minimum allowed value length\(^597\), the minimum allowed value length\(^597\) must be smaller than or equal to the maximum allowed value length\(^596\).

**Constraint validation:** If an element has a minimum allowed value length\(^597\), its dirty value flag\(^598\) is true, its value\(^593\) was last changed by a user edit (as opposed to a change made by a script), its value\(^592\) is not the empty string, and the length of the element’s API value\(^593\) is less than the element’s minimum allowed value length\(^597\), then the element is suffering from being too short\(^618\).

**Example**

In this example, there are four text controls. The first is required, and has to be at least 5 characters long. The other three are optional, but if the user fills one in, the user has to enter at least 10 characters.

```
<form action="/events/menu.cgi" method="post">
  <p><label>Describe what you would like for breakfast, if anything:</label>
  <textarea name="breakfast" minlength="10"></textarea></p>
  <p><label>Describe what you would like for lunch, if anything:</label>
  <textarea name="lunch" minlength="10"></textarea></p>
  <p><label>Describe what you would like for dinner, if anything:</label>
  <textarea name="dinner" minlength="10"></textarea></p>
  <p><input type="submit" value="Submit Request"></p>
</form>
```

4.10.18.5 Enabling and disabling form controls: the disabled\(^597\) attribute \(^599\)

The disabled content attribute is a boolean attribute\(^73\).

**Note**

The disabled\(^573\) attribute for option\(^572\) elements and the disabled\(^572\) attribute for optgroup\(^571\) elements are defined separately.

A form control is disabled if any of the following are true:

- the element is a button\(^561\), input\(^517\), select\(^564\), textarea\(^575\), or form-associated custom element\(^775\), and the disabled\(^597\) attribute is specified on this element (regardless of its value); or
- the element is a descendant of a fieldset\(^589\) element whose disabled\(^596\) attribute is specified, and is not a descendant of that fieldset\(^589\) element’s first legend\(^592\) element child, if any.

A form control that is disabled\(^597\) must prevent any click events that are queued\(^5106\) on the user interaction task source\(^5115\) from being dispatched on the element.

**Constraint validation:** If an element is disabled\(^597\), it is barred from constraint validation\(^617\).

The disabled IDL attribute must reflect\(^102\) the disabled\(^597\) content attribute.

4.10.18.6 Form submission attributes \(^598\)

**Attributes for form submission** can be specified both on form\(^516\) elements and on submit buttons\(^510\) (elements that represent buttons that submit forms, e.g. an input\(^517\) element whose type\(^519\) attribute is in the Submit Button\(^542\) state).

The attributes for form submission\(^599\) that may be specified on form\(^516\) elements are action\(^598\), enctype\(^599\), method\(^598\), novalidate\(^599\), and target\(^599\).

The corresponding attributes for form submission\(^597\) that may be specified on submit buttons\(^510\) are formaction\(^598\), formenctype\(^599\), formmethod\(^598\), formnovalidate\(^599\), and formtarget\(^599\). When omitted, they default to the values given on the corresponding
attributes on the `form` element.

The `action` and `formaction` content attributes, if specified, must have a value that is a valid non-empty URL potentially surrounded by spaces. The `action` of an element is the value of the element's `formaction` attribute, if the element is a submit button and has such an attribute, or the value of its form owner's `action` attribute, if it has one, or else the empty string.

The `method` and `formmethod` content attributes are enumerated attributes with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>get</td>
<td>GET</td>
<td>Indicates the <code>form</code> will use the HTTP GET method.</td>
</tr>
<tr>
<td>post</td>
<td>POST</td>
<td>Indicates the <code>form</code> will use the HTTP POST method.</td>
</tr>
<tr>
<td>dialog</td>
<td>Dialog</td>
<td>Indicates the <code>form</code> is intended to close the <code>dialog</code> box in which the form finds itself, if any, and otherwise not submit.</td>
</tr>
</tbody>
</table>

The `method` attribute's `missing value default` and `invalid value default` are both the GET state. The `formmethod` attribute has no `missing value default`, and its `invalid value default` is the GET state.

The `method` of an element is one of those states. If the element is a submit button and has a `formmethod` attribute, then the element's `method` is that attribute's state; otherwise, it is the form owner's `method` attribute's state.

Example

Here the `method` attribute is used to explicitly specify the default value, "get", so that the search query is submitted in the URL:

```html
<form method="get" action="/search.cgi">
  <p><label>Search terms: <input type=search name=q></label></p>
  <p><input type=submit></p>
</form>
```

Example

On the other hand, here the `method` attribute is used to specify the value "post", so that the user's message is submitted in the HTTP request's body:

```html
<form method="post" action="/post-message.cgi">
  <p><label>Message: <input type=text name=m></label></p>
  <p><input type=submit value="Submit message"></p>
</form>
```

Example

In this example, a `form` is used with a `dialog`. The `method` attribute's "dialog" keyword is used to have the dialog automatically close when the form is submitted.

```html
<dialog id="ship">
  <form method="dialog">
    <p>A ship has arrived in the harbour.</p>
    <button type=submit value="board">Board the ship</button>
    <button type=submit value="call">Call to the captain</button>
  </form>
</dialog>
```

```javascript
var ship = document.getElementById('ship');
ship.showModal();
ship.onclose = function (event) {
  if (ship.returnValue == 'board') {
    // ...
```
The `enctype` and `formenctype` content attributes are enumerated attributes with the following keywords and states:

- The "application/x-www-form-urlencoded" keyword and corresponding state.
- The "multipart/form-data" keyword and corresponding state.
- The "text/plain" keyword and corresponding state.

The attribute's missing value default and invalid value default are both the `application/x-www-form-urlencoded` state.

The `formenctype` attribute has no missing value default, and its invalid value default is the `application/x-www-form-urlencoded` state.

The `enctype` of an element is one of those three states. If the element is a submit button and has a `formenctype` attribute, then the element's `enctype` is that attribute's state; otherwise, it is the `form owner`'s `enctype` attribute's state.

The `target` and `formtarget` content attributes, if specified, must have values that are valid navigable target names or keywords. If present, they indicate that the form is not to be validated during submission.

The `novalidate` and `formnovalidate` content attributes are boolean attributes. If present, they indicate that the form is not to be validated during submission.

The `no-validate` state of an element is true if the element is a submit button and the element's `formnovalidate` attribute is present, or if the element's `form owner`'s `novalidate` attribute is present, and false otherwise.

**Example**

This attribute is useful to include "save" buttons on forms that have validation constraints, to allow users to save their progress even though they haven't fully entered the data in the form. The following example shows a simple form that has two required fields. There are three buttons: one to submit the form, which requires both fields to be filled in; one to save the form so that the user can come back and fill it in later; and one to cancel the form altogether.

```html
<form action="editor.cgi" method="post">
  <p><label>Name: <input required name=fn></label></p>
  <p><label>Essay: <textarea required name=essay></textarea></label></p>
  <p><input type=submit name=submit value="Submit essay"></p>
  <p><input type=submit formnovalidate name=save value="Save essay"></p>
  <p><input type=submit formnovalidate name=cancel value="Cancel"></p>
</form>
```

The `action` IDL attribute must reflect the content attribute of the same name, except that on getting, when the content attribute is missing or its value is the empty string, the element's `node document`'s URL must be returned instead. The `target` IDL attribute must reflect the content attribute of the same name. The `method` and `enctype` IDL attributes must reflect the respective content attributes of the same name, limited to only known values. The `encoding` IDL attribute must reflect the `enctype` content attribute, limited to only known values. The `noValidate` IDL attribute must reflect the `novalidate` content attribute. The `formAction` IDL attribute must reflect the `formaction` content attribute, except that on getting, when the content attribute is missing or its value is the empty string, the element's `node document`'s URL must be returned instead. The `formEnctype` IDL attribute must reflect the `formenctype` content attribute, limited to only known values. The `formMethod` IDL attribute must reflect the `formmethod` content attribute, limited to only known values. The `formNoValidate` IDL attribute must reflect the `formnovalidate` content attribute. The `formTarget` IDL attribute must reflect the `formtarget` content attribute.
4.10.18.7 Autofill

4.10.18.7.1 Autofilling form controls: the `autocomplete` attribute

User agents sometimes have features for helping users fill forms in, for example prefilling the user's address based on earlier user input. The `autocomplete` content attribute can be used to hint to the user agent how to, or indeed whether to, provide such a feature.

There are two ways this attribute is used. When wearing the `autofill expectation mantle`, the `autocomplete` attribute describes what input is expected from users. When wearing the `autofill anchor mantle`, the `autocomplete` attribute describes the meaning of the given value.

On an `input` element whose `type` attribute is in the `Hidden` state, the `autocomplete` attribute wears the `autofill anchor mantle`. In all other cases, it wears the `autofill expectation mantle`.

When wearing the `autofill expectation mantle`, the `autocomplete` attribute, if specified, must have a value that is an ordered `set of space-separated tokens` consisting of either a single token that is an ASCII case-insensitive match for the string “off”, or a single token that is an ASCII case-insensitive match for the string "on", or `autofill detail tokens`.

When wearing the `autofill anchor mantle`, the `autocomplete` attribute, if specified, must have a value that is an ordered `set of space-separated tokens` consisting of just `autofill detail tokens` (i.e. the “on” and “off” keywords are not allowed).

**Autofill detail tokens** are the following, in the order given below:

1. Optionally, a token whose first eight characters are an ASCII case-insensitive match for the string "section-", meaning that the field belongs to the named group.

**Example**

For example, if there are two shipping addresses in the form, then they could be marked up as:

```html
<fieldset>
  <legend>Ship the blue gift to...</legend>
  <p>
    <label> Address:  <textarea name=ba autocomplete="section-blue shipping street-address"></textarea> </label>
  </p>
  <p>
    <label> City:  <input name=bc autocomplete="section-blue shipping address-level2"></input> </label>
  </p>
  <p>
    <label> Postal Code:  <input name=bp autocomplete="section-blue shipping postal-code"></input> </label>
  </p>
</fieldset>

<fieldset>
  <legend>Ship the red gift to...</legend>
  <p>
    <label> Address:  <textarea name=ra autocomplete="section-red shipping street-address"></textarea> </label>
  </p>
  <p>
    <label> City:  <input name=rc autocomplete="section-red shipping address-level2"></input> </label>
  </p>
  <p>
    <label> Postal Code:  <input name=rp autocomplete="section-red shipping postal-code"></input> </label>
  </p>
</fieldset>
```

2. Optionally, a token that is an ASCII case-insensitive match for one of the following strings:
   - "shipping", meaning the field is part of the shipping address or contact information
   - "billing", meaning the field is part of the billing address or contact information

3. Either of the following two options:
   - A token that is an ASCII case-insensitive match for one of the following `autofill field` names, excluding those that are inappropriate for the control:
     - "name"
     - "honorific-prefix"
     - "given-name"
     - "additional-name"
     - "family-name"
     - "honorific-suffix"
     - "nickname"
     - "username"
     - "new-password"
The following, in the given order:

1. Optionally, a token that is an ASCII case-insensitive match for one of the following strings:
   - "home", meaning the field is for contacting someone at their residence
   - "work", meaning the field is for contacting someone at their workplace
   - "mobile", meaning the field is for contacting someone regardless of location
   - "fax", meaning the field describes a fax machine’s contact details
   - "pager", meaning the field describes a pager’s or beeper’s contact details

2. A token that is an ASCII case-insensitive match for one of the following autofill field names, excluding those that are inappropriate for the control:
   - "tel"
   - "tel-country-code"
   - "tel-national"
   - "tel-area-code"
   - "tel-local"
   - "tel-local-prefix"
   - "tel-local-suffix"
   - "email"
   - "impp"

(See the table below for descriptions of these values.)

4. Optionally, a token that is an ASCII case-insensitive match for the string "webauthn", meaning the user agent should show public key credentials available via conditional mediation when the user interacts with the form control. webauthn is only valid for input and textarea elements.

As noted earlier, the meaning of the attribute and its keywords depends on the mantle that the attribute is wearing.

灵气时佩戴的autofill expectation mantle...
the document provides its own autocomplete mechanism and does not want the user agent to provide autocompletion values.

The "on" keyword indicates that the user agent is allowed to provide the user with autocompletion values, but does not provide any further information about what kind of data the user might be expected to enter. User agents would have to use heuristics to decide what autocompletion values to suggest.

The autofill field listed above indicate that the user agent is allowed to provide the user with autocompletion values, and specifies what kind of value is expected. The meaning of each such keyword is described in the table below.

If the autocomplete attribute is omitted, the default value corresponding to the state of the element's form owner's autocomplete attribute is used instead (either "on" or "off"). If there is no form owner, then the value "on" is used.

When wearing the autofill anchor mantle...

The autofill field listed above indicate that the value of the particular kind of value specified is that value provided for this element. The meaning of each such keyword is described in the table below.

<table>
<thead>
<tr>
<th>Field name</th>
<th>Meaning</th>
<th>Canonical Format</th>
<th>Canonical Format Example</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;name&quot;</td>
<td>Full name</td>
<td>Free-form text, no newlines</td>
<td>Sir Timothy John Berners-Lee, OM, KBE, FRS, FREng, FRSA</td>
<td>Text</td>
</tr>
<tr>
<td>&quot;honorific-prefix&quot;</td>
<td>Prefix or title (e.g. &quot;Mr.&quot;, &quot;Ms.&quot;, &quot;Dr.&quot;, &quot;M&quot;\textsc{r})</td>
<td>Free-form text, no newlines</td>
<td>Sir</td>
<td>Text</td>
</tr>
<tr>
<td>&quot;given-name&quot;</td>
<td>Given name (in some Western cultures, also known as the first name)</td>
<td>Free-form text, no newlines</td>
<td>Timothy</td>
<td>Text</td>
</tr>
<tr>
<td>&quot;additional-name&quot;</td>
<td>Additional names (in some Western cultures, also known as middle names, forenames other than the first name)</td>
<td>Free-form text, no newlines</td>
<td>John</td>
<td>Text</td>
</tr>
<tr>
<td>&quot;family-name&quot;</td>
<td>Family name (in some Western cultures, also known as the last name or surname)</td>
<td>Free-form text, no newlines</td>
<td>Berners-Lee</td>
<td>Text</td>
</tr>
</tbody>
</table>

Note: Generally, authors are encouraged to use the broader fields rather than the narrower fields, as the narrower fields tend to expose Western biases. For example, while it is common in some Western cultures to have a given name and a family name, in that order (and thus often referred to as a first name and a surname), many cultures put the family name first and the given name second, and many others simply have one name (a mononym). Having a single field is therefore more flexible.

Some fields are only appropriate for certain form controls. An autofill field name is inappropriate for a control if the control does not belong to the group listed for that autofill field in the fifth column of the first row describing that autofill field in the table below. What controls fall into each group is described below the table.
<table>
<thead>
<tr>
<th>Field name</th>
<th>Meaning</th>
<th>Canonical Format</th>
<th>Canonical Format Example</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>“honorific-suffix”</strong></td>
<td>Suffix (e.g. “Dr.”, “B.Sc.”, “MBASW”, “II”)</td>
<td>Free-form text, no newlines</td>
<td>OM, KBE, FR5, FREng, FR5A</td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“nickname”</strong></td>
<td>Nickname, screen name, handle: a typically short name used instead of the full name</td>
<td>Free-form text, no newlines</td>
<td></td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“organization-title”</strong></td>
<td>Job title (e.g. “Software Engineer”, “Senior Vice President”, “Deputy Managing Director”)</td>
<td>Free-form text, no newlines</td>
<td>Professor</td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“username”</strong></td>
<td>A username</td>
<td>Free-form text, no newlines</td>
<td>timbl</td>
<td>Username*</td>
</tr>
<tr>
<td><strong>“new-password”</strong></td>
<td>A new password (e.g. when creating an account or changing a password)</td>
<td>Free-form text, no newlines</td>
<td>GUMFXbadyrS3</td>
<td>Password*</td>
</tr>
<tr>
<td><strong>“current-password”</strong></td>
<td>The current password for the account identified by the username field (e.g. when logging in)</td>
<td>Free-form text, no newlines</td>
<td>qwerty</td>
<td>Password*</td>
</tr>
<tr>
<td><strong>“one-time-code”</strong></td>
<td>One-time code used for verifying user identity</td>
<td>Free-form text, no newlines</td>
<td>123456</td>
<td>Password*</td>
</tr>
<tr>
<td><strong>“organization”</strong></td>
<td>Company name corresponding to the person, address, or contact information in the other fields associated with this field</td>
<td>Free-form text</td>
<td>World Wide Web Consortium</td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“street-address”</strong></td>
<td>Street address (multiple lines, newlines preserved)</td>
<td>Free-form text</td>
<td>32 Vassar Street MIT Room 32-G524</td>
<td>Multiline*</td>
</tr>
<tr>
<td><strong>“address-line1”</strong></td>
<td>Street address (one line per field)</td>
<td>Free-form text, no newlines</td>
<td>32 Vassar Street</td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“address-line2”</strong></td>
<td>Free-form text, no newlines</td>
<td>MIT Room 32-G524</td>
<td>Text*</td>
<td></td>
</tr>
<tr>
<td><strong>“address-line3”</strong></td>
<td>Free-form text, no newlines</td>
<td></td>
<td>Text*</td>
<td></td>
</tr>
<tr>
<td><strong>“address-level4”</strong></td>
<td>The most fine-grained administrative level, in addresses with four administrative levels</td>
<td>Free-form text, no newlines</td>
<td></td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“address-level3”</strong></td>
<td>The third administrative level, in addresses with three or more administrative levels</td>
<td>Free-form text, no newlines</td>
<td></td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“address-level2”</strong></td>
<td>The second administrative level, in addresses with two or more administrative levels; in the countries with two administrative levels, this would typically be the city, town, village, or other locality within which the relevant street address is found</td>
<td>Free-form text, no newlines</td>
<td>Cambridge</td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“address-level1”</strong></td>
<td>The broadest administrative level in the address, i.e. the province within which the locality is found; for example, in the US, this would be the state; in Switzerland it would be the canton; in the UK, the post town</td>
<td>Free-form text, no newlines</td>
<td>MA</td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“country”</strong></td>
<td>Country code</td>
<td>Valid ISO 3166-1-alpha-2 country code</td>
<td>US</td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“country-name”</strong></td>
<td>Country name</td>
<td>Free-form text, no newlines; derived from country in some cases</td>
<td>US</td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“postal-code”</strong></td>
<td>Postal code, post code, ZIP code, CEDEX code (if CEDEX, append “CEDEX”, and the arrondissement, if relevant, to the address-level2 field)</td>
<td>Free-form text, no newlines</td>
<td>02139</td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“cc-name”</strong></td>
<td>Full name as given on the payment instrument</td>
<td>Free-form text, no newlines</td>
<td>Tim Berners-Lee</td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“cc-given-name”</strong></td>
<td>Given name as given on the payment instrument (in some Western cultures, also known as the first name)</td>
<td>Free-form text, no newlines</td>
<td>Tim</td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“cc-additional-name”</strong></td>
<td>Additional names given on the payment instrument (in some Western cultures, also known as middle names, forenames other than the first name)</td>
<td>Free-form text, no newlines</td>
<td></td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“cc-family-name”</strong></td>
<td>Family name given on the payment instrument (in some Western cultures, also known as the last name or surname)</td>
<td>Free-form text, no newlines</td>
<td>Berners-Lee</td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“cc-number”</strong></td>
<td>Code identifying the payment instrument (e.g. the credit card number)</td>
<td>ASCII digits</td>
<td>4114360123456785</td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“cc-exp”</strong></td>
<td>Expiration date of the payment instrument</td>
<td>Valid month string in the range 1..12</td>
<td>2014-12</td>
<td>Month*</td>
</tr>
<tr>
<td><strong>“cc-exp-month”</strong></td>
<td>Month component of the expiration date of the payment instrument</td>
<td>Valid integer in the range 1..12</td>
<td>12</td>
<td>Numeric*</td>
</tr>
<tr>
<td><strong>“cc-exp-year”</strong></td>
<td>Year component of the expiration date of the payment instrument</td>
<td>Valid integer greater than zero</td>
<td>2014</td>
<td>Numeric*</td>
</tr>
<tr>
<td><strong>“cc-csc”</strong></td>
<td>Security code for the payment instrument (also known as the card security code (CSC), card validation code (CVC), card verification value (CVV), signature panel code (SPC), credit card ID (CCID), etc.)</td>
<td>ASCII digits</td>
<td>419</td>
<td>Text*</td>
</tr>
<tr>
<td><strong>“cc-type”</strong></td>
<td>Type of payment instrument</td>
<td>Free-form text, no newlines</td>
<td>Visa</td>
<td>Text*</td>
</tr>
<tr>
<td>Field name</td>
<td>Meaning</td>
<td>Canonical Format</td>
<td>Canonical Format Example</td>
<td>Control group</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>------------------</td>
<td>--------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>&quot;transaction-</td>
<td>The currency that the user would prefer the transaction to use</td>
<td>ISO 4217 currency code</td>
<td>GBP</td>
<td>Text&lt;sup&gt;604&lt;/sup&gt;</td>
</tr>
<tr>
<td>currency&quot;</td>
<td></td>
<td>(ISO4217)&lt;sup&gt;4450&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;transaction-</td>
<td>The amount that the user would like for the transaction (e.g. when</td>
<td>Valid floating-point</td>
<td>401.00</td>
<td>Numeric&lt;sup&gt;605&lt;/sup&gt;</td>
</tr>
<tr>
<td>amount&quot;</td>
<td>entering a bid or sale price)</td>
<td>number&lt;sup&gt;615&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;language&quot;</td>
<td>Preferred language</td>
<td>Valid BCP 47 language tag</td>
<td>en</td>
<td>Text&lt;sup&gt;604&lt;/sup&gt;</td>
</tr>
<tr>
<td>&quot;bday&quot;</td>
<td>Birthday</td>
<td>Valid date string&lt;sup&gt;81&lt;/sup&gt;</td>
<td>1955-06-08</td>
<td>Date&lt;sup&gt;605&lt;/sup&gt;</td>
</tr>
<tr>
<td>&quot;bday-day&quot;</td>
<td>Day component of birthday</td>
<td>Valid integer&lt;sup&gt;617&lt;/sup&gt; in the range 1..31</td>
<td>8</td>
<td>Numeric&lt;sup&gt;605&lt;/sup&gt;</td>
</tr>
<tr>
<td>&quot;bday-month&quot;</td>
<td>Month component of birthday</td>
<td>Valid integer&lt;sup&gt;617&lt;/sup&gt; in the range 1..12</td>
<td>6</td>
<td>Numeric&lt;sup&gt;605&lt;/sup&gt;</td>
</tr>
<tr>
<td>&quot;bday-year&quot;</td>
<td>Year component of birthday</td>
<td>Valid integer&lt;sup&gt;617&lt;/sup&gt; greater than zero</td>
<td>1955</td>
<td>Numeric&lt;sup&gt;605&lt;/sup&gt;</td>
</tr>
<tr>
<td>&quot;sex&quot;</td>
<td>Gender identity (e.g. Female, Fa'afafine)</td>
<td>Free-form text, no newlines</td>
<td>Male</td>
<td>Text&lt;sup&gt;604&lt;/sup&gt;</td>
</tr>
<tr>
<td>&quot;url&quot;</td>
<td>Home page or other web page corresponding to the company, person,</td>
<td>Valid URL string</td>
<td><a href="https://www.w3.org/People/Berners-Lee/">https://www.w3.org/People/Berners-Lee/</a></td>
<td>URL&lt;sup&gt;605&lt;/sup&gt;</td>
</tr>
<tr>
<td>&quot;photo&quot;</td>
<td>Photograph, icon, or other image corresponding to the company, person,</td>
<td>Valid URL string</td>
<td><a href="https://www.w3.org/Press/Stock/Berners-Lee/2001-europaeum-eighth.jpg">https://www.w3.org/Press/Stock/Berners-Lee/2001-europaeum-eighth.jpg</a></td>
<td>URL&lt;sup&gt;605&lt;/sup&gt;</td>
</tr>
<tr>
<td>&quot;tel&quot;</td>
<td>Full telephone number, including country code</td>
<td>ASCII digits and U+0020 SPACE characters, prefixed by a U+002B PLUS SIGN character (+)</td>
<td>+1 617 253 5702</td>
<td>Tel&lt;sup&gt;605&lt;/sup&gt;</td>
</tr>
<tr>
<td>&quot;tel-country-</td>
<td>Country code component of the telephone number</td>
<td>ASCII digits prefixed by a U+002B PLUS SIGN character (+)</td>
<td>+1</td>
<td>Text&lt;sup&gt;604&lt;/sup&gt;</td>
</tr>
<tr>
<td>code&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;tel-national&quot;</td>
<td>Telephone number without the country code component, with a country-</td>
<td>ASCII digits and U+0020 SPACE characters</td>
<td>617 253 5702</td>
<td>Text&lt;sup&gt;604&lt;/sup&gt;</td>
</tr>
<tr>
<td>&quot;tel-area-code&quot;</td>
<td>Area code component of the telephone number, with a country-internal</td>
<td>ASCII digits</td>
<td>617</td>
<td>Text&lt;sup&gt;604&lt;/sup&gt;</td>
</tr>
<tr>
<td>&quot;tel-local&quot;</td>
<td>Telephone number without the country code and area code components</td>
<td>ASCII digits</td>
<td>2535702</td>
<td>Text&lt;sup&gt;604&lt;/sup&gt;</td>
</tr>
<tr>
<td>&quot;tel-local-</td>
<td>First part of the component of the telephone number that follows the</td>
<td>ASCII digits</td>
<td>253</td>
<td>Text&lt;sup&gt;604&lt;/sup&gt;</td>
</tr>
<tr>
<td>prefix&quot;</td>
<td>area code, when that component is split into two components</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;tel-local-</td>
<td>Second part of the component of the telephone number that follows the</td>
<td>ASCII digits</td>
<td>5702</td>
<td>Text&lt;sup&gt;604&lt;/sup&gt;</td>
</tr>
<tr>
<td>suffix&quot;</td>
<td>area code, when that component is split into two components</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;tel-extension&quot;</td>
<td>Telephone number internal extension code</td>
<td>ASCII digits</td>
<td>1000</td>
<td>Text&lt;sup&gt;604&lt;/sup&gt;</td>
</tr>
<tr>
<td>&quot;email&quot;</td>
<td>Email address</td>
<td>Valid email address&lt;sup&gt;627&lt;/sup&gt;</td>
<td><a href="mailto:timbl@w3.org">timbl@w3.org</a></td>
<td></td>
</tr>
<tr>
<td>&quot;impp&quot;</td>
<td>URL representing an instant messaging protocol endpoint (for example,</td>
<td>Valid URL string</td>
<td>irc://example.org/timbl,isuser</td>
<td>URL&lt;sup&gt;605&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>“aim:goim?screenname=example” or “<a href="xmpp:fred@example.net">xmpp:fred@example.net</a>”)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The groups correspond to controls as follows:

**Text**

input<sup>517</sup> elements with a type<sup>519</sup> attribute in the Hidden<sup>523</sup> state
input<sup>517</sup> elements with a type<sup>519</sup> attribute in the Text<sup>524</sup> state
input<sup>517</sup> elements with a type<sup>519</sup> attribute in the Search<sup>524</sup> state
textarea<sup>575</sup> elements
select<sup>564</sup> elements

**Multiline**

input<sup>517</sup> elements with a type<sup>519</sup> attribute in the Hidden<sup>523</sup> state
textarea<sup>575</sup> elements
select<sup>564</sup> elements

**Password**

input<sup>517</sup> elements with a type<sup>519</sup> attribute in the Hidden<sup>523</sup> state
Address levels: The "address-level1" – "address-level4" fields are used to describe the locality of the street address. Different locales have different numbers of levels. For example, the US uses two levels (state and town), the UK uses one or two depending on the address (the post town, and in some cases the locality), and China can use three (province, city, district). The "address-level1" field represents the widest administrative division. Different locales order the fields in different ways; for example, in the US the town (level 2) precedes the state (level 1); while in Japan the prefecture (level 1) precedes the city (level 2) which precedes the district (level 3). Authors are encouraged to provide forms that are presented in a way that matches the country's conventions (hiding, showing, and rearranging fields accordingly as the user changes the country).
4.10.18.7.2 Processing model

Each `<input>` element to which the `autocomplete` attribute applies, each `<select>` element, and each `<textarea>` element, has an autofill hint set, an autofill scope, an autofill field name, a non-autofill credential type, and an IDL-exposed autofill value.

The autofill field name specifies the specific kind of data expected in the field, e.g. "street-address" or "cc-exp".

The autofill hint set identifies what address or contact information type the user agent is to look at, e.g. "shipping" or "billing".

The non-autofill credential type identifies a type of credential that may be offered by the user agent when the user interacts with the field alongside other autofill field values. If this value is "webauthn" instead of null, selecting a credential of that type will resolve a pending conditional mediation `navigator.credentials.get()` request, instead of autofilling the field.

For example, a sign-in page could instruct the user agent to either autofill a saved password, or show a public key credential that will resolve a pending conditional mediation `navigator.credentials.get()` request. A user can select either to sign-in.

```
<input name=password type=password autocomplete="current-password webauthn"/>
```

The autofill scope identifies the group of fields whose information concerns the same subject, and consists of the autofill hint set with, if applicable, the "section-*" prefix, e.g. "billing", "section-parent shipping", or "section-child shipping home".

These values are defined as the result of running the following algorithm:

1. If the element has no `autocomplete` attribute, then jump to the step labeled default.
2. Let tokens be the result of splitting the attribute's value on ASCII whitespace.
3. If tokens is empty, then jump to the step labeled default.
4. Let index be the index of the last token in tokens.
5. Let field be the indexth token in tokens.
6. Set the category, maximum tokens pair to the result of determining a field's category given field.
7. If category is null, then jump to the step labeled default.
8. If the number of tokens in tokens is greater than maximum tokens, then jump to the step labeled default.
9. If category is Off or Automatic but the element's `autocomplete` attribute is wearing the autofill anchor mantle, then jump to the step labeled default.
10. If category is Off, let the element's autofill field name be the string "off", let its autofill hint set be empty, and let its IDL-exposed autofill value be the string "off". Then, return.
11. If category is Automatic, let the element's autofill field name be the string "on", let its autofill hint set be empty, and let its IDL-exposed autofill value be the string "on". Then, return.
12. Let scope tokens be an empty list.
13. Let hint tokens be an empty set.
14. Let credential type be null.
15. Let IDL value have the same value as field.
16. If category is Credential and the indexth token in tokens is an ASCII case-insensitive match for "webauthn", then run the substeps that follow:
   1. Set credential type to "webauthn".
   2. If the indexth token in tokens is the first entry, then skip to the step labeled done.
   3. Decrement index by one.
4. Set the category, maximum tokens pair to the result of determining a field's category given the indexth token in tokens.

5. If category is not Normal and category is not Contact, then jump to the step labeled default.

6. If index is greater than maximum tokens minus one (i.e. if the number of remaining tokens is greater than maximum tokens), then jump to the step labeled default.

7. Set IDL value to the concatenation of the indexth token in tokens, a U+0020 SPACE character, and the previous value of IDL value.

17. If the indexth token in tokens is the first entry, then skip to the step labeled done.

18. Decrement index by one.

19. If category is Contact and the indexth token in tokens is an ASCII case-insensitive match for one of the strings in the following list, then run the substeps that follow:

   ◦  "home"
   ◦  "work"
   ◦  "mobile"
   ◦  "fax"
   ◦  "pager"

   The substeps are:
   1. Let contact be the matching string from the list above.
   2. Insert contact at the start of scope tokens.
   3. Add contact to hint tokens.
   4. Let IDL value be the concatenation of contact, a U+0020 SPACE character, and the previous value of IDL value.
   5. If the indexth entry in tokens is the first entry, then skip to the step labeled done.
   6. Decrement index by one.

20. If the indexth token in tokens is an ASCII case-insensitive match for one of the strings in the following list, then run the substeps that follow:

   ◦  "shipping"
   ◦  "billing"

   The substeps are:
   1. Let mode be the matching string from the list above.
   2. Insert mode at the start of scope tokens.
   3. Add mode to hint tokens.
   4. Let IDL value be the concatenation of mode, a U+0020 SPACE character, and the previous value of IDL value.
   5. If the indexth entry in tokens is the first entry, then skip to the step labeled done.
   6. Decrement index by one.

21. If the indexth entry in tokens is not the first entry, then jump to the step labeled default.

22. If the first eight characters of the indexth token in tokens are not an ASCII case-insensitive match for the string "section", then jump to the step labeled default.

23. Let section be the indexth token in tokens, converted to ASCII lowercase.

24. Insert section at the start of scope tokens.

25. Let IDL value be the concatenation of section, a U+0020 SPACE character, and the previous value of IDL value.

26. Done: Let the element's autofill hint set be hint tokens.

27. Let the element's non-autofill credential type be credential type.

28. Let the element's autofill scope be scope tokens.
29. Let the element’s autofill field name be field.

30. Let the element’s IDL-exposed autofill value be IDL value.

31. Return.

32. Default: Let the element’s IDL-exposed autofill value be the empty string, and its autofill hint set and autofill scope be empty.

33. If the element’s autocomplete attribute is wearing the autofill anchor mantle, then let the element’s autofill field name be the empty string and return.

34. Let form be the element’s form owner, if any, or null otherwise.

35. If form is not null and form’s autocomplete attribute is in the off state, then let the element’s autofill field name be "off".

To determine a field’s category, given field:

1. If the field is not an ASCII case-insensitive match for one of the tokens given in the first column of the following table, return the pair (null, null).

<table>
<thead>
<tr>
<th>Token</th>
<th>Maximum number of tokens</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;off&quot;</td>
<td>1</td>
<td>Off</td>
</tr>
<tr>
<td>&quot;on&quot;</td>
<td>1</td>
<td>Automatic</td>
</tr>
<tr>
<td>&quot;name&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;honorific-prefix&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;given-name&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;additional-name&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;family-name&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;honorific-suffix&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;nickname&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;organization-title&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;username&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;new-password&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;current-password&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;one-time-code&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;organization&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;street-address&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;address-line1&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;address-line2&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;address-line3&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;address-line4&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;address-level1&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;address-level2&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;address-level3&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;country&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;country-name&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;postal-code&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;cc-name&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;cc-given-name&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;cc-additional-name&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;cc-family-name&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;cc-number&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;cc-exp&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;cc-exp-month&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;cc-exp-year&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
<tr>
<td>&quot;cc-csc&quot;</td>
<td>3</td>
<td>Normal</td>
</tr>
</tbody>
</table>
For the purposes of autofill, a **control's data** depends on the kind of control:

**An input** element with its **type** attribute in the **Email** state and with the **multiple** attribute specified

The element's **values**.

**Any other input** element

A **textarea** element

The element's **value**.

**A select** element with its **multiple** attribute specified

The **option** elements in the select element's **list of options** that have their **selectedness** set to true.

**Any other select** element

The **option** element in the select element's **list of options** that has its **selectedness** set to true.

How to process the **autofill hint set**, **autofill scope**, and **autofill field name** depends on the mantle that the **autocomplete** attribute is wearing.

**When wearing the autofill expectation mantle** ...

When an element's **autofill field name** is "**off**", the user agent should not remember the **control's data**, and should not offer past values to the user.

**Note**

In addition, when an element's **autofill field name** is "**off**", **values are reset** when reactivating a document.

**Example**

Banks frequently do not want UAs to prefill login information:
When an element's autofill field name is not "off", the user agent may store the control's data, and may offer previously stored values to the user.

Example

For example, suppose a user visits a page with this control:

```html
<select name="country">
  <option>Afghanistan</option>
  <option>Albania</option>
  <option>Algeria</option>
  <option>Andorra</option>
  <option>Angola</option>
  <option>Antigua and Barbuda</option>
  <option>Argentina</option>
  <option>Armenia</option>
  <option>Yemen</option>
  <option>Zambia</option>
  <option>Zimbabwe</option>
</select>
```

This might render as follows:

![Example control]

Suppose that on the first visit to this page, the user selects "Zambia". On the second visit, the user agent could duplicate the entry for Zambia at the top of the list, so that the interface instead looks like this:

![Example control with duplicated entry]

When the autofill field name is "on", the user agent should attempt to use heuristics to determine the most appropriate values to offer the user, e.g. based on the element's name value, the position of the element in its tree, what other fields exist in the form, and so forth.

When the autofill field name is one of the names of the autofill fields described above, the user agent should provide suggestions that match the meaning of the field name as given in the table earlier in this section. The autofill hint set should
be used to select amongst multiple possible suggestions.

Example
For example, if a user once entered one address into fields that used the "shipping" keyword, and another address into fields that used the "billing" keyword, then in subsequent forms only the first address would be suggested for form controls whose autofill hint set contains the keyword "shipping". Both addresses might be suggested, however, for address-related form controls whose autofill hint set does not contain either keyword.

When wearing the autofill anchor mantle...

When the autofill field name is not the empty string, then the user agent must act as if the user had specified the control's data for the given autofill hint set, autofill scope, and autofill field name combination.

When the user agent autofills form controls, elements with the same form owner and the same autofill scope must use data relating to the same person, address, payment instrument, and contact details. When a user agent autofills "country" and "country-name" fields with the same form owner and autofill scope, and the user agent has a value for the "country" field(s), then the "country-name" field(s) must be filled using a human-readable name for the same country. When a user agent fills in multiple fields at once, all fields with the same autofill field name, form owner and autofill scope must be filled with the same value.

The "section-*" tokens in the autofill scope are opaque; user agents must not attempt to derive meaning from the precise values of these tokens.

This requirement interacts with the autofill anchor mantle also. Consider the following markup snippet:

```html
<form>
  <input type=hidden autocomplete="nickname" value="TreePlate">
  <input type=text autocomplete="nickname">
</form>
```

The only value that a conforming user agent could suggest in the text control is "TreePlate", the value given by the hidden input element.

The "section-*" tokens in the autofill scope are opaque; user agents must not attempt to derive meaning from the precise values of these tokens.

Example
For example, if a select element only has option elements with values "Steve" and "Rebecca", "Jay", and "Bob", and has an autofill field name "given-name", but the user agent's only idea for what to prefill the field with is "Evan", then the user agent cannot prefill the field. It would not be conforming to somehow set the select element to the value "Evan", since the user could not have done so themselves.

Example
Similarly, if a form for some reason contained both a "cc-exp" field and a "cc-exp-month" field, and the user agent prefilled the form, then the month component of the former would have to match the latter.

Example
This requirement interacts with the autofill anchor mantle also. Consider the following markup snippet:

```html
<form>
  <input type=hidden autocomplete="nickname" value="TreePlate">
  <input type=text autocomplete="nickname">
</form>
```

The only value that a conforming user agent could suggest in the text control is "TreePlate", the value given by the hidden input element.

The "section-*" tokens in the autofill scope are opaque; user agents must not attempt to derive meaning from the precise values of these tokens.

Example
For example, it would not be conforming if the user agent decided that it should offer the address it knows to be the user's daughter's address for "section-child" and the addresses it knows to be the user's spouses' addresses for "section-spouse".

The autocompletion mechanism must be implemented by the user agent acting as if the user had modified the control's data, and must be done at a time where the element is mutable (e.g. just after the element has been inserted into the document, or when the user agent stops parsing). User agents must only prefill controls using values that the user could have entered.

Example
For example, if a select element only has option elements with values "Steve" and "Rebecca", "Jay", and "Bob", and has an autofill field name "given-name", but the user agent's only idea for what to prefill the field with is "Evan", then the user agent cannot prefill the field. It would not be conforming to somehow set the select element to the value "Evan", since the user could not have done so themselves.
A user agent prefilling a form control must not discriminate between form controls that are in a document tree and those that are connected; that is, it is not conforming to make the decision on whether or not to autofill based on whether the element’s root is a shadow root versus a Document.

A user agent prefilling a form control’s value must not cause that control to suffer from a type mismatch, suffer from being too long, suffer from being too short, suffer from an underflow, suffer from an overflow, or suffer from a step mismatch. A user agent prefilling a form control’s value must not cause that control to suffer from a pattern mismatch either. Where possible given the control’s constraints, user agents must use the format given as canonical in the aforementioned table. Where it’s not possible for the canonical format to be used, user agents should use heuristics to attempt to convert values so that they can be used.

Example

For example, if the user agent knows that the user’s middle name is "Ines", and attempts to prefill a form control that looks like this:

```
<input name="middle-initial" maxlength=1 autocomplete="additional-name">
```

...then the user agent could convert "Ines" to "I" and prefill it that way.

Example

A more elaborate example would be with month values. If the user agent knows that the user’s birthday is the 27th of July 2012, then it might try to prefill all of the following controls with slightly different values, all driven from this information:

<table>
<thead>
<tr>
<th>Control</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;input name=&quot;b&quot; type=month autocomplete=&quot;bday&quot;&gt;</code></td>
<td>2012-07</td>
</tr>
<tr>
<td><code>&lt;select name=&quot;c&quot; autocomplete=&quot;bday&quot;&gt;</code></td>
<td>July</td>
</tr>
<tr>
<td><code>&lt;input name=&quot;a&quot; type=number min=1 max=12 autocomplete=&quot;bday-month&quot;&gt;</code></td>
<td>7</td>
</tr>
<tr>
<td><code>&lt;input name=&quot;a&quot; type=number min=0 max=11 autocomplete=&quot;bday-month&quot;&gt;</code></td>
<td>6</td>
</tr>
<tr>
<td><code>&lt;input name=&quot;a&quot; type=number min=1 max=11 autocomplete=&quot;bday-month&quot;&gt;</code></td>
<td></td>
</tr>
</tbody>
</table>

A user agent may allow the user to override an element’s autofill field name, e.g. to change it from "off" to "on" to allow values to be remembered and prefilled despite the page author’s objections, or to always "off", never remembering values.

More specifically, user agents may in particular consider replacing the autofill field name of form controls that match the description given in the first column of the following table, when their autofill field name is either "on" or "off", with the value given in the second cell of that row. If this table is used, the replacements must be done in tree order, since all but the first row references the autofill field name of earlier elements. When the descriptions below refer to form controls being preceded or followed by others, they mean in the list of listed elements that share the same form owner.

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### 4.10.19 APIs for the text control selections

The `input` and `textarea` elements define several attributes and methods for handling their selection. Their shared algorithms are defined here.

**For web developers (non-normative)**

```javascript
element.select()  // Selects everything in the text control.

element.selectionStart [ = value ]  // Returns the offset to the start of the selection. Can be set, to change the start of the selection.

element.selectionEnd [ = value ]  // Returns the offset to the end of the selection. Can be set, to change the end of the selection.

element.selectionDirection [ = value ]  // Returns the current direction of the selection. Can be set, to change the direction of the selection. The possible values are "forward", "backward", and "none".

element.setSelectionRange(start, end [, direction])  // Changes the selection to cover the given substring in the given direction. If the direction is omitted, it will be reset to be the platform default (none or forward).

element.setRangeText(replacement [, start, end [, selectionMode ]])  // Replaces a range of text with the new text. If the start and end arguments are not provided, the range is assumed to be the selection. The final argument determines how the selection will be set after the text has been replaced. The possible values are:

- "select"  // Selects the newly inserted text.
- "start"  // Moves the selection to just before the inserted text.
- "end"  // Moves the selection to just after the selected text.
- "preserve"  // Attempts to preserve the selection. This is the default.
```

All `input` elements to which these APIs apply, and all `textarea` elements, have either a `selection` or a `text entry cursor position` at all times (even for elements that are not being rendered), measured in offsets into the `code units` of the control's `relevant value`. The initial state must consist of a `text entry cursor` at the beginning of the control.

For `input` elements, these APIs must operate on the element's `value`. For `textarea` elements, these APIs must operate on
the element’s API value\(^{593}\). In the below algorithms, we call the value string being operated on the **relevant value**.

### Example

The use of API value\(^{593}\) instead of raw value\(^{576}\) for textarea\(^{575}\) elements means that U+000D (CR) characters are normalized away. For example,

```html
textarea id="demo">
<script>
  demo.value = "A\r\nB";
  demo.setRangeText("replaced", 0, 2);
  assert(demo.value === "replacedB");
</script>
```

If we had operated on the raw value\(^{576}\) of "A\r\nB", then we would have replaced the characters "A\r", ending up with a result of "replaced\nB". But since we used the API value\(^{593}\) of "A\nB", we replaced the characters "A\n", giving "replacedB".

### Note

Characters with no visible rendering, such as U+200D ZERO WIDTH JOINER, still count as characters. Thus, for instance, the selection can include just an invisible character, and the text insertion cursor can be placed to one side or another of such a character.

Whenever the relevant value\(^{614}\) changes for an element to which these APIs apply, run these steps:

1. If the element has a selection\(^{612}\):
   1. If the start of the selection is now past the end of the relevant value\(^{614}\), set it to the end of the relevant value\(^{614}\).
   2. If the end of the selection is now past the end of the relevant value\(^{614}\), set it to the end of the relevant value\(^{614}\).
   3. If the user agent does not support empty selection, and both the start and end of the selection are now pointing to the end of the relevant value\(^{614}\), then instead set the element's text entry cursor position\(^{613}\) to the end of the relevant value\(^{614}\), removing any selection.

2. Otherwise, the element must have a text entry cursor position\(^{613}\) position. If it is now past the end of the relevant value\(^{614}\), set it to the end of the relevant value\(^{614}\).

### Note

In some cases where the relevant value\(^{614}\) changes, other parts of the specification will also modify the text entry cursor position\(^{613}\), beyond just the clamping steps above. For example, see the value\(^{579}\) setter for textarea\(^{575}\).

Where possible, user interface features for changing the text selection\(^{611}\) in input\(^{517}\) and textarea\(^{575}\) elements must be implemented using the set the selection range\(^{616}\) algorithm so that, e.g., all the same events fire.

The selections\(^{613}\) of input\(^{517}\) and textarea\(^{575}\) elements have a selection direction, which is either "forward", "backward", or "none". The exact meaning of the selection direction depends on the platform. This direction is set when the user manipulates the selection. The initial selection direction\(^{614}\) must be "none" if the platform supports that direction, or "forward" otherwise.

To set the selection direction of an element to a given direction, update the element's selection direction\(^{614}\) to the given direction, unless the direction is "none" and the platform does not support that direction; in that case, update the element's selection direction\(^{614}\) to "forward".

### Note

On Windows, the direction indicates the position of the caret relative to the selection: a "forward" selection has the caret at the end of the selection and a "backward" selection has the caret at the start of the selection. Windows has no "none" direction.

On Mac, the direction indicates which end of the selection is affected when the user adjusts the size of the selection using the arrow keys with the Shift modifier: the "forward" direction means the end of the selection is modified, and the "backward" direction means the start of the selection is modified. The "none" direction is the default on Mac, it indicates that no particular direction has yet been selected. The user sets the direction implicitly when first adjusting the selection, based on which directional arrow key was used.
The `select()` method, when invoked, must run the following steps:

1. If this element is an `input` element, and either `select()` does not apply to this element or the corresponding control has no selectable text, return.

   **Example**
   
   For instance, in a user agent where `<input type=color>` is rendered as a color well with a picker, as opposed to a text control accepting a hexadecimal color code, there would be no selectable text, and thus calls to the method are ignored.

2. **Set the selection range** with 0 and infinity.

The `selectionStart` attribute's getter must run the following steps:

1. If this element is an `input` element, and `selectionStart` does not apply to this element, return null.
2. If there is no `selection`, return the `code unit` offset within the `relevant value` to the character that immediately follows the text entry cursor.
3. Return the `code unit` offset within the `relevant value` to the character that immediately follows the start of the `selection`.

The `selectionStart` attribute's setter must run the following steps:

1. If this element is an `input` element, and `selectionStart` does not apply to this element, throw an "InvalidStateError" DOMException.
2. Let `end` be the value of this element's `selectionEnd` attribute.
3. If `end` is less than the given value, set `end` to the given value.
4. **Set the selection range** with the given value, `end`, and the value of this element's `selectionDirection` attribute.

The `selectionEnd` attribute's getter must run the following steps:

1. If this element is an `input` element, and `selectionEnd` does not apply to this element, return null.
2. If there is no `selection`, return the `code unit` offset within the `relevant value` to the character that immediately follows the text entry cursor.
3. Return the `code unit` offset within the `relevant value` to the character that immediately follows the end of the `selection`.

The `selectionEnd` attribute's setter must run the following steps:

1. If this element is an `input` element, and `selectionEnd` does not apply to this element, throw an "InvalidStateError" DOMException.
2. **Set the selection range** with the value of this element's `selectionStart` attribute, the given value, and the value of this element's `selectionDirection` attribute.

The `selectionDirection` attribute's getter must run the following steps:

1. If this element is an `input` element, and `selectionDirection` does not apply to this element, return null.
2. Return this element's `selection direction`.

The `selectionDirection` attribute's setter must run the following steps:

1. If this element is an `input` element, and `selectionDirection` does not apply to this element, throw an "InvalidStateError" DOMException.
2. **Set the selection range** with the value of this element's `selectionStart` attribute, the value of this element's `selectionEnd` attribute, and the given value.

The `setSelectionRange(start, end, direction)` method, when invoked, must run the following steps:
1. If this element is an input\(^{517}\) element, and \texttt{setSelectionRange()}\(^{615}\) does not apply\(^{520}\) to this element, throw an "InvalidStateError" DOMException.

2. Set the selection range\(^{616}\) with start, end, and direction.

To set the selection range with an integer or null start, an integer or null or the special value infinity end, and optionally a string direction, run the following steps:

1. If start is null, let start be zero.

2. If end is null, let end be zero.

3. Set the selection\(^{613}\) of the text control to the sequence of code units within the relevant value\(^{614}\) starting with the code unit at the start position (in logical order) and ending with the code unit at the (end-1)th position. Arguments greater than the length of the relevant value\(^{614}\) of the text control (including the special value infinity) must be treated as pointing at the end of the text control. If end is less than or equal to start then the start of the selection and the end of the selection must both be placed immediately before the character with offset end. In UAs where there is no concept of an empty selection, this must set the cursor to be just before the character with offset end.

4. If direction is not identical to either "backward" or "forward", or if the direction argument was not given, set direction to "none".

5. Set the selection direction\(^{614}\) of the text control to direction.

6. If the previous steps caused the selection\(^{613}\) of the text control to be modified (in either extent or direction\(^{614}\)), then queue an element task\(^{610}\) on the user interaction task source\(^{611}\) given the element to fire an event named select\(^{1162}\) at the element, with the bubbles attribute initialized to true.

The \texttt{setRangeText(replacement, start, end, selectMode)} method, when invoked, must run the following steps:

1. If this element is an input\(^{517}\) element, and \texttt{setRangeText()}\(^{616}\) does not apply\(^{520}\) to this element, throw an "InvalidStateError" DOMException.

2. Set this element's dirty value flag\(^{593}\) to true.

3. If the method has only one argument, then let start and end have the values of the \texttt{selectionStart}\(^{615}\) attribute and the \texttt{selectionEnd}\(^{615}\) attribute respectively. Otherwise, let start, end have the values of the second and third arguments respectively.

4. If start is greater than end, then throw an "IndexSizeError" DOMException.

5. If start is greater than the length of the relevant value\(^{614}\) of the text control, then set it to the length of the relevant value\(^{614}\) of the text control.

6. If end is greater than the length of the relevant value\(^{614}\) of the text control, then set it to the length of the relevant value\(^{614}\) of the text control.

7. Let selection start be the current value of the \texttt{selectionStart}\(^{615}\) attribute.

8. Let selection end be the current value of the \texttt{selectionEnd}\(^{615}\) attribute.

9. If start is less than end, delete the sequence of code units within the element's relevant value\(^{614}\) starting with the code unit at the startth position and ending with the code unit at the (end-1)th position.

10. Insert the value of the first argument into the text of the relevant value\(^{614}\) of the text control, immediately before the startth code unit.

11. Let new length be the length of the value of the first argument.

12. Let new end be the sum of start and new length.

13. Run the appropriate set of substeps from the following list:

- If the fourth argument's value is "select"
  
  Let selection start be start.

  Let selection end be new end.
If the fourth argument's value is "start"
Let selection start and selection end be start.

If the fourth argument's value is "end"
Let selection start and selection end be new end.

If the fourth argument's value is "preserve"

If the method has only one argument

1. Let old length be end minus start.
2. Let delta be new length minus old length.
3. If selection start is greater than end, then increment it by delta. (If delta is negative, i.e. the new text is shorter than the old text, then this will decrease the value of selection start.)

   Otherwise: if selection start is greater than start, then set it to start. (This snaps the start of the selection to the start of the new text if it was in the middle of the text that it replaced.)

4. If selection end is greater than end, then increment it by delta in the same way.

   Otherwise: if selection end is greater than start, then set it to new end. (This snaps the end of the selection to the end of the new text if it was in the middle of the text that it replaced.)

14. Set the selection range with selection start and selection end.

The `setRangeText()` method uses the following enumeration:

```
IDL enum SelectionMode {
    "select",
    "start",
    "end",
    "preserve" // default
};
```

Example

To obtain the currently selected text, the following JavaScript suffices:

```javascript
var selectionText = control.value.substring(control.selectionStart, control.selectionEnd);
```

...where `control` is the `input` or `textarea` element.

Example

To add some text at the start of a text control, while maintaining the text selection, the three attributes must be preserved:

```javascript
var oldStart = control.selectionStart;
var oldEnd = control.selectionEnd;
var oldDirection = control.selectionDirection;
var prefix = "http://";
control.value = prefix + control.value;
control.setSelectionRange(oldStart + prefix.length, oldEnd + prefix.length, oldDirection);
```

...where `control` is the `input` or `textarea` element.

4.10.20 Constraints

4.10.20.1 Definitions

A `submittable element` is a candidate for constraint validation except when a condition has barred the element from
constraint validation. (For example, an element is barred from constraint validation if it has a datalist element ancestor.)

An element can have a custom validity error message defined. Initially, an element must have its custom validity error message set to the empty string. When its value is not the empty string, the element is suffering from a custom error. It can be set using the setCustomValidity() method, except for form-associated custom elements. Form-associated custom elements can have a custom validity error message set via their ElementInternals object’s setValidity() method. The user agent should use the custom validity error message when alerting the user to the problem with the control.

An element can be constrained in various ways. The following is the list of validity states that a form control can be in, making the control invalid for the purposes of constraint validation. (The definitions below are non-normative; other parts of this specification define more precisely when each state applies or does not.)

**Suffering from being missing**
When a control has no value but has a required attribute (input required, textarea required); or, more complicated rules for select elements and controls in radio button groups, as specified in their sections.

When the setValidity() method sets valueMissing flag to true for a form-associated custom element.

**Suffering from a type mismatch**
When a control that allows arbitrary user input has a value that is not in the correct syntax (Email, URL).

When the setValidity() method sets typeMismatch flag to true for a form-associated custom element.

**Suffering from a pattern mismatch**
When a control has a value that doesn't satisfy the pattern attribute.

When the setValidity() method sets patternMismatch flag to true for a form-associated custom element.

**Suffering from being too long**
When a control has a value that is too long for the form control maxlength attribute (input, textarea maxlength).

When the setValidity() method sets tooLong flag to true for a form-associated custom element.

**Suffering from being too short**
When a control has a value that is too short for the form control minlength attribute (input, textarea minlength).

When the setValidity() method sets tooShort flag to true for a form-associated custom element.

**Suffering from an underflow**
When a control has a value that is not the empty string and is too low for the min attribute.

When the setValidity() method sets rangeUnderflow flag to true for a form-associated custom element.

**Suffering from an overflow**
When a control has a value that is not the empty string and is too high for the max attribute.

When the setValidity() method sets rangeOverflow flag to true for a form-associated custom element.

**Suffering from a step mismatch**
When a control has a value that doesn't fit the rules given by the step attribute.

When the setValidity() method sets stepMismatch flag to true for a form-associated custom element.

**Suffering from bad input**
When a control has incomplete input and the user agent does not think the user ought to be able to submit the form in its current state.

When the setValidity() method sets badInput flag to true for a form-associated custom element.

**Suffering from a custom error**
When a control's custom validity error message (as set by the element's setCustomValidity() method or
An element can still suffer from these states even when the element is disabled; thus these states can be represented in the DOM even if validating the form during submission wouldn't indicate a problem to the user.

An element satisfies its constraints if it is not suffering from any of the above validity states.

4.10.20.2 Constraint validation

When the user agent is required to statically validate the constraints of form element form, it must run the following steps, which return either a positive result (all the controls in the form are valid) or a negative result (there are invalid controls) along with a (possibly empty) list of elements that are invalid and for which no script has claimed responsibility:

1. Let controls be a list of all the submittable elements whose form owner is form, in tree order.
2. Let invalid controls be an initially empty list of elements.
3. For each element field in controls, in tree order:
   1. If field is not a candidate for constraint validation, then move on to the next element.
   2. Otherwise, if field satisfies its constraints, then move on to the next element.
   3. Otherwise, add field to invalid controls.
4. If invalid controls is empty, then return a positive result.
5. Let unhandled invalid controls be an initially empty list of elements.
6. For each element field in invalid controls, if any, in tree order:
   1. Let notCanceled be the result of firing an event named invalid at field, with the cancelable attribute initialized to true.
   2. If notCanceled is true, then add field to unhandled invalid controls.
7. Return a negative result with the list of elements in the unhandled invalid controls list.

If a user agent is to interactively validate the constraints of form element form, then the user agent must run the following steps:

1. Statically validate the constraints of form, and let unhandled invalid controls be the list of elements returned if the result was negative.
2. If the result was positive, then return that result.
3. Report the problems with the constraints of at least one of the elements given in unhandled invalid controls to the user.
   - User agents may focus one of those elements in the process, by running the focusing steps for that element, and may change the scrolling position of the document, or perform some other action that brings the element to the user's attention. For elements that are form-associated custom elements, user agents should use their validation anchor instead, for the purposes of these actions.
   - User agents may report more than one constraint violation.
   - User agents may coalesce related constraint violation reports if appropriate (e.g. if multiple radio buttons in a group are marked as required, only one error need be reported).
   - If one of the controls is not being rendered (e.g. it has the hidden attribute set) then user agents may report a script error.
4. Return a negative result.
The `willValidate` attribute's getter must return true, if this element is a candidate for constraint validation, and false otherwise (i.e., false if any conditions are barring it from constraint validation).

The `willValidate` attribute of `ElementInternals` interface, on getting, must throw a `UnsupportedError` DOMException if the target element is not a form-associated custom element. Otherwise, it must return true if the target element is a candidate for constraint validation, and false otherwise.

The `setCustomValidity(error)` method steps are:

1. Set error to the result of normalizing newlines given error.
2. Set the `custom validity error message` to `error`.

Example

In the following example, a script checks the value of a form control each time it is edited, and whenever it is not a valid value, uses the `setCustomValidity()` method to set an appropriate message.

```html
<label>Feeling: <input name=f type="text" oninput="check(this)"></input></label>

<script>
function check(input) {
  if (input.value == "good" ||
      input.value == "fine" ||
      input.value == "tired") {
    input.setCustomValidity("'" + input.value + '" is not a feeling.');
  } else {
    // input is fine -- reset the error message
    input.setCustomValidity('');
  }
}
</script>
```

The `validity` attribute's getter must return a `ValidityState` object that represents the `validity states` of this element. This object is `live`.

The `validity` attribute of `ElementInternals` interface, on getting, must throw a "`NotSupportedError`" DOMException if the `target element` is not a `form-associated custom element`. Otherwise, it must return a `ValidityState` object that represents the `validity states` of the `target element`. This object is `live`.

```idl
[Exposed=Window]
interface ValidityState {
  readonly attribute boolean valueMissing;
  readonly attribute boolean typeMismatch;
  readonly attribute boolean patternMismatch;
  readonly attribute boolean tooLong;
  readonly attribute boolean tooShort;
  readonly attribute boolean rangeUnderflow;
  readonly attribute boolean rangeOverflow;
  readonly attribute boolean stepMismatch;
  readonly attribute boolean badInput;
  readonly attribute boolean customError;
  readonly attribute boolean valid;
};
```

A `ValidityState` object has the following attributes. On getting, they must return true if the corresponding condition given in the following list is true, and false otherwise.

- **valueMissing**
  The control is `suffering from being missing`.

- **typeMismatch**
  The control is `suffering from a type mismatch`.

- **patternMismatch**
  The control is `suffering from a pattern mismatch`.

- **tooLong**
  The control is `suffering from being too long`.

- **tooShort**
  The control is `suffering from being too short`. 

621
rangeUnderflow
The control is suffering from an underflow\textsuperscript{618}.

rangeOverflow
The control is suffering from an overflow\textsuperscript{618}.

stepMismatch
The control is suffering from a step mismatch\textsuperscript{618}.

badInput
The control is suffering from bad input\textsuperscript{618}.

customError
The control is suffering from a custom error\textsuperscript{618}.

valid
None of the other conditions are true.

The check validity steps for an element `element` are:

1. If `element` is a candidate for constraint validation\textsuperscript{617} and does not satisfy its constraints\textsuperscript{619}, then:
   1. Fire an event named `invalid`\textsuperscript{1451} at `element`, with the `cancelable` attribute initialized to true (though canceling has no effect).
   2. Return false.

2. Return true.

The checkValidity() method, when invoked, must run the check validity steps\textsuperscript{622} on this element.

The checkValidity() method of the `ElementInternals`\textsuperscript{766} interface must run these steps:

1. Let `element` be this `ElementInternals`\textsuperscript{766}'s target element\textsuperscript{766}.

2. If `element` is not a form-associated custom element\textsuperscript{755}, then throw a "NotSupportedError"\textsuperscript{DOMException}.

3. Run the check validity steps\textsuperscript{622} on `element`.

The report validity steps for an element `element` are:

1. If `element` is a candidate for constraint validation\textsuperscript{617} and does not satisfy its constraints\textsuperscript{619}, then:
   1. Let `report` be the result of firing an event named `invalid`\textsuperscript{1451} at `element`, with the `cancelable` attribute initialized to true.

   2. If `report` is true, then report the problems with the constraints of this element to the user. When reporting the problem with the constraints to the user, the user agent may run the focusing steps\textsuperscript{836} for `element`, and may change the scrolling position of the document, or perform some other action that brings `element` to the user's attention. User agents may report more than one constraint violation, if `element` suffers from multiple problems at once. If `element` is not being rendered\textsuperscript{91369}, then the user agent may, instead of notifying the user, report the error\textsuperscript{1085} for the running script\textsuperscript{1085}.

   3. Return false.

2. Return true.

The reportValidity() method, when invoked, must run the report validity steps\textsuperscript{622} on this element.

The reportValidity() method of the `ElementInternals`\textsuperscript{766} interface must run these steps:

1. Let `element` be this `ElementInternals`\textsuperscript{766}'s target element\textsuperscript{766}.

2. If `element` is not a form-associated custom element\textsuperscript{755}, then throw a "NotSupportedError"\textsuperscript{DOMException}.

3. Run the report validity steps\textsuperscript{622} on `element`. 622
The `validationMessage` attribute's getter must run these steps:

1. If this element is not a [candidate for constraint validation](#) or if this element [satisfies its constraints](#), then return the empty string.

2. Return a suitably localized message that the user agent would show the user if this were the only form control with a validity constraint problem. If the user agent would not actually show a textual message in such a situation (e.g., it would show a graphical cue instead), then return a suitably localized message that expresses (one or more of) the validity constraint(s) that the control does not satisfy. If the element is a [candidate for constraint validation](#) and is [suffering from a custom error](#), then the [custom validity error message](#) should be present in the return value.

### 4.10.20.4 Security

Servers should not rely on client-side validation. Client-side validation can be intentionally bypassed by hostile users, and unintentionally bypassed by users of older user agents or automated tools that do not implement these features. The constraint validation features are only intended to improve the user experience, not to provide any kind of security mechanism.

---

### 4.10.21 Form submission

#### 4.10.21.1 Introduction

This section is non-normative.

When a form is submitted, the data in the form is converted into the structure specified by the `enctype`, and then sent to the destination specified by the `action` using the given `method`.

For example, take the following form:

```html
<form action="/find.cgi" method="get">
  <input type="text" name="t"/>
  <input type="search" name="q"/>
  <input type="submit"/>
</form>
```

If the user types in "cats" in the first field and "fur" in the second, and then hits the submit button, then the user agent will load `/find.cgi?t=cats&q=fur`.

On the other hand, consider this form:

```html
<form action="/find.cgi" method="post" enctype="multipart/form-data">
  <input type="text" name="t"/>
  <input type="search" name="q"/>
  <input type="submit"/>
</form>
```

Given the same user input, the result on submission is quite different: the user agent instead does an HTTP POST to the given URL, with as the entity body something like the following text:

```
------kYFr0d4jNJEgCervE
Content-Disposition: form-data; name="t"

cats
------kYFr0d4jNJEgCervE
Content-Disposition: form-data; name="q"

t
------kYFr0d4jNJEgCervE--
```
4.10.21.2 Implicit submission

A form's default button is the first submit button in tree order whose form owner is that form element.

If the user agent supports letting the user submit a form implicitly (for example, on some platforms hitting the "enter" key while a text control is focused implicitly submits the form), then doing so for a form, whose default button has activation behavior and is not disabled, must cause the user agent to fire a click event at that default button.

If the form has no submit button, then the implicit submission mechanism must perform the following steps:

1. If the form has more than one field that blocks implicit submission, then return.
2. Submit the form element itself with userInvolvement set to "activation".

For the purpose of the previous paragraph, an element is a field that blocks implicit submission of a form element if it is an input element whose form owner is that form element and whose type attribute is in one of the following states: Text, Search, Telephone, URL, Email, Password, Date, Month, Week, Time, Local Date and Time, Number.

4.10.21.3 Form submission algorithm

Each form element has a constructing entry list boolean, initially false.

Each form element has a firing submission events boolean, initially false.

To submit a form element form from an element submitter (typically a button), given an optional boolean submitted from submit() method (default false) and an optional user navigation involvement userInvolvement (default "none"):

1. If form cannot navigate, then return.
2. If form's constructing entry list is true, then return.
4. If form document's active sandboxing flag set has its sandboxed forms browsing context flag set, then return.
5. If submitted from submit() method is false, then:
   1. If form's firing submission events is true, then return.
   2. Set form's firing submission events to true.
   3. For each element field in the list of submittable elements whose form owner is form, set field's user validity to true.
   4. If the submitter element's no-validate state is false, then interactively validate the constraints of form and examine the result. If the result is negative (i.e., the constraint validation concluded that there were invalid fields and probably informed the user of this), then:
      1. Set form's firing submission events to false.
      2. Return.
6. Let shouldContinue be the result of firing an event named submit at form using SubmitEvent, with the submitter attribute initialized to submitterButton, the bubbles attribute initialized to true, and the cancelable attribute initialized to true.
7. Set form's firing submission events to false.
8. If shouldContinue is false, then return.
9. If form cannot navigate, then return.

**Note**
Cannot navigate is run again as dispatching the submit event could have changed the outcome.

6. Let encoding be the result of picking an encoding for the form.

7. Let entry list be the result of constructing the entry list with form, submitter, and encoding.

8. Assert: entry list is not null.

9. If form cannot navigate, then return.

**Note**
Cannot navigate is run again as dispatching the formdata event in constructing the entry list could have changed the outcome.

10. Let method be the submitter element's method.

11. If method is dialog, then:

   1. If form does not have an ancestor dialog element, then return.
   2. Let subject be form's nearest ancestor dialog element.
   3. Let result be null.
   4. If submitter is an input element whose type attribute is in the Image Button state, then:
      1. Let \((x, y)\) be the selected coordinate.
      2. Set result to the concatenation of \(x\), ",", and \(y\).
   5. Otherwise, if submitter has a value, then set result to that value.
   6. Close the dialog subject with result.
   7. Return.

12. Let action be the submitter element's action.

13. If action is the empty string, let action be the URL of the form document.

14. Let parsed action be the result of encoding-parsing a URL given action, relative to submitter's node document.

15. If parsed action is failure, then return.

16. Let enctype be the submitter element's enctype.

17. Let formTarget be null.

18. If the submitter element is a submit button and it has a formtarget attribute, then set formTarget to the formtarget attribute value.

19. Let target be the result of getting an element's target given submitter's form owner and formTarget.

20. Let noopener be the result of getting an element's noopener with form and target.

21. Let targetNavigable be the first return value of applying the rules for choosing a navigable given target, form's node navigable, and noopener.

22. If targetNavigable is null, then return.

23. Let historyHandling be "auto".

24. If form document equals targetNavigable's active document, and form document has not yet completely loaded, then set historyHandling to "replace".

25. Select the appropriate row in the table below based on scheme as given by the first cell of each row. Then, select the
appropriate cell on that row based on method as given in the first cell of each column. Then, jump to the steps named in that cell and defined below the table.

<table>
<thead>
<tr>
<th>scheme</th>
<th>GET</th>
<th>POST</th>
</tr>
</thead>
<tbody>
<tr>
<td>http</td>
<td>Mutate action URL</td>
<td>Submit as entity body</td>
</tr>
<tr>
<td>https</td>
<td>Mutate action URL</td>
<td>Submit as entity body</td>
</tr>
<tr>
<td>ftp</td>
<td>Get action URL</td>
<td>Get action URL</td>
</tr>
<tr>
<td>javascript</td>
<td>Get action URL</td>
<td>Get action URL</td>
</tr>
<tr>
<td>data</td>
<td>Mutate action URL</td>
<td>Get action URL</td>
</tr>
<tr>
<td>mailto</td>
<td>Mail with headers</td>
<td>Mail as body</td>
</tr>
</tbody>
</table>

If scheme is not one of those listed in this table, then the behavior is not defined by this specification. User agents should, in the absence of another specification defining this, act in a manner analogous to that defined in this specification for similar schemes.

Each form element has a planned navigation, which is either null or a task when the form is first created, its planned navigation must be set to null. In the behaviors described below, when the user agent is required to plan to navigate to a URL url given an optional POST resource or-null postResource (default null), it must run the following steps:

1. Let referrerPolicy be the empty string.
2. If the form element's link types include the noreferrer keyword, then set referrerPolicy to "no-referrer".
3. If the form has a non-null planned navigation, remove it from its task queue.
4. Queue an element task on the DOM manipulation task source given the form element and the following steps:
   1. Set the form's planned navigation to null.
   2. Navigate targetNavigable to url using the form element's node document, with historyHandling set to historyHandling, userInvolvement set to userInvolvement, referrerPolicy set to referrerPolicy, documentResource set to postResource, and formDataEntryList set to entry list.
5. Set the form's planned navigation to the just-queued task.

The behaviors are as follows:

**Mutate action URL**

Let pairs be the result of converting to a list of name-value pairs with entry list.

Let query be the result of running the application/x-www-form-urlencoded serializer with pairs and encoding.

Set parsed action's query component to query.

Plan to navigate to parsed action.

**Submit as entity body**

**Assert:** method is POST.

Switch on enctype:

→ application/x-www-form-urlencoded

Let pairs be the result of converting to a list of name-value pairs with entry list.

Let body be the result of running the application/x-www-form-urlencoded serializer with pairs and encoding.

Set body to the result of encoding body.

Let mimeType be application/x-www-form-urlencoded.

→ multipart/form-data

Let body be the result of running the multipart/form-data encoding algorithm with entry list and encoding.
Let `mimeType` be the isomorphic encoding of the concatenation of "multipart/form-data; boundary=" and the `multipart/form-data boundary string` generated by the multipart/form-data encoding algorithm.

Let `pairs` be the result of converting to a list of name-value pairs with `entry list`.

Let `body` be the result of running the text/plain encoding algorithm with `pairs`.

Set `body` to the result of encoding `body` using encoding.

Let `mimeType` be `text/plain`.

Plan to navigate to parsed action given a POST resource whose request body is `body` and request content-type is `mimeType`.

Get action URL

Plan to navigate to parsed action.

Mail with headers

Let `pairs` be the result of converting to a list of name-value pairs with `entry list`.

Let `headers` be the result of running the application/x-www-form-urlencoded serializer with `pairs` and encoding.

Replace occurrences of U+002B PLUS SIGN characters (+) in `headers` with the string "%20".

Set parsed action's `query` to `headers`.

Plan to navigate to parsed action.

Mail as body

Let `pairs` be the result of converting to a list of name-value pairs with `entry list`.

Switch on `enctype`:

→ text/plain

Let `body` be the result of running the text/plain encoding algorithm with `pairs`.

Set `body` to the result of running UTF-8 percent-encode on `body` using the default encode set.

⇒ Otherwise

Let `body` be the result of running the application/x-www-form-urlencoded serializer with `pairs` and encoding.

If parsed action's `query` is null, then set it to the empty string.

If parsed action's `query` is not the empty string, then append a single U+0026 AMPERSAND character (&) to it.

Append "body=" to parsed action's `query`.

Append `body` to parsed action's `query`.

Plan to navigate to parsed action.

4.10.21.4 Constructing the entry list

An entry list is a list of entries, typically representing the contents of a form. An entry is a tuple consisting of a name (a scalar value string) and a value (either a scalar value string or a File object).

To create an entry given a string `name`, a string or `Blob` object value, and optionally a scalar value string `filename`:
1. Set \textit{name} to the result of \textit{converting name} into a \textit{scalar value string}.

2. If \textit{value} is a string, then set \textit{value} to the result of \textit{converting value} into a \textit{scalar value string}.

3. Otherwise:
   1. If \textit{value} is not a \textit{File} object, then set \textit{value} to a new \textit{File} object, representing the same bytes, whose \textit{name} attribute value is \textit{blob}.
   2. If \textit{filename} is given, then set \textit{value} to a new \textit{File} object, representing the same bytes, whose \textit{name} attribute is \textit{filename}.

\textbf{Note} These operations will create a new \textit{File} object if either \textit{filename} is given or the passed \textit{Blob} is not a \textit{File} object. In those cases, the identity of the passed \textit{Blob} object is not kept.

4. Return an \textit{entry} whose \textit{name} is \textit{name} and whose \textit{value} is \textit{value}.

\textbf{To construct the entry list} given a \textit{form}, an optional \textit{submitter} (default null), and an optional \textit{encoding} (default \textit{UTF-8}):

1. If \textit{form}'s \textit{constructing entry list} is true, then return null.

2. Set \textit{form}'s \textit{constructing entry list} to true.

3. Let \textit{controls} be a list of all the \textit{submittable elements} whose \textit{form owner} is \textit{form}, in \textit{tree order}.

4. Let \textit{entry list} be a new empty \textit{entry list}.

5. For each element \textit{field} in \textit{controls}, in \textit{tree order}:
   1. If any of the following are true:
      - \textit{field} has a \textit{datalist} element ancestor;
      - \textit{field} is \textit{disabled};
      - \textit{field} is a \textit{button} but it is not \textit{submitter};
      - \textit{field} is an \textit{input} element whose \textit{type} attribute is in the \textit{Checkbox} state and whose \textit{checkedness} is false; or
      - \textit{field} is an \textit{input} element whose \textit{type} attribute is in the \textit{Radio Button} state and whose \textit{checkedness} is false,

   then continue.

   2. If the \textit{field} element is an \textit{input} element whose \textit{type} attribute is in the \textit{Image Button} state, then:
      1. If the \textit{field} element is not \textit{submitter}, then continue.
      2. If the \textit{field} element has a \textit{name} attribute specified and its value is not the empty string, let \textit{name} be that value followed by U+002E (.). Otherwise, let \textit{name} be the empty string.
      3. Let \textit{name} be the concatenation of \textit{name} and U+0078 (x).
      4. Let \textit{name} be the concatenation of \textit{name} and U+0079 (y).
      5. Let (x, y) be the \textit{selected coordinate}.
      6. Create an \textit{entry} with \textit{name} and \textit{x}, and append it to \textit{entry list}.
      7. Create an \textit{entry} with \textit{name} and \textit{y}, and append it to \textit{entry list}.
      8. Continue.

   3. If the \textit{field} is a \textit{form-associated custom element}, then perform the \textit{entry construction algorithm} given \textit{field} and \textit{entry list}, then continue.

   4. If either the \textit{field} element does not have a \textit{name} attribute specified, or its \textit{name} attribute's value is the empty string, then continue.
5. Let name be the value of the field element's name attribute.

6. If the field element is a select element, then for each option element in the select element's list of options whose selectedness is true and that is not disabled, create an entry with name and the value of the option element, and append it to entry list.

7. Otherwise, if the field element is an input element whose type attribute is in the Checkbox state or the Radio Button state, then:
   1. If the field element has a value attribute specified, then let value be the value of that attribute; otherwise, let value be the string "on".
   2. Create an entry with name and value, and append it to entry list.

8. Otherwise, if the field element is an input element whose type attribute is in the File Upload state, then:
   1. If there are no selected files, then create an entry with name and a new File object with an empty name, application/octet-stream as type, and an empty body, and append it to entry list.
   2. Otherwise, for each file in selected files, create an entry with name and a File object representing the file, and append it to entry list.

9. Otherwise, if the field element is an input element whose type attribute is in the Hidden state and name is an ASCII case-insensitive match for "_charset_":
   1. Let charset be the name of encoding.
   2. Create an entry with name and charset, and append it to entry list.

10. Otherwise, create an entry with name and the value of the field element, and append it to entry list.

11. If the element has a dirname attribute, that attribute's value is not the empty string, and the element is an auto-directionality form-associated element:
   1. Let dirname be the value of the element's dirname attribute.
   2. Let dir be the string "ltr" if the directionality of the element is ltr, and "rtl" otherwise (i.e., when the directionality of the element is 'rtl').
   3. Create an entry with dirname and dir, and append it to entry list.

6. Let form data be a new FormData object associated with entry list.

7. Fire an event named formdata at form using FormDataEvent, with the form attribute initialized to form data and the bubbles attribute initialized to true.

8. Set form's constructing entry list to false.

9. Return a clone of entry list.

4.10.21.5 Selecting a form submission encoding

If the user agent is to pick an encoding for a form, it must run the following steps:

1. Let encoding be the document's character encoding.

2. If the form element has an accept-charset attribute, set encoding to the return value of running these substeps:
   1. Let input be the value of the form element's accept-charset attribute.
   2. Let candidate encoding labels be the result of splitting input on ASCII whitespace.
   3. Let candidate encodings be an empty list of character encodings.
   4. For each token in candidate encoding labels in turn (in the order in which they were found in input), get an encoding for the token and, if this does not result in failure, append the encoding to candidate encodings.
   5. If candidate encodings is empty, return UTF-8.
6. Return the first encoding in candidate encodings.

3. Return the result of getting an output encoding from encoding.

### 4.10.21.6 Converting an entry list to a list of name-value pairs

The application/x-www-form-urlencoded and text/plain encoding algorithms take a list of name-value pairs, where the values must be strings, rather than an entry list, where the value can be a File. The following algorithm performs the conversion.

To convert to a list of name-value pairs an entry list entry list, run these steps:

1. Let list be an empty list of name-value pairs.
2. For each entry of entry list:
   1. Let name be entry's name, with every occurrence of U+000D (CR) not followed by U+000A (LF), and every occurrence of U+000A (LF) not preceded by U+000D (CR), replaced by a string consisting of U+000D (CR) and U+000A (LF).
   2. If entry's value is a File object, then let value be entry's value's name. Otherwise, let value be entry's value.
   3. Replace every occurrence of U+000D (CR) not followed by U+000A (LF), and every occurrence of U+000A (LF) not preceded by U+000D (CR), in value, by a string consisting of U+000D (CR) and U+000A (LF).
   4. Append to list a new name-value pair whose name is name and whose value is value.
3. Return list.

### 4.10.21.7 URL-encoded form data

See URL for details on application/x-www-form-urlencoded, [URL](#).

### 4.10.21.8 Multipart form data

The multipart/form-data encoding algorithm, given an entry list entry list and an encoding encoding, is as follows:

1. For each entry of entry list:
   1. Replace every occurrence of U+000D (CR) not followed by U+000A (LF), and every occurrence of U+000A (LF) not preceded by U+000D (CR), in entry's name, by a string consisting of U+000D (CR) and U+000A (LF).
   2. If entry's value is not a File object, then replace every occurrence of U+000D (CR) not followed by U+000A (LF), and every occurrence of U+000A (LF) not preceded by U+000D (CR), in entry's value, by a string consisting of U+000D (CR) and U+000A (LF).
2. Return the byte sequence resulting from encoding the entry list using the rules described by RFC 7578, Returning Values from Forms: multipart/form-data, given the following conditions: [RFC7578](#).
   1. Each entry in entry list is a field, the name of the entry is the field name and the value of the entry is the field value.
   2. The order of parts must be the same as the order of fields in entry list. Multiple entries with the same name must be treated as distinct fields.
   3. Field names, field values for non-file fields, and filenames for file fields, in the generated multipart/form-data resource must be set to the result of encoding the corresponding entry's name or value with encoding, converted to a byte sequence.
   4. For field names and filenames for file fields, the result of the encoding in the previous bullet point must be escaped by replacing any 0x0A (LF) bytes with the byte sequence `%0A`, 0x0D (CR) with `%0D` and 0x22 ("), with `%22`. The user agent must not perform any other escapes.
The parts of the generated multipart/form-data resource that correspond to non-file fields must not have a `Content-Type` header specified.

The boundary used by the user agent in generating the return value of this algorithm is the multipart/form-data boundary string. (This value is used to generate the MIME type of the form submission payload generated by this algorithm.)

For details on how to interpret multipart/form-data payloads, see RFC 7578. [RFC7578]

4.10.21.9 Plain text form data

The text/plain encoding algorithm, given a list of name-value pairs pairs, is as follows:

1. Let result be the empty string.
2. For each pair in pairs:
   1. Append pair's name to result.
   2. Append a single U+003D EQUALS SIGN character (=) to result.
   3. Append pair's value to result.
   4. Append a U+000D CARRIAGE RETURN (CR) U+000A LINE FEED (LF) character pair to result.
3. Return result.

Payloads using the text/plain format are intended to be human readable. They are not reliably interpretable by computer, as the format is ambiguous (for example, there is no way to distinguish a literal newline in a value from the newline at the end of the value).

4.10.21.10 The SubmitEvent interface

IDL

[Exposed=Window]

interface SubmitEvent : Event {
  constructor(DOMString type, optional SubmitEventInit eventInitDict = {});

  readonly attribute HTMLElement? submitter;
};

dictionary SubmitEventInit : EventInit {
  HTMLElement? submitter = null;
};

For web developers (non-normative)

event.submitter

Returns the element representing the submit button that triggered the form submission, or null if the submission was not triggered by a button.

The submitter attribute must return the value it was initialized to.

4.10.21.11 The FormDataEvent interface

IDL

[Exposed=Window]

interface FormDataEvent : Event {
  constructor(DOMString type, FormDataEventInit eventInitDict);

  readonly attribute FormData formData;
};
The `FormData` attribute must return the value it was initialized to. It represents a `FormData` object associated to the entry list that is constructed when the form is submitted.

4.10.22 Resetting a form

When a `form` element is reset, run these steps:

1. Let `reset` be the result of firing an event named `reset` at `form`, with the `bubbles` and `Cancelable` attributes initialized to true.

2. If `reset` is true, then invoke the `reset algorithm` of each `resettable element` whose `form owner` is `form`.

Each `resettable element` defines its own `reset algorithm`. Changes made to form controls as part of these algorithms do not count as changes caused by the user (and thus, e.g., do not cause `input` events to fire).

4.11 Interactive elements

4.11.1 The `details` element

Categories:
- Flow content
- Interactive content
- Palpable content

Contexts in which this element can be used:
Where `flow content` is expected.

Content model:
One `summary` element followed by `flow content`.

Tag omission in `text/html`:
Neither tag is omissible.

Content attributes:
- `Global attributes`
- `name` — Name of group of mutually-exclusive `details` elements
- `open` — Whether the details are visible

Accessibility considerations:
- For authors
- For implementers

DOM interface:

```
interface HTMLDetailsElement : HTMLElement {
    [HTMLConstructor] constructor();
} [Exposed=Window]
```
The `details` element represents a disclosure widget from which the user can obtain additional information or controls.

**Note**

As with all HTML elements, it is not conforming to use the `details` element when attempting to represent another type of control. For example, tab widgets and menu widgets are not disclosure widgets, so abusing the `details` element to implement these patterns is incorrect.

**Note**

The `details` element is not appropriate for footnotes. Please see the section on footnotes for details on how to mark up footnotes.

The first `summary` element child of the element, if any, represents the summary or legend of the details. If there is no child `summary` element, the user agent should provide its own legend (e.g. "Details").

The rest of the element's contents represents the additional information or controls.

The `name` content attribute gives the name of the group of related `details` elements that the element is a member of. Opening one member of this group causes other members of the group to close. If the attribute is specified, its value must not be the empty string.

Before using this feature, authors should consider whether this grouping of related `details` elements into an exclusive accordion is helpful or harmful to users. While using an exclusive accordion can reduce the maximum amount of space that a set of content can occupy, it can also frustrate users who have to open many items to find what they want or users who want to look at the contents of multiple items at the same time.

A document must not contain more than one `details` element in the same `details name group` that has the `open` attribute present. Authors must not use script to add `details` elements to a document in a way that would cause a `details name group` to have more than one `details` element with the `open` attribute present.

**Note**

The group of elements that is created by a common `name` attribute is exclusive, meaning that at most one of the `details` elements can be open at once. While this exclusivity is enforced by user agents, the resulting enforcement immediately changes the `open` attributes in the markup. This requirement on authors forbids such misleading markup.

A document must not contain a `details` element that is a descendant of another `details` element in the same `details name group`.

Documents that use the `name` attribute to group multiple related `details` elements should keep those related elements together in a containing element (such as a `section` element or `article` element). When it makes sense for the group to be introduced with a heading, authors should put that heading in a `heading` element at the start of the containing element.

**Note**

Visually and programmatically grouping related elements together can be important for accessible user experiences. This can help users understand the relationship between such elements. When related elements are in disparate sections of a web page rather than being grouped, the elements' relationships to each other can be less discoverable or understandable.

The `open` content attribute is a `boolean attribute`. If present, it indicates that both the summary and the additional information is to be shown to the user. If the attribute is absent, only the summary is to be shown.

When the element is created, if the attribute is absent, the additional information should be hidden; if the attribute is present, that information should be shown. Subsequently, if the attribute is removed, then the information should be hidden; if the attribute is added, the information should be shown.

The user agent should allow the user to request that the additional information be shown or hidden. To honor a request for the details to be shown, the user agent must set the `open` attribute on the element to the empty string. To honor a request for the information to be hidden, the user agent must remove the `open` attribute from the element.
The details name group that contains a details element also contains all the other details elements that fulfill all of the following conditions:

- Both a and b are in the same tree.
- They both have a name attribute, their name attributes are not the empty string, and the value of a's name attribute equals the value of b's name attribute.

Every details element has a details toggle task tracker, which is a toggle task tracker or null, initially null.

The following attribute change steps, given element, localName, oldValue, value, and namespace, are used for all details elements:

1. If namespace is not null, then return.
2. If localName is name, then ensure details exclusivity by closing the given element if needed given element.
3. If localName is open, then:
   1. If one of oldValue or value is null and the other is not null, run the following steps, which are known as the details notification task steps, for this details element:
      1. If oldValue is null, queue a details toggle event task given the details element, "closed", and "open".
      2. Otherwise, queue a details toggle event task given the details element, "open", and "closed".
   2. If oldValue is null and value is not null, then ensure details exclusivity by closing other elements if needed given element.

The details HTML element insertion steps, given insertedNode, are:

1. Ensure details exclusivity by closing the given element if needed given insertedNode.

To queue a details toggle event task given a details element element, a string oldState, and a string newState:

1. If element's details toggle task tracker is not null, then:
   1. Set oldState to element's details toggle task tracker's old state.
   2. Remove element's details toggle task tracker's task from its task queue.
   3. Set element's details toggle task tracker to null.
2. Queue an element task given the DOM manipulation task source and element to run the following steps:
   1. Fire an event named toggle at element, using ToggleEvent, with the oldState attribute initialized to oldState and the newState attribute initialized to newState.
   2. Set element's details toggle task tracker to null.
3. Set element's details toggle task tracker to a struct with task set to the just-queued task and old state set to oldState.
To ensure details exclusivity by closing other elements if needed given a `details` element:

1. **Assert**: `element` has an `open` attribute.
2. If `element` does not have a `name` attribute, or its `name` attribute is the empty string, then return.
3. Let `document` be `element`'s `node document`.
4. Let `oldFlag` be the value of `document`'s `fire mutation events flag`.
5. Set `document`'s `fire mutation events flag` to false.
6. Let `groupMembers` be a list of elements, containing all elements in `element`'s `details name group` except for `element`, in tree order.
7. **For each** `element otherElement` of `groupMembers`:
   1. If the `open` attribute is set on `otherElement`, then:
      1. **Assert**: `otherElement` is the only element in `groupMembers` that has the `open` attribute set.
      2. **Remove** the `open` attribute on `otherElement`.
      3. **Break**.
8. Set `document`'s `fire mutation events flag` to `oldFlag`.

To ensure details exclusivity by closing the given element if needed given a `details` element:

1. If `element` does not have an `open` attribute, then return.
2. If `element` does not have a `name` attribute, or its `name` attribute is the empty string, then return.
3. Let `document` be `element`'s `node document`.
4. Let `oldFlag` be the value of `document`'s `fire mutation events flag`.
5. Set `document`'s `fire mutation events flag` to false.
6. Let `groupMembers` be a list of elements, containing all elements in `element`'s `details name group` except for `element`, in tree order.
7. **For each** `element otherElement` of `groupMembers`:
   1. If the `open` attribute is set on `otherElement`, then:
      1. **Remove** the `open` attribute on `element`.
      2. **Break**.
8. Set `document`'s `fire mutation events flag` to `oldFlag`.

The `name` and `open` IDL attributes must reflect the respective content attributes of the same name.

The **ancestor details revealing algorithm** is to run the following steps on `currentNode`:

1. **While** `currentNode` has a parent node within the **flat tree**:
   1. If `currentNode` is slotted into the second slot of a `details` element:
      1. Set `currentNode` to the `details` element which `currentNode` is slotted into.
      2. If the `open` attribute is not set on `currentNode`, then set the `open` attribute on `currentNode` to the empty string.
   2. Otherwise, set `currentNode` to the parent node of `currentNode` within the **flat tree**.

**Example**

The following example shows the `details` element being used to hide technical details in a progress report.
Example

The following shows how a details element can be used to hide some controls by default:

```html
<details>
  <summary><label for=fn>Name & Extension:</label></summary>
  <p><input type=text id=fn name=fn value="Pillar Magazine.pdf"></p>
  <p><label><input type=checkbox name=ext checked> Hide extension</label></p>
</details>
```

One could use this in conjunction with other details in a list to allow the user to collapse a set of fields down to a small set of headings, with the ability to open each one.
In these examples, the summary really just summarizes what the controls can change, and not the actual values, which is less than ideal.

Example

The following example shows the `name` attribute of the `details` element being used to create an exclusive accordion, a set of `details` elements where a user action to open one `details` element causes any open `details` to close.

```xml
<section class="characteristics">
  <details name="frame-characteristics">
    <summary>Material</summary>
    The picture frame is made of solid oak wood.
  </details>
  <details name="frame-characteristics">
    <summary>Size</summary>
    The picture frame fits a photo 40cm tall and 30cm wide.
  </details>
</section>
```
The frame is 45cm tall, 35cm wide, and 2cm thick.
</details>
<details name="frame-characteristics">
<summary>Color</summary>
The picture frame is available in its natural wood color, or with black stain.
</details>
</section>

Example
The following example shows what happens when the open attribute is set on a details element that is part of a set of elements using the name attribute to create an exclusive accordion.

Given the initial markup:

```html
<section class="characteristics">
  <details name="frame-characteristics" id="d1" open>...
  </details>
  <details name="frame-characteristics" id="d2">...
  </details>
  <details name="frame-characteristics" id="d3">...
</section>
```

and the script:

```javascript
document.getElementById("d2").setAttribute("open", "");
```

then the resulting tree after the script executes will be equivalent to the markup:

```html
<section class="characteristics">
  <details name="frame-characteristics" id="d1">...
  </details>
  <details name="frame-characteristics" id="d2" open>...
  </details>
  <details name="frame-characteristics" id="d3">...
</section>
```

because setting the open attribute on d2 removes it from d1.

The same happens when the user activates the summary element inside of d2.

Example
Because the open attribute is added and removed automatically as the user interacts with the control, it can be used in CSS to style the element differently based on its state. Here, a style sheet is used to animate the color of the summary when the element is opened or closed:

```css
<details>
  <summary>Automated Status: Operational</summary>
  <p>Velocity: 12m/s</p>
  <p>Direction: North</p>
</details>
```
4.11.2 The `summary` element

Categories:
None.

Contexts in which this element can be used:
As the first child of a `details` element.

Content model:
Phrasing content, optionally intermixed with `heading content`.

Tag omission in text/html:
Neither tag is omissible.

Content attributes:
Global attributes

Accessibility considerations:
For authors.
For implementers.

DOM interface:
Uses `HTMLElement`.

The `summary` element represents a summary, caption, or legend for the rest of the contents of the `summary` element's parent `details` element, if any.

A `summary` element is a summary for its parent details if the following algorithm returns true:

1. If this `summary` element has no parent, then return false.
2. Let `parent` be this `summary` element's parent.
3. If `parent` is not a `details` element, then return false.
4. If `parent`'s first `summary` element child is not this `summary` element, then return false.
5. Return true.

The activation behavior of `summary` elements is to run the following steps:

1. If this `summary` element is not the summary for its parent details, then return.
2. Let `parent` be this `summary` element's parent.
3. If the `open` attribute is present on `parent`, then remove it. Otherwise, set `parent`'s `open` attribute to the empty string.

Note
This will then run the details notification task steps.

4.11.3 Commands

4.11.3.1 Facets

A command is the abstraction behind menu items, buttons, and links. Once a command is defined, other parts of the interface can refer to the same command, allowing many access points to a single feature to share facets such as the Disabled State.

Commands are defined to have the following facets:

Label
The name of the command as seen by the user.

Access Key
A key combination selected by the user agent that triggers the command. A command might not have an Access Key.
Hidden State

Whether the command is hidden or not (basically, whether it should be shown in menus).

Disabled State

Whether the command is relevant and can be triggered or not.

Action

The actual effect that triggering the command will have. This could be a scripted event handler, a URL to which to navigate, or a form submission.

User agents may expose the commands that match the following criteria:

- The Hidden State facet is false (visible)
- The element is in a document with a non-null browsing context.
- Neither the element nor any of its ancestors has a hidden attribute specified.

User agents are encouraged to do this especially for commands that have Access Keys, as a way to advertise those keys to the user.

Example

For example, such commands could be listed in the user agent's menu bar.

4.11.3.2 Using the a element to define a command

An element with an attribute defines a command.

The Label of the command is the element's descendant text content.

The Access Key of the command is the element's assigned access key, if any.

The Hidden State of the command is true (hidden) if the element has a hidden attribute, and false otherwise.

The Disabled State facet of the command is true if the element or one of its ancestors is inert, and false otherwise.

The Action of the command is to fire a click event at the element.

4.11.3.3 Using the button element to define a command

A button element always defines a command.

The Label, Access Key, Hidden State, and Action facets of the command are determined as for a elements (see the previous section).

The Disabled State of the command is true if the element or one of its ancestors is inert, or if the element's disabled state is set, and false otherwise.

4.11.3.4 Using the input element to define a command

An element whose attribute is in one of the Submit Button, Reset Button, Image Button, Button, Radio Button, or Checkbox states defines a command.

The Label of the command is determined as follows:

- If the attribute is in one of the Submit Button, Reset Button, Image Button, or Button states, then the Label is the string given by the value attribute, if any, and a UA-dependent, locale-dependent value that the UA uses to label the button itself if the attribute is absent.
• Otherwise, if the element is a labeled control, then the Label is the descendant text content of the first label element in tree order whose labeled control is the element in question. (In JavaScript terms, this is given by element.labels[0].textContent.)

• Otherwise, if the value attribute is present, then the Label is the value of that attribute.

• Otherwise, the Label is the empty string.

The Access Key of the command is the element's assigned access key, if any.

The Hidden State of the command is true (hidden) if the element has a hidden attribute, and false otherwise.

The Disabled State of the command is true if the element or one of its ancestors is inert, or if the element's disabled state is set, and false otherwise.

The Action of the command is to fire a click event at the element.

4.11.3.5 Using the option element to define a command

An option element with an ancestor select element and either no value attribute or a value attribute that is not the empty string defines a command.

The Label of the command is the value of the option element's label attribute, if there is one, or else the option element's descendant text content, with ASCII whitespace stripped and collapsed.

The Access Key of the command is the element's assigned access key, if any.

The Hidden State of the command is true (hidden) if the element has a hidden attribute, and false otherwise.

The Disabled State of the command is true if the element is disabled, or if its nearest ancestor select element is disabled, or if it or one of its ancestors is inert, and false otherwise.

If the option's nearest ancestor select element has a multiple attribute, the Action of the command is to toggle the option element. Otherwise, the Action is to pick the option element.

4.11.3.6 Using the accesskey attribute on a legend element to define a command

A legend element defines a command if all of the following are true:

• It has an assigned access key.

• It is a child of a fieldset element.

• Its parent has a descendant that defines a command that is neither a label element nor a legend element. This element, if it exists, is the legend element's accesskey delegatee.

The Label of the command is the element's descendant text content.

The Access Key of the command is the element's assigned access key.

The Hidden State, Disabled State, and Action facets of the command are the same as the respective facets of the legend element's accesskey delegatee.

Example

In this example, the legend element specifies an accesskey, which, when activated, will delegate to the input element.
inside the `<legend>` element.

```html
<fieldset>
  <legend accesskey=p>
    <label>I want <input name=pizza type=number step=1 value=1 min=0>
pizza(s) with these toppings</label>
  </legend>
  <label><input name=pizza-cheese type=checkbox checked> Cheese</label>
  <label><input name=pizza-ham type=checkbox checked> Ham</label>
  <label><input name=pizza-pineapple type=checkbox> Pineapple</label>
</fieldset>
```

## 4.11.3.7 Using the `accesskey` attribute to define a command on other elements

An element that has an assigned access key defines a command.

If one of the earlier sections that define elements that define commands define that this element defines a command, then that section applies to this element, and this section does not. Otherwise, this section applies to that element.

The `Label` of the command depends on the element. If the element is a labeled control, the descendant text content of the first `label` element in tree order whose labeled control is the element in question is the `Label` (in JavaScript terms, this is given by `element.labels[0].textContent`). Otherwise, the `Label` is the element's descendant text content.

The `Access Key` of the command is the element's assigned access key.

The `Hidden State` of the command is true (hidden) if the element has a `hidden` attribute, and false otherwise.

The `Disabled State` of the command is true if the element or one of its ancestors is `inert`, and false otherwise.

The `Action` of the command is to run the following steps:

1. Run the focusing steps for the element.
2. Fire a click event at the element.

## 4.11.4 The `dialog` element

**Categories:**
- Flow content

**Contexts in which this element can be used:**
Where flow content is expected.

**Content model:**
- Flow content

**Tag omission in text/html:**
Neither tag is omissible.

**Content attributes:**
- Global attributes
  - `open` — Whether the dialog box is showing

**Accessibility considerations:**
- For authors
- For implementers
The `dialog` element represents a transitory part of an application, in the form of a small window (“dialog box”), which the user interacts with to perform a task or gather information. Once the user is done, the dialog can be automatically closed by the application, or manually closed by the user.

Especially for modal dialogs, which are a familiar pattern across all types of applications, authors should work to ensure that dialogs in their web applications behave in a way that is familiar to users of non-web applications.

### Note

As with all HTML elements, it is not conforming to use the `dialog` element when attempting to represent another type of control. For example, context menus, tooltips, and popup listboxes are not dialog boxes, so abusing the `dialog` element to implement these patterns is incorrect.

An important part of user-facing dialog behavior is the placement of initial focus. The dialog focusing steps attempt to pick a good candidate for initial focus when a dialog is shown, but might not be a substitute for authors carefully thinking through the correct choice to match user expectations for a specific dialog. As such, authors should use the `autofocus` attribute on the descendant element of the dialog that the user is expected to immediately interact with after the dialog opens. If there is no such element, then authors should use the `autofocus` attribute on the `dialog` element itself.

### Example

In the following example, a dialog is used for editing the details of a product in an inventory management web application.

```html
<dialog>
  <label>Product Number</label> <input type="text" readonly>
  <label>Product Name</label> <input type="text" autofocus>
</dialog>
```

If the `autofocus` attribute was not present, the Product Number field would have been focused by the dialog focusing steps. Although that is reasonable behavior, the author determined that the more relevant field to focus was the Product Name field, as the Product Number field is readonly and expects no user input. So, the author used autofocus to override the default.

Even if the author wants to focus the Product Number field by default, they are best off explicitly specifying that by using autofocus on that `input` element. This makes the intent obvious to future readers of the code, and ensures the code stays robust in the face of future updates. (For example, if another developer added a close button, and positioned it in the node tree before the Product Number field).

Another important aspect of user behavior is whether dialogs are scrollable or not. In some cases, overflow (and thus scrollability) cannot be avoided, e.g., when it is caused by the user’s high text zoom settings. But in general, scrollable dialogs are not expected by users. Adding large text nodes directly to dialog elements is particularly bad as this is likely to cause the dialog element itself to overflow. Authors are best off avoiding them.

### Example

The following terms of service dialog respects the above suggestions.

```html
<dialog style="height: 80vh;">
  <div style="overflow: auto; height: 60vh; autofocus">
    <p>By placing an order via this Web site on the first day of the fourth month of the year
```
The open attribute is a boolean attribute. When specified, it indicates that the dialog element is active and that the user can interact with it. A dialog element without an open attribute specified should not be shown to the user. This requirement may be implemented indirectly through the style layer. For example, user agents that support the suggested default rendering implement this requirement using the CSS rules described in the Rendering section.

The tabindex attribute must not be specified on dialog elements.

Note how the dialog focusing steps would have picked the scrollable div element by default, but similarly to the previous example, we have placed autofocus on the div so as to be more explicit and robust against future changes.

In contrast, if the elements expressing the terms of service did not have such a wrapper div element, then the dialog itself would become scrollable, violating the above advice. Furthermore, in the absence of any autofocus attribute, such a markup pattern would have violated the above advice and tripped up the dialog focusing steps’s default behavior, and caused focus to jump to the Agree button, which is a bad user experience.

Note

Removing the open attribute will usually hide the dialog. However, doing so has a number of strange additional consequences:

- The close event will not be fired.
- The close method, and any close requests, will no longer be able to close the dialog.
- If the dialog was shown using its showModal method, the Document will still be blocked.

For these reasons, it is generally better to never remove the open attribute manually. Instead, use the close method to close the dialog, or the hidden attribute to hide it.

For web developers (non-normative)

dialog.show()

Displays the dialog element.

dialog.showModal()

Displays the dialog element and makes it the top-most modal dialog.

This method honors the autofocus attribute.

dialog.close([ result ])

Closes the dialog element.

The argument, if provided, provides a return value.

dialog.returnValue[ = result ]

Returns the dialog’s return value.

Can be set, to update the return value.

The show() method steps are:
The showModal() method steps are:

1. If this has an open attribute and the is modal flag of this is false, then return.
2. If this has an open attribute, then throw an "InvalidStateError" DOMException.
3. Add an open attribute to this, whose value is the empty string.
4. Set this's previously focused element to the focused element.
5. Let hideUntil be the result of running topmost popover ancestor given this, null, and false.
6. If hideUntil is null, then set hideUntil to this's node document.
7. Run hide all popovers until given hideUntil, false, and true.
8. Run the dialog focusing steps given this.

The showModel() method steps are:

1. If this has an open attribute and the is modal flag of this is true, then return.
2. If this has an open attribute, then throw an "InvalidStateError" DOMException.
3. If this is not connected, then throw an "InvalidStateError" DOMException.
4. If this is in the popover showing state, then throw an "InvalidStateError" DOMException.
5. Add an open attribute to this, whose value is the empty string.
6. Set the is modal flag of this to true.
7. Let this's node document be blocked by the modal dialog this.

Note
This will cause the focused area of the document to become inert (unless that currently focused area is a shadow-including descendant of subject). In such cases, the focused area of the document will soon be reset to the viewport. In a couple steps we will attempt to find a better candidate to focus.

8. If this's node document's top layer does not already contain this, then add an element to the top layer given this.
9. Set this's close watcher to the result of establishing a close watcher given this's relevant global object, with:
   - cancelAction given canPreventClose being to return the result of firing an event named cancel at this, with the cancelable attribute initialized to canPreventClose.
   - closeAction being to close the dialog given this and null.
10. Set this's previously focused element to the focused element.
11. Let hideUntil be the result of running topmost popover ancestor given this, null, and false.
12. If hideUntil is null, then set hideUntil to this's node document.
13. Run hide all popovers until given hideUntil, false, and true.
14. Run the dialog focusing steps given this.

The dialog focusing steps, given a dialog element subject, are as follows:

1. Let control be null.
2. If subject has the autofocus attribute, then set control to subject.
3. If control is null, then set control to the focus delegate of subject.
4. If control is null, then set control to subject.
5. Run the focusing steps for control.

Note
If control is not focusable, this will do nothing. This would only happen if subject had no focus delegate, and the user...
Let $\text{topDocument}$ be control's node navigable's top-level traversable's active document.

7. If control's node document's origin is not the same as the origin of $\text{topDocument}$, then return.

8. Empty $\text{topDocument}$'s autofocus candidates.

9. Set $\text{topDocument}$'s autofocus processed flag to true.

The dialog HTML element removing steps, given removedNode and oldParent, are:

1. If removedNode's close watcher is not null, then:
   1. Destroy removedNode's close watcher.
   2. Set removedNode's close watcher to null.

2. If removedNode's node document's top layer contains removedNode, then remove an element from the top layer immediately given removedNode.

The close($\text{returnValue}$) method steps are:

1. If $\text{returnValue}$ is not given, then set it to null.

2. Close the dialog this with $\text{returnValue}$.

When a dialog element subject is to be closed, with null or a string result, run these steps:

1. If subject does not have an open attribute, then return.

2. Remove subject's open attribute.

3. If the is modal flag of subject is true, then request an element to be removed from the top layer given subject.

4. Let wasModal be the value of subject's is modal flag.

5. Set the is modal flag of subject to false.

6. If result is not null, then set the $\text{returnValue}$ attribute to result.

7. If subject's previously focused element is not null, then:
   1. Let element be subject's previously focused element.
   2. Set subject's previously focused element to null.
   3. If subject's node document's focused area of the document's DOM anchor is a shadow-including inclusive descendant of element, or wasModal is true, then run the focusing steps for element; the viewport should not be scrolled by doing this step.

8. Queue an element task on the user interaction task source given the subject element to fire an event named close at subject.

9. If subject's close watcher is not null, then:
   1. Destroy subject's close watcher.
   2. Set subject's close watcher to null.

The $\text{returnValue}$ IDL attribute, on getting, must return the last value to which it was set. On setting, it must be set to the new value.

When the element is created, it must be set to the empty string.

**Note**

We use show/close as the verbs for dialog elements, as opposed to verb pairs that are more commonly thought of as antonyms such as show/hide or open/close, due to the following constraints:
Each dialog element has a close watcher, which is a close watcher or null, initially null.

Each dialog element has an is modal flag. When a dialog element is created, this flag must be set to false.

Each HTML element has a previously focused element which is null or an element, and it is initially null. When showModal() and show() are called, this element is set to the currently focused element before running the dialog focusing steps.

Elements with the popover attribute set this element to the currently focused element during the show popover algorithm.

The open IDL attribute must reflect the open content attribute.

Example
This dialog box has some small print. The strong element is used to draw the user's attention to the more important part.

```html
<dialog>
  <h1>Add to Wallet</h1>
  <p><strong>How many gold coins do you want to add to your wallet?</strong></p>
  <p><input id=amt name=amt type=number min=0 step=0.01 value=100></p>
  <p><small>You add coins at your own risk.</small></p>
  <p><label><input name=round type=checkbox> Only add perfectly round coins</label></p>
  <p><input type=button onclick="submit()" value="Add Coins"></p>
</dialog>
```

4.12 Scripting

Scripts allow authors to add interactivity to their documents.

Authors are encouraged to use declarative alternatives to scripting where possible, as declarative mechanisms are often more maintainable, and many users disable scripting.

Example
For example, instead of using a script to show or hide a section to show more details, the details element could be used.

Authors are also encouraged to make their applications degrade gracefully in the absence of scripting support.

Example
For example, if an author provides a link in a table header to dynamically resort the table, the link could also be made to function
without scripts by requesting the sorted table from the server.

### 4.12.1 The `script` element

**Categories**: Metadata content, Flow content, Phrasing content, Script-supporting element.

**Contexts in which this element can be used**: Where metadata content is expected. Where phrasing content is expected. Where script-supporting elements are expected.

**Content model**: If there is no `src` attribute, depends on the value of the `type` attribute, but must match `script content restrictions`. If there is a `src` attribute, the element must be either empty or contain only `script documentation` that also matches `script content restrictions`.

**Tag omission in text/html**: Neither tag is omissible.

**Content attributes**: 
- `src` — Address of the resource
- `type` — Type of script
- `nomodule` — Prevents execution in user agents that support module scripts
- `async` — Execute script when available, without blocking while fetching
- `defer` — Defer script execution
- `crossorigin` — How the element handles crossorigin requests
- `integrity` — Integrity metadata used in Subresource Integrity checks [SRI]
- `referrerPolicy` — Referrer policy for fetches initiated by the element
- `blocking` — Whether the element is potentially render-blocking
- `fetchPriority` — Sets the priority for fetches initiated by the element

**Accessibility considerations**: 
- For authors.
- For implementers.

**DOM interface**:

```idl
[Exposed=Window]
interface HTMLScriptElement : HTMLElement {
  [HTMLConstructor] constructor();

  [CEReactions] attribute USVString src;
  [CEReactions] attribute DOMString type;
  [CEReactions] attribute boolean nomodule;
  [CEReactions] attribute boolean async;
  [CEReactions] attribute boolean defer;
  [CEReactions] attribute DOMString? crossOrigin;
  [CEReactions] attribute DOMString text;
  [CEReactions] attribute DOMString integrity;
  [CEReactions] attribute DOMString referrerPolicy;
  [SameObject, PutForwards=value] readonly attribute DOMTokenList blocking;
  [CEReactions] attribute DOMString fetchPriority;

  static boolean supports(DOMString type);
```
The `script` element allows authors to include dynamic script and data blocks in their documents. The element does not represent content for the user.

The `type` attribute allows customization of the type of script represented:

- Setting the attribute to an ASCII case-insensitive match for "module" means that the script is a `JavaScript module script`, to be interpreted according to the JavaScript `Script` top-level production. Module scripts are not affected by the async and defer attributes, but only when the `src` attribute is set. Authors should omit the `type` attribute instead of redundantly setting it.
- Setting the attribute to an ASCII case-insensitive match for "importmap" means that the script is an import map, containing JSON that will be used to control the behavior of module specifier resolution. Import maps can only be inline, i.e., the `src` attribute and most other attributes are meaningless and not to be used with them.
- Setting the attribute to any other value means that the script is a data block, which is not processed. None of the `script` attributes (except `type` itself) have any effect on data blocks. Authors must use a valid MIME type string that is not a JavaScript MIME type essence match to denote data blocks.

**Note**

The requirement that data blocks must be denoted using a valid MIME type string is in place to avoid potential future collisions. If this specification ever adds additional types of script, they will be triggered by setting the `type` attribute to something which is not a MIME type, like how the "module" value denotes module scripts. By using a valid MIME type string now, you ensure that your data block will not ever be reinterpreted as a different script type, even in future user agents.

Classic scripts and JavaScript module scripts can be embedded inline, or be imported from an external file using the `src` attribute, which if specified gives the URL of the external script resource to use. If `src` is specified, it must be a valid non-empty URL potentially surrounded by spaces.

The contents of inline script elements, or the external script resource, must conform with the requirements of the JavaScript specification's Script or Module productions, for classic scripts and JavaScript module scripts respectively.

The contents of the external script resource for CSS module scripts must conform to the requirements of the CSS specification.

The contents of the external script resource for JSON module scripts must conform to the requirements of the JSON specification.

For import map elements, the `src`, async, nomodule, defer, crossorigin, integrity, and referrerpolicy attributes must not be specified.

A document must not have more than one import map script element.

When used to include data blocks, the data must be embedded inline, the format of the data must be given using the `type` attribute, and the contents of the script element must conform to the requirements defined for the format used. The `src`, async, nomodule, defer, crossorigin, integrity, referrerpolicy, and fetchpriority attributes must not be specified.

The nomodule attribute is a boolean attribute that prevents a script from being executed in user agents that support module scripts. This allows selective execution of module scripts in modern user agents and classic scripts in older user agents, as shown below. The nomodule attribute must not be specified on module scripts (and will be ignored if it is).

The async and defer attributes are boolean attributes that indicate how the script should be evaluated. Classic scripts may specify defer or async, but must not specify either unless the `src` attribute is present. Module scripts may specify the
**async** attribute, but must not specify the **defer** attribute.

There are several possible modes that can be selected using these attributes, and depending on the script's type.

For **classic scripts**, if the **async** attribute is present, then the classic script will be fetched **in parallel** to parsing and evaluated as soon as it is available (potentially before parsing completes). If the **async** attribute is not present but the **defer** attribute is present, then the classic script will be fetched **in parallel** and evaluated when the page has finished parsing. If neither attribute is present, then the script is fetched and evaluated immediately, blocking parsing until these are both complete.

For **module scripts**, if the **async** attribute is present, then the module script and all its dependencies will be fetched **in parallel** to parsing, and the module script will be evaluated as soon as it is available (potentially before parsing completes). Otherwise, the module script and its dependencies will be fetched **in parallel** to parsing and evaluated when the page has finished parsing. (The **defer** attribute has no effect on module scripts.)

This is all summarized in the following schematic diagram:

```html
<script>  
  Scripting:
  HTML Parser:
</script>

<script defer>   
  Scripting:
  HTML Parser:
</script>

<script async>  
  Scripting:
  HTML Parser:
</script>

<script type="module"> 
  Scripting:
  HTML Parser:
</script>

<script type="module" async>  
  Scripting:
  HTML Parser:
</script>
```

**Note**

The exact processing details for these attributes are, for mostly historical reasons, somewhat non-trivial, involving a number of aspects of HTML. The implementation requirements are therefore by necessity scattered throughout the specification. The algorithms below (in this section) describe the core of this processing, but these algorithms reference and are referenced by the parsing rules for **script** start and **end** tags in HTML, **in foreign content**, and **in XML**, the rules for the **document.write()** method, the handling of **scripting**, etc.

**Note**

When inserted using the **document.write()** method, **script** elements **usually** execute (typically blocking further script execution or HTML parsing). When inserted using the **innerHTML** and **outerHTML** attributes, they do not execute at all.

The **defer** attribute may be specified even if the **async** attribute is specified, to cause legacy web browsers that only support **defer** (and not **async**) to fall back to the **defer** behavior instead of the blocking behavior that is the default.

The **crossorigin** attribute is a CORS settings attribute. For **classic scripts**, it controls whether error information will be exposed, when the script is obtained from other origins. For **module scripts**, it controls the credentials mode used for cross-origin requests.

**Note**

Unlike **classic scripts**, **module scripts** require the use of the **CORS protocol** for cross-origin fetching.

The **integrity** attribute represents the integrity metadata for requests which this element is responsible for. The value is text. The **integrity** attribute must not be specified when the **src** attribute is not specified. [SRI]

The **referrerpolicy** attribute is a referrer policy attribute. Its purpose is to set the referrer policy used when fetching the script, as well as any scripts imported from it. [REFFERRERPOLICY]

**Example**

An example of a **script** element's referrer policy being used when fetching imported scripts but not other subresources:
The **blocking** attribute is a blocking attribute\(^{101}\).

The **fetchpriority** attribute is a fetch priority attribute\(^{102}\). Its purpose is to set the priority used when fetching the script.

Changing the src, type, nomodule, async, defer, crossorigin, integrity, referrerpolicy, and fetchpriority\(^{101}\) attributes dynamically has no direct effect; these attributes are only used at specific times described below.

The IDL attributes src, type, defer, integrity, and blocking, must each reflect the respective content attributes of the same name.

The **referrerPolicy** IDL attribute must reflect the referrerpolicy\(^{103}\) content attribute, limited to only known values\(^{103}\).

The **fetchPriority** IDL attribute must reflect the fetchpriority\(^{103}\) content attribute, limited to only known values\(^{103}\).

The **crossOrigin** IDL attribute must reflect the crossorigin\(^{1050}\) content attribute, limited to only known values\(^{103}\).

The **noModule** IDL attribute must reflect the nomodule\(^{649}\) content attribute.

The async getter steps are:

1. If this’s force async\(^{654}\) is true, then return true.
2. If this’s async\(^{649}\) content attribute is present, then return true.
3. Return false.

The async\(^{651}\) setter steps are:

1. Set this’s force async\(^{654}\) to false.
2. If the given value is true, then set this’s async\(^{649}\) content attribute to the empty string.
3. Otherwise, remove this’s async\(^{649}\) content attribute.

---

The **text** attribute’s getter must return this script\(^{648}\) element’s child text content.

The **text**\(^{1051}\) attribute’s setter must string replace all with the given value within this script\(^{648}\) element.

The **supports**(type) method steps are:

1. If type is "classic", then return true.
2. If type is "module", then return true.
3. If type is "importmap", then return true.
4. Return false.

---

```html
<script referrerpolicy="origin">
  fetch('/api/data');  // not fetched with <script>'s referrer policy
  import('./utils.mjs'); // is fetched with <script>'s referrer policy ("origin" in this case)
</script>
```
The type argument has to exactly match these values; we do not perform an ASCII case-insensitive match. This is different from how `type` content attribute values are treated, and how `DOMTokenList`'s `supports()` method works, but it aligns with the `WorkerType` enumeration used in the `Worker()` constructor.

Example

In this example, two `script` elements are used. One embeds an external `classic script`, and the other includes some data as a `data block`.

```html
<script src="game-engine.js"></script>
<script type="text/x-game-map">
........U........
o............A....e
.....A......AAA....e
.A..AAA...AAAA...e
</script>
```

The data in this case might be used by the script to generate the map of a video game. The data doesn't have to be used that way, though; maybe the map data is actually embedded in other parts of the page's markup, and the data block here is just used by the site's search engine to help users who are looking for particular features in their game maps.

Example

The following sample shows how a `script` element can be used to define a function that is then used by other parts of the document, as part of a `classic script`. It also shows how a `script` element can be used to invoke script while the document is being parsed, in this case to initialize the form's output.

```html
<script>
function calculate(form) {
  var price = 52000;
  if (form.elements.brakes.checked)
    price += 1000;
  if (form.elements.radio.checked)
    price += 2500;
  if (form.elements.turbo.checked)
    price += 5000;
  if (form.elements.sticker.checked)
    price += 250;
  form.elements.result.value = price;
}
</script>
<form name="pricecalc" onsubmit="return false" onchange="calculate(this)"
<fieldset>
<legend>Work out the price of your car</legend>
<p>Base cost: £52000.</p>
<p>Select additional options:</p>
<ul>
<li><label><input type=checkbox name=brakes> Ceramic brakes (£1000)</label></li>
<li><label><input type=checkbox name=radio> Satellite radio (£2500)</label></li>
<li><label><input type=checkbox name=turbo> Turbo charger (£5000)</label></li>
<li><label><input type=checkbox name=sticker> "XZ" sticker (£250)</label></li>
</ul>
<p>Total: £<output name=result></output></p>
</fieldset>
<script>
calculate(document.forms.pricecalc);
</script>
</form>
```
The following sample shows how a `<script>` element can be used to include an external JavaScript module script.

```html
<script type="module" src="app.mjs"></script>
```

This module, and all its dependencies (expressed through JavaScript import statements in the source file), will be fetched. Once the entire resulting module graph has been imported, and the document has finished parsing, the contents of `app.mjs` will be evaluated.

Additionally, if code from another `<script>` element in the same `Window` imports the module from `app.mjs` (e.g. via `import './app.mjs';`), then the same JavaScript module script created by the former `<script>` element will be imported.

Example

This example shows how to include a JavaScript module script for modern user agents, and a classic script for older user agents:

```html
<script type="module" src="app.mjs"></script>
<script nomodule defer src="classic-app-bundle.js"></script>
```

In modern user agents that support JavaScript module scripts, the `<script>` element with the `nomodule` attribute will be ignored, and the `<script>` element with a `type` of "module" will be fetched and evaluated (as a JavaScript module script).

Conversely, older user agents will ignore the `<script>` element with a `type` of "module", as that is an unknown script type for them — but they will have no problem fetching and evaluating the other `<script>` element (as a classic script), since they do not implement the `nomodule` attribute.

Example

The following sample shows how a `<script>` element can be used to write an inline JavaScript module script that performs a number of substitutions on the document's text, in order to make for a more interesting reading experience (e.g. on a news site): [XKCD1288](https://xkcd.com/1288/)

```html
<script type="module">
    import { walkAllTextNodeDescendants } from "./dom-utils.js";

    const substitutions = new Map([  
        ['witnesses', "these dudes I know"],  
        ['allegedly', "kinda probably"],  
        ['new study', "Tumblr post"],  
        ['rebuild', "avenge"],  
        ['space', "spaaace"],  
        ['Google glass', "Virtual Boy"],  
        ['smartphone', "Pokédex"],  
        ['electric', "atomic"],  
        ['Senator', "Elf-Lord"],  
        ['car', "cat"],  
        ['election', "eating contest"],  
        ['Congressional leaders', "river spirits"],  
        ['homeland security', "Homestar Runner"],  
        ['could not be reached for comment', "is guilty and everyone knows it"]
    ]);

    function substitute(textNode) {
        for (const [before, after] of substitutions.entries()) {
            textNode.data = textNode.data.replace(new RegExp(`\b${before}\b`, "ig"), after);
        }
    }

    walkAllTextNodeDescendants(document.body, substitute);
</script>
```

Some notable features gained by using a JavaScript module script include the ability to import functions from other JavaScript
modules, strict mode by default, and how top-level declarations do not introduce new properties onto the global object. Also note that no matter where this `script` element appears in the document, it will not be evaluated until both document parsing has complete and its dependency (dom-utils.mjs) has been fetched and evaluated.

### Example

The following sample shows how a **JSON module script** can be imported from inside a **JavaScript module script**:

```html
<script type="module">
import peopleInSpace from "http://api.open-notify.org/astros.json" with { type: "json"};

const list = document.querySelector("#people-in-space");
for (const { craft, name } of peopleInSpace.people) {
    const li = document.createElement("li");
    li.textContent = `${name} / ${craft}`;
    list.appendChild(li);
}
</script>
```

MIME type checking for module scripts is strict. In order for the fetch of the **JSON module script** to succeed, the HTTP response must have a **JSON MIME type**, for example Content-Type: text/json. On the other hand, if the `with { type: "json" }` part of the statement is omitted, it is assumed that the intent is to import a **JavaScript module script**, and the fetch will fail if the HTTP response has a MIME type that is not a **JavaScript MIME type**.

4.12.1.1 Processing model

A `script` element has several associated pieces of state.

A `script` element has a **parser document**, which is either null or a `Document`, initially null. It is set by the HTML parser and the XML parser on `script` elements they insert, and affects the processing of those elements. `script` elements with non-null parser documents are known as **parser-inserted**.

A `script` element has a **preparation-time document**, which is either null or a `Document`, initially null. It is used to prevent scripts that move between documents during preparation from executing.

A `script` element has a `force async` boolean, initially true. It is set to false by the HTML parser and the XML parser on `script` elements they insert, and when the element gets an `async` content attribute added.

A `script` element has a **from an external file** boolean, initially false. It is determined when the script is prepared, based on the `src` attribute of the element at that time.

A `script` element has a **ready to be parser-executed** boolean, initially false. This is used only used for elements that are also parser-inserted, to let the parser know when to execute the script.

A `script` element has an **already started** boolean, initially false.

A `script` element has a **delaying the load event** boolean, initially false.

A `script` element has a **type**, which is either null, "classic", "module", or "importmap", initially null. It is determined when the element is prepared, based on the `type` attribute of the element at that time.

A `script` element has a **result**, which is either "initialized", null (representing an error), a `script`, or an import map parse result. It is initially "uninitialized".

A `script` element has **steps to run when the result is ready**, which are a series of steps or null, initially null. To mark as ready a `script` element `el` given a `script`, import map parse result, or null result:

1. Set `el`'s `result` to result.
2. If `el`'s `steps to run when the result is ready` are not null, then run them.
3. Set el's steps to run when the result is ready \textsuperscript{654} to null.

4. Set el's delaying the load event \textsuperscript{654} to false.

A \texttt{script} \textsuperscript{648} element el is implicitly potentially render-blocking \textsuperscript{1102} if el's type \textsuperscript{654} is "classic", el is parser-inserted \textsuperscript{654}, and el does not have an async \textsuperscript{649} or defer \textsuperscript{647} attribute.

The cloning steps for a \texttt{script} \textsuperscript{648} element el being cloned to a copy copy are to set copy's already started \textsuperscript{654} to el's already started \textsuperscript{654}.

When an async \textsuperscript{649} attribute is added to a \texttt{script} \textsuperscript{648} element el, the user agent must set el's force async \textsuperscript{654} to false.

Whenever a \texttt{script} \textsuperscript{648} element el's delaying the load event \textsuperscript{654} is true, the user agent must delay the load event \textsuperscript{1340} of el's preparation-time document \textsuperscript{654}.

When a \texttt{script} \textsuperscript{648} element el that is not parser-inserted \textsuperscript{654} experiences one of the events listed in the following list, the user agent must immediately \textsuperscript{644} prepare the script element \textsuperscript{655} el:

- The \texttt{script} \textsuperscript{655} element becomes connected \textsuperscript{46}.
- The \texttt{script} \textsuperscript{655} element is connected and a node or document fragment is inserted into the \texttt{script} \textsuperscript{655} element, after any \texttt{script} \textsuperscript{655} elements inserted at that time.
- The \texttt{script} \textsuperscript{655} element is connected and has a src \textsuperscript{649} attribute set where previously the element had no such attribute.

To prepare the script element given a \texttt{script} \textsuperscript{655} element el:

1. If el's already started \textsuperscript{654} is true, then return.
2. Let parser document be el's parser document \textsuperscript{654}.
3. Set el's parser document \textsuperscript{654} to null.

Note

This is done so that if parser-inserted \texttt{script} \textsuperscript{648} elements fail to run when the parser tries to run them, e.g. because they are empty or specify an unsupported scripting language, another script can later mutate them and cause them to run again.

4. If parser document is non-null and el does not have an async \textsuperscript{649} attribute, then set el's force async \textsuperscript{654} to true.

Note

This is done so that if a parser-inserted \texttt{script} \textsuperscript{648} element fails to run when the parser tries to run it, but it is later executed after a script dynamically updates it, it will execute in an async fashion even if the async \textsuperscript{649} attribute isn't set.

5. Let source text be el's child text content.
6. If el has no src \textsuperscript{649} attribute, and source text is the empty string, then return.
7. If el is not connected, then return.
8. If any of the following are true:
   - el has a type \textsuperscript{649} attribute whose value is the empty string;
   - el has no type \textsuperscript{649} attribute but it has a language \textsuperscript{1409} attribute and that attribute's value is the empty string; or
   - el has neither a type \textsuperscript{649} attribute nor a language \textsuperscript{1409} attribute,

   then let the script block's type string for this \texttt{script} \textsuperscript{648} element be "text/javascript".

Otherwise, if el has a type \textsuperscript{649} attribute, then let the script block's type string be the value of that attribute with leading and trailing ASCII whitespace stripped.

Otherwise, el has a non-empty language \textsuperscript{1409} attribute; let the script block's type string be the concatenation of "text/" and the value of el's language \textsuperscript{1409} attribute.
9. If the script block's type string is a JavaScript MIME type essence match, then set el's type to "classic".

10. Otherwise, if the script block's type string is an ASCII case-insensitive match for the string "module", then set el's type to "module".

11. Otherwise, if the script block's type string is an ASCII case-insensitive match for the string "importmap", then set el's type to "importmap".

12. Otherwise, return. (No script is executed, and el's type is left as null.)

13. If parser document is non-null, then set el's parser document back to parser document and set el's force async to false.

14. Set el's already started to true.

15. Set el's preparation-time document back to node document.

16. If parser document is non-null, and parser document is not equal to el's preparation-time document, then return.

17. If scripting is disabled for el, then return.

18. If el has a nomodule content attribute and its type is "classic", then return.

19. If el does not have a src content attribute, and the Should element's inline behavior be blocked by Content Security Policy? algorithm returns "Blocked" when given el, "script", and source text, then return. [CSP]

20. If el has an event attribute and a for attribute, and el's type is "classic", then:
   1. Let for be the value of el's for attribute.
   2. Let event be the value of el's event attribute.
   3. Strip leading and trailing ASCII whitespace from event and for.
   4. If for is not an ASCII case-insensitive match for the string "window", then return.
   5. If event is not an ASCII case-insensitive match for either the string "onload" or the string "onload()", then return.

21. If el has a charset attribute, then let encoding be the result of getting an encoding from the value of the charset attribute.

If el does not have a charset attribute, or if getting an encoding failed, then let encoding be el's node document's the encoding.

Note
If el's type is "module", this encoding will be ignored.

22. Let classic script CORS setting be the current state of el's crossorigin content attribute.

23. Let module script credentials mode be the CORS settings attribute credentials mode for el's crossorigin content attribute.

24. Let cryptographic nonce be el's [[CryptographicNonce]] internal slot's value.

25. If el has an integrity attribute, then let integrity metadata be that attribute's value.
26. Let referer policy be the current state of el's refererpolicy content attribute.
27. Let fetch priority be the current state of el's fetchpriority content attribute.
28. Let parser metadata be "parser-inserted" if el is parser-inserted, and "not-parser-inserted" otherwise.
29. Let options be a script fetch options whose cryptographic nonce is cryptographic nonce, integrity metadata is integrity metadata, parser metadata is parser metadata, credentials mode is module script credentials mode, referer policy is referer policy, and fetch priority is fetch priority.
30. Let settings object be el's node document's relevant settings object.
31. If el has a src content attribute, then:
   1. If el's type is "importmap", then queue an element task on the DOM manipulation task source given el to fire an event named error at el, and return.

   Note
   External import map scripts are not currently supported. See WICG/import-maps issue #235 for discussions on adding support.

   2. Let src be the value of el's src attribute.
   3. If src is the empty string, then queue an element task on the DOM manipulation task source given el to fire an event named error at el, and return.
   4. Set el's from an external file to true.
   5. Let url be the result of encoding-parsing a URL given src, relative to el's node document.
   6. If url is failure, then queue an element task on the DOM manipulation task source given el to fire an event named error at el, and return.
   7. If el is potentially render-blocking, then block rendering on el.
   8. Set el's delaying the load event to true.
   9. If el is currently render-blocking, then set options's render-blocking to true.
10. Let onComplete given result be the following steps:
    1. Mark as ready el given result.
11. Switch on el's type:
    ↦ "classic"
        Fetch a classic script given url, settings object, options, classic script CORS setting, encoding, and onComplete.
    ↦ "module"
        If el does not have an integrity attribute, then set options's integrity metadata to the result of resolving a module integrity metadata with url and settings object.
        Fetch an external module script graph given url, settings object, options, and onComplete.

For performance reasons, user agents may start fetching the classic script or module graph (as defined above) as soon as the src attribute is set, instead, in the hope that el will become connected (and that the crossorigin attribute won't change value in the meantime). Either way, once el becomes connected, the load must have started as described in this step. If the UA performs such prefetching, but el never becomes connected, or the src attribute is dynamically changed, or the crossorigin attribute is dynamically changed, then the user agent will not execute the script so obtained, and the fetching process will have been effectively wasted.

32. If el does not have a src content attribute:
   1. Let base URL be el's node document's document base URL.

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2. Switch on el's `type`:

→ "classic"

1. Let script be the result of creating a classic script using source text, settings object, base URL, and options.

2. Mark as ready el given script.

→ "module"

1. Set el's delaying the load event to true.

2. If el is potentially render-blocking, then:
   1. Block rendering on el.
   2. Set options's render-blocking to true.

3. Fetch an inline module script graph, given source text, base URL, settings object, options, and with the following steps given result:
   1. Queue an element task on the networking task source given el to perform the following steps:
      1. Mark as ready el given result.

4. Mark as ready el given result.

→ "importmap"

1. If el's relevant global object's import maps allowed is false, then queue an element task on the DOM manipulation task source given el to fire an event named error at el, and return.

2. Set el's relevant global object's import maps allowed to false.

3. Let result be the result of creating an import map parse result given source text and base URL.

4. Mark as ready el given result.

33. If el's `type` is "classic" and el has a `src` attribute, or el's `type` is "module":

1. Assert: el's `result` is "uninitialized".

2. If el has an `async` attribute or el's `force async` is true:
   1. Let scripts be el's preparation-time document's set of scripts that will execute as soon as possible.
   2. Append el to scripts.
   3. Set el's steps to run when the result is ready to the following:
      1. Execute the script element el.
      2. Remove el from scripts.

3. Otherwise, if el is not parser-inserted:
   1. Let scripts be el's preparation-time document's list of scripts that will execute in order as soon as possible.
   2. Append el to scripts.
   3. Set el's steps to run when the result is ready to the following:
      1. If scripts[0] is not el, then abort these steps.
2. While scripts is not empty, and scripts[0]'s result is not "uninitialized":
   1. Execute the script element scripts[0].
   2. Remove scripts[0].

4. Otherwise, if el has a defer attribute or el's type is "module":
   1. Append el to its parser document's list of scripts that will execute when the document has finished parsing.
   2. Set el's steps to run when the result is ready to the following: set el's ready to be parser-executed to true. (The parser will handle executing the script.)

5. Otherwise:
   1. Set el's parser document's pending parsing-blocking script to el.
   2. Block rendering on el.
   3. Set el's steps to run when the result is ready to the following: set el's ready to be parser-executed to true. (The parser will handle executing the script.)

34. Otherwise:
   1. Assert: el's result is not "uninitialized".
   2. If all of the following are true:
      ■ el's type is "classic";
      ■ el is parser-inserted;
      ■ el's parser document has a style sheet that is blocking scripts; and
      ■ either the parser that created el is an XML parser, or it's an HTML parser whose script nesting level is not greater than one,
      then:
      1. Set el's parser document's pending parsing-blocking script to el.
      2. Set el's ready to be parser-executed to true. (The parser will handle executing the script.)
   3. Otherwise, immediately execute the script element el, even if other scripts are already executing.

Each Document has a pending parsing-blocking script, which is a script element or null, initially null.

Each Document has a set of scripts that will execute as soon as possible, which is a set of script elements, initially empty.

Each Document has a list of scripts that will execute in order as soon as possible, which is a list of script elements, initially empty.

Each Document has a list of scripts that will execute when the document has finished parsing, which is a list of script elements, initially empty.

**Note**

If a script element that blocks a parser gets moved to another Document before it would normally have stopped blocking that parser, it nonetheless continues blocking that parser until the condition that causes it to be blocking the parser no longer applies (e.g., if the script is a pending parsing-blocking script because the original Document has a style sheet that is blocking scripts when it was parsed, but then the script is moved to another Document before the blocking style sheet(s) loaded, the script still blocks the parser until the style sheets are all loaded, at which time the script executes and the parser is unblocked).

To execute the script element given a script element el:

1. Let document be el's node document.
2. If `el's preparation-time document` is not equal to `document`, then return.

3. Unblock rendering on `el`.

4. If `el's result` is null, then fire an event named `error` at `el`, and return.

5. If `el's from an external file` is true, or `el's type` is "module", then increment `document's ignore-destructive-writes counter`.

6. Switch on `el's type`:
   - "classic"
     1. Let `oldCurrentScript` be the value to which `document's currentScript` object was most recently set.
     2. If `el's root` is not a `shadow root`, then set `document's currentScript` attribute to `el`. Otherwise, set it to null.

     **Note**
     This does not use the in a document tree check, as `el` could have been removed from the document prior to execution, and in that scenario `currentScript` still needs to point to it.

     3. Run the classic script given by `el's result`.

     4. Set `document's currentScript` attribute to `oldCurrentScript`.
   - "module"
     1. Assert: `document's currentScript` attribute is null.
     2. Run the module script given by `el's result`.
   - "importmap"
     1. Register an import map given `el's relevant global object` and `el's result`.

7. Decrement the `ignore-destructive-writes counter` of `document`, if it was incremented in the earlier step.

8. If `el's from an external file` is true, then fire an event named `load` at `el`.

4.12.1.2 Scripting languages

User agents are not required to support JavaScript. This standard needs to be updated if a language other than JavaScript comes along and gets similar wide adoption by web browsers. Until such a time, implementing other languages is in conflict with this standard, given the processing model defined for the `script` element.

Servers should use `text/javascript` for JavaScript resources, in accordance with Updates to ECMAScript Media Types. Servers should not use other JavaScript MIME types for JavaScript resources, and must not use non-JavaScript MIME types. [RFC9239]

For external JavaScript resources, MIME type parameters in `Content-Type` headers are generally ignored. (In some cases the `charset` parameter has an effect.) However, for the `script` element's `type` attribute they are significant; it uses the JavaScript MIME type essence match concept.

**Note**

For example, scripts with their `type` attribute set to "text/javascript; charset=utf-8" will not be evaluated, even though that is a valid JavaScript MIME type when parsed.

Furthermore, again for external JavaScript resources, special considerations apply around `Content-Type` header processing as detailed in the prepare the script element algorithm and Fetch. [FETCH]
The easiest and safest way to avoid the rather strange restrictions described in this section is to always escape an ASCII case-insensitive match for "<!--" as ":x3C!--:", "<script" as ":x3C/script:", and "</script" as "\x3C/script" when these sequences appear in literals in scripts (e.g., in strings, regular expressions, or comments), and to avoid writing code that uses such constructs in expressions. Doing so avoids the pitfalls that the restrictions in this section are prone to triggering; namely, that, for historical reasons, parsing of script blocks in HTML is a strange and exotic practice that acts unintuitively in the face of these sequences.

The script element's descendant text content must match the script production in the following ABNF, the character set for which is Unicode. [ABNF]

```
script = outer *( comment-open inner comment-close outer )

outer = < any string that doesn't contain a substring that matches not-in-outer >
not-in-outer = comment-open

inner = < any string that doesn't contain a substring that matches not-in-inner >
not-in-inner = comment-close / script-open

comment-open = "<!-".
comment-close = "-->"

script-open = "<" s c r i p t t a g - e n d

s = %x0053 ; U+0053 LATIN CAPITAL LETTER S
s = %x0073 ; U+0073 LATIN SMALL LETTER S
c = %x0043 ; U+0043 LATIN CAPITAL LETTER C
c = %x0063 ; U+0063 LATIN SMALL LETTER C
r = %x0052 ; U+0052 LATIN CAPITAL LETTER R
r = %x0072 ; U+0072 LATIN SMALL LETTER R
i = %x0049 ; U+0049 LATIN CAPITAL LETTER I
i = %x0069 ; U+0069 LATIN SMALL LETTER I
p = %x0050 ; U+0050 LATIN CAPITAL LETTER P
p = %x0070 ; U+0070 LATIN SMALL LETTER P
t = %x0054 ; U+0054 LATIN CAPITAL LETTER T
t = %x0074 ; U+0074 LATIN SMALL LETTER T

tag-end = %x0009 ; U+0009 CHARACTER TABULATION (tab)
tag-end = %x000A ; U+000A LINE FEED (LF)
tag-end = %x000C ; U+000C FORM FEED (FF)
tag-end = %x0020 ; U+0020 SPACE
ntag-end = %x002F ; U+002F SOLIDUS (/)
tag-end = %x003E ; U+003E GREATER-TIMES SIGN (>)
```

When a script element contains script documentation, there are further restrictions on the contents of the element, as described in the section below.

**Example**

The following script illustrates this issue. Suppose you have a script that contains a string, as in:

```javascript
const example = 'Consider this string: <!-- <script>
console.log(example);
```

If one were to put this string directly in a script block, it would violate the restrictions above:

```html
<script>
const example = 'Consider this string: <!-- <script>
console.log(example);
</script>
```
The bigger problem, though, and the reason why it would violate those restrictions, is that actually the script would get parsed weirdly: the script block above is not terminated. That is, what looks like a "</script>" end tag in this snippet is actually still part of the script\[648\] block. The script doesn't execute (since it's not terminated); if it somehow were to execute, as it might if the markup looked as follows, it would fail because the script (highlighted here) is not valid JavaScript:

```
<script>
  \n  const example = 'Consider this string: <!-- <script>\n  console.log(example);
  <!----</script>
  ...
  // this is the same script block still...
</script>
```

What is going on here is that for legacy reasons, "<!--" and "<!--" strings in script\[648\] elements in HTML need to be balanced in order for the parser to consider closing the block.

By escaping the problematic strings as mentioned at the top of this section, the problem is avoided entirely:

```
<script>
  // Note: '\x3C' is an escape sequence for '<'.
  const example = 'Consider this string: \x3C!-- \x3Cscript>\n  console.log(example);
  <!----</script>
  ...
  // this is a new script block
</script>
```

It is possible for these sequences to naturally occur in script expressions, as in the following examples:

```
if (x<!--y) { ... }
if ( player< script ) { ... }
```

In such cases the characters cannot be escaped, but the expressions can be rewritten so that the sequences don't occur, as in:

```
if (x < !--y) { ... }
if (!--y > x) { ... }
if (!!(--y > x)) { ... }
if (player < script) { ... }
if (script > player) { ... }
```

Doing this also avoids a different pitfall as well: for related historical reasons, the string "<!--" in classic scripts\[6172\] is actually treated as a line comment start, just like "//".

4.12.1.4 Inline documentation for external scripts \[5966\]

If a script\[648\] element's src\[649\] attribute is specified, then the contents of the script\[648\] element, if any, must be such that the value of the text\[650\] attribute, which is derived from the element's contents, matches the documentation production in the following ABNF, the character set for which is Unicode. [ABNF][6455]

```
documentation = *( *( space / tab / comment ) [ line-comment ] newline )
comment = slash *(*( not-star / star not-slash ) l*star slash
line-comment = slash slash *not-newline

; characters
tab = %x0009 ; U+0009 CHARACTER TABULATION (tab)
```
This section is non-normative.

This specification does not define how XSLT interacts with the `script` element. However, in the absence of another specification actually defining this, here are some guidelines for implementers, based on existing implementations:

- When an XSLT transformation program is triggered by an `<?xml-stylesheet?>` processing instruction and the browser implements a direct-to-DOM transformation, `script` elements created by the XSLT processor need to have its `parser document` set correctly, and run in document order (modulo scripts marked `defer` or `async`), immediately, as the transformation is occurring.

- The `XSLTProcessor.transformToDocument()` method adds elements to a `Document` object with a null `browsing context`, and, accordingly, any `script` elements they create need to have their `already started` set to true in the `prepare the script element` algorithm and never get executed (scripting is disabled). Such `script` elements still need to have their `parser document` set, though, such that their `async` IDL attribute will return false in the absence of an `async` content attribute.

- The `XSLTProcessor.transformToFragment()` method needs to create a fragment that is equivalent to one built manually by creating the elements using `document.createElementNS()`. For instance, it needs to create `script` elements with null `parser document` and with their `already started` set to false, so that they will execute when the fragment is inserted into a document.

The main distinction between the first two cases and the last case is that the first two operate on `Document`s and the last operates on a fragment.

Example

This allows authors to include documentation, such as license information or API information, inside their documents while still referring to external script files. The syntax is constrained so that authors don't accidentally include what looks like valid script while also providing a `src` attribute.

```xml
<script src="cool-effects.js">
    // create new instances using:
    //    var e = new Effect();
    // start the effect using .play, stop using .stop:
    //    e.play();
    //    e.stop();
</script>
```

4.12.1.5 Interaction of `script` elements and XSLT

This allows authors to include documentation, such as license information or API information, inside their documents while still referring to external script files. The syntax is constrained so that authors don't accidentally include what looks like valid script while also providing a `src` attribute.

```xml
<script src="cool-effects.js">
    // create new instances using:
    //    var e = new Effect();
    // start the effect using .play, stop using .stop:
    //    e.play();
    //    e.stop();
</script>
```
The `noscript` element

### Categories
- Metadata content
- Flow content
- Phrasing content

### Contexts in which this element can be used:

- In a `head` element of an HTML document, if there are no ancestor `noscript` elements.
- Where phrasing content is expected in HTML documents, if there are no ancestor `noscript` elements.

### Content model:

- When scripting is disabled, in a `head` element: in any order, zero or more `link` elements, zero or more `style` elements, and zero or more `meta` elements.
- When scripting is disabled, not in a `head` element: `transparent`, but there must be no `noscript` element descendants.
- Otherwise: text that conforms to the requirements given in the prose.

### Tag omission in text/html:

Neither tag is omissible.

### Content attributes:

- `Global attributes`

### Accessibility considerations:

- For authors.
- For implementers.

### DOM interface:

Uses `HTMLElement`.

The `noscript` element represents nothing if scripting is enabled, and represents its children if scripting is disabled. It is used to present different markup to user agents that support scripting and those that don't support scripting, by affecting how the document is parsed.

When used in HTML documents, the allowed content model is as follows:

- In a `head` element, if scripting is disabled for the `noscript` element
  - The `noscript` element must contain only `link`, `style`, and `meta` elements.

- In a `head` element, if scripting is enabled for the `noscript` element
  - The `noscript` element must contain only text, except that invoking the HTML fragment parsing algorithm with the `noscript` element as the `context` element and the text contents as the `input` must result in a list of nodes that consists only of `link`, `style`, and `meta` elements that would be conforming if they were children of the `noscript` element, and no `parse errors`.

Outside of `head` elements, if scripting is disabled for the `noscript` element

- The `noscript` element's content model is `transparent`, with the additional restriction that a `noscript` element must not have a `noscript` element as an ancestor (that is, `noscript` can't be nested).

Outside of `head` elements, if scripting is enabled for the `noscript` element

- The `noscript` element must contain only text, except that the text must be such that running the following algorithm results in a conforming document with no `noscript` elements and no `script` elements, and such that no step in the algorithm throws an exception or causes an HTML parser to flag a `parse error`:
  1. Remove every `script` element from the document.
  2. Make a list of every `noscript` element in the document. For every `noscript` element in that list, perform the following steps:
    1. Let s be the child text content of the `noscript` element.
    2. Set the `outerHTML` attribute of the `noscript` element to the value of s. (This, as a side-effect, causes the `noscript` element to be removed from the document.)
The `noscript` element must not be used in XML documents.

The `noscript` element has no other requirements. In particular, children of the `noscript` element are not exempt from form submission, scripting, and so forth, even when scripting is enabled for the element.

Note The `noscript` element is only effective in the HTML syntax, it has no effect in the XML syntax. This is because the way it works is by essentially "turning off" the parser when scripts are enabled, so that the contents of the element are treated as pure text and not as real elements. XML does not define a mechanism by which to do this.

In the following example, a `noscript` element is used to provide fallback for a script.

```html
<form action="calcSquare.php">
  
  <script>
    var x = document.getElementById('x');
    var output = document.createElement('p');
    output.textContent = 'Type a number; it will be squared right then!';
    x.form.appendChild(output);
    x.form.onSubmit = function () { return false; } 
    x.oninput = function () {
      var v = x.valueAsNumber;
      output.textContent = v + ' squared is ' + v * v;
    };
  </script>

  <noscript>
    <input id="submit" type="submit" value="Calculate Square">
  </noscript>

</form>
```

When script is disabled, a button appears to do the calculation on the server side. When script is enabled, the value is computed on-the-fly instead.

The `noscript` element is a blunt instrument. Sometimes, scripts might be enabled, but for some reason the page's script might fail. For this reason, it's generally better to avoid using `noscript`, and to instead design the script to change the page from being a scriptless page to a scripted page on the fly, as in the next example:

```html
<form action="calcSquare.php">
  
  <script>
    var x = document.getElementById('x');
    var output = document.createElement('p');
    output.textContent = 'Type a number; it will be squared right then!';
    x.form.appendChild(output);
    x.form.onSubmit = function () { return false; } 
    x.oninput = function () {
      var v = x.valueAsNumber;
      output.textContent = v + ' squared is ' + v * v;
    };
  </script>

  <input id="x" name="x" type="number">
  
  <input id="submit" type="submit" value="Calculate Square">

</form>
```
4.12.3 The `template` element

**Categories**:
- Metadata content
- Flow content
- Phrasing content
- Script-supporting element

**Contexts in which this element can be used**:
- Where metadata content is expected.
- Where phrasing content is expected.
- Where script-supporting elements are expected.
- As a child of a `colgroup` element that doesn't have a `span` attribute.

**Content model**:
- Nothing (for clarification, see example).

**Tag omission in text/html**:
- Neither tag is omissible.

**Content attributes**:
- Global attributes
  - `shadowrootmode` — Enables streaming declarative shadow roots
  - `shadowrootdelegatesfocus` — Sets `delegates focus` on a declarative shadow root
  - `shadowrootclonable` — Sets `clonable` on a declarative shadow root
  - `shadowrootserializable` — Sets `serializable` on a declarative shadow root

**Accessibility considerations**:
- For authors.
- For implementers.

**DOM interface**:

```idl
[Exposed=Window]
interface HTMLTemplateElement : HTMLElement {
    constructor();

    readonly attribute DocumentFragment content;
    [CFReactions] attribute DOMString shadowRootMode;
    [CFReactions] attribute boolean shadowRootDelegatesFocus;
    [CFReactions] attribute boolean shadowRootClonable;
    [CFReactions] attribute boolean shadowRootSerializable;
};
```

The `template` element is used to declare fragments of HTML that can be cloned and inserted in the document by script.

In a rendering, the `template` element represents nothing.

The `shadowrootmode` content attribute is an enumerated attribute with the following keywords and states:
<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>open</td>
<td>open</td>
<td>The template element represents an open declarative shadow root.</td>
</tr>
<tr>
<td>closed</td>
<td>closed</td>
<td>The template element represents a closed declarative shadow root.</td>
</tr>
</tbody>
</table>

The `shadowrootmode` attribute's `invalid value default` and `missing value default` are both the `none` state.

The `shadowrootdelegatesfocus` content attribute is a `boolean attribute`.

The `shadowrootclonable` content attribute is a `boolean attribute`.

The `shadowrootserializable` content attribute is a `boolean attribute`.

The `template contents` of a `template` element are not children of the element itself.

Each `template` element has an associated `DocumentFragment` object that is its `template contents`. The `template contents` have no conformance requirements. When a `template` element is created, the user agent must run the following steps to establish the `template contents`:

1. Let `doc` be the `template` element's `node document`'s `appropriate template contents owner document`.
2. Create a `DocumentFragment` object whose `node document` is `doc` and `host` is the `template` element.
3. Set the `template` element's `template contents` to the newly created `DocumentFragment` object.

A `Document`'s `appropriate template contents owner document` is the `Document` returned by the following algorithm:

1. If `doc` is not a `Document` created by this algorithm, then:

---

Note

It is also possible, as a result of DOM manipulation, for a `template` element to contain `Text` nodes and element nodes; however, having any is a violation of the `template` element's content model, since its content model is defined as `nothing`.

Example

For example, consider the following document:

```html
<!doctype html>
<html lang="en">
<head>
<title>Homework</title>
<body>
<template id="template"><p>Smile!</p></template>
<script>
let num = 3;
const fragment = document.getElementById('template').content.cloneNode(true);
while (num-- > 1) {
    fragment.firstChild.before(fragment.firstChild.cloneNode(true));
    fragment.firstChild.textContent += fragment.lastChild.textContent;
}
document.body.appendChild(fragment);
</script>
</body>
</html>
```

The `p` element in the `template` is not a child of the `template` in the DOM; it is a child of the `DocumentFragment` returned by the `template` element's `content` IDL attribute.

If the script were to call `appendChild()` on the `template` element, that would add a child to the `template` element (as for any other element); however, doing so is a violation of the `template` element's content model.

For web developers (non-normative)

`template.content` Returns the `template contents` (a `DocumentFragment`).

Each `template` element has an associated `DocumentFragment` object that is its `template contents`. The `template contents` have no conformance requirements. When a `template` element is created, the user agent must run the following steps to establish the `template contents`:

1. Let `doc` be the `template` element's `node document`'s `appropriate template contents owner document`.
2. Create a `DocumentFragment` object whose `node document` is `doc` and `host` is the `template` element.
3. Set the `template` element's `template contents` to the newly created `DocumentFragment` object.

A `Document`'s `appropriate template contents owner document` is the `Document` returned by the following algorithm:

1. If `doc` is not a `Document` created by this algorithm, then:
1. If doc does not yet have an associated inert template document, then:
   1. Let new doc be a new Document (whose browsing context is null). This is "a Document created by this algorithm" for the purposes of the step above.
   2. If doc is an HTML document, mark new doc as an HTML document also.
   3. Let doc's associated inert template document be new doc.

2. Set doc to doc's associated inert template document.

2. Return doc.

The adopting steps (with node and oldDocument as parameters) for template elements are the following:

1. Let doc be node's node document's appropriate template contents owner document.

Note
node's node document is the Document object that node was just adopted into.

2. Adopt node's template contents (a DocumentFragment object) into doc.

The content getter steps are to return template's template contents, if the template contents is not a ShadowRoot node; otherwise null.

The shadowRootMode IDL attribute must reflect the shadowrootmode content attribute, limited to only known values.

The shadowRootDelegatesFocus IDL attribute must reflect the shadowrootdelegatesfocus content attribute.

The shadowRootClonable IDL attribute must reflect the shadowrootclonable content attribute.

The shadowRootSerializable IDL attribute must reflect the shadowrootserializable content attribute.

The cloning steps for a template element node being cloned to a copy copy must run the following steps:

1. If the clone children flag is not set in the calling clone algorithm, return.

2. Let copied contents be the result of cloning all the children of node's template contents, with document set to copy's template contents's node document, and with the clone children flag set.

3. Append copied contents to copy's template contents.

Example
In this example, a script populates a table four-column with data from a data structure, using a template to provide the element structure instead of manually generating the structure from markup.

```html
<!DOCTYPE html>
<html lang='en'>
<title>Cat data</title>
<script>
// Data is hard-coded here, but could come from the server
var data = [
    { name: 'Pillar', color: 'Ticked Tabby', sex: 'Female (neutered)', legs: 3 },
    { name: 'Hedral', color: 'Tuxedo', sex: 'Male (neutered)', legs: 4 },
];
</script>
```
This section is non-normative.

This specification does not define how XSLT and XPath interact with the template element. However, in the absence of another specification actually defining this, here are some guidelines for implementers, which are intended to be consistent with other processing described in this specification:

- An XSLT processor based on an XML parser that acts as described in this specification needs to act as if template elements contain as descendants their template contents for the purposes of the transform.

- An XSLT processor that outputs a DOM needs to ensure that nodes that would go into a template element are instead placed into the element's template contents.

- XPath evaluation using the XPath DOM API when applied to a Document parsed using the HTML parser or the XML parser described in this specification needs to ignore template contents.

### 4.12.3.1 Interaction of template elements with XSLT and XPath

This section is non-normative.

This specification does not define how XSLT and XPath interact with the template element. However, in the absence of another specification actually defining this, here are some guidelines for implementers, which are intended to be consistent with other processing described in this specification:

- An XSLT processor based on an XML parser that acts as described in this specification needs to act as if template elements contain as descendants their template contents for the purposes of the transform.

- An XSLT processor that outputs a DOM needs to ensure that nodes that would go into a template element are instead placed into the element's template contents.

- XPath evaluation using the XPath DOM API when applied to a Document parsed using the HTML parser or the XML parser described in this specification needs to ignore template contents.

### 4.12.4 The slot element

Categories:

- Flow content
- Phrasing content

Contexts in which this element can be used:

Where phrasing content is expected.

Content model:

- Transparent
Tag omission in text/html:
Neither tag is omissible.

Content attributes:

Global attributes
name — Name of shadow tree slot

Accessibility considerations:
For authors.
For implementers.

DOM interface:

```
[Exposed=Window]
interface HTMLSlotElement : HTMLElement {
  [HTMLConstructor] constructor();

  [[CEReactions]] attribute DOMString name;
  sequence<Node> assignedNodes(optional AssignedNodesOptions options = {});
  sequence<Element> assignedElements(optional AssignedNodesOptions options = {});
  undefined assign((Element or Text)... nodes);
};

dictionary AssignedNodesOptions {
  boolean flatten = false;
};
```

The `slot` element defines a slot. It is typically used in a shadow tree. A `slot` element represents its assigned nodes, if any, and its contents otherwise.

The `name` content attribute may contain any string value. It represents a slot’s name.

Note

The `name` attribute is used to assign slots to other elements: a `slot` element with a `name` attribute creates a named slot to which any element is assigned if that element has a `slot` attribute whose value matches that `name` attribute’s value, and the `slot` element is a child of the shadow tree whose root’s host has that corresponding `slot` attribute value.

For web developers (non-normative)

`slot.name`

Can be used to get and set slot's name.

`slot.assignedNodes()`

Returns slot's assigned nodes.

`slot.assignedNodes({ flatten: true })`

Returns slot's assigned nodes, if any, and slot's children otherwise, and does the same for any `slot` elements encountered therein, recursively, until there are no `slot` elements left.

`slot.assignedElements()`

Returns slot's assigned nodes, limited to elements.

`slot.assignedElements({ flatten: true })`

Returns the same as `assignedNodes({ flatten: true })`, limited to elements.

`slot.assign(...nodes)`

Sets slot's manually assigned nodes to the given nodes.

The `name` IDL attribute must reflect the content attribute of the same name.

The `slot` element has manually assigned nodes, which is an ordered set of slottables set by `assign()`. This set is initially empty.
The **assignedNodes** method steps are:

1. If `options["flatten"]` is false, then return this's assigned nodes.
2. Return the result of finding flattened slottables with this.

The **assignedElements** method steps are:

1. If `options["flatten"]` is false, then return this's assigned nodes, filtered to contain only Element nodes.
2. Return the result of finding flattened slottables with this, filtered to contain only Element nodes.

The **assign(...nodes)** method steps are:

1. For each node of this's manually assigned nodes, set node's manual slot assignment to null.
2. Let nodesSet be a new ordered set.
3. For each node of nodes:
   1. If node's manual slot assignment refers to a slot, then remove node from that slot's manually assigned nodes.
   2. Set node's manual slot assignment to this.
   3. Append node to nodesSet.
4. Set this's manually assigned nodes to nodesSet.
5. Run assign slottables for a tree for this's root.

### 4.12.5 The canvas element

**Categories**

- Flow content
- Phrasing content
- Embedded content
- Palpable content

**Contexts in which this element can be used**: Where embedded content is expected.

**Content model**

- Transparent, but with no interactive content descendants except for `a` elements, `img` elements with `usemap` attributes, `button` elements, `input` elements whose `type` attribute are in the Checkbox or Radio Button states, `input` elements that are `buttons`, and `select` elements with a `multiple` attribute or a `display size` greater than 1.

**Tag omission in text/html**: Neither tag is omissible.

**Content attributes**: 

- Global attributes
  - `width` — Horizontal dimension
  - `height` — Vertical dimension

**Accessibility considerations**: 

- For authors.
- For implementers.
The `canvas` element provides scripts with a resolution-dependent bitmap canvas, which can be used for rendering graphs, game graphics, art, or other visual images on the fly.

Authors should not use the `canvas` element in a document when a more suitable element is available. For example, it is inappropriate to use a `canvas` element to render a page heading: if the desired presentation of the heading is graphically intense, it should be marked up using appropriate elements (typically `<h1>`) and then styled using CSS and supporting technologies such as shadow trees.

When authors use the `canvas` element, they must also provide content that, when presented to the user, conveys essentially the same function or purpose as the `canvas` element’s bitmap. This content may be placed as content of the `canvas` element. The contents of the `canvas` element, if any, are the element’s fallback content.

In interactive visual media, if scripting is enabled for the `canvas` element, and if support for `canvas` elements has been enabled, then the `canvas` element represents, consisting of a dynamically created image, the element’s bitmap.

In non-interactive, static, visual media, if the `canvas` element has been previously associated with a rendering context (e.g. if the page was viewed in an interactive visual medium and is now being printed, or if some script that ran during the page layout process painted on the element), then the `canvas` element represents, with the element’s current bitmap and size. Otherwise, the element represents its fallback content instead.

In non-visual media, and in visual media if scripting is disabled for the `canvas` element or if support for `canvas` elements has been disabled, the `canvas` element represents its fallback content instead.

When a `canvas` element represents, the user can still focus descendants of the `canvas` element (in the fallback content). When an element is focused, it is the target of keyboard interaction events (even though the element itself is not visible). This allows authors to make an interactive canvas keyboard-accessible: authors should have a one-to-one mapping of interactive regions to focusable areas in the fallback content. (Focus has no effect on mouse interaction events.)

An element whose nearest `canvas` element ancestor is being rendered and represents, is an element that is being used as relevant canvas fallback content.

The `canvas` element has two attributes to control the size of the element’s bitmap: `width` and `height`. These attributes, when specified, must have values that are valid non-negative integers. The rules for parsing non-negative integers must be used to obtain their numeric values. If an attribute is missing, or if parsing its value returns an error, then the default value must be used instead. The `width` attribute defaults to 300, and the `height` attribute defaults to 150.

When setting the value of the `width` or `height` attribute, if the context mode of the `canvas` element is set to
The user agent must throw an "InvalidStateError" `DOMException` and leave the attribute's value unchanged.

The natural dimensions of the `canvas` element when it `represents` embedded content are equal to the dimensions of the element's bitmap.

The user agent must use a square pixel density consisting of one pixel of image data per coordinate space unit for the bitmaps of a `canvas` and its rendering contexts.

---

**Note**

A `canvas` element can be sized arbitrarily by a style sheet, its bitmap is then subject to the 'object-fit' CSS property.

---

The bitmaps of `canvas` elements, the bitmaps of `ImageBitmap` objects, as well as some of the bitmaps of rendering contexts, such as those described in the sections on the `CanvasRenderingContext2D` and `ImageBitmapRenderingContext` objects below, have an `origin-clean` flag, which can be set to true or false. Initially, when the `canvas` element or `ImageBitmap` object is created, its bitmap's `origin-clean` flag must be set to true.

A `canvas` element can have a rendering context bound to it. Initially, it does not have a bound rendering context. To keep track of whether it has a rendering context or not, and what kind of rendering context it is, a `canvas` also has a `canvas context mode`, which is initially `none` but can be changed to either `placeholder`, `2d`, `bitmaprenderer`, `webgl`, `webgl2`, or `webgpu` by algorithms defined in this specification.

When its `canvas context mode` is `none`, a `canvas` element has no rendering context. It serves as a placeholder for an `OffscreenCanvas` object, and the content of the `canvas` element is updated by the `OffscreenCanvas` object's rendering context.

When its `canvas context mode` is `placeholder`, a `canvas` element has no rendering context. It provides a `paint source` whose width is the element's `natural width`, whose height is the element's `natural height`, and whose appearance is the element's bitmap.

Whenever the `width` and `height` content attributes are set, removed, changed, or redundantly set to the value they already have, then the user agent must perform the action from the row of the following table that corresponds to the `canvas` element's `context mode`.

---

<table>
<thead>
<tr>
<th>Context Mode</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>2d</td>
<td>Follow the steps to set bitmap dimensions to the numeric values of the <code>width</code> and <code>height</code> content attributes.</td>
</tr>
<tr>
<td><code>webgl</code> or <code>webgl2</code></td>
<td>Follow the behavior defined in the WebGL specifications. <a href="#">WEBGL</a></td>
</tr>
<tr>
<td>webgpu</td>
<td>Follow the behavior defined in WebGPU. <a href="#">WEBGPU</a></td>
</tr>
<tr>
<td>bitmaprenderer</td>
<td>If the context's <code>bitmap mode</code> is set to <code>blank</code>, run the steps to set an <code>ImageBitmapRenderingContext's output bitmap</code>, passing the <code>canvas</code> element's rendering context.</td>
</tr>
<tr>
<td>placeholder</td>
<td>Do nothing.</td>
</tr>
<tr>
<td>none</td>
<td>Do nothing.</td>
</tr>
</tbody>
</table>

The `width` and `height` IDL attributes must reflect the respective content attributes of the same name, with the same defaults.
The `getContext(contextId, options)` method of the `canvas` element, when invoked, must run these steps:

1. If `options` is not an `object`, then set `options` to `null`.  
2. Set `options` to the result of `converting options to a JavaScript value`.  
3. Run the steps in the cell of the following table whose column header matches this `canvas` element's `canvas context mode` and whose row header matches `contextId`:

<table>
<thead>
<tr>
<th>contextId</th>
<th>none</th>
<th>2d</th>
<th>bitmaprenderer</th>
<th>webgl</th>
<th>webgpu</th>
<th>placeholder</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2d</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Let context be the result of running the 2D context creation algorithm given this and options.</td>
<td></td>
<td>Return the same object as was returned the last time the method was invoked with this same first argument.</td>
<td>Return null.</td>
<td>Return null.</td>
<td>Return null.</td>
<td>Throw an &quot;InvalidStateError&quot; DOMException.</td>
</tr>
<tr>
<td>2. Set this's context mode to 2d.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Return context.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>bitmaprenderer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Let context be the result of running the ImageBitmapRenderingContext creation algorithm given this and options.</td>
<td>Return null.</td>
<td>Return the same object as was returned the last time the method was invoked with this same first argument.</td>
<td>Return null.</td>
<td>Return null.</td>
<td>Return null.</td>
<td>Throw an &quot;InvalidStateError&quot; DOMException.</td>
</tr>
<tr>
<td>2. Set this's context mode to bitmaprenderer.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Return context.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>webgl</strong> or <strong>webgl2</strong>, if the user agent supports the WebGL feature in its current configuration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Let context be the result of following the instructions given in the WebGL specifications' Context Creation sections.</td>
<td>Return null.</td>
<td>Return the same object as was returned the last time the method was invoked with this same first argument.</td>
<td>Return null.</td>
<td>Return null.</td>
<td>Return null.</td>
<td>Throw an &quot;InvalidStateError&quot; DOMException.</td>
</tr>
<tr>
<td>2. If context is null, then return null; otherwise set this's context mode to webgl or webgl2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Return context.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>webgpu</strong>, if the user agent supports the WebGPU feature in its current configuration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Let context be the result of following the instructions given in WebGPU's Canvas Rendering section.</td>
<td>Return null.</td>
<td>Return the same object as was returned the last time the method was invoked with this same first argument.</td>
<td>Return null.</td>
<td>Return null.</td>
<td>Return null.</td>
<td>Throw an &quot;InvalidStateError&quot; DOMException.</td>
</tr>
<tr>
<td>2. If context is null, then return null; otherwise set this's context mode to webgpu.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 3. Return context.
3. Return context.

An unsupported value*

- Return null.
- Return null.
- Return null.
- Return null.
- Throw an "InvalidStateError" DOMException.

* For example, the "webgl" or "webgl2" value in the case of a user agent having exhausted the graphics hardware's abilities and having no software fallback implementation.

---

**For web developers (non-normative)**

```javascript
url = canvas.toDataURL();
```

Returns a data: URL for the image in the canvas.

The first argument, if provided, controls the type of the image to be returned (e.g. PNG or JPEG). The default is "image/png"; that type is also used if the given type isn't supported. The second argument applies if the type is an image format that supports variable quality (such as "image/jpeg"), and is a number in the range 0.0 to 1.0 inclusive indicating the desired quality level for the resulting image.

When trying to use types other than "image/png", authors can check if the image was really returned in the requested format by checking to see if the returned string starts with one of the exact strings "data:image/png," or "data:image/png;".

If it does, the image is PNG, and thus the requested type was not supported. (The one exception to this is if the canvas has either no height or no width, in which case the result might simply be "data:;".)

```javascript
canvas.toBlob(callback, type, quality)
```

Creates a Blob object representing a file containing the image in the canvas, and invokes a callback with a handle to that object.

The second argument, if provided, controls the type of the image to be returned (e.g. PNG or JPEG). The default is "image/png"; that type is also used if the given type isn't supported. The third argument applies if the type is an image format that supports variable quality (such as "image/jpeg"), and is a number in the range 0.0 to 1.0 inclusive indicating the desired quality level for the resulting image.

```javascript
canvas.transferControlToOffscreen()
```

Returns a newly created OffscreenCanvas object that uses the canvas element as a placeholder. Once the canvas element has become a placeholder for an OffscreenCanvas object, its natural size can no longer be changed, and it cannot have a rendering context. The content of the placeholder canvas is updated on the OffscreenCanvas's relevant agent's event loop's update the rendering steps.

The `toDataURL(type, quality)` method, when invoked, must run these steps:

1. If this canvas element's bitmap's `origin-clean` flag is set to false, then throw a "SecurityError" DOMException.
2. If this canvas element's bitmap has no pixels (i.e. either its horizontal dimension or its vertical dimension is zero) then return the string "data:;". (This is the shortest data: URL; it represents the empty string in a text/plain resource.)
3. Let file be a serialization of this canvas element's bitmap as a file, passing type and quality if given.
4. If file is null then return "data:;".
5. Return a data: URL representing file. [RFC2397]

The `toBlob(callback, type, quality)` method, when invoked, must run these steps:

1. If this canvas element's bitmap's `origin-clean` flag is set to false, then throw a "SecurityError" DOMException.
2. Let result be null.
3. If this canvas element's bitmap has pixels (i.e., neither its horizontal dimension nor its vertical dimension is zero), then set result to a copy of this canvas element's bitmap.
4. Run these steps in parallel:

   a. If result is non-null, then set result to a serialization of result as a file with type and quality if given.
2. **Queue an element task** on the **canvas blob serialization task source** given the **canvas** element to run these steps:

   1. If `result` is non-null, then set `result` to a new **Blob** object, created in the **relevant realm** of this **canvas** element, representing `result`. [FILEAPI]

   2. **Invoke** `callback` with « `result` ».

The **transferControlToOffscreen()** method, when invoked, must run these steps:

   1. If this **canvas** element's **context mode** is not set to **none**, throw an "**InvalidStateError**" **DOMException**.

   2. Let `offscreenCanvas` be a new **OffscreenCanvas** object with its width and height equal to the values of the `width` and `height` content attributes of this **canvas** element.

   3. Set the **placeholder canvas element** of `offscreenCanvas` to a weak reference to this **canvas** element.

   4. Set this **canvas** element's **context mode** to **placeholder**.

   5. Return `offscreenCanvas`.

### 4.12.5.1 The 2D rendering context

```idl
typedef (HTMLImageElement or SVGImageElement) HTMLOrSVGImageElement;
typedef (HTMLOrSVGImageElement or HTMLVideoElement or HTMLCanvasElement or ImageBitmap or OffscreenCanvas or VideoFrame) CanvasImageSource;
enum PredefinedColorSpace { "srgb", "display-p3" };
enum CanvasFillRule { "nonzero", "evenodd" };
dictionary CanvasRenderingContext2DSettings {
    boolean alpha = true;
    boolean desynchronized = false;
    PredefinedColorSpace colorSpace = "srgb";
    boolean willReadFrequently = false;
};
enum ImageSmoothingQuality { "low", "medium", "high" };

[Exposed=Window]
interface CanvasRenderingContext2D {
    // back-reference to the canvas
    readonly attribute HTMLCanvasElement canvas;

    CanvasRenderingContext2DSettingsgetContextAttributes();
};
CanvasRenderingContext2D includes CanvasState;
CanvasRenderingContext2D includes CanvasTransform;
CanvasRenderingContext2D includes CanvasCompositing;
CanvasRenderingContext2D includes CanvasImageSmoothing;
CanvasRenderingContext2D includes CanvasFillStrokeStyles;
CanvasRenderingContext2D includes CanvasShadowStyles;
CanvasRenderingContext2D includes CanvasFilters;
CanvasRenderingContext2D includes CanvasRect;
CanvasRenderingContext2D includes CanvasDrawPath;
```
interface mixin CanvasStateException {
  // state
  undefined save(); // push state on state stack
  undefined restore(); // pop state stack and restore state
  undefined reset(); // reset the rendering context to its default state
  boolean isContextLost(); // return whether context is lost
};

interface mixin CanvasTransform {
  // transformations (default transform is the identity matrix)
  undefined scale(unrestricted double x, unrestricted double y);
  undefined rotate(unrestricted double angle);
  undefined translate(unrestricted double x, unrestricted double y);
  undefined transform(unrestricted double a, unrestricted double b, unrestricted double c, unrestricted double d, unrestricted double e, unrestricted double f);
}

interface mixin CanvasCompositing {
  // compositing
  attribute unrestricted double globalAlpha; // (default 1.0)
  attribute DOMString globalCompositeOperation; // (default "source-over")
};

interface mixin CanvasImageSmoothing {
  // image smoothing
  attribute boolean imageSmoothingEnabled; // (default true)
  attribute ImageSmoothingQuality imageSmoothingQuality; // (default low)
};

interface mixin CanvasFillStrokeStyles {
  // colors and styles (see also the CanvasPathDrawingStyles and CanvasTextDrawingStyles interfaces)
  attribute (DOMString or CanvasGradient or CanvasPattern) strokeStyle; // (default black)
  attribute (DOMString or CanvasGradient or CanvasPattern) fillStyle; // (default black)
  CanvasGradient createLinearGradient(double x0, double y0, double x1, double y1);
  CanvasGradient createRadialGradient(double x0, double y0, double r0, double x1, double y1, double r1);
  CanvasGradient createConicGradient(double startAngle, double x, double y);
  CanvasPattern? createPattern(CanvasImageSource image, [LegacyNullToEmptyString] DOMString repetition);
};

interface mixin CanvasShadowStyles {
  // shadows
  attribute unrestricted double shadowOffsetX; // (default 0)
  attribute unrestricted double shadowOffsetY; // (default 0)
  attribute unrestricted double shadowBlur; // (default 0)
attribute DOMString shadowColor; // (default transparent black)

interface mixin CanvasFilters {
    // filters
    attribute DOMString filter; // (default "none")
}

interface mixin CanvasRect {
    // rects
    undefined clearRect(unrestricted double x, unrestricted double y, unrestricted double w, unrestricted double h);
    undefined fillRect(unrestricted double x, unrestricted double y, unrestricted double w, unrestricted double h);
    undefined strokeRect(unrestricted double x, unrestricted double y, unrestricted double w, unrestricted double h);
}

interface mixin CanvasDrawPath {
    // path API (see also CanvasPath)
    undefined beginPath();
    undefined fill(optional CanvasFillRule fillRule = "nonzero");
    undefined fill(Path2D path, optional CanvasFillRule fillRule = "nonzero");
    undefined stroke();
    undefined stroke(Path2D path);
    undefined clip(optional CanvasFillRule fillRule = "nonzero");
    undefined clip(Path2D path, optional CanvasFillRule fillRule = "nonzero");
    boolean isPointInPath(unrestricted double x, unrestricted double y, optional CanvasFillRule fillRule = "nonzero");
    boolean isPointInPath(Path2D path, unrestricted double x, unrestricted double y, optional CanvasFillRule fillRule = "nonzero");
    boolean isPointInStroke(unrestricted double x, unrestricted double y);
    boolean isPointInStroke(Path2D path, unrestricted double x, unrestricted double y);
}

interface mixin CanvasUserInterface {
    undefined drawFocusIfNeeded(Element element);
    undefined drawFocusIfNeeded(Path2D path, Element element);
    undefined scrollTopIntoView();
    undefined scrollTopIntoView(Path2D path);
}

interface mixin CanvasText {
    // text (see also the CanvasPathDrawingStyles and CanvasTextDrawingStyles interfaces)
    undefined fillText(DOMString text, unrestricted double x, unrestricted double y, optional unrestricted double maxWidth);
    undefined strokeText(DOMString text, unrestricted double x, unrestricted double y, optional unrestricted double maxWidth);
    TextMetrics measureText(DOMString text);
}

interface mixin CanvasDrawImage {
    // drawing images
    undefined drawImage(CanvasImageSource image, unrestricted double dx, unrestricted double dy);
    undefined drawImage(CanvasImageSource image, unrestricted double dx, unrestricted double dy, unrestricted double dw, unrestricted double dh);
    undefined drawImage(CanvasImageSource image, unrestricted double sx, unrestricted double sy, unrestricted double sw, unrestricted double sh, unrestricted double dx, unrestricted double dy, unrestricted double dw, unrestricted double dh);
}
interface mixin CanvasImageData {
    // pixel manipulation
    ImageData createImageData([EnforceRange] long sw, [EnforceRange] long sh, optional ImageDataSettings settings = {});
    ImageData createImageData(ImageData imagedata);
    undefined putImageData(ImageData imagedata, [EnforceRange] long dx, [EnforceRange] long dy);
};

enum CanvasLineCap { "butt", "round", "square" };
enum CanvasLineJoin { "round", "bevel", "miter" };
enum CanvasTextAlign { "start", "end", "left", "right", "center" };
enum CanvasTextBaseline { "top", "hanging", "middle", "alphabetic", "ideographic", "bottom" };
enum CanvasDirection { "ltr", "rtl", "inherit" };
enum CanvasFontKerning { "auto", "normal", "none" };
enum CanvasFontVariantCaps { "normal", "small-caps", "all-small-caps", "petite-caps", "all-petite-caps", "unicase", "titling-caps" };
enum CanvasTextRendering { "auto", "optimizeSpeed", "optimizeLegibility", "geometricPrecision" };

interface mixin CanvasPathDrawingStyles {
    // line caps/joins
    attribute unrestricted double lineWidth; // (default 1)
    attribute CanvasLineCap lineCap; // (default "butt")
    attribute CanvasLineJoin lineJoin; // (default "miter")
    attribute unrestricted double miterLimit; // (default 10)

    // dashed lines
    undefined setLineDash(sequence<unrestricted double> segments); // default empty sequence
    unrestricted double lineDashOffset;
};

interface mixin CanvasTextDrawingStyles {
    // text
    attribute DOMString font; // (default 10px sans-serif)
    attribute CanvasTextAlign textAlign; // (default: "start")
    attribute CanvasTextBaseline textBaseline; // (default: "alphabetic")
    attribute CanvasDirection direction; // (default: "inherit")
    attribute DOMString letterSpacing; // (default: "0px")
    attribute CanvasFontKerning fontKerning; // (default: "auto")
    attribute CanvasFontStretch fontStretch; // (default: "normal")
    attribute CanvasFontVariantCaps fontVariantCaps; // (default: "normal")
    attribute CanvasTextRendering textRendering; // (default: "auto")
    attribute DOMString wordSpacing; // (default: "0px")
};

interface mixin CanvasPath {
    // shared path API methods
    undefined closePath();
    undefined moveTo(unrestricted double x, unrestricted double y);
    undefined lineTo(unrestricted double x, unrestricted double y);
    undefined quadraticCurveTo(unrestricted double cp1x, unrestricted double cp1y, unrestricted double cp2x, unrestricted double cp2y, unrestricted double x, unrestricted double y);
    undefined bezierCurveTo(unrestricted double cplx, unrestricted double cp1y, unrestricted double cp2x, unrestricted double cp2y, unrestricted double x, unrestricted double y);
}
undefined arcTo(unrestricted double x1, unrestricted double y1, unrestricted double x2, unrestricted double y2, unrestricted double radius);
undefined rect(unrestricted double x, unrestricted double y, unrestricted double w, unrestricted double h);
undefined roundRect(unrestricted double x, unrestricted double y, unrestricted double w, unrestricted double h, optional (unrestricted double or DOMPointInit or sequence<{unrestricted double or DOMPointInit}>) radii = 0);
undefined arc(unrestricted double x, unrestricted double y, unrestricted double radius, unrestricted double startAngle, unrestricted double endAngle, optional boolean counterclockwise = false);
undefined ellipse(unrestricted double x, unrestricted double y, unrestricted double radiusX, unrestricted double radiusY, unrestricted double rotation, unrestricted double startAngle, unrestricted double endAngle, optional boolean counterclockwise = false);

[Exposed=(Window,Worker)]
interface CanvasGradient {
  // opaque object
  undefined addColorStop(double offset, DOMString color);
};

[Exposed=(Window,Worker)]
interface CanvasPattern {
  // opaque object
  undefined setTransform(optional DOMMatrix2DInit transform = {});
};

[Exposed=(Window,Worker)]
interface TextMetrics {
  // x-direction
  readonly attribute double width; // advance width
  readonly attribute double actualBoundingBoxLeft;
  readonly attribute double actualBoundingBoxRight;

  // y-direction
  readonly attribute double fontBoundingBoxAscent;
  readonly attribute double fontBoundingBoxDescent;
  readonly attribute double actualBoundingBoxAscent;
  readonly attribute double actualBoundingBoxDescent;
  readonly attribute double emHeightAscent;
  readonly attribute double emHeightDescent;
  readonly attribute double hangingBaseline;
  readonly attribute double alphabeticBaseline;
  readonly attribute double ideographicBaseline;
};

dictionary ImageDataSettings {
  PredefinedColorSpace colorSpace;
};

[Exposed=(Window,Worker),
  Serializable]
interface ImageData {
  constructor(unsigned long sw, unsigned long sh, optional ImageDataSettings settings = {});
  constructor(Uint8ClampedArray data, unsigned long sw, optional unsigned long sh, optional ImageDataSettings settings = {});

  readonly attribute unsigned long width;
  readonly attribute unsigned long height;
  readonly attribute Uint8ClampedArray data;
  readonly attribute PredefinedColorSpace colorSpace;
};
Exposed=(Window,Worker)

interface Path2D {
    constructor(optional (Path2D or DOMString) path);

    undefined addPath(Path2D path, optional DOMMatrix2DInit transform = {});
};

Path2D includes CanvasPath;

Note
To maintain compatibility with existing web content, user agents need to enumerate methods defined in CanvasUserInterface immediately after the stroke method on CanvasRenderingContext2D objects.

For web developers (non-normative)


Returns a CanvasRenderingContext2D object that is permanently bound to a particular canvas element.

If the alpha member is false, then the context is forced to always be opaque.

If the desynchronized member is true, then the context might be desynchronized.

The colorSpace member specifies the color space of the rendering context.

If the willReadFrequently member is true, then the context is marked for readback optimization.

context.canvas
Returns the canvas element.

attributes = context.getContextAttributes()
Returns an object whose:

• alpha member is true if the context has an alpha channel, or false if it was forced to be opaque.

• desynchronized member is true if the context can be desynchronized.

• colorSpace member is a string indicating the context's color space.

• willReadFrequently member is true if the context is marked for readback optimization.

A CanvasRenderingContext2D object has an output bitmap that is initialized when the object is created.

The output bitmap has an origin-clean flag, which can be set to true or false. Initially, when one of these bitmaps is created, its origin-clean flag must be set to true.

The CanvasRenderingContext2D object also has an alpha boolean. When a CanvasRenderingContext2D object's alpha is false, then its alpha channel must be fixed to 1.0 (fully opaque) for all pixels, and attempts to change the alpha component of any pixel must be silently ignored.

Note
Thus, the bitmap of such a context starts off as opaque black instead of transparent black. clearRect always results in opaque black pixels, every fourth byte from getImageData is always 255, the putImageData method effectively ignores every fourth byte in its input, and so on. However, the alpha component of styles and images drawn onto the canvas are still honoured up to the point where they would impact the output bitmap's alpha channel; for instance, drawing a 50% transparent white square on a freshly created output bitmap with its alpha set to false will result in a fully-opaque gray square.

The CanvasRenderingContext2D object also has a desynchronized boolean. When a CanvasRenderingContext2D object's desynchronized is true, then the user agent may optimize the rendering of the canvas to reduce the latency, as measured from input events to rasterization, by desynchronizing the canvas paint cycle from the event loop, bypassing the ordinary user agent rendering algorithm, or both. Insofar as this mode involves bypassing the usual paint mechanisms, rasterization, or both, it might introduce visible tearing artifacts.
The user agent usually renders on a buffer which is not being displayed, quickly swapping it and the one being scanned out for presentation; the former buffer is called back buffer and the latter front buffer. A popular technique for reducing latency is called front buffer rendering, also known as single buffer rendering, where rendering happens in parallel and racily with the scanning out process. This technique reduces the latency at the price of potentially introducing tearing artifacts and can be used to implement in total or part of the desynchronized boolean. [MULTIPLEBUFFERING]

The desynchronized boolean can be useful when implementing certain kinds of applications, such as drawing applications, where the latency between input and rasterization is critical.

The CanvasRenderingContext2D object also has a will read frequently boolean. When a CanvasRenderingContext2D object's will read frequently is true, the user agent may optimize the canvas for readback operations.

Note
On most devices the user agent needs to decide whether to store the canvas's output bitmap on the GPU (this is also called "hardware accelerated"), or on the CPU (also called "software"). Most rendering operations are more performant for accelerated canvases, with the major exception being readback with getImageData(), toDataURL(), or toBlob(). CanvasRenderingContext2D objects with will read frequently equal to true tell the user agent that the webpage is likely to perform many readback operations and that it is advantageous to use a software canvas.

The CanvasRenderingContext2D object also has a color space setting of type PredefinedColorSpace. The CanvasRenderingContext2D object's color space indicates the color space for the output bitmap.

The getContextAttributes() method steps are to return « [ "alpha", "this", "alpha", "desynchronized", "this", "desynchronized", "this", "colorSpace", "this", "color space", "willReadFrequently", "this", "will read frequently" ] ».

The CanvasRenderingContext2D 2D rendering context represents a flat linear Cartesian surface whose origin (0,0) is at the top left corner, with the coordinate space having x values increasing when going right, and y values increasing when going down. The x-coordinate of the right-most edge is equal to the width of the rendering context's output bitmap in CSS pixels; similarly, the y-coordinate of the bottom-most edge is equal to the height of the rendering context's output bitmap in CSS pixels.

The size of the coordinate space does not necessarily represent the size of the actual bitmaps that the user agent will use internally or during rendering. On high-definition displays, for instance, the user agent may internally use bitmaps with four device pixels per unit in the coordinate space, so that the rendering remains at high quality throughout. Anti-aliasing can similarly be implemented using oversampling with bitmaps of a higher resolution than the final image on the display.

Example

Using CSS pixels to describe the size of a rendering context's output bitmap does not mean that when rendered the canvas will cover an equivalent area in CSS pixels. CSS pixels are reused for ease of integration with CSS features, such as text layout.

In other words, the canvas element below's rendering context has a 200x200 output bitmap (which internally uses CSS pixels as a unit for ease of integration with CSS) and is rendered as 100x100 CSS pixels:

```
<canvas width=200 height=200 style=width:100px;height:100px>
```

The 2D context creation algorithm, which is passed a target (a canvas element) and options, consists of running these steps:

1. Let settings be the result of converting options to the dictionary type CanvasRenderingContext2DSettings. (This can throw an exception.).
2. Let context be a new CanvasRenderingContext2D object.
3. Initialize context's canvas attribute to point to target.
4. Set context's output bitmap to the same bitmap as target's bitmap (so that they are shared).
5. Set bitmap dimensions to the numeric values of target's width and height content attributes.
6. Set context's `alpha` to settings["alpha"].
7. Set context's `desynchronized` to settings["desynchronized"].
8. Set context's `color space` to settings["colorSpace"].
9. Set context's `will read frequently` to settings["willReadFrequently"].
10. Return context.

When the user agent is to set bitmap dimensions to `width` and `height`, it must run these steps:

1. **Reset the rendering context to its default state**.
2. Resize the output bitmap to the new `width` and `height`.
3. Let `canvas` be the `canvas` element to which the rendering context's `canvas` attribute was initialized.
4. If the numeric value of `canvas`'s `width` content attribute differs from `width`, then set `canvas`'s `width` content attribute to the shortest possible string representing `width` as a valid non-negative integer.
5. If the numeric value of `canvas`'s `height` content attribute differs from `height`, then set `canvas`'s `height` content attribute to the shortest possible string representing `height` as a valid non-negative integer.

Example

Only one square appears to be drawn in the following example:

```javascript
// canvas is a reference to a <canvas> element
var context = canvas.getContext('2d');
context.fillRect(0, 0, 50, 50);
canvas.setAttribute('width', '300'); // clears the canvas
context.fillRect(0, 100, 50, 50); // clears the canvas
context.width = canvas.width; // clears the canvas
context.fillRect(100, 0, 50, 50); // only this square remains
```

The `canvas` attribute must return the value it was initialized to when the object was created.

The **PredefinedColorSpace** enumeration is used to specify the `color space` of the canvas's backing store.

The "srgb" value indicates the 'srgb' color space.

The "display-p3" value indicates the 'display-p3' color space.

**Note**

Algorithms for converting between color spaces are found in the Predefined color spaces section of CSS Color. [CSSCOLOR]

The **CanvasFillRule** enumeration is used to select the fill rule algorithm by which to determine if a point is inside or outside a path.

The value "nonzero" value indicates the nonzero winding rule, wherein a point is considered to be outside a shape if the number of times a half-infinite straight line drawn from that point crosses the shape's path going in one direction is equal to the number of times it crosses the path going in the other direction.

The "evenodd" value indicates the even-odd rule, wherein a point is considered to be outside a shape if the number of times a half-infinite straight line drawn from that point crosses the shape's path is even.

If a point is not outside a shape, it is inside the shape.
The `ImageSmoothingQuality`\(^{676}\) enumeration is used to express a preference for the interpolation quality to use when smoothing images.

The "low" value indicates a preference for a low level of image interpolation quality. Low-quality image interpolation may be more computationally efficient than higher settings.

The "medium" value indicates a preference for a medium level of image interpolation quality.

The "high" value indicates a preference for a high level of image interpolation quality. High-quality image interpolation may be more computationally expensive than lower settings.

---

**Note**

Bilinear scaling is an example of a relatively fast, lower-quality image-smoothing algorithm. Bicubic or Lanczos scaling are examples of image-smoothing algorithms that produce higher-quality output. This specification does not mandate that specific interpolation algorithms be used.

---

### 4.12.5.1.1 Implementation notes

This section is non-normative.

The output bitmap\(^{681}\), when it is not directly displayed by the user agent, implementations can, instead of updating this bitmap, merely remember the sequence of drawing operations that have been applied to it until such time as the bitmap's actual data is needed (for example because of a call to `drawImage()`\(^{712}\), or the `createImageBitmap()`\(^{1163}\) factory method). In many cases, this will be more memory efficient.

The bitmap of a canvas\(^{671}\) element is the one bitmap that's pretty much always going to be needed in practice. The output bitmap\(^{681}\) of a rendering context, when it has one, is always just an alias to a canvas\(^{671}\) element's bitmap.

Additional bitmaps are sometimes needed, e.g. to enable fast drawing when the canvas is being painted at a different size than its natural size, or to enable double buffering so that graphics updates, like page scrolling for example, can be processed concurrently while canvas draw commands are being executed.

---

### 4.12.5.1.2 The canvas state

Objects that implement the `CanvasState`\(^{677}\) interface maintain a stack of drawing states. Drawing states consist of:

- The current transformation matrix\(^{703}\).
- The current clipping region\(^{715}\).
- The current letter spacing\(^{692}\) , word spacing\(^{692}\) , fill style\(^{707}\) , stroke style\(^{707}\) , filter\(^{728}\) , global alpha\(^{726}\) , and compositing and blending operator\(^{726}\).
- The current values of the following attributes: `lineWidth`\(^{668}\) , `lineCap`\(^{686}\) , `lineJoin`\(^{686}\) , `miterLimit`\(^{686}\) , `lineDashOffset`\(^{687}\) , `shadowOffsetX`\(^{727}\) , `shadowOffsetY`\(^{727}\) , `shadowBlur`\(^{727}\) , `shadowColor`\(^{727}\) , `font`\(^{691}\) , `textAlign`\(^{691}\) , `textBaseline`\(^{691}\) , `direction`\(^{692}\) , `fontKerning`\(^{692}\) , `fontStretch`\(^{692}\) , `fontVariantCaps`\(^{692}\) , `textRendering`\(^{662}\) , `imageSmoothingEnabled`\(^{726}\) , `imageSmoothingQuality`\(^{726}\) .
- The current `dash list`\(^{686}\).

**Note**

The rendering context's bitmaps are not part of the drawing state, as they depend on whether and how the rendering context is bound to a canvas\(^{861}\) element.

Objects that implement the `CanvasState`\(^{677}\) mixin have a `context lost` boolean, that is initialized to false when the object is created. The `context lost`\(^{684}\) value is updated in the `context lost steps`\(^{9110}\).
The `save()` method steps are to push a copy of the current drawing state onto the drawing state stack. The `restore()` method steps are to pop the top entry in the drawing state stack, restoring the context to that state. The `reset()` method steps are to reset the rendering context, which includes the backing buffer, the drawing state stack, path, and styles. The `isContextLost()` method steps are to return this context lost.

To **reset the rendering context to its default state**:

1. Clear canvas's bitmap to transparent black.
2. Empty the list of subpaths in context's current default path.
3. Clear the context's drawing state stack.
4. Reset everything that drawing state consists of to their initial values.

The `isContextLost()` method steps are to return this context lost.

### 4.12.5.1.3 Line styles

For web developers (non-normative)

```javascript
context.lineWidth [ = value ]
styles.lineWidth [ = value ]
```

Returns the current line width. Can be set, to change the line width. Values that are not finite values greater than zero are ignored.

```javascript
context.lineCap [ = value ]
styles.lineCap [ = value ]
```

Returns the current line cap style. Can be set, to change the line cap style. The possible line cap styles are "butt", "round", and "square". Other values are ignored.

```javascript
context.lineJoin [ = value ]
styles.lineJoin [ = value ]
```

Returns the current line join style. Can be set, to change the line join style. The possible line join styles are "bevel", "round", and "miter". Other values are ignored.

```javascript
context.miterLimit [ = value ]
styles.miterLimit [ = value ]
```

Returns the current miter limit ratio. Can be set, to change the miter limit ratio. Values that are not finite values greater than zero are ignored.
Objects that implement the `CanvasPathDrawingStyles` interface have attributes and methods (defined in this section) that control how lines are treated by the object.

The `lineWidth` attribute gives the width of lines, in coordinate space units. On getting, it must return the current value. On setting, zero, negative, infinite, and NaN values must be ignored, leaving the value unchanged; other values must change the current value to the new value.

When the object implementing the `CanvasPathDrawingStyles` interface is created, the `lineWidth` attribute must initially have the value 1.0.

The `lineCap` attribute defines the type of endings that UAs will place on the end of lines. The three valid values are "butt", "round", and "square".

On getting, it must return the current value. On setting, the current value must be changed to the new value.

When the object implementing the `CanvasPathDrawingStyles` interface is created, the `lineCap` attribute must initially have the value "butt".

The `lineJoin` attribute defines the type of corners that UAs will place where two lines meet. The three valid values are "bevel", "round", and "miter".

On getting, it must return the current value. On setting, the current value must be changed to the new value.

When the object implementing the `CanvasPathDrawingStyles` interface is created, the `lineJoin` attribute must initially have the value "miter".

When the `lineJoin` attribute has the value "miter", strokes use the miter limit ratio to decide how to render joins. The miter limit ratio can be explicitly set using the `miterLimit` attribute. On getting, it must return the current value. On setting, zero, negative, infinite, and NaN values must be ignored, leaving the value unchanged; other values must change the current value to the new value.

When the object implementing the `CanvasPathDrawingStyles` interface is created, the `miterLimit` attribute must initially have the value 10.0.

Each `CanvasPathDrawingStyles` object has a dash list, which is either empty or consists of an even number of non-negative numbers. Initially, the dash list must be empty.

The `setLineDash` method, when invoked, must run these steps:

1. If any value in `segments` is not finite (e.g. an Infinity or a NaN value), or if any value is negative (less than zero), then return (without throwing an exception; user agents could show a message on a developer console, though, as that would be helpful for debugging).
2. If the number of elements in segments is odd, then let segments be the concatenation of two copies of segments.

3. Let the object's dash list be segments.

When the getLineDash() method is invoked, it must return a sequence whose values are the values of the object's dash list, in the same order.

It is sometimes useful to change the "phase" of the dash pattern, e.g. to achieve a "marching ants" effect. The phase can be set using the lineDashOffset attribute. On getting, it must return the current value. On setting, infinite and NaN values must be ignored, leaving the value unchanged; other values must change the current value to the new value.

When the object implementing the CanvasPathDrawingStyles interface is created, the lineDashOffset attribute must initially have the value 0.0.

When a user agent is to trace a path, given an object style that implements the CanvasPathDrawingStyles interface, it must run the following algorithm. This algorithm returns a new path.

1. Let path be a copy of the path being traced.

2. Prune all zero-length line segments from path.

3. Remove from path any subpaths containing no lines (i.e. subpaths with just one point).

4. Replace each point in each subpath of path other than the first point and the last point of each subpath by a join that joins the line leading to that point to the line leading out of that point, such that the subpaths all consist of two points (a starting point with a line leading out of it, and an ending point with a line leading into it), one or more lines (connecting the points and the joins), and zero or more joins (each connecting one line to another), connected together such that each subpath is a series of one or more lines with a join between each one and a point on each end.

5. Add a straight closing line to each closed subpath in path connecting the last point and the first point of that subpath; change the last point to a join (from the previously last line to the newly added closing line), and change the first point to a join (from the newly added closing line to the first line).

6. If style's dash list is empty, then jump to the step labeled convert.

7. Let pattern width be the concatenation of all the entries of style's dash list, in coordinate space units.

8. For each subpath subpath in path, run the following substeps. These substeps mutate the subpaths in path in vivo.

   1. Let subpath width be the length of all the lines of subpath, in coordinate space units.

   2. Let offset be the value of style's lineDashOffset, in coordinate space units.

   3. While offset is greater than pattern width, decrement it by pattern width.

   4. Define L to be a linear coordinate line defined along all lines in subpath, such that the start of the first line in the subpath is defined as coordinate 0, and the end of the last line in the subpath is defined as coordinate subpath width.

   5. Let position be zero minus offset.

   6. Let index be 0.

   7. Let current state be off (the other states being on and zero-on).

   8. Dash on: Let segment length be the value of style's dash list's indexth entry.

   9. Increment position by segment length.

10. If position is greater than subpath width, then end these substeps for this subpath and start them again for the next subpath; if there are no more subpaths, then jump to the step labeled convert instead.

11. If segment length is nonzero, then let current state be on.

12. Increment index by one.

13. Dash off: Let segment length be the value of style's dash list's indexth entry.
Let \( \text{start} \) be the offset \( \text{position} \) on \( L \).

Increment \( \text{position} \) by segment length.

If \( \text{position} \) is less than zero, then jump to the step labeled post-cut.

If \( \text{start} \) is less than zero, then let \( \text{start} \) be zero.

If \( \text{position} \) is greater than subpath width, then let \( \text{end} \) be the offset subpath width on \( L \). Otherwise, let \( \text{end} \) be the offset \( \text{position} \) on \( L \).

Jump to the first appropriate step:

\( \rightarrow \) **If segment length is zero and current state is off**

Do nothing, just continue to the next step.

\( \rightarrow \) **If current state is off**

Cut the line on which \( \text{end} \) finds itself short at \( \text{end} \) and place a point there, cutting in two the subpath that it was in; remove all line segments, joins, points, and subpaths that are between \( \text{start} \) and \( \text{end} \); and finally place a single point at \( \text{start} \) with no lines connecting to it.

The point has a directionality for the purposes of drawing line caps (see below). The directionality is the direction that the original line had at that point (i.e. when \( L \) was defined above).

\( \rightarrow \) **Otherwise**

Cut the line on which \( \text{start} \) finds itself into two at \( \text{start} \) and place a point there, cutting in two the subpath that it was in, and similarly cut the line on which \( \text{end} \) finds itself short at \( \text{end} \) and place a point there, cutting in two the subpath that it was in, and then remove all line segments, joins, points, and subpaths that are between \( \text{start} \) and \( \text{end} \).

If \( \text{start} \) and \( \text{end} \) are the same point, then this results in just the line being cut in two and two points being inserted there, with nothing being removed, unless a join also happens to be at that point, in which case the join must be removed.

20. **Post-cut**: If \( \text{position} \) is greater than subpath width, then jump to the step labeled convert.

21. If segment length is greater than zero, then let positioned-at-on-dash be false.

22. Increment \( \text{index} \) by one. If it is equal to the number of entries in \( \text{style}'s \) dash list, then let \( \text{index} \) be 0.

23. Return to the step labeled dash on.

9. **Convert**: This is the step that converts the path to a new path that represents its stroke.

Create a new path that describes the edge of the areas that would be covered if a straight line of length equal to \( \text{style}'s \) lineWidth was swept along each subpath in path while being kept at an angle such that the line is orthogonal to the path being swept, replacing each point with the end cap necessary to satisfy \( \text{style}'s \) lineCap attribute as described previously and elaborated below, and replacing each join with the join necessary to satisfy \( \text{style}'s \) lineJoin type, as defined below.

**Caps**: Each point has a flat edge perpendicular to the direction of the line coming out of it. This is then augmented according to the value of \( \text{style}'s \) lineCap. The "butt" value means that no additional line cap is added. The "round" value means that a semi-circle with the diameter equal to \( \text{style}'s \) lineWidth width must additionally be placed on to the line coming out of each point. The "square" value means that a rectangle with the length of \( \text{style}'s \) lineWidth width and the width of half \( \text{style}'s \) lineWidth width, placed flat against the edge perpendicular to the direction of the line coming out of the point, must be added at each point.

Points with no lines coming out of them must have two caps placed back-to-back as if it was really two points connected to each other by an infinitesimally short straight line in the direction of the point's directionality (as defined above).

**Joins**: In addition to the point where a join occurs, two additional points are relevant to each join, one for each line: the two corners found half the line width away from the join point, one perpendicular to each line, each on the side furthest from the other line.

A triangle connecting these two opposite corners with a straight line, with the third point of the triangle being the join point, must be added at all joins. The lineJoin attribute controls whether anything else is rendered. The three aforementioned values have the following meanings:

The "bevel" value means that this is all that is rendered at joins.
The "round" value means that an arc connecting the two aforementioned corners of the join, abutting (and not overlapping) the aforementioned triangle, with the diameter equal to the line width and the origin at the point of the join, must be added at joins.

The "miter" value means that a second triangle must (if it can given the miter length) be added at the join, with one line being the line between the two aforementioned corners, abutting the first triangle, and the other two being continuations of the outside edges of the two joining lines, as long as required to intersect without going over the miter length.

The miter length is the distance from the point where the join occurs to the intersection of the line edges on the outside of the join. The miter limit ratio is the maximum allowed ratio of the miter length to half the line width. If the miter length would cause the miter limit ratio (as set by style's miterLimit attribute) to be exceeded, then this second triangle must not be added.

The subpaths in the newly created path must be oriented such that for any point, the number of times a half-infinite straight line drawn from that point crosses a subpath is even if and only if the number of times a half-infinite straight line drawn from that same point crosses a subpath going in one direction is equal to the number of times it crosses a subpath going in the other direction.

10. Return the newly created path.

### 4.12.5.1.4 Text styles

For web developers (non-normative)

```javascript
context.font = value
styles.font = value
```

Returns the current font settings.

Can be set, to change the font. The syntax is the same as for the CSS `font` property; values that cannot be parsed as CSS font values are ignored.

Relative keywords and lengths are computed relative to the font of the canvas element.

```javascript
context.textAlign = value
styles.textAlign = value
```

Returns the current text alignment settings.

Can be set, to change the alignment. The possible values and their meanings are given below. Other values are ignored. The default is "start".

```javascript
context.textBaseline = value
styles.textBaseline = value
```

Returns the current baseline alignment settings.

Can be set, to change the baseline alignment. The possible values and their meanings are given below. Other values are ignored. The default is "alphabetic".

```javascript
context.direction = value
styles.direction = value
```

Returns the current directionality.

Can be set, to change the directionality. The possible values and their meanings are given below. Other values are ignored. The default is "inherit".

```javascript
context.letterSpacing = value
styles.letterSpacing = value
```

Returns the current spacing between characters in the text.

Can be set, to change spacing between characters. Values that cannot be parsed as a CSS `<length>` are ignored. The default is "0px".

```javascript
context.fontKerning = value
styles.fontKerning = value
```

Returns the current font kerning settings.

Can be set, to change the font kerning. The possible values and their meanings are given below. Other values are ignored. The default is "auto".
Objects that implement the `CanvasTextDrawingStyles` interface have attributes (defined in this section) that control how text is laid out (rasterized or outlined) by the object. Such objects can also have a font style source object. For `CanvasRenderingContext2D` objects, this is the `canvas` element given by the value of the context's `canvas` attribute. For `OffscreenCanvasRenderingContext2D` objects, this is the associated `OffscreenCanvas` object.

Font resolution for the font style source object requires a font source. This is determined for a given object implementing `CanvasTextDrawingStyles` by the following steps:

1. If object's font style source object is a `canvas` element, return the element's node document.
2. Otherwise, object's font style source object is an `OffscreenCanvas` object:
   1. Let `global` be object's relevant global object.
   2. If `global` is a `Window` object, then return `global`'s associated `Document`.
   3. Assert: `global` implements `WorkerGlobalScope`.
   4. Return `global`.

Example 690

This is an example of font resolution with a regular `canvas` element with ID `c1`.

```javascript
const font = new FontFace("MyCanvasFont", "url(mycanvasfont.ttf)"); documents.fonts.add(font);

const context = document.getElementById("c1").getContext("2d");
document.fonts.ready.then(function() {
  context.font = "64px MyCanvasFont";
  context.fillText("hello", 0, 0);
});
```

In this example, the canvas will display text using `mycanvasfont.ttf` as its font.

Example 690

```
context.fontStretch [ = value ]
styles.fontStretch [ = value ]

Returns the current font stretch settings.
Can be set, to change the font stretch. The possible values and their meanings are given below. Other values are ignored. The default is "normal".

context.fontVariantCaps [ = value ]
styles.fontVariantCaps [ = value ]

Returns the current font variant caps settings.
Can be set, to change the font variant caps. The possible values and their meanings are given below. Other values are ignored. The default is "normal".

context.textRendering [ = value ]
styles.textRendering [ = value ]

Returns the current text rendering settings.
Can be set, to change the text rendering. The possible values and their meanings are given below. Other values are ignored. The default is "auto".

context.wordSpacing [ = value ]
styles.wordSpacing [ = value ]

Returns the current spacing between words in the text.
Can be set, to change spacing between words. Values that cannot be parsed as a CSS `<length>` are ignored. The default is "0px".
```
This is an example of how font resolution can happen using `OffscreenCanvas`. Assuming a `canvas` element with ID `c2` which is transferred to a worker like so:

```javascript
const offscreenCanvas = document.getElementById("c2").transferControlToOffscreen();
worker.postMessage(offscreenCanvas, [offscreenCanvas]);
```

Then, in the worker:

```javascript
self.onmessage = function(ev) {
  const transferredCanvas = ev.data;
  const context = transferredCanvas.getContext("2d");
  const font = new FontFace("MyFont", "url(myfont.ttf)");
  self.fonts.add(font);
  self.fonts.ready.then(function() {
    context.font = "64px MyFont";
    context.fillText("hello", 0, 0);
  });
};
```

In this example, the canvas will display a text using `myfont.ttf`. Notice that the font is only loaded inside the worker, and not in the document context.

The `font` IDL attribute, on setting, must be parsed as a CSS `<font>` value (but without supporting property-independent style sheet syntax like ‘inherit’), and the resulting font must be assigned to the context, with the ‘line-height’ component forced to ‘normal’, with the ‘font-size’ component converted to CSS pixels, and with system fonts being computed to explicit values. If the new value is syntactically incorrect (including using property-independent style sheet syntax like ‘inherit’ or ‘initial’), then it must be ignored, without assigning a new font value. [CSS]

Font family names must be interpreted in the context of the font style source object when the font is to be used; any fonts embedded using `@font-face` or loaded using `FontFace` objects that are visible to the font style source object must therefore be available once they are loaded. (Each `font style source object` has a `font source`, which determines what fonts are available.) If a font is used before it is fully loaded, or if the `font style source object` does not have that font in scope at the time the font is to be used, then it must be treated as if it was an unknown font, falling back to another as described by the relevant CSS specifications. [CSSFONTS] [CSSFONTLOAD]

On getting, the `font` attribute must return the serialized form of the current font of the context (with no ‘line-height’ component). [CSSOM]

Example

For example, after the following statement:

```javascript
context.font = 'italic 400 12px/2 Unknown Font, sans-serif';
```

...the expression `context.font` would evaluate to the string "italic 12px "Unknown Font", sans-serif". The "400" font-weight doesn't appear because that is the default value. The line-height doesn't appear because it is forced to "normal", the default value.

When the object implementing the `CanvasTextDrawingStyles` interface is created, the font of the context must be set to 10px sans-serif. When the ‘font-size’ component is set to lengths using percentages, ‘em’ or ‘ex’ units, or the ‘larger’ or ‘smaller’ keywords, these must be interpreted relative to the `computed value` of the ‘font-size’ property of the `font style source object` at the time that the attribute is set, if it is an element. When the ‘font-weight’ component is set to the relative values ‘bolder’ and ‘lighter’, these must be interpreted relative to the `computed value` of the ‘font-weight’ property of the `font style source object` at the time that the attribute is set, if it is an element. If the `computed values` are undefined for a particular case (e.g. because the `font style source object` is not an element or is not `being rendered`), then the relative keywords must be interpreted relative to the normal-weight 10px sans-serif default.

The `textAlign` IDL attribute, on getting, must return the current value. On setting, the current value must be changed to the new value. When the object implementing the `CanvasTextDrawingStyles` interface is created, the `textAlign` attribute must initially have the value `start`.

The `textBaseline` IDL attribute, on getting, must return the current value. On setting, the current value must be changed to the new
value. When the object implementing the `CanvasTextDrawingStyles` interface is created, the `textBaseline` attribute must initially have the value `alphabetic`.

The `direction` IDL attribute, on getting, must return the current value. On setting, the current value must be changed to the new value. When the object implementing the `CanvasTextDrawingStyles` interface is created, the `direction` attribute must initially have the value "inherit".

Objects that implement the `CanvasTextDrawingStyles` interface have attributes that control the spacing between letters and words. Such objects have associated `letter spacing` and `word spacing` values, which are CSS `<length>` values. Initially, both must be the result of parsing "0px" as a CSS `<length>`.

The `letterSpacing` getter steps are to return the serialized form of this's `letter spacing`.

The `letterSpacing` setter steps are:
1. Let `parsed` be the result of parsing the given value as a CSS `<length>`.
2. If `parsed` is failure, then return.
3. Set this's `letter spacing` to `parsed`.

The `wordSpacing` getter steps are to return the serialized form of this's `word spacing`.

The `wordSpacing` setter steps are:
1. Let `parsed` be the result of parsing the given value as a CSS `<length>`.
2. If `parsed` is failure, then return.
3. Set this's `word spacing` to `parsed`.

The `fontKerning` IDL attribute, on getting, must return the current value. On setting, the current value must be changed to the new value. When the object implementing the `CanvasTextDrawingStyles` interface is created, the `fontKerning` attribute must initially have the value "auto".

The `fontStretch` IDL attribute, on getting, must return the current value. On setting, the current value must be changed to the new value. When the object implementing the `CanvasTextDrawingStyles` interface is created, the `fontStretch` attribute must initially have the value "normal".

The `fontVariantCaps` IDL attribute, on getting, must return the current value. On setting, the current value must be changed to the new value. When the object implementing the `CanvasTextDrawingStyles` interface is created, the `fontVariantCaps` attribute must initially have the value "normal".

The `textRendering` IDL attribute, on getting, must return the current value. On setting, the current value must be changed to the new value. When the object implementing the `CanvasTextDrawingStyles` interface is created, the `textRendering` attribute must initially have the value "auto".

The `textAlign` attribute's allowed keywords are as follows:

- **start**
  Align to the start edge of the text (left side in left-to-right text, right side in right-to-left text).

- **end**
  Align to the end edge of the text (right side in left-to-right text, left side in right-to-left text).

- **left**
  Align to the left.

- **right**
  Align to the right.

- **center**
  Align to the center.

The `textBaseline` attribute's allowed keywords correspond to alignment points in the font.
The keywords map to these alignment points as follows:

**top**
The top of the em square

**hanging**
The [hanging baseline](#)

**middle**
The middle of the em square

**alphabetic**
The [alphabetic baseline](#)

**ideographic**
The [ideographic-under baseline](#)

**bottom**
The bottom of the em square

The [direction](#) attribute's allowed keywords are as follows:

**ltr**
Treat input to the [text preparation algorithm](#) as left-to-right text.

**rtl**
Treat input to the [text preparation algorithm](#) as right-to-left text.

**inherit**
Default to the directionality of the [canvas](#) element or [Document](#) as appropriate.

The [fontKerning](#) attribute's allowed keywords are as follows:

**auto**
Kerning is applied at the discretion of the user agent.

**normal**
Kerning is applied.

**none**
Kerning is not applied.

The [fontStretch](#) attribute's allowed keywords are as follows:
ultra-condensed
    Same as CSS `font-stretch' 'ultra-condensed' setting.

extra-condensed
    Same as CSS `font-stretch' 'extra-condensed' setting.

condensed
    Same as CSS `font-stretch' 'condensed' setting.

semi-condensed
    Same as CSS `font-stretch' 'semi-condensed' setting.

normal
    The default setting, where width of the glyphs is at 100%.

semi-expanded
    Same as CSS `font-stretch' 'semi-expanded' setting.

expanded
    Same as CSS `font-stretch' 'expanded' setting.

extra-expanded
    Same as CSS `font-stretch' 'extra-expanded' setting.

ultra-expanded
    Same as CSS `font-stretch' 'ultra-expanded' setting.

The `fontVariantCaps' attribute's allowed keywords are as follows:

normal
    None of the features listed below are enabled.

small-caps
    Same as CSS `font-variant-caps' 'small-caps' setting.

all-small-caps
    Same as CSS `font-variant-caps' 'all-small-caps' setting.

petite-caps
    Same as CSS `font-variant-caps' 'petite-caps' setting.

all-petite-caps
    Same as CSS `font-variant-caps' 'all-petite-caps' setting.

unicase
    Same as CSS `font-variant-caps' 'unicase' setting.

titling-caps
    Same as CSS `font-variant-caps' 'titling-caps' setting.

The `textRendering' attribute's allowed keywords are as follows:

auto
    Same as 'auto' in SVG text-rendering property.

optimizeSpeed
    Same as 'optimizeSpeed' in SVG text-rendering property.

optimizeLegibility
    Same as 'optimizeLegibility' in SVG text-rendering property.
The text preparation algorithm is as follows. It takes as input a string text, a `CanvasTextDrawingStyles` object target, and an optional length maxWidth. It returns an array of glyph shapes, each positioned on a common coordinate space, a physical alignment whose value is one of left, right, and center, and an inline box. (Most callers of this algorithm ignore the physical alignment and the inline box.)

1. If maxWidth was provided but is less than or equal to zero or equal to NaN, then return an empty array.
2. Replace all ASCII whitespace in text with U+0020 SPACE characters.
3. Let font be the current font of target, as given by that object's `font` attribute.
4. Apply the appropriate step from the following list to determine the value of direction:
   - If the target object's `direction` attribute has the value "ltr"
     Let direction be 'ltr'.
   - If the target object's `direction` attribute has the value "rtl"
     Let direction be 'rtl'.
   - If the target object's `font style source object` is an element
     Let direction be the directionality of the target object's `font style source object`.
   - If the target object's `font style source object` is a `Document` with a non-null document element
     Let direction be the directionality of the target object's `font style source object`'s document element.
   - Otherwise
     Let direction be 'ltr'.
5. Form a hypothetical infinitely-wide CSS line box containing a single inline box containing the text text, with its CSS properties set as follows:

<table>
<thead>
<tr>
<th>Property</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>'direction'</td>
<td>direction</td>
</tr>
<tr>
<td>'font'</td>
<td>font</td>
</tr>
<tr>
<td>'font-kerning'</td>
<td>target's <code>fontKerning</code></td>
</tr>
<tr>
<td>'font-stretch'</td>
<td>target's <code>fontStretch</code></td>
</tr>
<tr>
<td>'font-variant-caps'</td>
<td>target's <code>fontVariantCaps</code></td>
</tr>
<tr>
<td>'letter-spacing'</td>
<td>target's <code>letterSpacing</code></td>
</tr>
<tr>
<td>SVG text-rendering</td>
<td>target's <code>textRendering</code></td>
</tr>
<tr>
<td>'white-space'</td>
<td>'pre'</td>
</tr>
<tr>
<td>'word-spacing'</td>
<td>target's <code>wordSpacing</code></td>
</tr>
</tbody>
</table>

and with all other properties set to their initial values.
6. If maxWidth was provided and the hypothetical width of the inline box in the hypothetical line box is greater than maxWidth CSS pixels, then change font to have a more condensed font (if one is available or if a reasonably readable one can be synthesized by applying a horizontal scale factor to the font) or a smaller font, and return to the previous step.
7. The anchor point is a point on the inline box, and the physical alignment is one of the values left, right, and center. These variables are determined by the `textAlign` and `textBaseline` values as follows:

   Horizontal position:
   - If `textAlign` is left
     If `textAlign` is start and direction is 'ltr'
       Let the anchor point's horizontal position be the left edge of the inline box, and let physical alignment be left.
     If `textAlign` is end and direction is 'rtl'
       Let the anchor point's horizontal position be the right edge of the inline box, and let physical alignment be right.
   - If `textAlign` is right
     If `textAlign` is end and direction is 'ltr'
       Let the anchor point's horizontal position be the right edge of the inline box, and let physical alignment be right.
If `textAlign` is `center`
Let the anchor point's horizontal position be half way between the left and right edges of the inline box, and let physical alignment be center.

Vertical position:

If `textBaseline` is `top`
Let the anchor point's vertical position be the top of the em box of the first available font of the inline box.

If `textBaseline` is `hanging`
Let the anchor point's vertical position be the hanging baseline of the first available font of the inline box.

If `textBaseline` is `middle`
Let the anchor point's vertical position be half way between the bottom and the top of the em box of the first available font of the inline box.

If `textBaseline` is `alphabetic`
Let the anchor point's vertical position be the alphabetic baseline of the first available font of the inline box.

If `textBaseline` is `ideographic`
Let the anchor point's vertical position be the ideographic-under baseline of the first available font of the inline box.

If `textBaseline` is `bottom`
Let the anchor point's vertical position be the bottom of the em box of the first available font of the inline box.

Let `result` be an array constructed by iterating over each glyph in the inline box from left to right (if any), adding to the array, for each glyph, the shape of the glyph as it is in the inline box, positioned on a coordinate space using CSS pixels with its origin is at the anchor point.

9. Return `result`, physical alignment, and the inline box.

### 4.12.5.1.5 Building paths

Objects that implement the `CanvasPath` interface have a `path`. A path has a list of zero or more subpaths. Each subpath consists of a list of one or more points, connected by straight or curved line segments, and a flag indicating whether the subpath is closed or not. A closed subpath is one where the last point of the subpath is connected to the first point of the subpath by a straight line. Subpaths with only one point are ignored when painting the path.

Paths have a `need new subpath` flag. When this flag is set, certain APIs create a new subpath rather than extending the previous one. When a `path` is created, its `need new subpath` flag must be set.

When an object implementing the `CanvasPath` interface is created, its `path` must be initialized to zero subpaths.

---

For web developers (non-normative)

```javascript
context.moveTo(x, y)

context.lineTo(x, y)

context.quadraticCurveTo(cpx, cpy, x, y)
```
context.bezierCurveTo(cp1x, cp1y, cp2x, cp2y, x, y)

`path.bezierCurveTo(cp1x, cp1y, cp2x, cp2y, x, y)`

Adds the given point to the current subpath, connected to the previous one by a cubic Bézier curve with the given control points.

context.arcTo(x1, y1, x2, y2, radius)

`path.arcTo(x1, y1, x2, y2, radius)`

Adds an arc with the given control points and radius to the current subpath, connected to the previous point by a straight line.

Throws an "IndexSizeError" DOMException if the given radius is negative.
context.arc(x, y, radius, startAngle, endAngle [, counterclockwise ])

Adds points to the subpath such that the arc described by the circumference of the circle described by the arguments, starting at the given start angle and ending at the given end angle, going in the given direction (defaulting to clockwise), is added to the path, connected to the previous point by a straight line.

Throws an "IndexSizeError" DOMException if the given radius is negative.

context.ellipse(x, y, radiusX, radiusY, rotation, startAngle, endAngle [, counterclockwise] ]

Adds points to the subpath such that the arc described by the circumference of the ellipse described by the arguments, starting at the given start angle and ending at the given end angle, going in the given direction (defaulting to clockwise), is added to the path, connected to the previous point by a straight line.

Throws an "IndexSizeError" DOMException if the given radius is negative.

context.rect(x, y, w, h)

path.rect(x, y, w, h)

Adds a new closed subpath to the path, representing the given rectangle.

context.roundRect(x, y, w, h, radii)

path.roundRect(x, y, w, h, radii)

Adds a new closed subpath to the path representing the given rounded rectangle. radii is either a list of radii or a single radius representing the corners of the rectangle in pixels. If a list is provided, the number and order of these radii function in the same
The following methods allow authors to manipulate the paths of objects implementing the CanvasPath interface. For objects implementing the CanvasDrawPath and CanvasTransform interfaces, the points passed to the methods, and the resulting lines added to the current default path by these methods, must be transformed according to the current transformation matrix before being added to the path.

The moveTo(x, y) method, when invoked, must run these steps:

1. If either of the arguments are infinite or NaN, then return.
2. Create a new subpath with the specified point as its first (and only) point.

When the user agent is to ensure there is a subpath for a coordinate (x, y) on a path, the user agent must check to see if the path has its need new subpath flag set. If it does, then the user agent must create a new subpath with the point (x, y) as its first (and only) point, as if the moveTo() method had been called, and must then unset the path's need new subpath flag.

The closePath() method, when invoked, must do nothing if the object's path has no subpaths. Otherwise, it must mark the last subpath as closed, create a new subpath whose first point is the same as the previous subpath's first point, and finally add this new subpath to the path.

Note: If the last subpath had more than one point in its list of points, then this is equivalent to adding a straight line connecting the last point back to the first point of the last subpath, thus "closing" the subpath.

New points and the lines connecting them are added to subpaths using the methods described below. In all cases, the methods only modify the last subpath in the object's path.

The lineTo(x, y) method, when invoked, must run these steps:

1. If either of the arguments are infinite or NaN, then return.
2. If the object's path has no subpaths, then ensure there is a subpath for (x, y).
3. Otherwise, connect the last point in the subpath to the given point (x, y) using a straight line, and then add the given point to the subpath.

The quadraticCurveTo(cpx, cpy, x, y) method, when invoked, must run these steps:

1. If any of the arguments are infinite or NaN, then return.
2. Ensure there is a subpath for (cpx, cpy)
3. Connect the last point in the subpath to the given point (x, y) using a quadratic Bézier curve with control point (cpx, cpy).
4. Add the given point \((x, y)\) to the subpath.

The `bezierCurveTo(cp1x, cp1y, cp2x, cp2y, x, y)` method, when invoked, must run these steps:

1. If any of the arguments are infinite or NaN, then return.
2. Ensure there is a subpath for \((cp1x, cp1y)\).
3. Connect the last point in the subpath to the given point \((x, y)\) using a cubic Bézier curve with control points \((cp1x, cp1y)\) and \((cp2x, cp2y)\). \[BEZIER\]
4. Add the point \((x, y)\) to the subpath.

The `arcTo(x1, y1, x2, y2, radius)` method, when invoked, must run these steps:

1. If any of the arguments are infinite or NaN, then return.
2. Ensure there is a subpath for \((x1, y1)\).
3. If \(radius\) is negative, then throw an "IndexSizeError" DOMException.
4. Let the point \((x0, y0)\) be the last point in the subpath, transformed by the inverse of the current transformation matrix (so that it is in the same coordinate system as the points passed to the method).
5. If the point \((x0, y0)\) is equal to the point \((x1, y1)\), or if the point \((x1, y1)\) is equal to the point \((x2, y2)\), or if \(radius\) is zero, then add the point \((x1, y1)\) to the subpath, and connect that point to the previous point \((x0, y0)\) by a straight line.
6. Otherwise, if the points \((x0, y0), (x1, y1),\) and \((x2, y2)\) all lie on a single straight line, then add the point \((x1, y1)\) to the subpath, and connect that point to the previous point \((x0, y0)\) by a straight line.
7. Otherwise, let The Arc be the shortest arc given by circumference of the circle that has radius \(radius\), and that has one point tangent to the half-infinite line that crosses the point \((x0, y0)\) and ends at the point \((x1, y1)\), and that has a different point tangent to the half-infinite line that ends at the point \((x1, y1)\) and crosses the point \((x2, y2)\). The points at which this circle touches these two lines are called the start and end tangent points respectively. Connect the point \((x0, y0)\) to the start tangent point by a straight line, adding the start tangent point to the subpath, and then connect the start tangent point to the end tangent point by The Arc, adding the end tangent point to the subpath.

The `arc(x, y, radius, startAngle, endAngle, counterclockwise)` method, when invoked, must run the ellipse method steps with this, \(x, y, radius, startAngle, endAngle,\) and counterclockwise.

**Note**

This makes it equivalent to `ellipse()` except that both radii are equal and rotation is 0.

The `ellipse(x, y, radiusX, radiusY, rotation, startAngle, endAngle, counterclockwise)` method, when invoked, must run the ellipse method steps with this, \(x, y, radiusX, radiusY, rotation, startAngle, endAngle,\) and counterclockwise.

The **determine the point on an ellipse steps**, given `ellipse`, and `angle`, are:

1. Let `eccentricCircle` be the circle that shares its origin with `ellipse`, with a radius equal to the semi-major axis of `ellipse`.
2. Let `outerPoint` be the point on `eccentricCircle`'s circumference at `angle` measured in radians clockwise from `ellipse`'s semi-major axis.
3. Let `chord` be the line perpendicular to `ellipse`'s major axis between this axis and `outerPoint`.
4. Return the point on `chord` that crosses `ellipse`'s circumference.

The **ellipse method steps**, given `canvasPath`, \(x, y, radiusX, radiusY, rotation, startAngle, endAngle,\) and counterclockwise, are:

1. If any of the arguments are infinite or NaN, then return.
2. If either `radiusX` or `radiusY` are negative, then throw an "IndexSizeError" DOMException.
3. If `canvasPath`'s path has any subpaths, then add a straight line from the last point in the subpath to the start point of the arc.
4. Add the start and end points of the arc to the subpath, and connect them with an arc. The arc and its start and end points are defined as follows:

Consider an ellipse that has its origin at \((x, y)\), that has a major-axis radius \(radiusX\) and a minor-axis radius \(radiusY\), and that is rotated about its origin such that its semi-major axis is inclined \(rotation\) radians clockwise from the x-axis.

If \(counterclockwise\) is false and \(endAngle - startAngle\) is greater than or equal to \(2\pi\), or, if \(counterclockwise\) is true and \(startAngle - endAngle\) is greater than or equal to \(2\pi\), then the arc is the whole circumference of this ellipse, and both the start point and the end point are the result of running the determine the point on an ellipse steps\(^{6700}\) given this ellipse and \(startAngle\).

Otherwise, the start point is the result of running the determine the point on an ellipse steps\(^{6700}\) given this ellipse and \(startAngle\), the end point is the result of running the determine the point on an ellipse steps\(^{6700}\) given this ellipse and \(endAngle\), and the arc is the path along the circumference of this ellipse from the start point to the end point, going counterclockwise if \(counterclockwise\) is true, and clockwise otherwise. Since the points are on the ellipse, as opposed to being simply angles from zero, the arc can never cover an angle greater than \(2\pi\) radians.

The \(\text{rect}(x, y, w, h)\) method, when invoked, must run these steps:

1. If any of the arguments are infinite or NaN, then return.
2. Create a new subpath containing just the four points \((x, y)\), \((x+w, y)\), \((x+w, y+h)\), \((x, y+h)\), in that order, with those four points connected by straight lines.
3. Mark the subpath as closed.
4. Create a new subpath with the point \((x, y)\) as the only point in the subpath.

The \(\text{roundRect}(x, y, w, h, \text{radii})\) method steps are:

1. If any of \(x\), \(y\), \(w\), or \(h\) are infinite or NaN, then return.
2. If \(\text{radii}\) is an unrestricted double or DOMPointInit, then set \(\text{radii}\) to \[['\text{radii}']\].
3. If \(\text{radii}\) is not a list of size one, two, three, or four, then throw a RangeError.
4. Let \(\text{normalizedRadii}\) be an empty list.
5. For each radius of \(\text{radii}\):
   1. If \(\text{radius}\) is a DOMPointInit:
      1. If \(\text{radius}\) is infinite or NaN, then return.
      2. If \(\text{radius}\) is negative, then throw a RangeError.
      3. Otherwise, append \(\text{radius}\) to \(\text{normalizedRadii}\).
   2. If \(\text{radius}\) is a unrestricted double:
      1. If \(\text{radius}\) is infinite or NaN, then return.
      2. If \(\text{radius}\) is negative, then throw a RangeError.
      3. Otherwise append \[[''\text{radius}'\rightarrow 'radius']\] to \(\text{normalizedRadii}\).
6. Let upperLeft, upperRight, lowerRight, and lowerLeft be null.
7. If \(\text{normalizedRadii}\)'s size is 4, then set upperLeft to \(\text{normalizedRadii[0]}\), set upperRight to \(\text{normalizedRadii[1]}\), set lowerRight to \(\text{normalizedRadii[2]}\), and set lowerLeft to \(\text{normalizedRadii[3]}\).
8. If \(\text{normalizedRadii}\)'s size is 3, then set upperLeft to \(\text{normalizedRadii[0]}\), set upperRight and lowerLeft to \(\text{normalizedRadii[1]}\), and set lowerRight to \(\text{normalizedRadii[2]}\).
9. If \( \text{normalizedRadii} \)'s size is 2, then set \( \text{upperLeft} \) and \( \text{lowerRight} \) to \( \text{normalizedRadii}[0] \) and set \( \text{upperRight} \) and \( \text{lowerLeft} \) to \( \text{normalizedRadii}[1] \).

10. If \( \text{normalizedRadii} \)'s size is 1, then set \( \text{upperLeft} \), \( \text{upperRight} \), \( \text{lowerRight} \), and \( \text{lowerLeft} \) to \( \text{normalizedRadii}[0] \).

11. Corner curves must not overlap. Scale all radii to prevent this:
   1. Let \( \text{top} \) be \( \text{upperLeft}["x"] + \text{upperRight}["x"] \).
   2. Let \( \text{right} \) be \( \text{upperRight}["y"] + \text{lowerRight}["y"] \).
   3. Let \( \text{bottom} \) be \( \text{lowerRight}["x"] + \text{lowerLeft}["x"] \).
   4. Let \( \text{left} \) be \( \text{upperLeft}["y"] + \text{lowerLeft}["y"] \).
   5. Let \( \text{scale} \) be the minimum value of the ratios \( w / \text{top}, h / \text{right}, w / \text{bottom}, h / \text{left} \).
   6. If \( \text{scale} \) is less than 1, then set the \( x \) and \( y \) members of \( \text{upperLeft} \), \( \text{upperRight} \), \( \text{lowerLeft} \), and \( \text{lowerRight} \) to their current values multiplied by \( \text{scale} \).

12. Create a new subpath:
   1. Move to the point \( (x + \text{upperLeft}["x",], y) \).
   2. Draw a straight line to the point \( (x + w - \text{upperRight}["x",], y) \).
   3. Draw an arc to the point \( (x + w, y + \text{upperRight}["y",]) \).
   4. Draw a straight line to the point \( (x + w, y + h - \text{lowerRight}["y",]) \).
   5. Draw an arc to the point \( (x + w - \text{lowerRight}["x",], y + h) \).
   6. Draw a straight line to the point \( (x + \text{lowerLeft}["x",], y + h) \).
   7. Draw an arc to the point \( (x, y + h - \text{lowerLeft}["y",]) \).
   8. Draw a straight line to the point \( (x, y + \text{upperLeft}["y",]) \).
   9. Draw an arc to the point \( (x + \text{upperLeft}["x",], y) \).

13. Mark the subpath as closed.

14. Create a new subpath with the point \( (x, y) \) as the only point in the subpath.

Note

This is designed to behave similarly to the CSS 'border-radius' property.

4.12.5.1.6 Path2D objects

Path2D objects can be used to declare paths that are then later used on objects implementing the CanvasDrawPath interface. In addition to many of the APIs described in earlier sections, Path2D objects have methods to combine paths, and to add text to paths.

For web developers (non-normative)

```
path = new Path2D()  # Creates a new empty Path2D object.

path = new Path2D(path)  # When path is a Path2D object, returns a copy.

when path is a Path2D object, returns a copy.

path.addPath(path [, transform ])  # Adds to the path the path given by the argument.
```

The Path2D(path) constructor, when invoked, must run these steps:
1. Let output be a new Path2D object.
2. If path is not given, then return output.
3. If path is a Path2D object, then add all subpaths of path to output and return output. (In other words, it returns a copy of the argument.)
4. Let svgPath be the result of parsing and interpreting path according to SVG 2's rules for path data. [SVG]\(^{1462}\)

Note

The resulting path could be empty. SVG defines error handling rules for parsing and applying path data.

5. Let \((x, y)\) be the last point in svgPath.
6. Add all the subpaths, if any, from svgPath to output.
7. Create a new subpath in output with \((x, y)\) as the only point in the subpath.
8. Return output.

The `addPath(path, transform)` method, when invoked on a Path2D object `a`, must run these steps:

1. If the Path2D object `path` has no subpaths, then return.
2. Let `matrix` be the result of creating a DOMMatrix from the 2D dictionary `transform`.
3. If one or more of `matrix`'s `m11 element`, `m12 element`, `m21 element`, `m22 element`, `m41 element`, or `m42 element` are infinite or NaN, then return.
4. Create a copy of all the subpaths in `path`. Let this copy be known as `c`.
5. Transform all the coordinates and lines in `c` by the transform matrix `matrix`.
6. Let \((x, y)\) be the last point in the last subpath of `c`.
7. Add all the subpaths in `c` to `a`.
8. Create a new subpath in `a` with \((x, y)\) as the only point in the subpath.

### 4.12.5.1.7 Transformations

Objects that implement the CanvasTransform interface have a current transformation matrix, as well as methods (described in this section) to manipulate it. When an object implementing the CanvasTransform interface is created, its transformation matrix must be initialized to the identity matrix.

The current transformation matrix is applied to coordinates when creating the current default path, and when painting text, shapes, and Path2D objects, on objects implementing the CanvasTransform interface.

The transformations must be performed in reverse order.

Note

For instance, if a scale transformation that doubles the width is applied to the canvas, followed by a rotation transformation that rotates drawing operations by a quarter turn, and a rectangle twice as wide as it is tall is then drawn on the canvas, the actual result will be a square.

For web developers (non-normative)

```javascript
context.scale(x, y)
```

Changes the current transformation matrix to apply a scaling transformation with the given characteristics.

```javascript
context.rotate(angle)
```

Changes the current transformation matrix to apply a rotation transformation with the given characteristics. The angle is in radians.
The scale method, when invoked, must run these steps:

1. If either of the arguments are infinite or NaN, then return.
2. Add the scaling transformation described by the arguments to the current transformation matrix. The x argument represents the scale factor in the horizontal direction and the y argument represents the scale factor in the vertical direction. The factors are multiples.

The rotate method, when invoked, must run these steps:

1. If angle is infinite or NaN, then return.
2. Add the rotation transformation described by the argument to the current transformation matrix. The angle argument represents a clockwise rotation angle expressed in radians.

The translate method, when invoked, must run these steps:

1. If either of the arguments are infinite or NaN, then return.
2. Add the translation transformation described by the arguments to the current transformation matrix. The x argument represents the translation distance in the horizontal direction and the y argument represents the translation distance in the vertical direction. The arguments are in coordinate space units.

The transform method, when invoked, must run these steps:

1. If any of the arguments are infinite or NaN, then return.
2. Replace the current transformation matrix with the result of multiplying the current transformation matrix with the matrix described by:

   \[
   \begin{pmatrix}
   a & c & e \\
   b & d & f \\
   0 & 0 & 1
   \end{pmatrix}
   \]

   The arguments a, b, c, d, e, and f are sometimes called m11, m12, m21, m22, dx, and dy or m11, m21, m12, m22, dx, and dy. Care ought to be taken in particular with the order of the second and third arguments (b and c) as their order varies from API to API and APIs sometimes use the notation m12/m21 and sometimes m21/m12 for those positions.

The getTransform method, when invoked, must return a newly created DOMMatrix representing a copy of the current transformation matrix matrix of the context.

This returned object is not live, so updating it will not affect the current transformation matrix, and updating the current transformation matrix will not affect an already returned DOMMatrix.
The `setTransform(a, b, c, d, e, f)` method, when invoked, must run these steps:

1. If any of the arguments are infinite or NaN, then return.
2. Reset the current transformation matrix to the matrix described by:
   \[
   \begin{bmatrix}
   a & c & e \\
   b & d & f \\
   0 & 0 & 1
   \end{bmatrix}
   \]

The `setTransform(transform)` method, when invoked, must run these steps:

1. Let `matrix` be the result of creating a DOMMatrix from the 2D dictionary `transform`.
2. If one or more of `matrix`'s `m11` element, `m12` element, `m21` element, `m22` element, `m41` element, or `m42` element are infinite or NaN, then return.
3. Reset the current transformation matrix to `matrix`.

The `resetTransform()` method, when invoked, must reset the current transformation matrix to the identity matrix.

Note
Given a matrix of the form created by the `transform()` and `setTransform()` methods, i.e.,
\[
\begin{bmatrix}
   a & c & e \\
   b & d & f \\
   0 & 0 & 1
\end{bmatrix}
\]
the resulting transformed coordinates after transform matrix multiplication will be
\[
\begin{align*}
x_{\text{new}} &= ax + cy + e \\
y_{\text{new}} &= bx + dy + f
\end{align*}
\]

### 4.12.5.1.8 Image sources for 2D rendering contexts

Some methods on the `CanvasDrawImage` and `CanvasFillStrokeStyles` interfaces take the union type `CanvasImageSource` as an argument.

This union type allows objects implementing any of the following interfaces to be used as image sources:

- `HTMLImageElement` (or `SVG image` elements)
- `HTMLVideoElement` (or `video` elements)
- `HTMLCanvasElement` (or `canvas` elements)
- `OffscreenCanvas`
- `ImageBitmap`
- `VideoFrame`

Note
Although not formally specified as such, `SVG image` elements are expected to be implemented nearly identical to `img` elements. That is, `SVG image` elements share the fundamental concepts and features of `img` elements.

Note
The `ImageBitmap` interface can be created from a number of other image-representing types, including `ImageData`.

To check the usability of the `image` argument, where `image` is a `CanvasImageSource` object, run these steps:

1. Switch on `image`:
If image's current request's state is broken, then throw an "InvalidStateError" DOMException.

If image is not fully decodable, then return bad.

If image has a natural width or natural height (or both) equal to zero, then return bad.

If image's readyState attribute is either HAVE_NOTHING or HAVE_METADATA, then return bad.

If image has either a horizontal dimension or a vertical dimension equal to zero, then throw an "InvalidStateError" DOMException.

If image's [[Detached]] internal slot value is set to true, then throw an "InvalidStateError" DOMException.

2. Return good.

When a CanvasImageSource object represents an HTMLOrSVGImageElement, the element's image must be used as the source image.

Specifically, when a CanvasImageSource object represents an animated image in an HTMLOrSVGImageElement, the user agent must use the default image of the animation (the one that the format defines is to be used when animation is not supported or is disabled), or, if there is no such image, the first frame of the animation, when rendering the image for CanvasRenderingContext2D APIs.

When a CanvasImageSource object represents an HTMLVideoElement, then the frame at the current playback position when the method with the argument is invoked must be used as the source image when rendering the image for CanvasRenderingContext2D APIs, and the source image's dimensions must be the natural width and natural height of the media resource (i.e., after any aspect-ratio correction has been applied).

When a CanvasImageSource object represents an HTMLCanvasElement, the element's bitmap must be used as the source image.

When a CanvasImageSource object represents an ImageBitmap, the object's bitmap image data must be used as the source image.

When a CanvasImageSource object represents an OffscreenCanvas, the object's bitmap must be used as the source image.

When a CanvasImageSource object represents a VideoFrame, the object's pixel data must be used as the source image, and the source image's dimensions must be the object's [[display width]] and [[display height]].

An object image is not origin-clean if, switching on image's type:

↓ HTMLOrSVGImageElement

image's current request's image data is CORS-cross-origin.

↓ HTMLVideoElement

image's media data is CORS-cross-origin.

↓ HTMLCanvasElement

↓ ImageBitmap

↓ OffscreenCanvas

image's bitmap's origin-clean flag is false.
For web developers (non-normative)

**context.fillStyle**

Returns the current style used for filling shapes.

Can be set, to change the fill style.

The style can be either a string containing a CSS color, or a CanvasGradient or CanvasPattern object. Invalid values are ignored.

**context.strokeStyle**

Returns the current style used for stroking shapes.

Can be set, to change the stroke style.

The style can be either a string containing a CSS color, or a CanvasGradient or CanvasPattern object. Invalid values are ignored.

Objects that implement the CanvasFillStrokeStyles interface have attributes and methods (defined in this section) that control how shapes are treated by the object.

Such objects have associated fill style and stroke style values, which are either CSS colors, CanvasPattern, or CanvasGradient objects. Initially, both must be the result of parsing the string "#000000".

When the value is a CSS color, it must not be affected by the transformation matrix when used to draw on bitmaps.

**Note**

When set to a CanvasPattern or CanvasGradient object, changes made to the object after the assignment do affect subsequent stroking or filling of shapes.

The fillStyle getter steps are:

1. If this's fill style is a CSS color, then return the serialization of that color.
2. Return this's fill style.

The fillStyle setter steps are:

1. If the given value is a string, then:
   1. Let parsedValue be the result of parsing the given value with this's canvas attribute's value.
   2. If parsedValue is failure, then return.
   3. Set this's fill style to parsedValue.
   4. Return.
2. If the given value is a CanvasPattern object that is marked as not origin-clean, then set this's origin-clean flag to false.
3. Set this's fill style to the given value.

The strokeStyle getter steps are:

1. If this's stroke style is a CSS color, then return the serialization of that color.
2. Return this's stroke style.

The strokeStyle setter steps are:

1. If the given value is a string, then:
   1. Let parsedValue be the result of parsing the given value with this's canvas attribute's value.
   2. If parsedValue is failure, then return.
3. Set this's stroke style to parsedValue.

4. Return.

2. If the given value is a CanvasPattern object that is marked as not-clean, then set this's origin-clean flag to false.

3. Set this's stroke style to the given value.

The serialization of a color for a color value is a string, computed as follows: if it has alpha equal to 1.0, then the string is a lowercase six-digit hex value, prefixed with a "#" character (U+0023 NUMBER SIGN), with the first two digits representing the red component, the next two digits representing the green component, and the last two digits representing the blue component, the digits being ASCII lower hex digits. Otherwise, the color value has alpha less than 1.0, and the string is the color value in the CSS rgba() functional-notation format: "rgba" (U+0072 U+0067 U+0062 U+0061) followed by a U+0028 LEFT PARENTHESIS, a base-ten integer in the range 0-255 representing the red component (using ASCII digits in the shortest form possible), a literal U+002C COMMA and SPACE, an integer for the green component, a comma and a space, an integer for the blue component, another comma and space, a U+0030 DIGIT ZERO, if the alpha value is greater than zero then a U+002E FULL STOP (representing the decimal point), if the alpha value is greater than zero then one or more ASCII digits representing the fractional part of the alpha, and finally a U+0029 RIGHT PARENTHESIS. User agents must express the fractional part of the alpha value, if any, with the level of precision necessary for the alpha value, when reparsed, to be interpreted as the same alpha value.

There are three types of gradients, linear gradients, radial gradients, and conic gradients, represented by objects implementing the opaque CanvasGradient interface.

Once a gradient has been created (see below), stops are placed along it to define how the colors are distributed along the gradient. The color of the gradient at each stop is the color specified for that stop. Between each such stop, the colors and the alpha component must be linearly interpolated over the RGBA space without premultiplying the alpha value to find the color to use at that offset. Before the first stop, the color must be the color of the first stop. After the last stop, the color must be the color of the last stop. When there are no stops, the gradient is transparent black.

For web developers (non-normative)

```
gradient.addColorStop(offset, color)
```

Adds a color stop with the given color to the gradient at the given offset. 0.0 is the offset at one end of the gradient, 1.0 is the offset at the other end.

Throws an "IndexSizeError" DOMException if the offset is out of range. Throws a "SyntaxError" DOMException if the color cannot be parsed.

```
gradient = context.createLinearGradient(x0, y0, x1, y1)
```

Returns a CanvasGradient object that represents a linear gradient that paints along the line given by the coordinates represented by the arguments.

```
gradient = context.createRadialGradient(x0, y0, r0, x1, y1, r1)
```

Returns a CanvasGradient object that represents a radial gradient that paints along the cone given by the circles represented by the arguments.

If either of the radii are negative, throws an "IndexSizeError" DOMException exception.

```
gradient = context.createConicGradient(startAngle, x, y)
```

Returns a CanvasGradient object that represents a conic gradient that paints clockwise along the rotation around the center represented by the arguments.

The addColorStop(offset, color) method on the CanvasGradient, when invoked, must run these steps:

1. If the offset is less than 0 or greater than 1, then throw an "IndexSizeError" DOMException.

2. Let parsed color be the result of parsing color.

   **Note**
   
   No element is passed to the parser because CanvasGradient objects are canvas-neutral — a CanvasGradient object created by one canvas can be used by another, and there is therefore no way to know which is the "element in question" at the time that the color is specified.

3. If parsed color is failure, throw a "SyntaxError" DOMException.
4. Place a new stop on the gradient, at offset offset relative to the whole gradient, and with the color parsed color.

If multiple stops are added at the same offset on a gradient, then they must be placed in the order added, with the first one closest to the start of the gradient, and each subsequent one infinitesimally further along towards the end point (in effect causing all but the first and last stop added at each point to be ignored).

The createLinearGradient(x0, y0, x1, y1) method takes four arguments that represent the start point (x0, y0) and end point (x1, y1) of the gradient. The method, when invoked, must return a linear CanvasGradient initialized with the specified line.

Linear gradients must be rendered such that all points on a line perpendicular to the line that crosses the start and end points have the color at the point where those two lines cross (with the colors coming from the interpolation and extrapolation described above). The points in the linear gradient must be transformed as described by the current transformation matrix when rendering.

If x0 = x1 and y0 = y1, then the linear gradient must paint nothing.

The createRadialGradient(x0, y0, r0, x1, y1, r1) method takes six arguments, the first three representing the start circle with origin (x0, y0) and radius r0, and the last three representing the end circle with origin (x1, y1) and radius r1. The values are in coordinate space units. If either of r0 or r1 are negative, then an "IndexSizeError" DOMException must be thrown. Otherwise, the method, when invoked, must return a radial CanvasGradient initialized with the two specified circles.

Radial gradients must be rendered by following these steps:

1. If x0 = x1 and y0 = y1 and r0 = r1, then the radial gradient must paint nothing. Return.
2. Let x(ω) = (x1-x0)ω + x0
   Let y(ω) = (y1-y0)ω + y0
   Let r(ω) = (r1-r0)ω + r0
   Let the color at ω be the color at that position on the gradient (with the colors coming from the interpolation and extrapolation described above).
3. For all values of ω where r(ω) > 0, starting with the value of ω nearest to positive infinity and ending with the value of ω nearest to negative infinity, draw the circumference of the circle with radius r(ω) at position (x(ω), y(ω)), with the color at ω, but only painting on the parts of the bitmap that have not yet been painted on by earlier circles in this step for this rendering of the gradient.

The resulting radial gradient must then be transformed as described by the current transformation matrix when rendering.

The createConicGradient(startAngle, x, y) method takes three arguments, the first argument, startAngle, represents the angle in radians at which the gradient begins, and the last two arguments, (x, y), represent the center of the gradient in CSS pixels. The method, when invoked, must return a conic CanvasGradient initialized with the specified center and angle.

It follows the same rendering rule as CSS 'conic-gradient' and it is equivalent to CSS 'conic-gradient(from adjustedStartAngle rad at xpx ypx, angularColorStopList)'. Here:

- adjustedStartAngle is given by startAngle + π/2;
- angularColorStopList is given by the color stops that have been added to the CanvasGradient using addColorStop() with the color stop offsets interpreted as percentages.

Gradients must be painted only where the relevant stroking or filling effects requires that they be drawn.

Patterns are represented by objects implementing the opaque CanvasPattern interface.
pattern = context.createPattern(image, repetition)

Returns a `CanvasPattern` object that uses the given image and repeats in the direction(s) given by the `repetition` argument. The allowed values for `repetition` are `repeat` (both directions), `repeat-x` (horizontal only), `repeat-y` (vertical only), and `no-repeat` (neither). If the `repetition` argument is empty, the value `repeat` is used.

If the image isn't yet fully decoded, then nothing is drawn. If the image is a canvas with no data, throws an "InvalidStateError" DOMException.

`pattern.setTransform(transform)`

Sets the transformation matrix that will be used when rendering the pattern during a fill or stroke painting operation.

The `createPattern(image, repetition)` method, when invoked, must run these steps:

1. Let `usability` be the result of checking the usability of image.
2. If `usability` is bad, then return null.
3. Assert: `usability` is good.
4. If `repetition` is the empty string, then set it to "repeat".
5. If `repetition` is not identical to one of "repeat", "repeat-x", "repeat-y", or "no-repeat", then throw a "SyntaxError" DOMException.
6. Let `pattern` be a new `CanvasPattern` object with the image and the repetition behavior given by `repetition`.
7. If `image` is not origin-clean, then mark `pattern` as not origin-clean.
8. Return `pattern`.

Modifying the image used when creating a CanvasPattern object after calling the `createPattern()` method must not affect the pattern(s) rendered by the CanvasPattern object.

Patterns have a transformation matrix, which controls how the pattern is used when it is painted. Initially, a pattern's transformation matrix must be the identity matrix.

The `setTransform(transform)` method, when invoked, must run these steps:

1. Let `matrix` be the result of creating a DOMMatrix from the 2D dictionary `transform`.
2. If one or more of `matrix`'s `m11 element`, `m12 element`, `m21 element`, `m22 element`, `m41 element`, or `m42 element` are infinite or NaN, then return.
3. Reset the pattern's transformation matrix to `matrix`.

When a pattern is to be rendered within an area, the user agent must run the following steps to determine what is rendered:

1. Create an infinite transparent black bitmap.
2. Place a copy of the image on the bitmap, anchored such that its top left corner is at the origin of the coordinate space, with one coordinate space unit per CSS pixel of the image, then place repeated copies of this image horizontally to the left and right, if the repetition behavior is "repeat-x", or vertically up and down, if the repetition behavior is "repeat-y", or in all four directions all over the bitmap, if the repetition behavior is "repeat".

If the original image data is a bitmap image, then the value painted at a point in the area of the repetitions is computed by filtering the original image data. When scaling up, if the `imageSmoothingEnabled` attribute is set to false, then the image must be rendered using nearest-neighbor interpolation. Otherwise, the user agent may use any filtering algorithm (for example bilinear interpolation or nearest-neighbor). User agents which support multiple filtering algorithms may use the value of the `imageSmoothingQuality` attribute to guide the choice of filtering algorithm. When such a filtering algorithm requires a pixel value from outside the original image data, it must instead use the value from wrapping the pixel's coordinates to the original image's dimensions. (That is, the filter uses 'repeat' behavior, regardless of the value of the pattern's repetition behavior.)

3. Transform the resulting bitmap according to the pattern's transformation matrix.
4. Transform the resulting bitmap again, this time according to the current transformation matrix.
5. Replace any part of the image outside the area in which the pattern is to be rendered with transparent black.

6. The resulting bitmap is what is to be rendered, with the same origin and same scale.

If a radial gradient or repeated pattern is used when the transformation matrix is singular, then the resulting style must be transparent black (otherwise the gradient or pattern would be collapsed to a point or line, leaving the other pixels undefined). Linear gradients and solid colors always define all points even with singular transformation matrices.

4.12.5.1.10 Drawing rectangles to the bitmap

Objects that implement the CanvasRect\(^{678}\) interface provide the following methods for immediately drawing rectangles to the bitmap. The methods each take four arguments; the first two give the \(x\) and \(y\) coordinates of the top left of the rectangle, and the second two give the width \(w\) and height \(h\) of the rectangle, respectively.

The current transformation matrix\(^{5703}\) must be applied to the following four coordinates, which form the path that must then be closed to get the specified rectangle: \((x, y)\), \((x+w, y)\), \((x+w, y+h)\), \((x, y+h)\).

Shapes are painted without affecting the current default path\(^{5714}\), and are subject to the clipping region\(^{5715}\), and, with the exception of clearRect\(^{5711}\), also shadow effects\(^{5723}\), global alpha\(^{5726}\), and the current compositing and blending operator\(^{5726}\).

For web developers (non-normative)

```
canvas.context.clearRect(x, y, w, h)
```
Clears all pixels on the bitmap in the given rectangle to transparent black.

```
canvas.context.fillRect(x, y, w, h)
```
Paints the given rectangle onto the bitmap, using the current fill style.

```
canvas.context.strokeRect(x, y, w, h)
```
Paints the box that outlines the given rectangle onto the bitmap, using the current stroke style.

The clearRect\((x, y, w, h)\) method, when invoked, must run these steps:

1. If any of the arguments are infinite or NaN, then return.
2. Let \(pixels\) be the set of pixels in the specified rectangle that also intersect the current clipping region\(^{5715}\).
3. Clear the pixels in \(pixels\) to a transparent black, erasing any previous image.

Note

If either height or width are zero, this method has no effect, since the set of pixels would be empty.

The fillRect\((x, y, w, h)\) method, when invoked, must run these steps:

1. If any of the arguments are infinite or NaN, then return.
2. If either \(w\) or \(h\) are zero, then return.
3. Paint the specified rectangular area using this\'s fill style\(^{5707}\).

The strokeRect\((x, y, w, h)\) method, when invoked, must run these steps:

1. If any of the arguments are infinite or NaN, then return.
2. Take the result of tracing the path\(^{687}\) described below, using the CanvasPathDrawingStyles\(^{679}\) interface\'s line styles, and fill it with this\'s stroke style\(^{5707}\).

If both \(w\) and \(h\) are zero, the path has a single subpath with just one point \((x, y)\), and no lines, and this method thus has no effect (the trace a path\(^{687}\) algorithm returns an empty path in that case).

If just one of either \(w\) or \(h\) is zero, then the path has a single subpath consisting of two points, with coordinates \((x, y)\) and \((x+w, y+h)\), in that order, connected by a single straight line.
Otherwise, the path has a single subpath consisting of four points, with coordinates \((x, y), (x+w, y), (x+w, y+h),\) and \((x, y+h),\) connected to each other in that order by straight lines.

### 4.12.5.1.11 Drawing text to the bitmap

For web developers (non-normative)

```javascript
context.fillText(text, x, y [, maxWidth ])
context.strokeText(text, x, y [, maxWidth ])
```

Fills or strokes (respectively) the given text at the given position. If a maximum width is provided, the text will be scaled to fit that width if necessary.

```javascript
metrics = context.measureText(text)
```

Returns a `TextMetrics` object with the metrics of the given text in the current font.

- `metrics.width`
- `metrics.actualBoundingBoxLeft`
- `metrics.actualBoundingBoxRight`
- `metrics.fontBoundingBoxAscent`
- `metrics.fontBoundingBoxDescent`
- `metrics.actualBoundingBoxAscent`
- `metrics.actualBoundingBoxDescent`
- `metrics.fontHeightAscent`
- `metrics.fontHeightDescent`
- `metrics.hangingBaseline`
- `metrics.alphabeticBaseline`
- `metrics.ideographicBaseline`

Returns the measurement described below.

Objects that implement the `CanvasText` interface provide the following methods for rendering text.

The `fillText(text, x, y, maxWidth)` and `strokeText(text, x, y, maxWidth)` methods render the given text at the given \((x, y)\) coordinates ensuring that the text isn't wider than `maxWidth` if specified, using the current `font`, `textAlign`, and `textBaseline` values. Specifically, when the methods are invoked, the user agent must run these steps:

1. If any of the arguments are infinite or NaN, then return.
2. Run the text preparation algorithm, passing it `text`, the object implementing the `CanvasText` interface, and, if the `maxWidth` argument was provided, that argument. Let `glyphs` be the result.
3. Move all the shapes in `glyphs` to the right by \(x\) CSS pixels and down by \(y\) CSS pixels.
4. Paint the shapes given in `glyphs`, as transformed by the current transformation matrix, with each CSS pixel in the coordinate space of `glyphs` mapped to one coordinate space unit.

   For `fillText()`, this's fill style must be applied to the shapes and this's stroke style must be ignored. For `strokeText()`, the reverse holds; this's stroke style must be applied to the result of tracing the shapes using the object implementing the `CanvasText` interface for the line styles, and this's fill style must be ignored.

   These shapes are painted without affecting the current path, and are subject to shadow effects, global alpha, the clipping region, and the current compositing and blending operator.

The `measureText(text)` method steps are to run the text preparation algorithm, passing it `text` and the object implementing the `CanvasText` interface, and then using the returned inline box must return a new `TextMetrics` object with members behaving as described in the following list: [CSS].

- **width attribute**
  - The width of that inline box, in CSS pixels. (The text's advance width.)

- **actualBoundingBoxLeft attribute**
  - The distance parallel to the baseline from the alignment point given by the `textAlign` attribute to the left side of the bounding
The sum of this value and the next (actualBoundingBoxRight\textsuperscript{713}) can be wider than the width of the inline box (width\textsuperscript{712}), in particular with slanted fonts where characters overhang their advance width.

actualBoundingBoxBoxRight attribute

The distance parallel to the baseline from the alignment point given by the textAlign\textsuperscript{691} attribute to the right side of the bounding rectangle of the given text, in CSS pixels; positive numbers indicating a distance going right from the given alignment point.

fontBoundingBoxAscent attribute

The distance from the horizontal line indicated by the textBaseline\textsuperscript{691} attribute to the ascent metric of the first available font, in CSS pixels; positive numbers indicating a distance going up from the given baseline.

Note

This value and the next are useful when rendering a background that have to have a consistent height even if the exact text being rendered changes. The actualBoundingBoxAscent\textsuperscript{713} attribute (and its corresponding attribute for the descent) are useful when drawing a bounding box around specific text.

fontBoundingBoxDescent attribute

The distance from the horizontal line indicated by the textBaseline\textsuperscript{691} attribute to the descent metric of the first available font, in CSS pixels; positive numbers indicating a distance going down from the given baseline.

actualBoundingBoxAscent attribute

The distance from the horizontal line indicated by the textBaseline\textsuperscript{691} attribute to the top of the bounding rectangle of the given text, in CSS pixels; positive numbers indicating a distance going up from the given baseline.

Note

This number can vary greatly based on the input text, even if the first font specified covers all the characters in the input. For example, the actualBoundingBoxAscent\textsuperscript{713} of a lowercase "o" from an alphabetic baseline would be less than that of an uppercase "F". The value can easily be negative; for example, the distance from the top of the em box (textBaseline\textsuperscript{691} value "top\textsuperscript{693}") to the top of the bounding rectangle when the given text is just a single comma ",," would likely (unless the font is quite unusual) be negative.

actualBoundingBoxDescent attribute

The distance from the horizontal line indicated by the textBaseline\textsuperscript{691} attribute to the bottom of the bounding rectangle of the given text, in CSS pixels; positive numbers indicating a distance going down from the given baseline.

emHeightAscent attribute

The distance from the horizontal line indicated by the textBaseline\textsuperscript{691} attribute to the highest top of the em squares in the inline box, in CSS pixels; positive numbers indicating that the given baseline is below the top of that em square (so this value will usually be positive). Zero if the given baseline is the top of that em square; half the font size if the given baseline is the middle of that em square.

emHeightDescent attribute

The distance from the horizontal line indicated by the textBaseline\textsuperscript{691} attribute to the lowest bottom of the em squares in the inline box, in CSS pixels; positive numbers indicating that the given baseline is above the bottom of that em square. (Zero if the given baseline is the bottom of that em square.)

hangingBaseline attribute

The distance from the horizontal line indicated by the textBaseline\textsuperscript{691} attribute to the hanging baseline of the inline box, in CSS pixels; positive numbers indicating that the given baseline is below the hanging baseline. (Zero if the given baseline is the hanging baseline.)

alphabeticBaseline attribute

The distance from the horizontal line indicated by the textBaseline\textsuperscript{691} attribute to the alphabetic baseline of the inline box, in CSS pixels; positive numbers indicating that the given baseline is below the alphabetic baseline. (Zero if the given baseline is the alphabetic baseline.)
ideographicBaseline attribute

The distance from the horizontal line indicated by the textBaseline attribute to the ideographic-under baseline of the inline box, in CSS pixels; positive numbers indicating that the given baseline is below the ideographic-under baseline. (Zero if the given baseline is the ideographic-under baseline.)

Note

Glyphs rendered using fillText and strokeText can spill out of the box given by the font size (the em square size) and the width returned by measureText (the text width). Authors are encouraged to use the bounding box values described above if this is an issue.

Note

A future version of the 2D context API might provide a way to render fragments of documents, rendered using CSS, straight to the canvas. This would be provided in preference to a dedicated way of doing multiline layout.

4.12.5.1.12 Drawing paths to the canvas

Objects that implement the CanvasDrawPath interface have a current default path. There is only one current default path; it is not part of the drawing state. The current default path is a path, as described above.

For web developers (non-normative)

```
context.beginPath();
context.fill();
context.fill(path, fillRule);
context.stroke();
context.stroke(path);
context.clip();
context.clip(path, fillRule);
context.isPointInPath(x, y, fillRule);
context.isPointInPath(path, x, y, fillRule);
context.isPointInStroke(x, y);
context.isPointInStroke(path, x, y);
```

The beginPath() method steps are to empty the list of subpaths in this's current default path so that it once again has zero subpaths.

Where the following method definitions use the term intended path for a Path2D or-null path, it means path itself if it is a Path2D object, or the current default path otherwise.

When the intended path is a Path2D object, the coordinates and lines of its subpaths must be transformed according to the current transformation matrix on the object implementing the CanvasTransform interface when used by these methods (without affecting the Path2D object itself). When the intended path is the current default path, it is not affected by the transform. (This is because transformations already affect the current default path when it is constructed, so applying it when it is painted as well would result in a double transformation.)

The fill(fillRule) method steps are to run the fill steps given this, null, and fillRule.
The **fill** method steps are to run the **fill steps** given this, path, and fillRule.

The **fill** method steps, given a `CanvasDrawPath` context, a `Path2D` or-null path, and a fillRule fillRule, are to fill all the subpaths of the intended path for path, using context's fillStyle, and using the fill rule indicated by fillRule. Open subpaths must be implicitly closed when being filled (without affecting the actual subpaths).

The **stroke** method steps are to run the **stroke steps** given this and null.

The **stroke** method steps are to run the **stroke steps** given this and path.

The **stroke** steps, given a `CanvasDrawPath` context and a `Path2D` or-null path, are to trace the intended path for path, using context's line styles as set by its `CanvasPathDrawingStyles` mixin, and then fill the resulting path using context's stroke style, using the nonzero winding rule.

As a result of how the algorithm to trace a path is defined, overlapping parts of the paths in one stroke operation are treated as if their union was what was painted.

The stroke style is affected by the transformation during painting, even if the current default path is used.

Paths, when filled or stroked, must be painted without affecting the current default path or any `Path2D` objects, and must be subject to shadow effects, global alpha, the clipping region, and the current compositing and blending operator. (The effect of transformations is described above and varies based on which path is being used.)

The **clip** method steps are to run the **clip steps** given this, null, and fillRule.

The **clip** method steps are to run the **clip steps** given this, path, and fillRule.

The **clip** steps, given a `CanvasDrawPath` context, a `Path2D` or-null path, and a fillRule fillRule, are to create a new clipping region by calculating the intersection of context's current clipping region and the area described by the intended path for path, using the fill rule indicated by fillRule. Open subpaths must be implicitly closed when computing the clipping region, without affecting the actual subpaths. The new clipping region replaces the current clipping region.

When the context is initialized, its current clipping region must be set to the largest infinite surface (i.e. by default, no clipping occurs).

The **isPointInPath** method steps are to return the result of the **is point in path steps** given this, null, x, y, and fillRule.

The **isPointInPath** method steps are to return the result of the **is point in path steps** given this, path, x, y, and fillRule.

The **is point in path steps** method steps, given a `CanvasDrawPath` context, a `Path2D` or-null path, two numbers x and y, and a fillRule fillRule, are:

1. If x or y are infinite or NaN, then return false.
2. If the point given by the x and y coordinates, when treated as coordinates in the canvas coordinate space unaffected by the current transformation, is inside the intended path for path as determined by the fill rule indicated by fillRule, then return true. Open subpaths must be implicitly closed when computing the area inside the path, without affecting the actual subpaths. Points on the path itself must be considered to be inside the path.
3. Return false.

The **isPointInStroke** method steps are to return the result of the **is point in stroke steps** given this, null, x, and y.

The **isPointInStroke** method steps are to return the result of the **is point in stroke steps** given this, path, x, and y.

The **is point in stroke steps** method steps, given a `CanvasDrawPath` context, a `Path2D` or-null path, and two numbers x and y, are:
1. If \(x\) or \(y\) are infinite or NaN, then return false.

2. If the point given by the \(x\) and \(y\) coordinates, when treated as coordinates in the canvas coordinate space unaffected by the current transformation, is inside the path that results from tracing the intended path for \(path\), using the nonzero winding rule, and using \(context\)'s line styles as set by its \texttt{CanvasPathDrawingStyles} mixin, then return true. Points on the resulting path must be considered to be inside the path.

3. Return false.

Example \texttt{canvas} element has a couple of checkboxes. The path-related commands are highlighted:

```html
<canvas height=400 width=750>
  <label><input type=checkbox id=showA> Show A</label>
  <label><input type=checkbox id=showB> Show B</label>
</canvas>

<script>
  function drawCheckbox(context, element, x, y, paint) {
    context.save();
    context.font = '10px sans-serif';
    context.textAlign = 'left';
    context.textBaseline = 'middle';
    var metrics = context.measureText(element.labels[0].textContent);
    if (paint) {
      context.beginPath();
      context.strokeStyle = 'black';
      context.rect(x-5, y-5, 10, 10);
      context.stroke();
      if (element.checked) {
        context.fillStyle = 'black';
        context.fill();
      }
      context.fillText(element.labels[0].textContent, x+5, y);
    }
    context.beginPath();
    context.rect(x-7, y-7, 12 + metrics.width+2, 14);
    context.drawFocusIfNeeded(element);
    context.restore();
  }

  function drawBase() { /* ... */ }
  function drawAs() { /* ... */ }
  function drawBs() { /* ... */ }

  function redraw() {
    var canvas = document.getElementsByTagName('canvas')[0];
    var context = canvas.getContext('2d');
    context.clearRect(0, 0, canvas.width, canvas.height);
    drawCheckbox(context, document.getElementById('showA'), 20, 40, true);
    drawCheckbox(context, document.getElementById('showB'), 20, 60, true);
    drawBase();
    if (document.getElementById('showA').checked)
      drawAs();
    if (document.getElementById('showB').checked)
      drawBs();
  }

  function processClick(event) {
    var canvas = document.getElementsByTagName('canvas')[0];
    var context = canvas.getContext('2d');
    var x = event.clientX;
    var y = event.clientY;
</script>
```
Objects that implement the CanvasUserInterface interface provide the following methods to control drawing focus rings and scrolling paths into view.

The `drawFocusIfNeeded(element)` method, when invoked, must run these steps:

1. If `element` is not focused or is not a descendant of the element with whose context the method is associated, then return.
2. Draw a focus ring of the appropriate style along the intended path, following platform conventions. The focus ring should not be subject to the shadow effects, the global alpha, the current compositing and blending operator, the fill style, the stroke style, or any of the members in the CanvasPathDrawingStyles, CanvasTextDrawingStyles interfaces, but should be subject to the clipping region. (The effect of transformations is described above and varies based on which path is being used.)
3. Inform the user that the focus is at the location given by the intended path. User agents may wait until the next time the event loop reaches its update the rendering step to optionally inform the user.

```javascript
var node = event.target;
while (node) {
    x -= node.offsetLeft - node.scrollLeft;
    y -= node.offsetTop - node.scrollTop;
    node = node.offsetParent;
}
drawCheckbox(context, document.getElementById('showA'), 20, 40, false);
if (context.isPointInPath(x, y))
    document.getElementById('showA').checked = !document.getElementById('showA').checked;
drawCheckbox(context, document.getElementById('showB'), 20, 60, false);
if (context.isPointInPath(x, y))
    document.getElementById('showB').checked = !document.getElementById('showB').checked;
redraw();
}
document.getElementsByTagName('canvas')[0].addEventListener('focus', redraw, true);
document.getElementsByTagName('canvas')[0].addEventListener('blur', redraw, true);
document.getElementsByTagName('canvas')[0].addEventListener('change', redraw, true);
document.getElementsByTagName('canvas')[0].addEventListener('click', processClick, false);
redraw();
</script>
User agents should not implicitly close open subpaths in the intended path when drawing the focus ring.

**Note**

This might be a moot point, however. For example, if the focus ring is drawn as an axis-aligned bounding rectangle around the points in the intended path, then whether the subpaths are closed or not has no effect. This specification intentionally does not specify precisely how focus rings are to be drawn: user agents are expected to honor their platform's native conventions.

The `scrollPathIntoView()` method, when invoked, must run these steps:

1. Let `specifiedRectangle` be the rectangle of the bounding box of the intended path.
2. Let `notionalChild` be a hypothetical element that is a rendered child of the `canvas` element whose dimensions are those of `specifiedRectangle`.
3. Scroll `notionalChild` into view with behavior set to "auto", block set to "start", and inline set to "nearest".
4. Optionally, inform the user that the caret or selection (or both) cover `specifiedRectangle` of the canvas. The user agent may wait until the next time the event loop reaches its update the rendering step to optionally inform the user.

"Inform the user", as used in this section, does not imply any persistent state change. It could mean, for instance, calling a system accessibility API to notify assistive technologies such as magnification tools so that the user's magnifier moves to the given area of the canvas. However, it does not associate the path with the element, or provide a region for tactile feedback, etc.

### 4.12.5.1.14 Drawing images

Objects that implement the `CanvasDrawImage` interface have the `drawImage()` method to draw images.

This method can be invoked with three different sets of arguments:

- `drawImage(image, dx, dy)`
- `drawImage(image, dx, dy, dw, dh)`
- `drawImage(image, sx, sy, sw, sh, dx, dy, dw, dh)`

For web developers (non-normative)

```javascript
context.drawImage(image, dx, dy)
context.drawImage(image, dx, dy, dw, dh)
context.drawImage(image, sx, sy, sw, sh, dx, dy, dw, dh)
```

Draws the given image onto the canvas. The arguments are interpreted as follows:
When the `drawImage()` method is invoked, the user agent must run these steps:

1. If any of the arguments are infinite or NaN, then return.
2. Let `usability` be the result of checking the usability of `image`.
3. If `usability` is bad, then return (without drawing anything).
4. Establish the source and destination rectangles as follows:
   - If not specified, the `dw` and `dh` arguments must default to the values of `sw` and `sh`, interpreted such that one CSS pixel in the image is treated as one unit in the output bitmap’s coordinate space. If the `sx`, `sy`, `sw`, and `sh` arguments are omitted, then they must default to 0, 0, the image’s natural width in image pixels, and the image’s natural height in image pixels, respectively. If the image has no natural dimensions, then the concrete object size must be used instead, as determined using the CSS "Concrete Object Size Resolution" algorithm, with the specified size having neither a definite width nor height, nor any additional constraints, the object’s natural properties being those of the image argument, and the default object size being the size of the output bitmap.
   - The source rectangle is the rectangle whose corners are the four points (`sx, sy`, (`sx+sw, sy`), (`sx+sw, sy+sh`), (`sx, sy+sh`)).
   - The destination rectangle is the rectangle whose corners are the four points (`dx, dy`, (`dx+dw, dy`), (`dx+dw, dy+dh`), (`dx, dy+dh`)).
5. If one of the `sw` or `sh` arguments is zero, then return. Nothing is painted.
6. Paint the region of the `image` argument specified by the source rectangle on the region of the rendering context’s output bitmap specified by the destination rectangle, after applying the current transformation matrix to the destination rectangle.

If the image isn't yet fully decoded, then nothing is drawn. If the image is a canvas with no data, throws an "InvalidStateError" DOMException.
The image data must be processed in the original direction, even if the dimensions given are negative.

When scaling up, if the `imageSmoothingEnabled` attribute is set to true, the user agent should attempt to apply a smoothing algorithm to the image data when it is scaled. User agents which support multiple filtering algorithms may use the value of the `imageSmoothingQuality` attribute to guide the choice of filtering algorithm when the `imageSmoothingEnabled` attribute is set to true. Otherwise, the image must be rendered using nearest-neighbor interpolation.

**Note**

This specification does not define the precise algorithm to use when scaling an image down, or when scaling an image up when the `imageSmoothingEnabled` attribute is set to true.

**Note**

When a `canvas` element is drawn onto itself, the drawing model requires the source to be copied before the image is drawn, so it is possible to copy parts of a `canvas` element onto overlapping parts of itself.

If the original image data is a bitmap image, then the value painted at a point in the destination rectangle is computed by filtering the original image data. The user agent may use any filtering algorithm (for example bilinear interpolation or nearest-neighbor). When the filtering algorithm requires a pixel value from outside the original image data, it must instead use the value from the nearest edge pixel. (That is, the filter uses 'clamp-to-edge' behavior.) When the filtering algorithm requires a pixel value from outside the source rectangle but inside the original image data, then the value from the original image data must be used.

**Note**

Thus, scaling an image in parts or in whole will have the same effect. This does mean that when sprites coming from a single sprite sheet are to be scaled, adjacent images in the sprite sheet can interfere. This can be avoided by ensuring each sprite in the sheet is surrounded by a border of transparent black, or by copying sprites to be scaled into temporary `canvas` elements and drawing the scaled sprites from there.

Images are painted without affecting the current path, and are subject to shadow effects, global alpha, the clipping region, and the current compositing and blending operator.

7. If `image` is not origin-clean, then set the `CanvasRenderingContext2D`'s origin-clean flag to false.

### 4.12.5.1.15 Pixel manipulation

For web developers (non-normative)

```javascript
imagedata = new ImageData(sw, sh [, settings])

Returns an `ImageData` object with the given dimensions and the color space indicated by `settings`. All the pixels in the returned object are transparent black.

Throws an "IndexSizeError" DOMException if either of the width or height arguments are zero.

imagedata = new ImageData(data, sw [, sh [, settings ] ])

Returns an `ImageData` object using the data provided in the `Uint8ClampedArray` argument, interpreted using the given dimensions and the color space indicated by `settings`.

As each pixel in the data is represented by four numbers, the length of the data needs to be a multiple of four times the given width. If the height is provided as well, then the length needs to be exactly the width times the height times 4.

Throws an "IndexSizeError" DOMException if the given data and dimensions can't be interpreted consistently, or if either dimension is zero.

imagedata = context.createImageData(sw, sh [, settings])

Returns an `ImageData` object with the same dimensions and color space as the argument. All the pixels in the returned object are transparent black.

imagedata = context.createImageData(sw, sh [, settings])

Returns an `ImageData` object with the given dimensions. The color space of the returned object is the `color space` of context unless overridden by `settings`. All the pixels in the returned object are transparent black.

Throws an "IndexSizeError" DOMException if either of the width or height arguments are zero.
```
Objects that implement the CanvasImageData interface provide the following methods for reading and writing pixel data to the bitmap.

The `new ImageData(sw, sh, settings)` constructor steps are:

1. If one or both of `sw` and `sh` are zero, then throw an "IndexSizeError" DOMException.
2. Initialize this given `sw`, `sh`, and `settings` set to `settings`.
3. Initialize the image data of this to transparent black.

The `new ImageData(data, sw, sh, settings)` constructor steps are:

1. Let `length` be the number of bytes in `data`.
2. If `length` is not a nonzero integral multiple of four, then throw an "InvalidStateError" DOMException.
3. Let `length` be `length` divided by four.
4. If `length` is not an integral multiple of `sw`, then throw an "IndexSizeError" DOMException.

   **Note**
   At this step, the length is guaranteed to be greater than zero (otherwise the second step above would have aborted the steps), so if `sw` is zero, this step will throw the exception and return.

5. Let `height` be `length` divided by `sw`.
6. If `sh` was given and its value is not equal to `height`, then throw an "IndexSizeError" DOMException.
7. Initialize this given `sw`, `sh`, `settings` set to `settings`, and `source` set to `data`.

   **Note**
   This step does not set this's data to a copy of data. It sets it to the actual Uint8ClampedArray object passed as data.

The `createImageData(sw, sh, settings)` method steps are:

1. If one or both of `sw` and `sh` are zero, then throw an "IndexSizeError" DOMException.
2. Let `newImageData` be a new `ImageData` object.
3. Initialize `newImageData` given the absolute magnitude of `sw`, the absolute magnitude of `sh`, `settings` set to `settings`,
and `defaultColorSpace` set to this's `colorSpace`.

4. Initialize the image data of `newImageData` to `transparent black`.

5. Return `newImageData`.

The `createImageData(imagedata)` method steps are:

1. Let `newImageData` be a new `ImageData` object.
2. Initialize `newImageData` given the value of `imagedata`'s `width` attribute, the value of `imagedata`'s `height` attribute, and `defaultColorSpace` set to the value of `imagedata`'s `colorSpace` attribute.
3. Initialize the image data of `newImageData` to `transparent black`.
4. Return `newImageData`.

The `getImageData(sx, sy, sw, sh, settings)` method steps are:

1. If either the `sw` or `sh` arguments are zero, then throw an "IndexSizeError" `DOMException`.
2. If the `CanvasRenderingContext2D`'s `origin-clean` flag is set to false, then throw a "SecurityError" `DOMException`.
3. Let `ImageData` be a new `ImageData` object.
4. Initialize `ImageData` given `sw`, `sh`, `settings` set to settings, and `defaultColorSpace` set to this's `colorSpace`.
5. Let the source rectangle be the rectangle whose corners are the four points `(sx, sy), (sx+sw, sy), (sx+sw, sy+sh), (sx, sy+sh)`.
6. Set the pixel values of `ImageData` to be the pixels of this's `output bitmap` in the area specified by the source rectangle in the bitmap's coordinate space units, converted from this's `color space` to `ImageData`'s `colorSpace` using 'relative-colorimetric' rendering intent.
7. Set the pixels values of `ImageData` for areas of the source rectangle that are outside of the `output bitmap` to `transparent black`.
8. Return `ImageData`.

To initialize an `ImageData` object `ImageData`, given a positive integer number of rows `rows`, a positive integer number of pixels per row `pixelsPerRow`, an optional `ImageDataSettings` `settings`, an optional `Uint8ClampedArray source`, and an optional `PredefinedColorSpace` `defaultColorSpace`:

1. If `source` was given, then initialize the `data` attribute of `ImageData` to `source`.
2. Otherwise (`source` was not given), initialize the `data` attribute of `ImageData` to a new `Uint8ClampedArray` object. The `Uint8ClampedArray` object must use a new `Canvas Pixel ArrayBuffer` for its storage, and must have a zero start offset and a length equal to the length of its storage, in bytes. The `Canvas Pixel ArrayBuffer` must have the correct size to store `rows` x `pixelsPerRow` pixels.
   If the `Canvas Pixel ArrayBuffer` cannot be allocated, then rethrow the `RangeError` thrown by JavaScript, and return.
3. Initialize the `width` attribute of `ImageData` to `pixelsPerRow`.
4. Initialize the `height` attribute of `ImageData` to `rows`.
5. If `settings` was given and `settings["colorSpace"]` exists, then initialize the `colorSpace` attribute of `ImageData` to `settings["colorSpace"]`.
6. Otherwise, if `defaultColorSpace` was given, then initialize the `colorSpace` attribute of `ImageData` to `defaultColorSpace`.
7. Otherwise, initialize the `colorSpace` attribute of `ImageData` to "srgb".

`ImageData` objects are `serializable objects`. Their `serialization steps`, given value and serialized, are:

1. Set `serialized.[[Data]]` to the sub-serialization of the value's `data` attribute.
2. Set `serialized.[[Width]]` to the value of value's `width` attribute.
3. Set `serialized.|[Height]|` to the value of value's `height`\textsuperscript{p722} attribute.
4. Set `serialized.|[ColorSpace]|` to the value of value's `colorSpace`\textsuperscript{p722} attribute.

Their deserialization steps\textsuperscript{p316}, given `serialized`, `value`, and `targetRealm`, are:

1. Initialize value's `data`\textsuperscript{p722} attribute to the sub-deserialization\textsuperscript{p324} of `serialized.|[Data]|`.
2. Initialize value's `width`\textsuperscript{p722} attribute to `serialized.|[Width]|`.
3. Initialize value's `height`\textsuperscript{p722} attribute to `serialized.|[Height]|`.
4. Initialize value's `colorSpace`\textsuperscript{p722} attribute to `serialized.|[ColorSpace]|`.

A Canvas Pixel ArrayBuffer is an ArrayBuffer whose data is represented in left-to-right order, row by row top to bottom, starting with the top left, with each pixel's red, green, blue, and alpha components being given in that order for each pixel. Each component of each pixel represented in this array must be in the range 0..255, representing the 8 bit value for that component. The components must be assigned consecutive indices starting with 0 for the top left pixel's red component.

The `putImageData()` method writes data from `ImageData`\textsuperscript{p680} structures back to the rendering context's `output bitmap`\textsuperscript{p681}. Its arguments are: `imagedata`, `dx`, `dy`, `dirtyX`, `dirtyY`, `dirtyWidth`, and `dirtyHeight`.

When the last four arguments to this method are omitted, they must be assumed to have the values 0, 0, the `width`\textsuperscript{p722} member of the `imagedata` structure, and the `height`\textsuperscript{p722} member of the `imagedata` structure, respectively.

The method, when invoked, must act as follows:

1. Let `buffer` be `imagedata`'s `data`\textsuperscript{p722} attribute value's `[[ViewedArrayBuffer]]` internal slot.
2. If `IsDetachedBuffer(buffer)` is true, then throw an "**InvalidStateError**" DOMException.
3. If `dirtyWidth` is negative, then let `dirtyX` be `dirtyX+dirtyWidth`, and let `dirtyWidth` be equal to the absolute magnitude of `dirtyWidth`.
   
   If `dirtyHeight` is negative, then let `dirtyY` be `dirtyY+dirtyHeight`, and let `dirtyHeight` be equal to the absolute magnitude of `dirtyHeight`.

4. If `dirtyX` is negative, then let `dirtyWidth` be `dirtyWidth+dirtyX`, and let `dirtyX` be zero.
   
   If `dirtyY` is negative, then let `dirtyHeight` be `dirtyHeight+dirtyY`, and let `dirtyY` be zero.

5. If `dirtyX+dirtyWidth` is greater than the `width`\textsuperscript{p722} attribute of the `imagedata` argument, then let `dirtyWidth` be the value of that `width`\textsuperscript{p722} attribute, minus the value of `dirtyX`.
   
   If `dirtyY+dirtyHeight` is greater than the `height`\textsuperscript{p722} attribute of the `imagedata` argument, then let `dirtyHeight` be the value of that `height`\textsuperscript{p722} attribute, minus the value of `dirtyY`.

6. If, after those changes, either `dirtyWidth` or `dirtyHeight` are negative or zero, then return without affecting any bitmaps.

7. For all integer values of `x` and `y` where `dirtyX ≤ x < dirtyX+dirtyWidth` and `dirtyY ≤ y < dirtyY+dirtyHeight`, copy the four channels of the pixel with coordinate `(x, y)` in the `imagedata` data structure's Canvas Pixel ArrayBuffer\textsuperscript{p723} to the pixel with coordinate `(dx+x, dy+y)` in the rendering context's `output bitmap`\textsuperscript{p681}.

---

**Note**

*Due to the lossy nature of converting between color spaces and converting to and from premultiplied alpha\textsuperscript{p743} color values, pixels that have just been set using `putImageData()`\textsuperscript{p723} and are not completely opaque, might be returned to an equivalent `getImageData()`\textsuperscript{p722} as different values.*

The current path, transformation matrix\textsuperscript{p703}, shadow attributes\textsuperscript{p727}, global alpha\textsuperscript{p726}, the clipping region\textsuperscript{p715}, and current compositing and blending operator\textsuperscript{p726} must not affect the methods described in this section.

**Example**

In the following example, the script generates an `ImageData`\textsuperscript{p680} object so that it can draw onto it.

```javascript
// canvas is a reference to a <canvas> element
```
Here is an example of using `getImageData()` and `putImageData()` to implement an edge detection filter.
```javascript
inputData[i - 4] + 8*inputData[i] - inputData[i + 4]
+ inputData[i + w*4 - 4] - inputData[i + w*4] - inputData[i + w*4 + 4];
}
outputData[(y*w + x)*4 + 3] = 255; // alpha
}

// put the image data back after manipulation
context.putImageData(output, 0, 0);
</script>
</head>
<body onload="init()">
<canvas></canvas>
</body>
</html>
```

**Example**

Here is an example of color space conversion applied when drawing a solid color and reading the result back using and `getImageData()`.

```html
<!DOCTYPE HTML>
<html lang="en">
<title>Color space image data demo</title>
<canvas></canvas>
<script>
const canvas = document.querySelector('canvas');
const context = canvas.getContext('2d', {colorSpace:'display-p3'});

// Draw a red rectangle. Note that the hex color notation
// specifies sRGB colors.
context.fillStyle = "#FF0000";
context.fillRect(0, 0, 64, 64);

// Get the image data.
const pixels = context.getImageData(0, 0, 1, 1);

// This will print 'display-p3', reflecting the default behavior
// of returning image data in the canvas's color space.
console.log(pixels.colorSpace);

// This will print the values 234, 51, and 35, reflecting the
// red fill color, converted to 'display-p3'.
console.log(pixels.data[0]);
console.log(pixels.data[1]);
console.log(pixels.data[2]);
</script>
```

4.12.5.1.16 Compositing

For web developers (non-normative)
Objects that implement the CanvasCompositing interface have a global alpha value and a current compositing and blending operator value that both affect all the drawing operations on this object.

The global alpha value gives an alpha value that is applied to shapes and images before they are composited onto the output bitmap. The value ranges from 0.0 (fully transparent) to 1.0 (no additional transparency). It must initially have the value 1.0.

The globalAlpha getter steps are to return this’s global alpha.

The globalAlpha setter steps are:
1. If the given value is either infinite, NaN, or not in the range 0.0 to 1.0, then return.
2. Otherwise, set this’s global alpha to the given value.

The current compositing and blending operator value controls how shapes and images are drawn onto the output bitmap, once they have had the global alpha and the current transformation matrix applied. Initially, it must be set to "source-over".

The globalCompositeOperation getter steps are to return this’s current compositing and blending operator.

The globalCompositeOperation setter steps are:
1. If the given value is not identical to any of the values that the <blend-mode> or the <composite-mode> properties are defined to take, then return. [COMPOSITE]
2. Otherwise, set this’s current compositing and blending operator to the given value.

4.12.5.1.17 Image smoothing

Objects that implement the CanvasImageSmoothing interface have attributes that control how image smoothing is performed.

The imageSmoothingEnabled attribute, on getting, must return the last value it was set to. On setting, it must be set to the new value. When the object implementing the CanvasImageSmoothing interface is created, the attribute must be set to true.

The imageSmoothingQuality attribute, on getting, must return the last value it was set to. On setting, it must be set to the new value. When the object implementing the CanvasImageSmoothing interface is created, the attribute must be set to "low".
All drawing operations on an object which implements the CanvasShadowStyles interface are affected by the four global shadow attributes.

The `shadowColor` attribute sets the color of the shadow. When the context is created, the `shadowColor` attribute initially must be transparent black.

On getting, the serialization of the color must be returned.

On setting, the new value must be parsed with this `canvas` element and the color assigned. If parsing the value results in failure then it must be ignored, and the attribute must retain its previous value.

The `shadowOffsetX` and `shadowOffsetY` attributes specify the distance that the shadow will be offset in the positive horizontal and positive vertical distance respectively. Their values are in coordinate space units. They are not affected by the current transformation matrix.

When the context is created, the shadow offset attributes must initially have the value 0.

On getting, they must return their current value. On setting, the attribute being set must be set to the new value, except if the value is infinite or NaN, in which case the new value must be ignored.

The `shadowBlur` attribute specifies the level of the blurring effect. (The units do not map to coordinate space units, and are not affected by the current transformation matrix.)

When the context is created, the `shadowBlur` attribute must initially have the value 0.

On getting, the attribute must return its current value. On setting the attribute must be set to the new value, except if the value is negative, infinite or NaN, in which case the new value must be ignored.

Shadows are only drawn if the opacity component of the alpha component of the color of `shadowColor` is nonzero and either the `shadowBlur` is nonzero, or the `shadowOffsetX` is nonzero, or the `shadowOffsetY` is nonzero.

When shadows are drawn, they must be rendered as follows:

1. Let $A$ be an infinite transparent black bitmap on which the source image for which a shadow is being created has been rendered.
2. Let $B$ be an infinite transparent black bitmap, with a coordinate space and an origin identical to $A$.
3. Copy the alpha channel of $A$ to $B$, offset by `shadowOffsetX` in the positive $x$ direction, and `shadowOffsetY` in the positive $y$ direction.
4. If `shadowBlur` is greater than 0:
   1. Let $\sigma$ be half the value of `shadowBlur`.
   2. Perform a 2D Gaussian Blur on $B$, using $\sigma$ as the standard deviation.

User agents may limit values of $\sigma$ to an implementation-specific maximum value to avoid exceeding hardware limitations.
5. Set the red, green, and blue components of every pixel in B to the red, green, and blue components (respectively) of the color of \texttt{shadowColor}.

6. Multiply the alpha component of every pixel in B by the alpha component of the color of \texttt{shadowColor}.

7. The shadow is in the bitmap B, and is rendered as part of the drawing model described below.

If the \texttt{current compositing and blending operator} is "copy", then shadows effectively won't render (since the shape will overwrite the shadow).

4.12.5.1.19 Filters

All drawing operations on an object which implements the \texttt{CanvasFilters} interface are affected by the global \texttt{filter} attribute.

For web developers (non-normative)

\begin{verbatim}
context.filter [ = value ]
\end{verbatim}

Returns the current filter.

Can be set, to change the filter. Values can either be the string "none" or a string parseable as a \texttt{<filter-value-list>}. Other values are ignored.

Such objects have an associated \texttt{current filter}, which is a string. Initially the \texttt{current filter} is set to the string "none". Whenever the value of the \texttt{current filter} is the string "none" filters will be disabled for the context.

The \texttt{filter} getter steps are to return \texttt{this}'s \texttt{current filter}.

The \texttt{filter} setter steps are:

1. If the given value is "none", then set \texttt{this}'s \texttt{current filter} to "none" and return.

2. Let \texttt{parsedValue} be the result of parsing the given values as a \texttt{<filter-value-list>}. If any property-independent style sheet syntax like 'inherit' or 'initial' is present, then this parsing must return failure.

3. If \texttt{parsedValue} is failure, then return.

4. Set \texttt{this}'s \texttt{current filter} to the given value.

Note

\begin{verbatim}
Though context.filter = "none" will disable filters for the context, context.filter = ", context.filter = null, and context.filter = undefined are all treated as unparsable inputs and the value of the current filter is left unchanged.
\end{verbatim}

Coordinates used in the value of the \texttt{current filter} are interpreted such that one pixel is equivalent to one SVG user space unit and to one canvas coordinate space unit. Filter coordinates are not affected by the \texttt{current transformation matrix}. The current transformation matrix affects only the input to the filter. Filters are applied in the \texttt{output bitmap}'s coordinate space.

When the value of the \texttt{current filter} is a string parsable as a \texttt{<filter-value-list>} which defines lengths using percentages or using \texttt{em} or \texttt{ex} units, these must be interpreted relative to the computed value of the \texttt{font-size} property of the font style source object at the time that the attribute is set. If the computed values are undefined for a particular case (e.g. because the font style source object is not an element or is not being rendered), then the relative keywords must be interpreted relative to the default value of the \texttt{font} attribute. The 'larger' and 'smaller' keywords are not supported.

If the value of the \texttt{current filter} is a string parseable as a \texttt{<filter-value-list>} with a reference to an SVG filter in the same document, and this SVG filter changes, then the changed filter is used for the next draw operation.

If the value of the \texttt{current filter} is a string parseable as a \texttt{<filter-value-list>} with a reference to an SVG filter in an external resource document and that document is not loaded when a drawing operation is invoked, then the drawing operation must proceed with no filtering.
4.12.5.1.20 Working with externally-defined SVG filters

This section is non-normative.

Since drawing is performed using filter value "none" until an externally-defined filter has finished loading, authors might wish to determine whether such a filter has finished loading before proceeding with a drawing operation. One way to accomplish this is to load the externally-defined filter elsewhere within the same page in some element that sends a load event (for example, an SVG use element), and wait for the load event to be dispatched.

4.12.5.1.21 Drawing model

When a shape or image is painted, user agents must follow these steps, in the order given (or act as if they do):

1. Render the shape or image onto an infinite transparent black bitmap, creating image A, as described in the previous sections. For shapes, the current fill, stroke, and line styles must be honored, and the stroke must itself also be subjected to the current transformation matrix.

2. When the current filter is set to a value other than "none" and all the externally-defined filters it references, if any, are in documents that are currently loaded, then use image A as the input to the current filter, creating image B. If the current filter is a string parseable as a <filter-value-list>, then draw using the current filter in the same manner as SVG.

   Otherwise, let B be an alias for A.

3. When shadows are drawn, render the shadow from image B, using the current shadow styles, creating image C.

4. When shadows are drawn, multiply the alpha component of every pixel in C by global alpha.

5. When shadows are drawn, composite C within the clipping region over the current output bitmap using the current compositing and blending operator.

6. Multiply the alpha component of every pixel in B by global alpha.

7. Composite B within the clipping region over the current output bitmap using the current compositing and blending operator.

When compositing onto the output bitmap, pixels that would fall outside of the output bitmap must be discarded.

4.12.5.1.22 Best practices

When a canvas is interactive, authors should include focusable elements in the element’s fallback content corresponding to each focusable part of the canvas, as in the example above.

When rendering focus rings, to ensure that focus rings have the appearance of native focus rings, authors should use the drawFocusIfNeeded() method, passing it the element for which a ring is being drawn. This method only draws the focus ring if the element is focused, so that it can simply be called whenever drawing the element, without checking whether the element is focused or not first.

In addition to drawing focus rings, authors should use the scrollPathIntoView() method when an element in the canvas is focused, to make sure it is visible on the screen (if applicable).

Authors should avoid implementing text editing controls using the canvas element. Doing so has a large number of disadvantages:

- Mouse placement of the caret has to be reimplemented.
- Keyboard movement of the caret has to be reimplemented (possibly across lines, for multiline text input).
- Scrolling of the text control has to be implemented (horizontally for long lines, vertically for multiline input).
- Native features such as copy-and-paste have to be reimplemented.
- Native features such as spell-checking have to be reimplemented.
- Native features such as drag-and-drop have to be reimplemented.
• Native features such as page-wide text search have to be reimplemented.
• Native features specific to the user, for example custom text services, have to be reimplemented. This is close to impossible since each user might have different services installed, and there is an unbounded set of possible such services.
• Bidirectional text editing has to be reimplemented.
• For multiline text editing, line wrapping has to be implemented for all relevant languages.
• Text selection has to be reimplemented.
• Dragging of bidirectional text selections has to be reimplemented.
• Platform-native keyboard shortcuts have to be reimplemented.
• Platform-native input method editors (IMEs) have to be reimplemented.
• Undo and redo functionality has to be reimplemented.
• Accessibility features such as magnification following the caret or selection have to be reimplemented.

This is a huge amount of work, and authors are most strongly encouraged to avoid doing any of it by instead using the input element, the textarea element, or the contenteditable attribute.

4.12.5.1.23 Examples

This section is non-normative.

Example

Here is an example of a script that uses canvas to draw pretty glowing lines.

```html
<canvas width="800" height="450"></canvas>

<script>
  var context = document.getElementsByTagName('canvas')[0].getContext('2d');

  var lastX = context.canvas.width * Math.random();
  var lastY = context.canvas.height * Math.random();
  var hue = 0;
  function line() {
    context.save();
    context.translate(context.canvas.width/2, context.canvas.height/2);
    context.scale(0.9, 0.9);
    context.translate(-context.canvas.width/2, -context.canvas.height/2);
    context.beginPath();
    context.lineWidth = 5 + Math.random() * 10;
    context.moveTo(lastX, lastY);
    context.lineTo(lastX, lastY);
    context.bezierCurveTo(context.canvas.width * Math.random(),
                          context.canvas.height * Math.random(),
                          context.canvas.width * Math.random(),
                          context.canvas.height * Math.random(),
                          lastX, lastY);

    hue = hue + 10 * Math.random();
    context.strokeStyle = 'hsl('+hue+', 50%, 50%)';
    context.shadowColor = 'white';
    context.shadowBlur = 10;
    context.stroke();
    context.restore();
  }

  setInterval(line, 50);
</script>
```
function blank() {
    context.fillStyle = 'rgba(0,0,0,0.1)';
    context.fillRect(0, 0, context.canvas.width, context.canvas.height);
}
setInterval(blank, 40);

The 2D rendering context for canvas is often used for sprite-based games. The following example demonstrates this:

Example

The 2D rendering context for canvas is often used for sprite-based games. The following example demonstrates this:

Here is the source for this example:

```html
<!DOCTYPE HTML>
<html lang="en">
<meta charset="utf-8">
<title>Blue Robot Demo</title>
<style>
html { overflow: hidden; min-height: 200px; min-width: 380px; }
body { height: 200px; position: relative; margin: 8px; }
.buttons { position: absolute; bottom: 0px; left: 0px; margin: 4px; }
</style>
<canvas width="380" height="200"></canvas>
<script>
var Landscape = function (context, width, height) {
    this.offset = 0;
    this.width = width;
    this.advance = function (dx) {
        this.offset += dx;
    }
    this.horizon = height * 0.7;
    // This creates the sky gradient (from a darker blue to white at the bottom)
    this.sky = context.createLinearGradient(0, 0, this.horizon);
    this.sky.addColorStop(0.0, 'rgb(55,121,179)');
    this.sky.addColorStop(0.7, 'rgb(121,194,245)');
    this.sky.addColorStop(1.0, 'rgb(164,200,214)');
    // this creates the grass gradient (from a darker green to a lighter green)
    this.earth = context.createLinearGradient(0, this.horizon, 0, height);
    this.earth.addColorStop(0.0, 'rgb(81,140,20)');
    this.earth.addColorStop(1.0, 'rgb(123,177,57)');
    this.paintBackground = function (context, width, height) {
        // first, paint the sky and grass rectangles
        context.fillStyle = this.sky;
```
context.fillRect(0, 0, width, this.horizon);
context.fillStyle = this.earth;
context.fillRect(0, this.horizon, width, height-this.horizon);

// then, draw the cloudy banner
// we make it cloudy by having the draw text off the top of the
canvas, and just having the blurred shadow shown on the canvas
context.save();
context.translate(width-((this.offset+(this.width*3.2)) % (this.width*4.0))+0, 0);
context.shadowColor = 'white';
context.shadowOffsetY = 30+this.horizon/3; // offset down on canvas
context.shadowBlur = '5';
context.fillStyle = 'white';
context.strokeStyle = 'rgb(10,10,10)';
context.lineWidth = 2;
context.fillRect(0, this.horizon+5, 10, -50); // trunk
context.fill();
context.stroke();
context.beginPath();
context.fillStyle = 'rgb(78,154,6)';
context.strokeStyle = 'rgb(220,154,94)';
context.lineWidth = 2;
context.arc(5, this.horizon-60, 30, 0, Math.PI*2); // leaves
context.fill();
context.stroke();
context.restore();

this.earth = function () { }

this.paintForeground = function (context, width, height) { // draw the box that goes in front
context.save();
context.translate(width-((this.offset+(this.width*0.7)) % (this.width*1.1))+0, 0);
context.beginPath();
context.fillRect(0, this.horizon - 5, 25, 25);
context.fillStyle = 'rgb(220,154,94)';
context.strokeStyle = 'rgb(10,10,10)';
context.lineWidth = 2;
context.fill();
context.stroke();
context.restore();
};

this.targetMode = 'idle';
this.walk = function () { 
    this.targetMode = 'walk';
};

this.stop = function () { 
    this.targetMode = 'idle';
};
this.frameIndex = {
    'idle': [0], // first cell is the idle frame
    'walk': [1,2,3,4,5,6], // the walking animation is cells 1-6
    'stop': [7], // last cell is the stopping animation
};
this.mode = 'idle';
this.frame = 0; // index into frameIndex
this.tick = function () {
    // this advances the frame and the robot
    // the return value is how many pixels the robot has moved
    this.frame += 1;
    if (this.frame >= this.frameIndex[this.mode].length) {
        // we've reached the end of this animation cycle
        this.frame = 0;
        if (this.mode != this.targetMode) {
            // switch to next cycle
            if (this.mode == 'walk') {
                this.mode = 'stop';
            } else if (this.mode == 'stop') {
                if (this.targetMode == 'walk')
                    this.mode = 'walk';
                else
                    this.mode = 'idle';
            } else if (this.mode == 'idle') {
                if (this.targetMode == 'walk')
                    this.mode = 'walk';
            }
        }
    }
    if (this.mode == 'walk')
        return 8;
    return 0;
},
this.paint = function (context, x, y) {
    if (!this.sprites.complete) return;
    // draw the right frame out of the sprite sheet onto the canvas
    // we assume each frame is as high as the sprite sheet
    // the x,y coordinates give the position of the bottom center of the sprite
    context.drawImage(this.sprites,
        this.frameIndex[this.mode][this.frame] * this.sprites.height, 0,
        this.sprites.height, this.sprites.height,
        x - this.sprites.height/2, y - this.sprites.height, this.sprites.height,
        this.sprites.height);
};
</script>
<script>
var canvas = document.getElementsByTagName('canvas')[0];
var context = canvas.getContext('2d');
var landscape = new Landscape(context, canvas.width, canvas.height);
var blueRobot = new BlueRobot();
// paint when the browser wants us to, using requestAnimationFrame()
function paint() {
    context.clearRect(0, 0, canvas.width, canvas.height);
    landscape.paintBackground(context, canvas.width, canvas.height);
    blueRobot.paintBackground(context, canvas.width/2, landscape.horizon*1.1);
    landscape.paintForeground(context, canvas.width, canvas.height);
    requestAnimationFrame(paint);
}
4.12.5.2 The ImageBitmap rendering context

4.12.5.2.1 Introduction

ImageBitmapRenderingContext is a performance-oriented interface that provides a low overhead method for displaying the contents of ImageBitmap objects. It uses transfer semantics to reduce overall memory consumption. It also streamlines performance by avoiding intermediate compositing, unlike the drawImage() method of CanvasRenderingContext2D.

Using an img element as an intermediate for getting an image resource into a canvas, for example, would result in two copies of the decoded image existing in memory at the same time: the img element's copy, and the one in the canvas's backing store. This memory cost can be prohibitive when dealing with extremely large images. This can be avoided by using ImageBitmapRenderingContext.

Example

Using ImageBitmapRenderingContext, here is how to transcode an image to the JPEG format in a memory- and CPU-efficient way:

```javascript
createImageBitmap(inputImageBlob).then(image => {
  const canvas = document.createElement('canvas');
  const context = canvas.getContext('bitmaprenderer');
  context.transferFromImageBitmap(image);
  canvas.toBlob(outputJPEGBlob => {
    // Do something with outputJPEGBlob.
  }, 'image/jpeg');
});
```

4.12.5.2.2 The ImageBitmapRenderingContext interface

IDL

```javascript
[Exposed=(Window,Worker)]
interface ImageBitmapRenderingContext { readonly attribute (HTMLCanvasElement or OffscreenCanvas) canvas;
  undefined transferFromImageBitmap(ImageBitmap? bitmap);
};
```

dictionary ImageBitmapRenderingContextSettings {
boolean alpha = true;
;
For web developers (non-normative)

canvas

context = canvas.getContext('bitmaprenderer', { alpha: false })

Returns an ImageBitmapRenderingContext object that is permanently bound to a particular canvas element.

If the alpha setting is provided and set to false, then the canvas is forced to always be opaque.

canvas

context.canvas

Returns the canvas element to which context is bound.

canvas

context.transferFromImageBitmap(imageBitmap)

Transfers the underlying bitmap data from imageBitmap to context, and the bitmap becomes the contents of the canvas element to which context is bound.

canvas

context.transferFromImageBitmap(null)

Replaces contents of the canvas element to which context is bound with a transparent black bitmap whose size corresponds to the width and height content attributes of the canvas element.

The canvas attribute must return the value it was initialized to when the object was created.

An ImageBitmapRenderingContext object has an output bitmap, which is a reference to bitmap data.

An ImageBitmapRenderingContext object has a bitmap mode, which can be set to valid or blank. A value of valid indicates that the context's output bitmap refers to bitmap data that was acquired via transferFromImageBitmap(). A value blank indicates that the context's output bitmap is a default transparent bitmap.

An ImageBitmapRenderingContext object also has an alpha flag, which can be set to true or false. When an ImageBitmapRenderingContext object has its alpha flag set to false, the contents of the canvas element to which the context is bound are obtained by compositing the context's output bitmap onto an opaque black bitmap of the same size using the source-over compositing operator. If the alpha flag is set to true, then the output bitmap is used as the contents of the canvas element to which the context is bound. [COMPOSITE]

Note

The step of compositing over an opaque black bitmap ought to be elided whenever equivalent results can be obtained more efficiently by other means.

When a user agent is required to set an ImageBitmapRenderingContext's output bitmap, with a context argument that is an ImageBitmapRenderingContext object and an optional argument bitmap that refers to bitmap data, it must run these steps:

1. If a bitmap argument was not provided, then:
   1. Set context's bitmap mode to blank.
   2. Let canvas be the canvas element to which context is bound.
   3. Set context's output bitmap to be transparent black with a natural width equal to the numeric value of canvas's width attribute and a natural height equal to the numeric value of canvas's height attribute, those values being interpreted in CSS pixels.
   4. Set the output bitmap's origin-clean flag to true.

2. If a bitmap argument was provided, then:
   1. Set context's bitmap mode to valid.
   2. Set context's output bitmap to refer to the same underlying bitmap data as bitmap, without making a copy.

Note

The origin-clean flag of bitmap is included in the bitmap data to be referenced by context's output bitmap.
The `ImageBitmapRenderingContext` creation algorithm, which is passed a `target` and `options`, consists of running these steps:

1. Let `settings` be the result of converting `options` to the dictionary type `ImageBitmapRenderingContextSettings`. (This can throw an exception.)
2. Let `context` be a new `ImageBitmapRenderingContext` object.
3. Initialize `context`'s `canvas` attribute to point to `target`.
4. Set `context`'s `output bitmap` to the same bitmap as `target`'s bitmap (so that they are shared).
5. Run the steps to set an `ImageBitmapRenderingContext`'s `output bitmap` with `context`.
6. Initialize `context`'s `alpha` flag to true.
7. Process each of the members of `settings` as follows:
   - `alpha`
     - If false, then set `context`'s `alpha` flag to false.
8. Return `context`.

The `transferFromImageBitmap(bitmap)` method, when invoked, must run these steps:

1. Let `bitmapContext` be the `ImageBitmapRenderingContext` object on which the `transferFromImageBitmap()` method was called.
2. If `bitmap` is null, then run the steps to set an `ImageBitmapRenderingContext`'s `output bitmap`, with `bitmapContext` as the `context` argument and no `bitmap` argument, then return.
3. If the value of `bitmap`'s `[[Detached]]` internal slot is set to true, then throw an "InvalidStateError" `DOMException`.
4. Run the steps to set an `ImageBitmapRenderingContext`'s `output bitmap`, with the `context` argument equal to `bitmapContext`, and the `bitmap` argument referring to `bitmap`'s underlying `bitmap data`.
5. Set the value of `bitmap`'s `[[Detached]]` internal slot to true.
6. Unset `bitmap`'s `bitmap data`.

4.12.5.3 The `OffscreenCanvas` interface

```idl
typedef (OffscreenCanvasRenderingContext2D or ImageBitmapRenderingContext or WebGLRenderingContext or WebGL2RenderingContext or GPUCanvasContext) OffscreenRenderingContext;

dictionary ImageEncodeOptions {
    DOMString type = "image/png";
    unrestricted double quality;
};

enum OffscreenRenderingContextId { "2d", "bitmaprenderer", "webgl", "webgl2", "webgpu" };

[Exposed=(Window,Worker), Transferable]
interface OffscreenCanvas : EventTarget {
    constructor([EnforceRange] unsigned long long width, [EnforceRange] unsigned long long height);

    attribute [EnforceRange] unsigned long long width;
    attribute [EnforceRange] unsigned long long height;

    OffscreenRenderingContext? getContext(OffscreenRenderingContextId contextId, optional any options = null);
    ImageBitmap transferToImageBitmap();
    Promise<Blob> convertToBlob(optional ImageEncodeOptions options = {});
}```
OffscreenCanvas objects are used to create rendering contexts, much like an HTMLCanvasElement, but with no connection to the DOM. This makes it possible to use canvas rendering contexts in workers.

An OffscreenCanvas object may hold a weak reference to a placeholder canvas element, which is typically in the DOM, whose embedded content is provided by the OffscreenCanvas object. The bitmap of the OffscreenCanvas object is pushed to the placeholder canvas element as part of the OffscreenCanvas object's relevant agent's event loop's update the rendering steps.

For web developers (non-normative)

```
OffscreenCanvas = new OffscreenCanvas(width, height)
```

Returns a new OffscreenCanvas object that is not linked to a placeholder canvas element, and whose bitmap's size is determined by the width and height arguments.

```
context = OffscreenCanvas.getContext(contextId [, options ])
```

Returns an object that exposes an API for drawing on the OffscreenCanvas object. contextId specifies the desired API: "2d", "bitmaprenderer", "webgl", "webgl2", or "webgpu". options is handled by that API.

This specification defines the "2d" context below, which is similar but distinct from the "2d" context that is created from a canvas element. The WebGL specifications define the "webgl" and "webgl2" contexts. WebGPU defines the "webgpu" context.

Returns null if the canvas has already been initialized with another context type (e.g., trying to get a "webgl" context after getting a "2d" context).

An OffscreenCanvas object has an internal bitmap that is initialized when the object is created. The width and height of the bitmap are equal to the values of the width and height attributes of the OffscreenCanvas object. Initially, all the bitmap's pixels are transparent black.

An OffscreenCanvas object can have a rendering context bound to it. Initially, it does not have a bound rendering context. To keep track of whether it has a rendering context or not, and what kind of rendering context it is, an OffscreenCanvas object also has a context mode, which is initially none but can be changed to either 2d, bitmaprenderer, webgl, webgl2, webgpu, or detached by algorithms defined in this specification.

The constructor OffscreenCanvas(width, height), when invoked, must create a new OffscreenCanvas object with its bitmap initialized to a rectangular array of transparent black pixels of the dimensions specified by width and height; and its width and height attributes initialized to width and height respectively.

OffscreenCanvas objects are transferable. Their transfer steps, given value and dataHolder, are as follows:

1. If value's context mode is not equal to none, then throw an InvalidState error.
2. Set value's context mode to detached.
3. Let width and height be the dimensions of value's bitmap.
4. Unset value's bitmap.
5. Set dataHolder.[[Width]] to width and dataHolder.[[Height]] to height.
6. Set dataHolder.[[PlaceholderCanvas]] to be a weak reference to value's placeholder canvas element, if value has one, or null if it does not.

Their transfer-receiving steps, given dataHolder and value, are:
1. Initialize value's bitmap to a rectangular array of transparent black pixels with width given by `dataHolder.[[Width]]` and height given by `dataHolder.[[Height]]`.

2. If `dataHolder.[[PlaceholderCanvas]]` is not null, set value's placeholder canvas element to `dataHolder.[[PlaceholderCanvas]]` (while maintaining the weak reference semantics).

The `getContext(contextId, options)` method of an `OffscreenCanvas` object, when invoked, must run these steps:

1. If `options` is not an object, then set `options` to null.

2. Set `options` to the result of converting `options` to a JavaScript value.

3. Run the steps in the cell of the following table whose column header matches this `OffscreenCanvas` object's `context mode` and whose row header matches `contextId`:

<table>
<thead>
<tr>
<th>contextId</th>
<th>none</th>
<th>2d</th>
<th>bitmaprenderer</th>
<th>webgl</th>
<th>webgpu</th>
<th>detached</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;2d&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Let context be the result of running the <code>offscreen 2D context creation algorithm</code> given this and options.</td>
<td>Return the same object as was returned the last time the method was invoked with this same first argument.</td>
<td>Return null.</td>
<td>Return null.</td>
<td>Return null.</td>
<td>Throw an &quot;InvalidStateError&quot; DOMException.</td>
</tr>
<tr>
<td></td>
<td>2. Set this's <code>context mode</code> to 2d.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Return context.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;bitmaprenderer&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Let context be the result of running the <code>ImageBitmapRenderingContext creation algorithm</code> given this and options.</td>
<td>Return null.</td>
<td>Return the same object as was returned the last time the method was invoked with this same first argument.</td>
<td>Return null.</td>
<td>Return null.</td>
<td>Throw an &quot;InvalidStateError&quot; DOMException.</td>
</tr>
<tr>
<td></td>
<td>2. Set this's <code>context mode</code> to <code>bitmaprenderer</code>.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Return context.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;webgl&quot; or &quot;webgl2&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Let context be the result of following the instructions given in the WebGL specifications' Context Creation sections. [WEBGL]</td>
<td>Return null.</td>
<td>Return null.</td>
<td>Return the same value as was returned the last time the method was invoked with this same first argument.</td>
<td>Return null.</td>
<td>Throw an &quot;InvalidStateError&quot; DOMException.</td>
</tr>
<tr>
<td></td>
<td>2. If context is null, then return null; otherwise set this's <code>context mode</code> to <code>webgl</code> or <code>webgl2</code>.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Return context.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;webgpu&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Let context be the result of following the instructions given in WebGPU's Canvas Rendering section. [WEBGPU]</td>
<td>Return null.</td>
<td>Return null.</td>
<td>Return null.</td>
<td>Return the same value as was returned the last time the method was invoked with this same first argument.</td>
<td>Throw an &quot;InvalidStateError&quot; DOMException.</td>
</tr>
<tr>
<td></td>
<td>2. If context is null, then return null; otherwise set this's <code>context mode</code> to <code>webgpu</code>.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Return context.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
For web developers (non-normative)

`offscreenCanvas.width` [ = value ]
`offscreenCanvas.height` [ = value ]

These attributes return the dimensions of the `OffscreenCanvas` object's `bitmap`. They can be set to replace the `bitmap` with a new, transparent black bitmap of the specified dimensions (effectively resizing it).

If either the `width` or `height` attributes of an `OffscreenCanvas` object are set (to a new value or to the same value as before) and the `OffscreenCanvas` object's `context mode` is `2d`, then reset the rendering context to its default state and resize the `OffscreenCanvas` object's `bitmap` to the new values of the `width` and `height` attributes.

The resizing behavior for "webgl" and "webgl2" contexts is defined in the WebGL specifications. [WEBGL]

The resizing behavior for "webgpu" context is defined in WebGPU. [WEBGPU]

Note

If an `OffscreenCanvas` object whose dimensions were changed has a `placeholder canvas element`'s natural size will only be updated during the `OffscreenCanvas` object’s `relevant agent`'s event loop, update the rendering steps.

For web developers (non-normative)

`promise = offscreenCanvas.convertToBlob((options))`

Returns a promise that will fulfill with a new `Blob` object representing a file containing the image in the `OffscreenCanvas` object.

The argument, if provided, is a dictionary that controls the encoding options of the image file to be created. The `type` field specifies the file format and has a default value of "image/png"; that type is also used if the requested type isn't supported. If the image format supports variable quality (such as "image/jpeg"), then the `quality` field is a number in the range 0.0 to 1.0 inclusive indicating the desired quality level for the resulting image.

`canvas.transferToImageBitmap()`

Returns a newly created `ImageBitmap` object with the image in the `OffscreenCanvas` object. The image in the `OffscreenCanvas` object is replaced with a new blank image.

The `convertToBlob(options)` method, when invoked, must run the following steps:

1. If the value of this `OffscreenCanvas` object's `[[Detached]]` internal slot is set to true, then return a `DOMException` with an "InvalidStateError".
2. If this `OffscreenCanvas` object's `context mode` is `2d` and the rendering context's `bitmap`'s `origin-clean` flag is set to false, then return a `DOMException` with a "SecurityError".
3. If this `OffscreenCanvas` object's `bitmap` has no pixels (i.e., either its horizontal dimension or its vertical dimension is zero) then return a `DOMException` with an "IndexSizeError".
4. Let `bitmap` be a copy of this `OffscreenCanvas` object's `bitmap`.
5. Let `result` be a new promise object.
6. Run these steps in parallel:
   1. Let `file` be a serialization of `bitmap as a file`, with `options`'s `type` and `quality` if present.
   2. Queue an element task on the `canvas blob serialization task source` given the `canvas` element to run these steps:
      1. If `file` is null, then reject `result` with an "EncodingError".
      2. Otherwise, resolve `result` with a new `Blob` object, created in the `relevant realm` of this `OffscreenCanvas` object, representing `file`. [FILEAPI]

The `transferToImageBitmap()` method, when invoked, must run the following steps:
1. If the value of this `OffscreenCanvas` object's `[[Detached]]` internal slot is set to true, then throw an "InvalidStateError" DOMException.

2. If this `OffscreenCanvas` object's `context mode` is set to `none`, then throw an "InvalidStateError" DOMException.

3. Let `image` be a newly created `ImageBitmap` object that references the same underlying bitmap data as this `OffscreenCanvas` object's `bitmap`. Set this `OffscreenCanvas` object's `bitmap` to reference a newly created bitmap of the same dimensions and color space as the previous bitmap, and with its pixels initialized to transparent black, or opaque black if the rendering context's `alpha` flag is set to false.

4. Return `image`.

The following are the event handlers (and their corresponding event handler event types) that must be supported, as event handler IDL attributes, by all objects implementing the `OffscreenCanvas` interface:

<table>
<thead>
<tr>
<th>Event handler</th>
<th>Event handler event type</th>
</tr>
</thead>
<tbody>
<tr>
<td>oncontextlost</td>
<td>contextlost</td>
</tr>
<tr>
<td>oncontextrestored</td>
<td>contextrestored</td>
</tr>
</tbody>
</table>

4.12.5.3.1 The offscreen 2D rendering context

```idl
[Exposed=(Window,Worker)]
interface OffscreenCanvasRenderingContext2D {
  readonly attribute OffscreenCanvas canvas;
};
```

The `OffscreenCanvasRenderingContext2D` object is a rendering context for drawing to the `bitmap` of an `OffscreenCanvas` object. It is similar to the `CanvasRenderingContext2D` object, with the following differences:

- there is no support for user interface features;
- its `canvas` attribute refers to an `OffscreenCanvas` object rather than a `canvas` element;

An `OffscreenCanvasRenderingContext2D` object has a `bitmap` that is initialized when the object is created.

The `bitmap` has an `origin-clean` flag, which can be set to true or false. Initially, when one of these bitmaps is created, its `origin-clean` flag must be set to true.

An `OffscreenCanvasRenderingContext2D` object also has an `alpha` flag, which can be set to true or false. Initially, when the
context is created, its alpha flag must be set to true. When an `OffscreenCanvasRenderingContext2D` object has its `alpha` flag set to false, then its alpha channel must be fixed to 1.0 (fully opaque) for all pixels, and attempts to change the alpha component of any pixel must be silently ignored.

An `OffscreenCanvasRenderingContext2D` object also has a `color space` setting of type `PredefinedColorSpace`. The color space for the context's `bitmap` is set to the context's `color space`.

An `OffscreenCanvasRenderingContext2D` object has an associated `OffscreenCanvas` object, which is the `OffscreenCanvas` object from which the `OffscreenCanvasRenderingContext2D` object was created.

The **offscreen 2D context creation algorithm**, which is passed a `target` (an `OffscreenCanvas` object) and optionally some arguments, consists of running the following steps:

1. If the algorithm was passed some arguments, let `arg` be the first such argument. Otherwise, let `arg` be undefined.
2. Let `settings` be the result of converting `arg` to the dictionary type `CanvasRenderingContext2DSettings`. (This can throw an exception.).
3. Let `context` be a new `OffscreenCanvasRenderingContext2D` object.
4. Set `context`'s `associated OffscreenCanvas object` to `target`.
5. If `settings["alpha"]` is false, then set `context`'s `alpha` flag to false.
6. Set `context`'s `color space` to `settings["colorSpace"]`.
7. Set `context`'s `bitmap` to a newly created bitmap with the dimensions specified by the `width` and `height` attributes of `target`, and set `target`'s bitmap to the same bitmap (so that they are shared).
8. If `context`'s `alpha` flag is set to true, initialize all the pixels of `context`'s `bitmap` to transparent black. Otherwise, initialize the pixels to opaque black.
9. Return `context`.

**Note**

Implementations are encouraged to short-circuit the graphics update steps of the `window event loop` for the purposes of updating the contents of a `placeholder canvas element` to the display. This could mean, for example, that the bitmap contents are copied directly to a graphics buffer that is mapped to the physical display location of the `placeholder canvas element`. This or similar short-circuiting approaches can significantly reduce display latency, especially in cases where the `OffscreenCanvas` is updated from a `worker event loop` and the `window event loop` of the `placeholder canvas element` is busy. However, such shortcuts cannot have any script-observable side-effects. This means that the committed bitmap still needs to be sent to the `placeholder canvas element`, in case the element is used as a `CanvasImageSource`, as an `ImageBitmapSource`, or in case `toDataURL()` or `toBlob()` are called on it.

The `canvas` attribute, on getting, must return this `OffscreenCanvasRenderingContext2D`'s `associated OffscreenCanvas object`.

### 4.12.5.4 Color spaces and color space conversion

The `canvas` APIs provide mechanisms for specifying the color space of the canvas's backing store. The default backing store color space for all canvas APIs is 'srgb'.

Color space conversion must be applied to the canvas's backing store when rendering the canvas to the output device. This color space conversion must be identical to the color space conversion that would be applied to an `img` element with a color profile that specifies the same `color space`, as the canvas's backing store.

When drawing content to a 2D context, all inputs must be converted to the `context's color space` before drawing. Interpolation of gradient color stops must be performed on color values after conversion to the `context's color space`. Alpha blending must be performed on values after conversion to the `context's color space`.
4.12.5.5 Serializing bitmaps to a file

When a user agent is to create a serialization of the bitmap as a file, given a type and an optional quality, it must create an image file in the format given by type. If an error occurs during the creation of the image file (e.g. an internal encoder error), then the result of the serialization is null. [PNG]

The image file's pixel data must be the bitmap's pixel data scaled to one image pixel per coordinate space unit, and if the file format used supports encoding resolution metadata, the resolution must be given as 96dpi (one image pixel per CSS pixel).

If type is supplied, then it must be interpreted as a MIME type giving the format to use. If the type has any parameters, then it must be treated as not supported.

Example

For example, the value "image/png" would mean to generate a PNG image, the value "image/jpeg" would mean to generate a JPEG image, and the value "image/svg+xml" would mean to generate an SVG image (which would require that the user agent track how the bitmap was generated, an unlikely, though potentially awesome, feature).

User agents must support PNG ("image/png"). User agents may support other types. If the user agent does not support the requested type, then it must create the file using the PNG format. [PNG]

User agents must convert the provided type to ASCII lowercase before establishing if they support that type.

For image types that do not support an alpha channel, the serialized image must be the bitmap image composited onto an opaque black background using the source-over compositing operator.

For image types that support color profiles, the serialized image must include a color profile indicating the color space of the underlying bitmap. For image types that do not support color profiles, the serialized image must be converted to the 'srgb' color space using 'relative-colorimetric' rendering intent.

Note

Thus, in the 2D context, calling the drawImage() method to render the output of the toDataURL() or toBlob() method to the canvas, given the appropriate dimensions, has no visible effect beyond, at most, clipping colors of the canvas to a more narrow gamut.

If type is an image format that supports variable quality (such as "image/jpeg"), quality is given, and type is not "image/png", then, if type is a Number, and quality is in the range 0.0 to 1.0 inclusive, the user agent must treat quality as the desired quality level. Otherwise, the user agent must use its default quality value, as if the quality argument had not been given.

Note

The use of type-testing here, instead of simply declaring quality as a Web IDL double, is a historical artifact.

Note

Different implementations can have slightly different interpretations of "quality". When the quality is not specified, an implementation-specific default is used that represents a reasonable compromise between compression ratio, image quality, and encoding time.

4.12.5.6 Security with canvas elements

This section is non-normative.

Information leakage can occur if scripts from one origin can access information (e.g. read pixels) from images from another origin.
To mitigate this, bitmaps used with canvas elements, OffscreenCanvas objects, and ImageBitmap objects are defined to have a flag indicating whether they are origin-clean. All bitmaps start with their origin-clean set to true. The flag is set to false when cross-origin images are used.

The toDataURL(), toBlob(), and getImageData() methods check the flag and will throw a "SecurityError" DOMException rather than leak cross-origin data.

The value of the origin-clean flag is propagated from a source's bitmap to a new ImageBitmap object by createImageBitmap(). Conversely, a destination canvas element's bitmap will have its origin-clean flags set to false by drawImage if the source image is an ImageBitmap object whose bitmap has its origin-clean flag set to false.

The flag can be reset in certain situations; for example, when changing the value of the width or the height content attribute of the canvas element to which a CanvasRenderingContext2D is bound, the bitmap is cleared and its origin-clean flag is reset.

When using an ImageBitmapRenderingContext, the value of the origin-clean flag is propagated from ImageBitmap objects when they are transferred to the canvas via transferFromImageBitmap().

### 4.12.5.7 Premultiplied alpha and the 2D rendering context

Premultiplied alpha refers to one way of representing transparency in an image, the other being non-premultiplied alpha.

Under non-premultiplied alpha, the red, green, and blue channels of a pixel represent that pixel's color, and its alpha channel represents that pixel's opacity.

Under premultiplied alpha, however, the red, green, and blue channels of a pixel represent the amounts of color that the pixel adds to the image, and its alpha channel represents the amount that the pixel obscures whatever is behind it.

<table>
<thead>
<tr>
<th>CSS color representation</th>
<th>Premultiplied representation</th>
<th>Non-premultiplied representation</th>
<th>Description of color</th>
<th>Image of color blended above other content</th>
</tr>
</thead>
<tbody>
<tr>
<td>rgba(255, 127, 0, 1)</td>
<td>255, 127, 0, 255</td>
<td>255, 127, 0, 255</td>
<td>Completely-opaque orange</td>
<td></td>
</tr>
<tr>
<td>rgba(255, 255, 0, 0.5)</td>
<td>127, 127, 0, 127</td>
<td>255, 255, 0, 127</td>
<td>Halfway-opaque yellow</td>
<td></td>
</tr>
<tr>
<td>Unrepresentable</td>
<td>255, 127, 0, 127</td>
<td>Unrepresentable</td>
<td>Additive halfway-opaque orange</td>
<td></td>
</tr>
</tbody>
</table>
Converting a color value from a non-premultiplied representation to a premultiplied one involves multiplying the color's red, green, and blue channels by its alpha channel (remapping the range of the alpha channel such that "fully transparent" is 0, and "fully opaque" is 1).

Converting a color value from a premultiplied representation to a non-premultiplied one involves the inverse: dividing the color's red, green, and blue channels by its alpha channel.

As certain colors can only be represented under premultiplied alpha (for instance, additive colors), and others can only be represented under non-premultiplied alpha (for instance, "invisible" colors which hold certain red, green, and blue values even with no opacity); and division and multiplication on 8-bit integers (which is how canvas's colors are currently stored) entails a loss of precision, converting between premultiplied and non-premultiplied alpha is a lossy operation on colors that are not fully opaque.

A `CanvasRenderingContext2D`'s output bitmap and an `OffscreenCanvasRenderingContext2D`'s bitmap must use premultiplied alpha to represent transparent colors.

It is important for canvas bitmaps to represent colors using premultiplied alpha because it affects the range of representable colors. While additive colors cannot currently be drawn onto canvases directly because CSS colors are non-premultiplied and cannot represent them, it is still possible to, for instance, draw additive colors onto a WebGL canvas and then draw that WebGL canvas onto a 2D canvas via `drawImage()`.

**4.13 Custom elements**

**4.13.1 Introduction**

This section is non-normative.

Custom elements provide a way for authors to build their own fully-featured DOM elements. Although authors could always use non-standard elements in their documents, with application-specific behavior added after the fact by scripting or similar, such elements have historically been non-conforming and not very functional. By defining a custom element, authors can inform the parser how to properly construct an element and how elements of that class should react to changes.
Custom elements are part of a larger effort to "rationalise the platform", by explaining existing platform features (like the elements of HTML) in terms of lower-level author-exposed extensibility points (like custom element definition). Although today there are many limitations on the capabilities of custom elements—both functionally and semantically—that prevent them from fully explaining the behaviors of HTML's existing elements, we hope to shrink this gap over time.

### 4.13.1.1 Creating an autonomous custom element

This section is non-normative.

For the purposes of illustrating how to create an autonomous custom element, let's define a custom element that encapsulates rendering a small icon for a country flag. Our goal is to be able to use it like so:

```html
<flag-icon country="nl"></flag-icon>
```

To do this, we first declare a class for the custom element, extending `HTMLElement`:

```javascript
class FlagIcon extends HTMLElement {
  constructor() {
    super();
    this._countryCode = null;
  }

  static observedAttributes = ["country"];

  attributeChangedCallback(name, oldValue, newValue) {
    // name will always be "country" due to observedAttributes
    this._countryCode = newValue;
    this._updateRendering();
  }

  connectedCallback() {
    this._updateRendering();
  }

  get country() {
    return this._countryCode;
  }

  set country(v) {
    this.setAttribute("country", v);
  }

  _updateRendering() {
    // Left as an exercise for the reader. But, you'll probably want to
    // check this.ownerDocument.defaultView to see if we've been
    // inserted into a document with a browsing context, and avoid
    // doing any work if not.
  }
}
```

We then need to use this class to define the element:

```javascript
customElements.define("flag-icon", FlagIcon);
```

At this point, our above code will work! The parser, whenever it sees the `flag-icon` tag, will construct a new instance of our FlagIcon class, and tell our code about its new `country` attribute, which we then use to set the element's internal state and update its rendering (when appropriate).

You can also create `flag-icon` elements using the DOM API:

```javascript
const flagIcon = document.createElement("flag-icon")
flagIcon.country = "jp"
```
Finally, we can also use the `custom element constructor` itself. That is, the above code is equivalent to:

```javascript
const flagIcon = new FlagIcon()
flagIcon.country = "jp"
document.body.appendChild(flagIcon)
```

### 4.13.1.2 Creating a form-associated custom element

This section is non-normative.

Adding a static `formAssociated` property, with a true value, makes an autonomous custom element a form-associated custom element. The `ElementInternals` interface helps you to implement functions and properties common to form control elements.

```javascript
class MyCheckbox extends HTMLElement {
    static formAssociated = true;
    static observedAttributes = ['checked'];

    constructor() {
        super();
        this._internals = this.attachInternals();
        this.addEventListener('click', this._onClick.bind(this));
    }

    get form() { return this._internals.form; }
    get name() { return this.getAttribute('name'); }
    get type() { return this.localName; }

    get checked() { return this.hasAttribute('checked'); }
    set checked(flag) { this.toggleAttribute('checked', Boolean(flag)); }

    attributeChangedCallback(name, oldValue, newValue) {
        // name will always be "checked" due to observedAttributes
        this._internals.setFormValue(this.checked ? 'on' : null);
    }

    _onClick(event) {
        this.checked = !this.checked;
    }
}
```

You can use the custom element `my-checkbox` like a built-in form-associated element. For example, putting it in `form` or `label` associates the `my-checkbox` element with them, and submitting the `form` will send data provided by `my-checkbox` implementation.

```html
<form action="..." method="...">
    <label><my-checkbox name="agreed">I read the agreement.</my-checkbox></label>
    <input type="submit"/>
</form>
```

### 4.13.1.3 Creating a custom element with default accessible roles, states, and properties

This section is non-normative.

By using the appropriate properties of `ElementInternals`, your custom element can have default accessibility semantics. The following code expands our form-associated checkbox from the previous section to properly set its default role and checkedsness, as
viewed by accessibility technology:

class MyCheckbox extends HTMLElement {
  static formAssociated = true;
  static observedAttributes = ['checked'];

  constructor() {
    super();
    this._internals = this.attachInternals();
    this.addEventListener('click', this._onClick.bind(this));

    this._internals.role = 'checkbox';
    this._internals.ariaChecked = 'false';
  }

  get form() { return this._internals.form; }
  get name() { return this.getAttribute('name'); }
  get type() { return this.localName; }

  get checked() { return this.hasAttribute('checked'); }
  set checked(flag) { this.toggleAttribute('checked', Boolean(flag)); }

  attributeChangedCallback(name, oldValue, newValue) {
    // name will always be "checked" due to observedAttributes
    this._internals.setFormValue(this.checked ? 'on' : null);
    this._internals.ariaChecked = this.checked;
  }

  _onClick(event) {
    this.checked = !this.checked;
  }
}

customElements.define('my-checkbox', MyCheckbox);

Note that, like for built-in elements, these are only defaults, and can be overridden by the page author using the role and aria-* attributes:

<!-- This markup is non-conforming -->
<input type="checkbox" checked role="button" aria-checked="false">

<!-- This markup is probably not what the custom element author intended -->
<my-checkbox role="button" checked aria-checked="false">

Custom element authors are encouraged to state what aspects of their accessibility semantics are strong native semantics, i.e., should not be overridden by users of the custom element. In our example, the author of the my-checkbox element would state that its role and aria-checked values are strong native semantics, thus discouraging code such as the above.

4.13.1.4 Creating a customized built-in element

This section is non-normative.

Customized built-in elements are a distinct kind of custom element, which are defined slightly differently and used very differently compared to autonomous custom elements. They exist to allow reuse of behaviors from the existing elements of HTML, by extending those elements with new custom functionality. This is important since many of the existing behaviors of HTML elements can unfortunately not be duplicated by using purely autonomous custom elements. Instead, customized built-in elements allow the installation of custom construction behavior, lifecycle hooks, and prototype chain onto existing elements, essentially "mixing in" these capabilities on top of the already-existing element.

Customized built-in elements require a distinct syntax from autonomous custom elements because user agents and other software key off an element’s local name in order to identify the element’s semantics and behavior. That is, the concept of customized
built-in elements building on top of existing behavior depends crucially on the extended elements retaining their original local name.

In this example, we’ll be creating a customized built-in named plastic-button, which behaves like a normal button but gets fancy animation effects added whenever you click on it. We start by defining a class, just like before, although this time we extend HTMLButtonElement instead of HTMLElement:

```javascript
class PlasticButton extends HTMLButtonElement {
  constructor() {
    super();

    this.addEventListener("click", () => {
      // Draw some fancy animation effects!
    });
  }
}
```

When defining our custom element, we have to also specify the extends option:

```javascript
customElements.define("plastic-button", PlasticButton, { extends: "button" });
```

In general, the name of the element being extended cannot be determined simply by looking at what element interface it extends, as many elements share the same interface (such as `p` and `blockquote` both sharing `HTMLQuoteElement`).

To construct our customized built-in from parsed HTML source text, we use the `is` attribute on a `button` element:

```html
<button is="plastic-button">Click Me!</button>
```

Trying to use a customized built-in as an autonomous custom element will not work; that is, `<plastic-button>Click me?</plastic-button>` will simply create an `HTMLElement` with no special behavior.

If you need to create a customized built-in element programmatically, you can use the following form of `createElement()`:

```javascript
const plasticButton = document.createElement("button", { is: "plastic-button" });
plasticButton.textContent = "Click me!";
```

And as before, the constructor will also work:

```javascript
const plasticButton2 = new PlasticButton();
console.log(plasticButton2.localName); // will output "button"
console.assert(plasticButton2 instanceof PlasticButton);
console.assert(plasticButton2 instanceof HTMLButtonElement);
```

Note that when creating a customized built-in element programmatically, the `is` attribute will not be present in the DOM, since it was not explicitly set. However, it will be added to the output when serializing:

```javascript
console.assert(!plasticButton.hasAttribute("is"));
console.log(plasticButton.outerHTML); // will output '<button is="plastic-button"></button>'
```

Regardless of how it is created, all of the ways in which `button` is special apply to such "plastic buttons" as well: their focus behavior, ability to participate in form submission, the `disabled` attribute, and so on.

Customized built-in elements are designed to allow extension of existing HTML elements that have useful user-agent supplied behavior or APIs. As such, they can only extend existing HTML elements defined in this specification, and cannot extend legacy elements such as `bgsound`, `blink`, `isindex`, `keygen`, `multicol`, `nextid`, or `spacer` that have been defined to use `HTMLUnknownElement` as their element interface.

One reason for this requirement is future-compatibility: if a customized built-in was defined that extended a currently-unknown element, for example `combobox`, this would prevent this specification from defining a `combobox` element in the future, as consumers of the derived customized built-in would have come to depend on their base element having no interesting user-agent-supplied behavior.
This section is non-normative.

As specified below, and alluded to above, simply defining and using an element called taco-button does not mean that such elements represent buttons. That is, tools such as web browsers, search engines, or accessibility technology will not automatically treat the resulting element as a button just based on its defined name.

To convey the desired button semantics to a variety of users, while still using an autonomous custom element, a number of techniques would need to be employed:

- The addition of the tabindex attribute would make the taco-button focusable. Note that if the taco-button were to become logically disabled, the tabindex attribute would need to be removed.
- The addition of an ARIA role and various ARIA states and properties helps convey semantics to accessibility technology. For example, setting the role to "button" will convey the semantics that this is a button, enabling users to successfully interact with the control using usual button-like interactions in their accessibility technology. Setting the aria-label property is necessary to give the button an accessible name, instead of having accessibility technology traverse its child text nodes and announce them. And setting the aria-disabled state to "true" when the button is logically disabled conveys to accessibility technology the button's disabled state.
- The addition of event handlers to handle commonly-expected button behaviors helps convey the semantics of the button to web browser users. In this case, the most relevant event handler would be one that proxies appropriate keydown events to become click events, so that you can activate the button both with keyboard and by clicking.
- In addition to any default visual styling provided for taco-button elements, the visual styling will also need to be updated to reflect changes in logical state, such as becoming disabled; that is, whatever style sheet has rules for taco-button will also need to have rules for taco-button[disabled].

With these points in mind, a full-featured taco-button that took on the responsibility of conveying button semantics (including the ability to be disabled) might look something like this:

```javascript
class TacoButton extends HTMLElement {
    static observedAttributes = ["disabled"];

    constructor() {
        super();
        this._internals = this.attachInternals();
        this._internals.role = "button";

        this.addEventListener("keydown", e => {
            if (e.code === "Enter" || e.code === "Space") {
                this.dispatchEvent(new PointerEvent("click", {
                    bubbles: true,
                    cancelable: true
                }));
            }
        });

        this.addEventListener("click", e => {
            if (this.disabled) {
                e.preventDefault();
                e.stopImmediatePropagation();
            }
        });

        this._observer = new MutationObserver(() => {
            this._internals.ariaLabel = this.textContent;
        });
    }

    connectedCallback() {
        this.setAttribute("tabindex", "0");
    }
}
```
```javascript
this._observer.observe(this, {
  childList: true,
  characterData: true,
  subtree: true
});

disconnectedCallback() {
  this._observer.disconnect();
}

get disabled() {
  return this.hasAttribute("disabled");
}

set disabled(flag)
{
  this.toggleAttribute("disabled", Boolean(flag));
}

attributeChangedCallback(name, oldValue, newValue) {
  // name will always be "disabled" due to observedAttributes
  if (this.disabled)
  {
    this.removeAttribute("tabindex");
    this._internals.ariaDisabled = "true";
  }
  else {
    this.setAttribute("tabindex", "0");
    this._internals.ariaDisabled = "false";
  }
}
```

Even with this rather-complicated element definition, the element is not a pleasure to use for consumers: it will be continually "sprouting" `tabindex` attributes of its own volition, and its choice of `tabindex="0"` focusability behavior may not match the `button` behavior on the current platform. This is because as of now there is no way to specify default focus behavior for custom elements, forcing the use of the `tabindex` attribute to do so (even though it is usually reserved for allowing the consumer to override default behavior).

In contrast, a simple customized built-in element, as shown in the previous section, would automatically inherit the semantics and behavior of the `button` element, with no need to implement these behaviors manually. In general, for any elements with nontrivial behavior and semantics that build on top of existing elements of HTML, customized built-in elements will be easier to develop, maintain, and consume.

### 4.13.1.6 Upgrading elements after their creation

This section is non-normative.

Because element definition can occur at any time, a non-custom element could be created, and then later become a custom element after an appropriate definition is registered. We call this process "upgrading" the element, from a normal element into a custom element.

Upgrades enable scenarios where it may be preferable for custom element definitions to be registered after relevant elements have been initially created, such as by the parser. They allow progressive enhancement of the content in the custom element. For example, in the following HTML document the element definition for `img-viewer` is loaded asynchronously:

```html
<!DOCTYPE html>
<html lang="en">
<title>Image viewer example</title>

<img-viewer filter="Kelvin">
  <img src="images/tree.jpg" alt="A beautiful tree towering over an empty savannah">
</img-viewer>
```
The definition for the `img-viewer` element here is loaded using a `<script>` element marked with the `async` attribute, placed after the `<img-viewer>` tag in the markup. While the script is loading, the `img-viewer` element will be treated as an undefined element, similar to a `span`. Once the script loads, it will define the `img-viewer` element, and the existing `img-viewer` element on the page will be upgraded, applying the custom element's definition (which presumably includes applying an image filter identified by the string "Kelvin", enhancing the image's visual appearance).

Note that upgrades only apply to elements in the document tree. (Formally, elements that are connected.) An element that is not inserted into a document will stay un-upgraded. An example illustrates this point:

```html
<!DOCTYPE html>
<html lang="en">
<title>Upgrade edge-cases example</title>
<example-element/>
<script>
  "use strict";

  const inDocument = document.querySelector("example-element");
  const outOfDocument = document.createElement("example-element");

  // Before the element definition, both are HTMLElement:
  console.assert(inDocument instanceof HTMLElement);
  console.assert(outOfDocument instanceof HTMLElement);

  class ExampleElement extends HTMLElement {
    customElements.define("example-element", ExampleElement);

    // After element definition, the in-document element was upgraded:
    console.assert(inDocument instanceof ExampleElement);
    console.assert(!(outOfDocument instanceof ExampleElement));

    document.body.appendChild(outOfDocument);

    // Now that we've moved the element into the document, it too was upgraded:
    console.assert(outOfDocument instanceof ExampleElement);
  }</script>
</html>
```

4.13.1.7 Exposing custom element states

Built-in elements provided by user agents have certain states that can change over time depending on user interaction and other factors, and are exposed to web authors through pseudo-classes. For example, some form controls have the "invalid" state, which is exposed through the `:invalid` pseudo-class.

Like built-in elements, custom elements can have various states to be in too, and custom element authors want to expose these states in a similar fashion as the built-in elements.

This is done via the `:state()` pseudo-class. A custom element author can use the `:states` property of `ElementInternals` to add and remove such custom states, which are then exposed as arguments to the `:state()` pseudo-class.

Example

The following shows how `:state()` can be used to style a custom checkbox element. Assume that `LabeledCheckbox` doesn't expose its "checked" state via a content attribute.
```html
class LabeledCheckbox extends HTMLElement {
  constructor() {
    super();
    this._internals = this.attachInternals();
    this.addEventListener('click', this._onClick.bind(this));

    const shadowRoot = this.attachShadow({mode: 'closed'});
    shadowRoot.innerHTML = `<style>
      :host::before {
        content: '[]';
        white-space: pre;
        font-family: monospace;
      }
      :host(:state(checked))::before { content: '[x]' }
    </style>
    <slot>Label</slot>
  }

  get checked() { return this._internals.states.has('checked'); }
  set checked(flag) {
    if (flag)
      this._internals.states.add('checked');
    else
      this._internals.states.delete('checked');

    _onClick(event) {
      this.checked = !this.checked;
    }
  }
}

customElements.define('labeled-checkbox', LabeledCheckbox);
</script>

<labeled-checkbox>Yes</labeled-checkbox>
```

**Example**

Custom pseudo-classes can even target shadow parts. An extension of the above example shows this:

```html
<script>
class QuestionBox extends HTMLElement {
  constructor() {
    super();
    const shadowRoot = this.attachShadow({mode: 'closed'});
    shadowRoot.innerHTML = '<div><slot>Question</slot></div>
      <labeled-checkbox part='checkbox'>Yes</labeled-checkbox>';
  }
}

customElements.define('question-box', QuestionBox);
</script>
<labeled-checkbox>You need to check this</labeled-checkbox>
```
4.13.2 Requirements for custom element constructors and reactions

When authoring custom element constructors, authors are bound by the following conformance requirements:

- A parameter-less call to `super()` must be the first statement in the constructor body, to establish the correct prototype chain and `this` value before any further code is run.
- A `return` statement must not appear anywhere inside the constructor body, unless it is a simple early-return (`return` or `return this`).
- The constructor must not use the `document.write()` or `document.open()` methods.
- The element's attributes and children must not be inspected, as in the non-upgrade case none will be present, and relying on upgrades makes the element less usable.
- The element must not gain any attributes or children, as this violates the expectations of consumers who use the `createElement` or `createElementNS` methods.
- In general, work should be deferred to `connectedCallback` as much as possible—especially work involving fetching resources or rendering. However, note that `connectedCallback` can be called more than once, so any initialization work that is truly one-time will need a guard to prevent it from running twice.
- In general, the constructor should be used to set up initial state and default values, and to set up event listeners and possibly a shadow root.

Several of these requirements are checked during element creation, either directly or indirectly, and failing to follow them will result in a custom element that cannot be instantiated by the parser or DOM APIs. This is true even if the work is done inside a constructor-initiated microtask, as a microtask checkpoint can occur immediately after construction.

When authoring custom element reactions, authors should avoid manipulating the node tree as this can lead to unexpected results.

Example

An element's `connectedCallback` can be queued before the element is disconnected, but as the callback queue is still processed, it results in a `connectedCallback` for an element that is no longer connected:

```javascript
// Example code

class CParent extends HTMLElement {
  connectedCallback() {
    this.firstChild.remove();
  }
}
customElements.define("c-parent", CParent);

class CChild extends HTMLElement {
  connectedCallback() {
    console.log("CChild connectedCallback: isConnected =", this.isConnected);
  }
}
customElements.define("c-child", CChild);

const parent = new CParent(),
child = new CChild();
parent.appendChild(child);
```
A custom element is an element that is custom. Informally, this means that its constructor and prototype are defined by the author, instead of by the user agent. This author-supplied constructor function is called the custom element constructor.

Two distinct types of custom elements can be defined:

1. An autonomous custom element, which is defined with no extends option. These types of custom elements have a local name equal to their defined name.

2. A customized built-in element, which is defined with an extends option. These types of custom elements have a local name equal to the value passed in their extends option, and their defined name is used as the value of the is attribute, which therefore must be a valid custom element name.

After a custom element is created, changing the value of the is attribute does not change the element's behavior, as it is saved on the element as its is value.

Autonomous custom elements have the following element definition:

Categories:
- Flow content
- Phrasing content
- Palpable content

For form-associated custom elements: Listed, labelable, submittable, and resettable form-associated element.

Contexts in which this element can be used:
Where phrasing content is expected.

Content model:
- Transparent

Content attributes:
- Global attributes, except the is attribute
  - form, for form-associated custom elements — Associates the element with a form element
  - disabled, for form-associated custom elements — Whether the form control is disabled
  - readonly, for form-associated custom elements — Affects willValidate, plus any behavior added by the custom element author
  - name, for form-associated custom elements — Name of the element to use for form submission and in the form.elements API
- Any other attribute that has no namespace (see prose).

Accessibility considerations:
- For form-associated custom elements: for authors; for implementers.
- Otherwise: for authors; for implementers.

DOM interface:
Supplied by the element's author (inherits from HTML Element)

An autonomous custom element does not have any special meaning: it represents its children. A customized built-in element inherits the semantics of the element that it extends.

Any namespace-less attribute that is relevant to the element's functioning, as determined by the element's author, may be specified on an autonomous custom element, so long as the attribute name is XML-compatible and contains no ASCII upper alphas. The exception is the is attribute, which must not be specified on an autonomous custom element (and which will have no effect if it
Customized built-in elements\textsuperscript{p754} follow the normal requirements for attributes, based on the elements they extend. To add custom attribute-based behavior, use \texttt{data-*} attributes.

An autonomous custom element\textsuperscript{p754}, is called a form-associated custom element if the element is associated with a custom element definition\textsuperscript{p756} whose form-associated\textsuperscript{p756} field is set to true.

The \texttt{name}\textsuperscript{p755} attribute represents the form-associated custom element\textsuperscript{p755}'s name. The \texttt{disabled}\textsuperscript{p767} attribute is used to make the form-associated custom element\textsuperscript{p755} non-interactive and to prevent its submission value\textsuperscript{p767} from being submitted. The \texttt{form}\textsuperscript{p763} attribute is used to explicitly associate the form-associated custom element\textsuperscript{p755} with its form owner\textsuperscript{p593}.

The \texttt{readonly}\textsuperscript{p547} attribute of form-associated custom elements\textsuperscript{p755} specifies that the element is barred from constraint validation\textsuperscript{p617}. User agents don't provide any other behavior for the attribute, but custom element authors should, where possible, use its presence to make their control non-editable in some appropriate fashion, similar to the behavior for the \texttt{readonly}\textsuperscript{p547} attribute on built-in form controls.

Constraint validation: If the \texttt{readonly}\textsuperscript{p755} attribute is specified on a form-associated custom element\textsuperscript{p755}, the element is barred from constraint validation\textsuperscript{p617}.

The reset algorithm\textsuperscript{p632} for form-associated custom elements\textsuperscript{p755} is to enqueue a custom element callback reaction\textsuperscript{p764} with the element, callback name "formResetCallback", and an empty argument list.

A valid custom element name is a sequence of characters name that meets all of the following requirements:

- name must match the \texttt{PotentialCustomElementName}\textsuperscript{p755} production:

  \[
  \texttt{PotentialCustomElementName} ::=
  \texttt{[a-z]}\,
  \texttt{(PCENChar}\textsuperscript{p755})*\,
  \texttt{'.]+'\,
  \texttt{(PCENChar}\textsuperscript{p755})*
  \]

  \[
  \texttt{PCENChar} :::=
  \texttt{"\-" | "." | [0-9] | "," | [a-z] | #x87 | #xC0-#xFD6 | #xD8-#xF6 | #xF8-#x37D | #x37F-#x1FFF | #x200C-#x200D | #x203F-#x2040 | #x2070-#x218F | #x2C00-#x2FFD | #x3001-#x30FF | #xF900-#xFDCF | #xFDF0-#xFFFD | #x10000-#x1FFFF}
  \]

  This uses the EBNF notation from the XML specification. [XML]\textsuperscript{p1464}

- name must not be any of the following:

  - annotation-xml
  - color-profile
  - font-face
  - font-face-src
  - font-face-uri
  - font-face-format
  - font-face-name
  - missing-glyph

  \[\textcolor{green}{\textbf{Note}}\]
  The list of names above is the summary of all hyphen-containing element names from the applicable specifications\textsuperscript{p671}, namely SVG 2 and MathML. [SVG]\textsuperscript{p1462} [MATHML]\textsuperscript{p1459}

  \[\textcolor{green}{\textbf{Note}}\]
  These requirements ensure a number of goals for valid custom element names\textsuperscript{p755}:

  - They start with an ASCII lower alpha, ensuring that the HTML parser will treat them as tags instead of as text.
  - They do not contain any ASCII upper alphas, ensuring that the user agent can always treat HTML elements ASCII-case-insensitively.
  - They contain a hyphen, used for namespacing and to ensure forward compatibility (since no elements will be added to HTML, SVG, or MathML with hyphen-containing local names in the future).
  - They can always be created with \texttt{createElement()} and \texttt{createElementNS()}, which have restrictions that go beyond the
A custom element definition describes a custom element and consists of:

A name
A valid custom element name

A local name
A local name

A constructor
A Web IDL CustomElementConstructor callback function type value wrapping the custom element constructor

A list of observed attributes
A sequence<DOMString>

A collection of lifecycle callbacks
A map, whose keys are the strings "connectedCallback", "disconnectedCallback", "adoptedCallback", "attributeChangedCallback", "formAssociatedCallback", "formDisabledCallback", "formResetCallback", and "formStateRestoreCallback". The corresponding values are either a Web IDL Function callback function type value, or null. By default the value of each entry is null.

A construction stack
A list, initially empty, that is manipulated by the upgrade an element algorithm and the HTML element constructors. Each entry in the list will be either an element or an already constructed marker.

A form-associated boolean
If this is true, user agent treats elements associated to this custom element definition as form-associated custom elements.

A disable internals boolean
Controls attachInternals().

A disable shadow boolean
Controls attachShadow().

To look up a custom element definition, given a document, namespace, localName, and is, perform the following steps. They will return either a custom element definition or null:

1. If namespace is not the HTML namespace, return null.
2. If document's browsing context is null, return null.
3. Let registry be document's relevant global object's CustomElementRegistry object.
4. If there is custom element definition in registry with name and local name both equal to localName, return that custom element definition.
5. If there is a custom element definition in registry with name equal to is and local name equal to localName, return that custom element definition.
6. Return null.

4.13.4 The CustomElementRegistry interface

Each Window object is associated with a unique instance of a CustomElementRegistry object, allocated when the Window object is created.

Note

Custom element registries are associated with Window objects, instead of Document objects, since each custom element...
The `customElements` attribute of the `Window` interface must return the `CustomElementRegistry` object for that `Window` object.

Every `CustomElementRegistry` has a set of `custom element definitions`, initially empty. In general, algorithms in this specification look up elements in the registry by any of `name`, `local name`, or `constructor`.

Every `CustomElementRegistry` also has an `element definition is running` flag which is used to prevent reentrant invocations of `element definition`. It is initially unset.

Every `CustomElementRegistry` also has a `when-defined promise map`, mapping `valid custom element names` to promises. It is used to implement the `whenDefined()` method.

**For web developers (non-normative)**

```javascript
window.customElements.define(name, constructor)

Defines a new custom element, mapping the given name to the given constructor as an autonomous custom element.

window.customElements.define(name, constructor, { extends: baseLocalName })

Defines a new custom element, mapping the given name to the given constructor as a customized built-in element for the element type identified by the supplied baseLocalName. A `NotSupportedError` will be thrown upon trying to extend a custom element or an unknown element.

window.customElements.get(name)

Retrieves the custom element constructor defined for the given name. Returns undefined if there is no custom element definition with the given name.

window.customElements.get(name)

Retrieves the given name for a custom element defined with the given constructor. Returns null if there is no custom element definition with the given constructor.

window.customElements.whenDefined(name)

Retrieves a promise that will be fulfilled with the custom element's constructor when a custom element becomes defined with the given name. If such a custom element is already defined, the returned promise will be immediately fulfilled. Returns a promise rejected with a `SyntaxError` if not given a valid custom element name.

window.customElements.upgrade(root)

Tries to upgrade all shadow-including inclusive descendant elements of `root`, even if they are not connected.
```

**Element definition** is a process of adding a `custom element definition` to the `CustomElementRegistry`. This is accomplished by the `define()` method. When invoked, the `define(name, constructor, options)` method must run these steps:

1. If `IsConstructor(constructor)` is false, then throw a `TypeError`.
2. If `name` is not a **valid custom element name**\(^{755}\), then throw a "**SyntaxError**" **DOMException**.

3. If this **CustomElementRegistry**\(^{757}\) contains an entry with `name`\(^{756}\) name, then throw a "**NotSupportedError**" **DOMException**.

4. If this **CustomElementRegistry**\(^{757}\) contains an entry with `constructor`\(^{756}\) constructor, then throw a "**NotSupportedError**" **DOMException**.

5. Let `localName` be `name`.

6. Let `extends` be the value of the `extends` member of `options`, or null if no such member exists.

7. If `extends` is not null, then:
   1. If `extends` is a **valid custom element name**\(^{755}\), then throw a "**NotSupportedError**" **DOMException**.
   2. If the *element interface* for `extends` and the *HTML namespace* is **HTMLUnknownElement**\(^{140}\) (e.g., if `extends` does not indicate an element definition in this specification), then throw a "**NotSupportedError**" **DOMException**.
   3. Set `localName` to `extends`.

8. If this **CustomElementRegistry**\(^{757}\)’s *element definition is running*\(^{757}\) flag is set, then throw a "**NotSupportedError**" **DOMException**.

9. Set this **CustomElementRegistry**\(^{757}\)’s *element definition is running*\(^{757}\) flag.

10. Let `formAssociated` be false.

11. Let `disableInternals` be false.

12. Let `disableShadow` be false.

13. Let `observedAttributes` be an empty sequence\(<\text{DOMString}>\).

14. Run the following substeps while catching any exceptions:
   1. Let `prototype` be ? **Get**(constructor, "prototype").
   2. If **Type**(`prototype`) is not `Object`, then throw a **TypeError** exception.
   3. Let `lifecycleCallbacks` be a map with the keys "connectedCallback", "disconnectedCallback", "adoptedCallback", and "attributeChangedCallback", each of which belongs to an entry whose value is null.
   4. For each of the keys `callbackName` in `lifecycleCallbacks`, in the order listed in the previous step:
      1. Let `callbackValue` be ? **Get**(`prototype`, `callbackName`).
      2. If `callbackValue` is not undefined, then set the value of the entry in `lifecycleCallbacks` with key `callbackName` to the result of **converting** `callbackValue` to the Web IDL **Function** callback type. Rethrow any exceptions from the conversion.
   5. If the value of the entry in `lifecycleCallbacks` with key "attributeChangedCallback" is not null, then:
      1. Let `observedAttributesIterable` be ? **Get**(constructor, "observedAttributes").
      2. If `observedAttributesIterable` is not undefined, then set `observedAttributes` to the result of **converting** `observedAttributesIterable` to a sequence\(<\text{DOMString}>\). Rethrow any exceptions from the conversion.
   6. Let `disabledFeatures` be an empty sequence\(<\text{DOMString}>\).
   7. Let `disabledFeaturesIterable` be ? **Get**(constructor, "disabledFeatures").
   8. If `disabledFeaturesIterable` is not undefined, then set `disabledFeatures` to the result of **converting** `disabledFeaturesIterable` to a sequence\(<\text{DOMString}>\). Rethrow any exceptions from the conversion.
   9. Set `disableInternals` to true if `disabledFeatures` contains "internals".
   10. Set `disableShadow` to true if `disabledFeatures` contains "shadow".
   11. Let `formAssociatedValue` be ? **Get**(constructor, "formAssociated").
   12. Set `formAssociated` to the result of **converting** `formAssociatedValue` to a boolean. Rethrow any exceptions from the conversion.
13. If \texttt{formAssociated} is true, for each of "formAssociatedCallback", "formResetCallback", "formDisabledCallback", and "formStateRestoreCallback" \texttt{callbackName}:

1. Let \texttt{callbackValue} be \texttt{Get(prototype, callbackName)}.

2. If \texttt{callbackValue} is not undefined, then set the value of the entry in \texttt{lifecycleCallbacks} with key \texttt{callbackName} to the result of converting \texttt{callbackValue} to the Web IDL \texttt{Function callback} type. Rethrow any exceptions from the conversion.

Then, perform the following substep, regardless of whether the above steps threw an exception or not:

1. Unset this \texttt{CustomElementRegistry.element definition is running} flag.

Finally, if the first set of substeps threw an exception, then rethrow that exception (thus terminating this algorithm). Otherwise, continue onward.

15. Let \texttt{definition} be a new \texttt{custom element definition} with \texttt{name}, \texttt{local name}, \texttt{constructor}, \texttt{observed attributes}, \texttt{lifecycle callbacks lifecycleCallbacks}, \texttt{form-associated}, \texttt{disable internals}, \texttt{disable shadow}, and \texttt{disable shadow}.

16. Add \texttt{definition} to this \texttt{CustomElementRegistry}.

17. Let \texttt{document} be this \texttt{CustomElementRegistry's relevant global object}'s associated \texttt{Document}.

18. Let \texttt{upgrade candidates} be all elements that are shadow-including descendants of \texttt{document}, whose namespace is the HTML namespace and whose local name is \texttt{localName}, in shadow-including tree order. Additionally, if \texttt{extends} is non-null, only include elements whose \texttt{is value} is equal to \texttt{name}.

19. For each element \texttt{element} in \texttt{upgrade candidates}, enqueue a custom element upgrade reaction given \texttt{element} and \texttt{definition}.

20. If this \texttt{CustomElementRegistry's when-defined promise map} contains an entry with key \texttt{name}:

1. Let \texttt{promise} be the value of that entry.

2. Resolve \texttt{promise} with \texttt{constructor}.

3. Delete the entry with key \texttt{name} from this \texttt{CustomElementRegistry's when-defined promise map}.

When invoked, the \texttt{get(name)} method must run these steps:

1. If this \texttt{CustomElementRegistry} contains an entry with \texttt{name}, then return that entry's \texttt{constructor}.

2. Otherwise, return undefined.

The \texttt{getName(constructor)} method steps are:

1. If this \texttt{CustomElementRegistry} contains an entry with \texttt{constructor}, then return that entry's \texttt{name}.

2. Return null.

When invoked, the \texttt{whenDefined(name)} method must run these steps:

1. If \texttt{name} is not a valid custom element name, then return a promise rejected with a "SyntaxError" DOMException.

2. If this \texttt{CustomElementRegistry} contains an entry with \texttt{name} name, then return a promise resolved with that entry's \texttt{constructor}.

3. Let \texttt{map} be this \texttt{CustomElementRegistry's when-defined promise map}.

4. If \texttt{map} does not contain an entry with key \texttt{name}, create an entry in \texttt{map} with key \texttt{name} and whose value is a new promise.

5. Let \texttt{promise} be the value of the entry in \texttt{map} with key \texttt{name}.

6. Return \texttt{promise}.
When invoked, the `upgrade(root)` method must run these steps:

1. Let `candidates` be a list of all of `root`'s shadow-including inclusive descendant elements, in shadow-including tree order.
2. For each candidate of candidates, try to upgrade candidate.

Example

The `upgrade()` method allows upgrading of elements at will. Normally elements are automatically upgraded when they become connected, but this method can be used if you need to upgrade before you're ready to connect the element.

```javascript
const el = document.createElement("spider-man");

class SpiderMan extends HTMLElement {}
customElements.define("spider-man", SpiderMan);

console.assert(!(el instanceof SpiderMan)); // not yet upgraded

customElements.upgrade(el);
console.assert(el instanceof SpiderMan); // upgraded!
```

4.13.5 Upgrades

To upgrade an element, given as input a custom element definition definition and an element element, run the following steps:

1. If element's custom element state is not "undefined" or "uncustomized", then return.

Example

One scenario where this can occur due to reentrant invocation of this algorithm, as in the following example:

```html
<!DOCTYPE html>
<x-foo id="a"></x-foo>
<x-foo id="b"></x-foo>

<script>
// Defining enqueues upgrade reactions for both "a" and "b"
customElements.define("x-foo", class extends HTMLElement {
    constructor() {
        ...
    }
});
```

The `whenDefined()` method can be used to avoid performing an action until all appropriate custom elements are defined. In this example, we combine it with the `:defined` pseudo-class to hide a dynamically-loaded article's contents until we're sure that all of the autonomous custom elements it uses are defined.

```
articleContainer.hidden = true;
fetch(articleURL)
  .then(response => response.text())
  .then(text => {
    articleContainer.innerHTML = text;

    return Promise.all(
      [...articleContainer.querySelectorAll(":not(:defined)")]
        .map(el => customElements.whenDefined(el.localName))
    );
  })
  .then(() => {
    articleContainer.hidden = false;
  });
```

When invoked, the `upgrade(root)` method must run these steps:

1. Let `candidates` be a list of all of `root`'s shadow-including inclusive descendant elements, in shadow-including tree order.
2. For each candidate of candidates, try to upgrade candidate.
super();

const b = document.querySelector("#b");
b.remove();

// While this constructor is running for "a", "b" is still
// undefined, and so inserting it into the document will enqueue a
// second upgrade reaction for "b" in addition to the one enqueued
// by defining x-foo.
document.body.appendChild(b);
}
})
</script>

This step will thus bail out the algorithm early when upgrade an element is invoked with "b" a second time.

2. Set element's custom element definition to definition.
3. Set element's custom element state to "failed".
4. For each attribute in element's attribute list, in order, enqueue a custom element callback reaction with element, callback name "attributeChangedCallback", and an argument list containing attribute's local name, null, attribute's value, and attribute's namespace.
5. If element is connected, then enqueue a custom element callback reaction with element, callback name "connectedCallback", and an empty argument list.
6. Add element to the end of definition's construction stack.
7. Let C be definition's constructor.
8. Run the following substeps while catching any exceptions:
   1. If definition's disable shadow is true and element's shadow root is non-null, then throw a "NotSupportedError" DOMException.
      
      This is needed as attachShadow() does not use look up a custom element definition while attachInternals() does.

      Note

      If C non-conformantly uses an API decorated with the [CEReactions] extended attribute, then the reactions enqueued at the beginning of this algorithm will execute during this step, before C finishes and control returns to this algorithm. Otherwise, they will execute after C and the rest of the upgrade process finishes.

2. Set element's custom element state to "precustomized".
3. Let constructResult be the result of constructing C, with no arguments.

   Note

   This can occur if C constructs another instance of the same custom element before calling super(), or if C uses JavaScript's return-override feature to return an arbitrary HTMLElement object from the constructor.

4. If SameValue(constructResult, element) is false, then throw a TypeError.

Then, perform the following substep, regardless of whether the above steps threw an exception or not:

1. Remove the last entry from the end of definition's construction stack.
Finally, if the above steps threw an exception, then:

1. Set element's custom element definition to null.
2. Empty element's custom element reaction queue.
3. Rethrow the exception (thus terminating this algorithm).

9. If element is a form-associated custom element, then:
   1. Reset the form owner of element. If element is associated with a form element, then enqueue a custom element callback reaction with element, callback name "formAssociatedCallback", and « the associated form ».
   2. If element is disabled, then enqueue a custom element callback reaction with element, callback name "formDisabledCallback" and « true ».

10. Set element's custom element state to "custom".

To try to upgrade an element, given as input an element element, run the following steps:

1. Let definition be the result of looking up a custom element definition given element's node document, element's namespace, element's local name, and element's is value.
2. If definition is not null, then enqueue a custom element upgrade reaction given element and definition.

4.13.6 Custom element reactions

A custom element possesses the ability to respond to certain occurrences by running author code:

- When upgraded, its constructor is run, with no arguments.
- When it becomes connected, its connectedCallback is called, with no arguments.
- When it becomes disconnected, its disconnectedCallback is called, with no arguments.
- When it is adopted into a new document, its adoptedCallback is called, given the old document and new document as arguments.
- When any of its attributes are changed, appended, removed, or replaced, its attributeChangedCallback is called, given the attribute's local name, old value, new value, and namespace as arguments. (An attribute's old or new value is considered to be null when the attribute is added or removed, respectively.)
- When the user agent resets the form owner of a form-associated custom element and doing so changes the form owner, its formAssociatedCallback is called, given the new form owner (or null if no owner) as an argument.
- When the form owner of a form-associated custom element is reset, its formResetCallback is called.
- When the disabled state of a form-associated custom element is changed, its formDisabledCallback is called, given the new state as an argument.
- When user agent updates a form-associated custom element's value on behalf of a user or as part of navigation, its formStateRestoreCallback is called, given the new state and a string indicating a reason, "autocomplete" or "restore", as arguments.
We call these reactions collectively **custom element reactions**.

The way in which custom element reactions are invoked is done with special care, to avoid running author code during the middle of delicate operations. Effectively, they are delayed until “just before returning to user script”. This means that for most purposes they appear to execute synchronously, but in the case of complicated composite operations (like cloning, or range manipulation), they will instead be delayed until after all the relevant user agent processing steps have completed, and then run together as a batch.

Additionally, the precise ordering of these reactions is managed via a somewhat-complicated stack-of-queues system, described below. The intention behind this system is to guarantee that custom element reactions always are invoked in the same order as their triggering actions, at least within the local context of a single custom element. (Because custom element reaction code can perform its own mutations, it is not possible to give a global ordering guarantee across multiple elements.)

Each similar-origin window agent has a custom element reactions stack, which is initially empty. A similar-origin window agent’s current element queue is the element queue at the top of its custom element reactions stack. Each item in the stack is an element queue, which is initially empty as well. Each item in an element queue is an element. (The elements are not necessarily custom yet, since this queue is used for upgrades as well.)

Each custom element reactions stack has an associated backup element queue, which is an initially-empty element queue. Elements are pushed onto the backup element queue during operations that affect the DOM without going through an API decorated with \[CEReactions\], or through the parser’s `create an element for the token` algorithm. An example of this is a user-initiated editing operation which modifies the descendants or attributes of an editable element. To prevent reentrancy when processing the backup element queue, each custom element reactions stack also has a processing the backup element queue flag, initially unset.

All elements have an associated custom element reaction queue, initially empty. Each item in the custom element reaction queue is of one of two types:

- An upgrade reaction, which will upgrade the custom element and contains a custom element definition; or
- A callback reaction, which will call a lifecycle callback, and contains a callback function as well as a list of arguments.

This is all summarized in the following schematic diagram:

```
  custom element reactions stack
    ▶  element queue
        ▶ <x-a>  <x-b>  <x-c>  ⋯
          ▶
        ▶
          ▶
    ▼  backup element queue
      ▶ processing backup element queue flag
```

To enqueue an element on the appropriate element queue, given an element `element`, run the following steps:

1. Let reactionsStack be `element`'s relevant agent's custom element reactions stack.
2. If `reactionsStack` is empty, then:
   1. Add `element` to `reactionsStack`'s backup element queue.
   2. If `reactionsStack`'s processing the backup element queue flag is set, then return.
   3. Set `reactionsStack`'s processing the backup element queue flag.
   4. Queue a microtask to perform the following steps:
      1. Invoke custom element reactions in `reactionsStack`'s backup element queue.
      2. Unset `reactionsStack`'s processing the backup element queue flag.
   3. Otherwise, add `element` to `element`'s relevant agent's current element queue.

To enqueue a custom element callback reaction, given a custom element element, a callback name callbackName, and a list of arguments args, run the following steps:

1. Let definition be element's custom element definition.
2. Let callback be the value of the entry in definition's lifecycle callbacks with key callbackName.
3. If callback is null, then return.
4. If callbackName is "attributeChangedCallback", then:
   1. Let attributeName be the first element of args.
   2. If definition's observed attributes does not contain attributeName, then return.
5. Add a new callback reaction to element's custom element reaction queue, with callback function callback and arguments args.
6. Enqueue an element on the appropriate element queue given element.

To enqueue a custom element upgrade reaction, given an element element and custom element definition definition, run the following steps:

1. Add a new upgrade reaction to element's custom element reaction queue, with custom element definition.
2. Enqueue an element on the appropriate element queue given element.

To invoke custom element reactions in an element queue queue, run the following steps:

1. While queue is not empty:
   1. Let element be the result of dequeuing from queue.
   2. Let reactions be element's custom element reaction queue.
   3. Repeat until reactions is empty:
      1. Remove the first element of reactions, and let reaction be that element. Switch on reaction's type:
         1. upgrade reaction
            Upgrade element using reaction's custom element definition.
         2. callback reaction
            Invoke reaction's callback function with reaction's arguments, and with element as the callback this value.

      If this throws an exception, catch it, and report the exception.

To ensure custom element reactions are triggered appropriately, we introduce the [CEReactions] IDL extended attribute. It indicates that the relevant algorithm is to be supplemented with additional steps in order to appropriately track and invoke custom element reactions.
The `[CEReactions]` extended attribute must take no arguments, and must not appear on anything other than an operation, attribute, setter, or deleter. Additionally, it must not appear on readonly attributes.

Operations, attributes, setters, or deleters annotated with the `[CEReactions]` extended attribute must run the following steps in place of the ones specified in their description:

1. Push a new element queue onto this object's relevant agent's custom element reactions stack.
2. Run the originally-specified steps for this construct, catching any exceptions. If the steps return a value, let value be the returned value. If they throw an exception, let exception be the thrown exception.
3. Let queue be the result of popping from this object's relevant agent's custom element reactions stack.
4. Invoke custom element reactions in queue.
5. If an exception exception was thrown by the original steps, rethrow exception.
6. If a value value was returned from the original steps, return value.

Note
The intent behind this extended attribute is somewhat subtle. One way of accomplishing its goals would be to say that every operation, attribute, setter, and deleter on the platform must have these steps inserted, and to allow implementers to optimize away unnecessary cases (where no DOM mutation is possible that could cause custom element reactions to occur).

However, in practice this imprecision could lead to non-interoperable implementations of custom element reactions, as some implementations might forget to invoke these steps in some cases. Instead, we settled on the approach of explicitly annotating all relevant IDL constructs, as a way of ensuring interoperable behavior and helping implementations easily pinpoint all cases where these steps are necessary.

Any nonstandard APIs introduced by the user agent that could modify the DOM in such a way as to cause enqueuing a custom element callback reaction or enqueuing a custom element upgrade reaction, for example by modifying any attributes or child elements, must also be decorated with the `[CEReactions]` attribute.

Note
As of the time of this writing, the following nonstandard or not-yet-standardized APIs are known to fall into this category:

- `HTMLInputElement`'s `webkitdirectory` and `incremental` IDL attributes
- `HTMLLinkElement`'s `scope` IDL attribute

4.13.7 Element internals

Certain capabilities are meant to be available to a custom element author, but not to a custom element consumer. These are provided by the `element.attachInternals()` method, which returns an instance of `ElementInternals`. The properties and methods of `ElementInternals` allow control over internal features which the user agent provides to all elements.

For web developers (non-normative)

`element.attachInternals()` Returns an `ElementInternals` object targeting the custom element element. Throws an exception if element is not a custom element, if the "internals" feature was disabled as part of the element definition, or if it is called twice on the same element.

Each `HTMLElement` has an attached internals (null or an `ElementInternals` object), initially null.

The `attachInternals()` method steps are:

1. If this's `is value` is not null, then throw a "NotSupportedError" DOMException.
2. Let definition be the result of looking up a custom element definition given this's node document, its namespace, its local name, and null as the `is value`.
3. If `definition` is null, then throw an "UnsupportedError" `DOMException`.

4. If `definition`'s `disable internals` is true, then throw a "UnsupportedError" `DOMException`.

5. If this's `attached internals` is non-null, then throw an "UnsupportedError" `DOMException`.

6. If this's custom element state is not "precustomized" or "custom", then throw a "UnsupportedError" `DOMException`.

7. Set this's `attached internals` to a new `ElementInternals` instance whose `target element` is this.

8. Return this's `attached internals`.

4.13.7.1 The `ElementInternals` interface

The IDL for the `ElementInternals` interface is as follows, with the various operations and attributes defined in the following sections:

```idl
[Exposed=Window]
interface ElementInternals {
    // Shadow root access
    readonly attribute ShadowRoot? shadowRoot;

    // Form-associated custom elements
    undefined setFormValue((File or USVString or FormData)? value,
                          optional (File or USVString or FormData)? state);

    readonly attribute HTMLFormElement? form;

    undefined setValidity(optional ValidityStateFlags flags = {},
                          optional DOMString message,
                          optional HTMLElement anchor);

    readonly attribute boolean willValidate;
    readonly attribute ValidityState validity;
    readonly attribute DOMString validationMessage;
    boolean checkValidity();
    boolean reportValidity();

    readonly attribute NodeList labels;

    // Custom state pseudo-class
    [SameObject] readonly attribute CustomStateSet states;
};

// Accessibility semantics
ElementInternals includes ARIAMixin;

dictionary ValidityStateFlags {
    boolean valueMissing = false;
    boolean typeMismatch = false;
    boolean patternMismatch = false;
    boolean tooLong = false;
    boolean tooShort = false;
    boolean rangeUnderflow = false;
    boolean rangeOverflow = false;
    boolean stepMismatch = false;
    boolean badInput = false;
    boolean customError = false;
};
```

Each `ElementInternals` has a target element, which is a custom element.
The shadowRoot getter steps are:

1. Let target be this's target element.
2. If target is not a shadow host, then return null.
3. Let shadow be target's shadow root.
4. If shadow's available to element internals is false, then return null.
5. Return shadow.

Each form-associated custom element has submission value. It is used to provide one or more entries on form submission. The initial value of submission value is null, and submission value can be null, a string, a File, or a list of entries.

For web developers (non-normative)

`internals.shadowRoot` returns the ShadowRoot for internals's target element, if the target element is a shadow host, or null otherwise.

The shadowRoot getter steps are:

1. Let target be this's target element.
2. If target is not a shadow host, then return null.
3. Let shadow be target's shadow root.
4. If shadow's available to element internals is false, then return null.
5. Return shadow.

For web developers (non-normative)

`internals.setFormValue(value)` sets both the state and submission value of internals's target element to value. If value is null, the element won't participate in form submission.

`internals.setFormValue(value, state)` sets the submission value of internals's target element to value, and its state to state. If value is null, the element won't participate in form submission.

`internals.form()` returns the form owner of internals's target element.

`internals.setValidity(flags, message [, anchor])` marks internals's target element as suffering from the constraints indicated by the flags argument, and sets the element's validation message to message. If anchor is specified, the user agent might use it to indicate problems with the constraints of internals's target element when the form owner is validated interactively or `reportValidity()` is called.

`internals.setValidity({})` marks internals's target element as satisfying its constraints.

`internals.willValidate()` returns true if internals's target element will be validated when the form is submitted; false otherwise.

`internals.validity()` returns the ValidityState object for internals's target element.

`internals.validationMessage()` returns the error message that would be shown to the user if internals's target element was to be checked for validity.

`valid = internals.checkValidity()` returns true if internals's target element has no validity problems; false otherwise. Fires an invalid event at the element in the latter case.

`valid = internals.reportValidity()` returns true if internals's target element has no validity problems; otherwise, returns false, fires an invalid event at the element, and (if the event isn't canceled) reports the problem to the user.

`internals.labels()` returns a NodeList of all the label elements that internals's target element is associated with.

Each form-associated custom element has submission value. It is used to provide one or more entries on form submission. The initial value of submission value is null, and submission value can be null, a string, a File, or a list of entries.
Each form-associated custom element\(^{755}\) has state. It is information with which the user agent can restore a user's input for the element. The initial value of state\(^{756}\) is null, and state\(^{756}\) can be null, a string, a File, or a list of entries\(^{967}\).

The `setFormValue()`\(^{976}\) method is used by the custom element author to set the element’s submission value\(^{767}\) and state\(^{768}\), thus communicating these to the user agent.

When the user agent believes it is a good idea to restore a form-associated custom element\(^{755}\)’s state\(^{756}\), for example after navigation\(^{1044}\) or restarting the user agent, they may enqueue a custom element callback reaction\(^{764}\) with that element, callback name “formStateRestoreCallback”, an argument list containing the state to be restored, and "restore".

If the user agent has a form-filling assist feature, then when the feature is invoked, it may enqueue a custom element callback reaction\(^{764}\) with a form-associated custom element\(^{755}\), callback name "formStateRestoreCallback", an argument list containing the state value determined by history of state value and some heuristics, and "autocomplete".

In general, the state\(^{768}\) is information specified by a user, and the submission value\(^{767}\) is a value after canonicalization or sanitization, suitable for submission to the server. The following examples makes this concrete:

**Example**

Suppose that we have a form-associated custom element\(^{755}\) which asks a user to specify a date. The user specifies "3/15/2019", but the control wishes to submit "2019-03-15" to the server. "3/15/2019" would be a state\(^{768}\) of the element, and "2019-03-15" would be a submission value\(^{767}\).

**Example**

Suppose you develop a custom element emulating the behavior of the existing checkbox\(^{653}\) input\(^{917}\) type. Its submission value\(^{768}\) would be the value of its value content attribute, or the string "on". Its state\(^{768}\) would be one of "checked", "unchecked", "checked/indeterminate", or "unchecked/indeterminate".

The `setFormValue(value, state)` method steps are:

1. Let element be this’s target element\(^{776}\).
2. If element is not a form-associated custom element\(^{755}\), then throw a "NotSupportedError" DOMException.
3. Set target element\(^{776}\)’s submission value\(^{767}\) to value if value is not a FormData object, or to a clone of value’s entry list otherwise.
4. If the state argument of the function is omitted, set element’s state\(^{768}\) to its submission value\(^{767}\).
5. Otherwise, if state is a FormData object, set element’s state\(^{768}\) to a clone of state’s entry list.
6. Otherwise, set element’s state\(^{768}\) to state.

Each form-associated custom element\(^{755}\) has validity flags named valueMissing, typeMismatch, patternMismatch, tooLong, tooShort, rangeUnderflow, rangeOverflow, stepMismatch, and customError. They are false initially.

Each form-associated custom element\(^{755}\) has a validation message string. It is the empty string initially.

Each form-associated custom element\(^{755}\) has a validation anchor element. It is null initially.

The `setValidity(flags, message, anchor)` method steps are:

1. Let element be this’s target element\(^{776}\).
2. If element is not a form-associated custom element\(^{755}\), then throw a "NotSupportedError" DOMException.
3. If flags contains one or more true values and message is not given or is the empty string, then throw a TypeError.
4. For each entry flag → value of flags, set element’s validity flag with the name flag to value.
5. Set element’s validation message\(^{768}\) to the empty string if message is not given or all of element’s validity flags are false, or to message otherwise.
6. If element’s customError validity flag is true, then set element’s custom validity error message\(^{961}\) to element’s validation message\(^{768}\). Otherwise, set element’s custom validity error message\(^{961}\) to the empty string.
7. Set element's validation anchor\(^{768}\) to null if anchor is not given. Otherwise, if anchor is not a shadow-including descendant of element, then throw a "NotFoundError" DOMException. Otherwise, set element's validation anchor\(^{768}\) to anchor.

The validationMessage getter steps are:

1. Let element be this's target element\(^{766}\).
2. If element is not a form-associated custom element\(^{755}\), then throw a "NotFoundError" DOMException.
3. Return element's validation message\(^{768}\).

The entry construction algorithm for a form-associated custom element\(^{755}\), given an element element and an entry list\(^{627}\) entry list, consists of the following steps:

1. If element's submission value\(^{767}\) is a list of entries\(^{627}\), then append each item of element's submission value\(^{767}\) to entry list, and return.

   In this case, user agent does not refer to the name\(^{595}\) content attribute value. An implementation of form-associated custom element\(^{755}\) is responsible to decide names of entries\(^{627}\). They can be the name\(^{595}\) content attribute value, they can be strings based on the name\(^{595}\) content attribute value, or they can be unrelated to the name\(^{595}\) content attribute.

2. If the element does not have a name\(^{595}\) attribute specified, or its name\(^{595}\) attribute's value is the empty string, then return.
3. If the element's submission value\(^{767}\) is not null, create an entry\(^{627}\) with the name\(^{595}\) attribute value and the submission value\(^{767}\), and append it to entry list.

4.13.7.4 Accessibility semantics \(^{76}\)

For web developers (non-normative)

```javascript
internals.role\(^{67}\) [ = value ]
Sets or retrieves the default ARIA role for internals's target element\(^{766}\), which will be used unless the page author overrides it using the role\(^{67}\) attribute.
```

```javascript
internals.aria*\(^{67}\) [ = value ]
Sets or retrieves various default ARIA states or property values for internals's target element\(^{766}\), which will be used unless the page author overrides them using the aria-*\(^{67}\) attributes.
```

Each custom element\(^{754}\) has an internal content attribute map, which is a map, initially empty. See the Requirements related to ARIA and to platform accessibility APIs\(^{913}\) section for information on how this impacts platform accessibility APIs.

4.13.7.5 Custom state pseudo-class \(^{76}\)

For web developers (non-normative)

```javascript
internals.states\(^{77}\) .add(value)
 Adds the string value to the element's states set\(^{770}\) to be exposed as a pseudo-class.
```

```javascript
internals.states\(^{77}\) .has(value)
 Returns true if value is in the element's states set\(^{770}\), otherwise false.
```

```javascript
internals.states\(^{77}\) .delete(value)
 If the element's states set\(^{770}\) has value, then it will be removed and true will be returned. Otherwise, false will be returned.
```

```javascript
internals.states\(^{77}\) .clear()
 Removes all values from the element's states set\(^{770}\).
```
for (const stateName of internals.states)
for (const stateName of internals.states.entries())
for (const stateName of internals.states.keys())
for (const stateName of internals.states.values())
      iterates over all values in the element's states set.

ids.states.forEach(callback)
      iterates over all values in the element's states set by calling callback once for each value.

ids.states.size
      Returns the number of values in the element's states set.

Each custom element has a states set, which is a CustomStateSet, initially empty.

IDL
[Exposed=Window]
interface CustomStateSet {
   setlike<DOMString>;
};

The states getter steps are to return this's target element's states set.

Example
The states set can expose boolean states represented by existence/non-existence of string values. If an author wants to expose a state which can have three values, it can be converted to three exclusive boolean states. For example, a state called readyState with "loading", "interactive", and "complete" values can be mapped to three exclusive boolean states, "loading", "interactive", and "complete":

```
// Change the readyState from anything to "complete".
this._readyState = "complete";
this._internals.states.delete("loading");
this._internals.states.delete("interactive");
this._internals.states.add("complete");
```

4.14 Common idioms without dedicated elements

4.14.1 Breadcrumb navigation

This specification does not provide a machine-readable way of describing breadcrumb navigation menus. Authors are encouraged to just use a series of links in a paragraph. The nav element can be used to mark the section containing these paragraphs as being navigation blocks.

Example
In the following example, the current page can be reached via two paths.

```html
<nv>
  <p>
    <a href="/">Main</a> ▼
    <a href="/products/">Products</a> ▼
    <a href="/products/dishwashers/">Dishwashers</a> ▼
  </p>
  <a>Second hand</a>
</p>
  <p>
    <a href="/">Main</a> ▼
    <a href="/second-hand/">Second hand</a> ▼
  </p>
  <a>Dishwashers</a>
```
This specification does not define any markup specifically for marking up lists of keywords that apply to a group of pages (also known as tag clouds). In general, authors are encouraged to either mark up such lists using `ul` elements with explicit inline counts that are then hidden and turned into a presentational effect using a style sheet, or to use SVG.

**Example**

Here, three tags are included in a short tag cloud:

```html
<style>
.tag-cloud > li > span { display: none; }
.tag-cloud > li { display: inline; }
.tag-cloud-1 { font-size: 0.7em; }
.tag-cloud-2 { font-size: 0.9em; }
.tag-cloud-3 { font-size: 1.1em; }
.tag-cloud-4 { font-size: 1.3em; }
.tag-cloud-5 { font-size: 1.5em; }
@media speech {
  .tag-cloud > li > span { display:inline }
}
</style>
...
<ul class="tag-cloud">
  <li class="tag-cloud-4"><a title="28 instances" href="/t/apple">apple</a> <span>(popular)</span></li>
  <li class="tag-cloud-2"><a title="6 instances" href="/t/kiwi">kiwi</a> <span>(rare)</span></li>
  <li class="tag-cloud-5"><a title="41 instances" href="/t/pear">pear</a> <span>(very popular)</span></li>
</ul>
```

The actual frequency of each tag is given using the `title` attribute. A CSS style sheet is provided to convert the markup into a cloud of differently-sized words, but for user agents that do not support CSS or are not visual, the markup contains annotations like "(popular)" or "(rare)" to categorize the various tags by frequency, thus enabling all users to benefit from the information.

The `ul` element is used (rather than `ol`) because the order is not particularly important: while the list is in fact ordered alphabetically, it would convey the same information if ordered by, say, the length of the tag.

The `tag`-keyword is not used on these `a` elements because they do not represent tags that apply to the page itself; they are just part of an index listing the tags themselves.

---

### 4.14.2 Tag clouds

This specification does not define any markup specifically for marking up lists of keywords that apply to a group of pages (also known as tag clouds). In general, authors are encouraged to either mark up such lists using `ul` elements with explicit inline counts that are then hidden and turned into a presentational effect using a style sheet, or to use SVG.

**Example**

Here, three tags are included in a short tag cloud:

```html
<style>
.tag-cloud > li > span { display: none; }
.tag-cloud > li { display: inline; }
.tag-cloud-1 { font-size: 0.7em; }
.tag-cloud-2 { font-size: 0.9em; }
.tag-cloud-3 { font-size: 1.1em; }
.tag-cloud-4 { font-size: 1.3em; }
.tag-cloud-5 { font-size: 1.5em; }
@media speech {
  .tag-cloud > li > span { display:inline }
}
</style>
...
<ul class="tag-cloud">
  <li class="tag-cloud-4"><a title="28 instances" href="/t/apple">apple</a> <span>(popular)</span></li>
  <li class="tag-cloud-2"><a title="6 instances" href="/t/kiwi">kiwi</a> <span>(rare)</span></li>
  <li class="tag-cloud-5"><a title="41 instances" href="/t/pear">pear</a> <span>(very popular)</span></li>
</ul>
```

The actual frequency of each tag is given using the `title` attribute. A CSS style sheet is provided to convert the markup into a cloud of differently-sized words, but for user agents that do not support CSS or are not visual, the markup contains annotations like "(popular)" or "(rare)" to categorize the various tags by frequency, thus enabling all users to benefit from the information.

The `ul` element is used (rather than `ol`) because the order is not particularly important: while the list is in fact ordered alphabetically, it would convey the same information if ordered by, say, the length of the tag.

The `tag`-keyword is not used on these `a` elements because they do not represent tags that apply to the page itself; they are just part of an index listing the tags themselves.

---

### 4.14.3 Conversations

This specification does not define a specific element for marking up conversations, meeting minutes, chat transcripts, dialogues in screenplays, instant message logs, and other situations where different players take turns in discourse.

Instead, authors are encouraged to mark up conversations using `p` elements and punctuation. Authors who need to mark the speaker for styling purposes are encouraged to use `span` or `b`. Paragraphs with their text wrapped in the `i` element can be used for marking up stage directions.

**Example**

This example demonstrates this using an extract from Abbot and Costello’s famous sketch, *Who’s on first*: 

```html

```
Costello: Look, you gotta first baseman?
Abbott: Certainly.
Costello: Who's playing first?
Abbott: That's right.
Costello becomes exasperated.
Costello: When you pay off the first baseman every month, who gets the money?
Abbott: Every dollar of it.

The following extract shows how an IM conversation log could be marked up, using the data element to provide Unix timestamps for each line. Note that the timestamps are provided in a format that the time element does not support, so the data element is used instead (namely, Unix time_t timestamps). Had the author wished to mark up the data using one of the date and time formats supported by the time element, that element could have been used instead of data. This could be advantageous as it would allow data analysis tools to detect the timestamps unambiguously, without coordination with the page author.

I'm not that nerdy, I've only seen 30% of the star trek episodes
if you know what percentage of the star trek episodes you have seen, you are inarguably nerdy
it's unarguably
it's unarguably
you are not helping your case

Next, you meet a fisher. You can say one of several greetings:
She responds with "Hello, how may I help you?"; you can respond with:
She sells you a fish and the conversation finishes.
"Can I borrow your boat?"
She lends you her boat. The conversation ends.
"A fish." (if you have one)
"A newspaper." (if you have one)
"A pebble." (if you have one)
"No thanks", she replies. Your conversation options at this point are the same as they were after asking to borrow her boat, minus any options you've suggested before.
"Vote for me in the next election!"
She turns away. The conversation finishes.
"Madam, are you aware that your fish are running away?"

She looks at you skeptically and says "Fish cannot run, miss".

"You got me!"

The fisher sighs and the conversation ends.

"Only kidding."

"Good one!" she retorts. Your conversation options at this point are the same as those following "Hello there!" above.

"Oh, then what are they doing?"

She looks at her fish, giving you an opportunity to steal her boat, which you do. The conversation ends.

"Only kidding."

"Good one!" she retorts.

In some games, conversations are simpler: each character merely has a fixed set of lines that they say. In this example, a game FAQ/walkthrough lists some of the known possible responses for each character:

Example

In some games, conversations are simpler: each character merely has a fixed set of lines that they say. In this example, a game FAQ/walkthrough lists some of the known possible responses for each character:

Dialogue

Some characters repeat their lines in order each time you interact with them, others randomly pick from amongst their lines. Those who respond in order have numbered entries in the lists below.

The Shopkeeper

How may I help you?
Fresh apples!
A loaf of bread for madam?

The pilot

Before the accident:
I'm about to fly out, sorry!
Sorry, I'm just waiting for flight clearance and then I'll be off!

After the accident:
I'm about to fly out, sorry!
Ok, I'm not leaving right now, my plane is being cleaned.
Ok, it's not being cleaned, it needs a minor repair first.
Ok, ok, stop bothering me! Truth is, I had a crash.

Clan Leader

During the first clan meeting:
Hey, have you seen my daughter? I bet she's up to something nefarious again...
Nice weather we're having today, eh?
The name is Bailey, Jeff Bailey. How can I help you today?
A glass of water? Fresh from the well!

After the earthquake:
Everyone is safe in the shelter, we just have to put out the fire!
I'll go and tell the fire brigade, you keep hosing it down!
4.14.4 Footnotes

HTML does not have a dedicated mechanism for marking up footnotes. Here are the suggested alternatives.

For short inline annotations, the `title` attribute could be used.

**Example**

In this example, two parts of a dialogue are annotated with footnote-like content using the `title` attribute.

```html
<p><b>Customer</b>: Hello! I wish to register a complaint. Hello. Miss?</p>
<p><b>Shopkeeper</b>: <span title="Colloquial pronunciation of 'What do you'">Watcha</span> mean, miss?</p>
<p><b>Customer</b>: Uh, I'm sorry, I have a cold. I wish to make a complaint.</p>
<p><b>Shopkeeper</b>: Sorry, <span title="This is, of course, a lie.">we're closing for lunch</span>.</p>
```

**Note**

Unfortunately, relying on the `title` attribute is currently discouraged as many user agents do not expose the attribute in an accessible manner as required by this specification (e.g. requiring a pointing device such as a mouse to cause a tooltip to appear, which excludes keyboard-only users and touch-only users, such as anyone with a modern phone or tablet).

**Note**

If the `title` attribute is used, CSS can be used to draw the reader's attention to the elements with the attribute.

**Example**

For example, the following CSS places a dashed line below elements that have a `title` attribute.

```css
[title] { border-bottom: thin dashed; }
```

For longer annotations, the `a` element should be used, pointing to an element later in the document. The convention is that the contents of the link be a number in square brackets.

**Example**

In this example, a footnote in the dialogue links to a paragraph below the dialogue. The paragraph then reciprocally links back to the dialogue, allowing the user to return to the location of the footnote.

```html
<p>Announcer: Number 16: The <i>hand</i>.</p>
<p>Interviewer: Good evening. I have with me in the studio tonight Mr Norman John Polevaulter, who for the past few years has been contradicting people. Mr Polevaulter, why <em>do</em> you contradict people?</p>
<p>Norman: I don't. <sup><a href="#fn1" id="r1">[1]</a></sup></p>
<p>Interviewer: You told me you did! ...</p>
<section><p id="fn1"><a href="#r1">[1]</a> This is, naturally, a lie, but paradoxically if it were true he could not say so without contradicting the interviewer and thus making it false.</p></section>
```

For side notes, longer annotations that apply to entire sections of the text rather than just specific words or sentences, the `aside` element should be used.
For figures or tables, footnotes can be included in the relevant `figcaption` element, or in surrounding prose.

Example

In this example, a table has cells with footnotes that are given in prose. A `figure` element is used to give a single legend to the combination of the table and its footnotes.

```html
<figure>
<figcaption>Table 1. Alternative activities for knights.</figcaption>
<table>
<tr>
<th>Activity</th>
<th>Location</th>
<th>Cost</th>
</tr>
<tr>
<td>Dance</td>
<td>Wherever possible</td>
<td><sup>1</sup><a href="#fn1">£0</a></td>
</tr>
<tr>
<td>Routines, chorus scenes</td>
<td>Undisclosed</td>
<td><a href="#fn2">2</a></td>
</tr>
<tr>
<td>Dining</td>
<td>Camelot</td>
<td><sup>3</sup><a href="#fn3">Cost of ham, jam, and spam</a></td>
</tr>
</table>
<p id="fn1">1. Assumed.</p>
<p id="fn2">2. Footwork impeccable.</p>
<p id="fn3">3. Quality described as "well".</p>
<p id="fn4">4. A lot.</p>
</figure>
```

### 4.15 Disabled elements

An element is said to be **actually disabled** if it is one of the following:

- a `button` element that is `disabled`
- an `input` element that is `disabled`
- a `select` element that is `disabled`
- a `textarea` element that is `disabled`
• an `<optgroup>` element that has a `disabled` attribute
• an `<option>` element that is `disabled`
• a `<fieldset>` element that is `disabled`
• a form-associated custom element that is `disabled`

**Note**

This definition is used to determine what elements are `focusable` and which elements match the `:enabled` and `:disabled` pseudo classes.

### 4.16 Matching HTML elements using selectors and CSS

#### 4.16.1 Case-sensitivity of the CSS `attr()` function

CSS Values and Units leaves the case-sensitivity of attribute names for the purpose of the `attr()` function to be defined by the host language. [CSSVALUES]

When comparing the attribute name part of a CSS `attr()` function to the names of namespace-less attributes on HTML elements in HTML documents, the name part of the CSS `attr()` function must first be converted to ASCII lowercase. The same function when compared to other attributes must be compared according to its original case. In both cases, to match the values must be identical to each other (and therefore the comparison is case sensitive).

**Note**

This is the same as comparing the name part of a CSS attribute selector, specified in the next section.

#### 4.16.2 Case-sensitivity of selectors

Selectors leaves the case-sensitivity of element names, attribute names, and attribute values to be defined by the host language. [SELECTORS]

When comparing a CSS element type selector to the names of HTML elements in HTML documents, the CSS element type selector must first be converted to ASCII lowercase. The same selector when compared to other elements must be compared according to its original case. In both cases, to match the values must be identical to each other (and therefore the comparison is case sensitive).

When comparing the name part of a CSS attribute selector to the names of attributes on HTML elements in HTML documents, the name part of the CSS attribute selector must first be converted to ASCII lowercase. The same selector when compared to other attributes must be compared according to its original case. In both cases, the comparison is case-sensitive.

Attribute selectors on an HTML element in an HTML document must treat the values of attributes with the following names as ASCII case-insensitive:

- accept
- accept-charset
- align
- alink
- axis
- bgcolor
- charset
- checked
- clear
- codetype
- color
- compact
- declare
- defer
- dir
- direction
- disabled
- enctype
- face
- frame
• hreflang
• http-equiv
• lang
• language
• link
• media
• method
• multiple
• nohref
• noresize
• noshade
• nowrap
• readonly
• rel
• rev
• rules
• scope
• scrolling
• selected
• shape
• target
• text
• type
• valign
• valuetype
• vlink

Example
For example, the selector `[bgcolor="#ffffff"]` will match any HTML element with a `bgcolor` attribute with values including `#ffffff`, `#FFFFFF` and `#ffffff`. This happens even if `bgcolor` has no effect for a given element (e.g., `div`).

The selector `[type=a s]` will match any HTML element with a `type` attribute whose value is `a`, but not whose value is `A`, due to the `s` flag.

All other attribute values and everything else must be treated as entirely identical to each other for the purposes of selector matching. This includes:

- IDs and classes in no-quirks mode and limited-quirks mode
- the names of elements not in the HTML namespace
- the names of HTML elements in XML documents
- the names of attributes of elements not in the HTML namespace
- the names of attributes of HTML elements in XML documents
- the names of attributes that themselves have namespaces

Note
Selectors defines that ID and class selectors (such as `#foo` and `.bar`), when matched against elements in documents that are in quirks mode, will be matched in an ASCII case-insensitive manner. However, this does not apply for attribute selectors with "id" or "class" as the name part. The selector `[class="foobar"]` will treat its value as case-sensitive even in quirks mode.

4.16.3 Pseudo-classes

There are a number of dynamic selectors that can be used with HTML. This section defines when these selectors match HTML elements. [SELECTIONS][1][CSSUI][2][3][4][5]

:defined
The :defined pseudo-class must match any element that is defined.

:link :visited
All a elements that have an `href` attribute, and all area elements that have an `href` attribute, must match one of :link and :visited.
Other specifications might apply more specific rules regarding how these elements are to match these pseudo-classes, to mitigate some privacy concerns that apply with straightforward implementations of this requirement.

**:active**

The **:active** pseudo-class is defined to match an element “while an element is being activated by the user”.

To determine whether a particular element is being activated for the purposes of defining the **:active** pseudo-class only, an HTML user agent must use the first relevant entry in the following list.

- If the element is a button element
- If the element is an input element whose type attribute is in the Submit Button, Image Button, Reset Button, or Button state
- If the element is an a element that has an href attribute
- If the element is an area element that has an href attribute
- If the element is focusable

The element is being activated if it is in a formal activation state.

An element is said to be in a formal activation state between the time the user begins to indicate an intent to trigger the element's activation behavior and either the time the user stops indicating an intent to trigger the element's activation behavior, or the time the element's activation behavior has finished running, which ever comes first.

An element is said to be being actively pointed at while the user indicates the element using a pointing device while that pointing device is in the “down” state (e.g. for a mouse, between the time the mouse button is pressed and the time it is depressed; for a finger in a multitouch environment, while the finger is touching the display surface).

**Example**

For example, if the user is using a keyboard to push a button element by pressing the space bar, the element would match this pseudo-class in between the time that the element received the keydown event and the time the element received the keyup event.

If the element is being actively pointed at

The element is being activated.

An element is said to be in a formal activation state between the time the user begins to indicate an intent to trigger the element's activation behavior and either the time the user stops indicating an intent to trigger the element's activation behavior, or the time the element's activation behavior has finished running, which ever comes first.

An element is said to be being actively pointed at while the user indicates the element using a pointing device while that pointing device is in the "down" state (e.g. for a mouse, between the time the mouse button is pressed and the time it is depressed; for a finger in a multitouch environment, while the finger is touching the display surface).

**Note**

Per the definition in Selectors, **:active** also matches flat tree ancestors of elements that are being activated.

**:hover**

The **:hover** pseudo-class is defined to match an element “while the user designates an element with a pointing device”. For the purposes of defining the **:hover** pseudo-class only, an HTML user agent must consider an element as being one that the user designates if it is an element that the user indicates using a pointing device.

Additionally, any element that is the labeled control of a label element that is currently matching **:active**, also matches **:active**. (But, it does not count as being being activated.)

**Note**

Per the definition in Selectors, **:hover** also matches flat tree ancestors of elements that are designated.

Additionally, any element that is the labeled control of a label element that is currently matching **:hover**, also matches **:hover**. (But, it does not count as being designated.)

**Example**

Consider in particular a fragment such as:

```html
<p> <label for=c> <input id=a> </label> <input id=b> <input id=c> </span> </p>
```

If the user designates the element with ID "a" with their pointing device, then the p element (and all its ancestors not shown in the snippet above), the label element, the element with ID "a", and the element with ID "c" will match the **:hover**
For the purposes of the CSS :focus pseudo-class, an element has the focus when:

- it is not itself a navigable container; and
- any of the following are true:
  - it is one of the elements listed in the current focus chain of the top-level traversable; or
  - its shadow root is not null and shadowRoot is the root of at least one element that has the focus.

:target

For the purposes of the CSS :target pseudo-class, the Document's target elements are a list containing the Document's target element, if it is not null, or containing no elements, if it is.

:popover-open

The :popover-open pseudo-class is defined to match any HTML element whose popover attribute is not in the no popover state and whose popover visibility state is showing.

:enabled

The :enabled pseudo-class must match any button, input, select, textarea, optgroup, option, fieldset element, or form-associated custom element that is not actually disabled.

:disabled

The :disabled pseudo-class must match any element that is actually disabled.

:checked

The :checked pseudo-class must match any element falling into one of the following categories:

- input elements whose type attribute is in the Checkbox state and whose checked state is true
- input elements whose type attribute is in the Radio Button state and whose checked state is true
- option elements whose selected state is true

:indeterminate

The :indeterminate pseudo-class must match any element falling into one of the following categories:

- input elements whose type attribute is in the Checkbox state and whose indeterminate IDL attribute is set to true
- input elements whose type attribute is in the Radio Button state and whose radio button group contains no input elements whose checked state is true.
- progress elements with no value content attribute

:default

The :default pseudo-class must match any element falling into one of the following categories:

- Submit buttons that are default buttons of their form owner.
- input elements to which the checked attribute applies and that have a checked attribute
- option elements that have a selected attribute

:placeholder-shown

The :placeholder-shown pseudo-class must match any element falling into one of the following categories:
• **input** elements that have a **placeholder** attribute whose value is currently being presented to the user

• **textarea** elements that have a **placeholder** attribute whose value is currently being presented to the user

:valid
The **:valid** pseudo-class must match any element falling into one of the following categories:

• elements that are **candidates for constraint validation** and that **satisfy their constraints**

• **form** elements that are not the **form owner** of any elements that themselves are **candidates for constraint validation** but do not **satisfy their constraints**

• **fieldset** elements that have no descendant elements that themselves are **candidates for constraint validation** but do not **satisfy their constraints**

:invalid
The **:invalid** pseudo-class must match any element falling into one of the following categories:

• elements that are **candidates for constraint validation** but that do not **satisfy their constraints**

• **form** elements that are the **form owner** of one or more elements that themselves are **candidates for constraint validation** but do not **satisfy their constraints**

• **fieldset** elements that have of one or more descendant elements that themselves are **candidates for constraint validation** but do not **satisfy their constraints**

:valid
The **:valid** pseudo-class must match input, textarea, and select elements whose **user validity** is true, are **candidates for constraint validation**, and that **satisfy their constraints**.

:invalid
The **:invalid** pseudo-class must match input, textarea, and select elements whose **user validity** is true, are **candidates for constraint validation**, but do not **satisfy their constraints**.

:required
The **:required** pseudo-class must match any element falling into one of the following categories:

• **input** elements that are **required**

• **select** elements that have a **required** attribute

• **textarea** elements that have a **required** attribute

:optional
The **:optional** pseudo-class must match any element falling into one of the following categories:

• **input** elements to which the **required** attribute applies that are not **required**

• **select** elements that do not have a **required** attribute

• **textarea** elements that do not have a **required** attribute

:autofill
```
:autofill
```
```css
:-webkit-autofill
```
```
The **:autofill** and **:-webkit-autofill** pseudo-classes must match input elements which have been autofilled by user agent. These pseudo-classes must stop matching if the user edits the autofilled field.
The :read-only pseudo-class must match any element falling into one of the following categories, which for the purposes of Selectors are thus considered user-alterable: [SELECTORS]

- `input` elements to which the `readonly` attribute applies, and that are not mutable (i.e. that do not have the `readonly` attribute specified and that are not disabled)
- `textarea` elements that do not have a `readonly` attribute, and that are not disabled
- elements that are editing hosts or editable and are neither `input` elements nor `textarea` elements

The :read-only pseudo-class must match all other HTML elements.

The :modal pseudo-class must match any element falling into one of the following categories:

- `dialog` elements whose `is modal` flag is true
- elements whose `fullscreen flag` is true

The :dir(ltr) pseudo-class must match all elements whose `directionality` is 'ltr'.

The :dir(rtl) pseudo-class must match all elements whose `directionality` is 'rtl'.

Custom state pseudo-class

The :state(identifier) pseudo-class must match all `custom element`'s whose `states set`'s `set entries` contains `identifier`.

The :playing pseudo-class must match all `media elements` whose `paused` attribute is false.

The :paused pseudo-class must match all `media elements` whose `paused` attribute is true.

The :seeking pseudo-class must match all `media elements` whose `seeking` attribute is true.

The buffering pseudo-class must match all `media elements` whose `paused` attribute is false, `networkState` attribute is `NETWORK_LOADING`, and ready state is `HAVE_CURRENT_DATA` or less.

The :stalled pseudo-class must match all `media elements` that match the :buffering pseudo-class and whose `is currently stalled` is true.

The :muted pseudo-class must match all `media elements` that are muted.

The :volume-locked pseudo-class must match all `media elements` when the user agent's `volume locked` is true.

Note

This specification does not define when an element matches the :lang() dynamic pseudo-class, as it is defined in sufficient detail in a language-agnostic fashion in Selectors. [SELECTORS]
5 Microdata

5.1 Introduction

5.1.1 Overview

This section is non-normative.

Sometimes, it is desirable to annotate content with specific machine-readable labels, e.g. to allow generic scripts to provide services that are customized to the page, or to enable content from a variety of cooperating authors to be processed by a single script in a consistent manner.

For this purpose, authors can use the microdata features described in this section. Microdata allows nested groups of name-value pairs to be added to documents, in parallel with the existing content.

5.1.2 The basic syntax

This section is non-normative.

At a high level, microdata consists of a group of name-value pairs. The groups are called items, and each name-value pair is a property. Items and properties are represented by regular elements.

To create an item, the itemscope attribute is used.

To add a property to an item, the itemprop attribute is used on one of the item's descendants.

Example

Here there are two items, each of which has the property "name":

```
<div itemscope>
  <p>My name is <span itemprop="name">Elizabeth</span>.</p>
</div>

<div itemscope>
  <p>My name is <span itemprop="name">Daniel</span>.</p>
</div>
```

Example

These two examples are exactly equivalent, at a microdata level, as the previous two examples respectively:

```
<div itemscope>
  <p>My <em name</em> is <span itemprop="name">E<strong>lizabeth</strong></span>.</p>
</div>

<section>
  <div itemscope>
    <aside>
      <p>My name is <span itemprop="name"><a href="/?user=daniel">Daniel</a></span>.</p>
    </aside>
  </div>
</section>
```

Properties generally have values that are strings.
Example

Here the item has three properties:

```html
<div itemscope>
  <p>My name is <span itemprop="name">Neil</span>.</p>
  <p>My band is called <span itemprop="band">Four Parts Water</span>.</p>
  <p>I am <span itemprop="nationality">British</span>.</p>
</div>
```

When a string value is a URL, it is expressed using the `<a>` element and its `href` attribute, the `<img>` element and its `src` attribute, or other elements that link to or embed external resources.

Example

In this example, the item has one property, "image", whose value is a URL:

```html
<div itemscope>
  <img itemprop="image" src="google-logo.png" alt="Google">
</div>
```

When a string value is in some machine-readable format unsuitable for human consumption, it is expressed using the `value` attribute of the `<data>` element, with the human-readable version given in the element's contents.

Example

Here, there is an item with a property whose value is a product ID. The ID is not human-friendly, so the product's name is used the human-visible text instead of the ID.

```html
<h1 itemscope>
  <data itemprop="product-id" value="9678AOU879">The Instigator 2000</data>
</h1>
```

For numeric data, the `<meter>` element and its `value` attribute can be used instead.

Example

Here a rating is given using a `<meter>` element.

```html
<div itemscope itemtype="http://schema.org/Product">
  <span itemprop="name">Panasonic White 60L Refrigerator</span>
  <img src="panasonic-fridge-60l-white.jpg" alt="">
  <div itemprop="aggregateRating" itemscope itemtype="http://schema.org/AccumulatedRating">
    <meter itemprop="ratingValue" min="0" value="3.5" max="5">Rated 3.5/5</meter>
    (based on <span itemprop="reviewCount">11</span> customer reviews)
  </div>
</div>
```

Similarly, for date- and time-related data, the `<time>` element and its `datetime` attribute can be used instead.

Example

In this example, the item has one property, "birthday", whose value is a date:

```html
<div itemscope>
  I was born on <time itemprop="birthday" datetime="2009-05-10">May 10th 2009</time>.
</div>
```

Properties can also themselves be groups of name-value pairs, by putting the `itemscope` attribute on the element that declares the property.
Items that are not part of others are called top-level microdata items.

Example
In this example, the outer item represents a person, and the inner one represents a band:

```
<div itemscope>
    <p>name</p>: <span itemprop="name">Amanda</span></div>
```

The outer item here has two properties, "name" and "band". The "name" is "Amanda", and the "band" is an item in its own right, with two properties, "name" and "size". The "name" of the band is "Jazz Band", and the "size" is "12".

The outer item in this example is a top-level microdata item.

Properties that are not descendants of the element with the `itemscope` attribute can be associated with the `item` using the `itemref` attribute. This attribute takes a list of IDs of elements to crawl in addition to crawling the children of the element with the `itemscope` attribute.

Example
This example is the same as the previous one, but all the properties are separated from their `items`:

```
<dl id="amanda" itemref="a b"></dl>
```

This gives the same result as the previous example. The first item has two properties, "name", set to "Amanda", and "band", set to another item. That second item has two further properties, "name", set to "Jazz Band", and "size", set to "12".

An `item` can have multiple properties with the same name and different values.

Example
This example describes an ice cream, with two flavors:

```
<ul>
    <li itemprop="flavor">Lemon sorbet</li>
    <li itemprop="flavor">Apricot sorbet</li>
</ul>
```

This thus results in an item with two properties, both "flavor", having the values "Lemon sorbet" and "Apricot sorbet".

An element introducing a property can also introduce multiple properties at once, to avoid duplication when some of the properties have the same value.

Example
Here we see an item with two properties, "favorite-color" and "favorite-fruit", both set to the value "orange":

```
<span itemprop="favorite-color favorite-fruit">orange</span>
```
It's important to note that there is no relationship between the microdata and the content of the document where the microdata is marked up.

Example

There is no semantic difference, for instance, between the following two examples:

```html
<figure>
  <img src="castle.jpeg">
  <figcaption><span itemscope><span itemprop="name">The Castle</span> (1986)</span></figcaption>
</figure>

<spanscope><meta itemprop="name" content="The Castle"></spanscope>
<figure>
  <img src="castle.jpeg">
  <figcaption>The Castle (1986)</figcaption>
</figure>
```

Both have a figure with a caption, and both, completely unrelated to the figure, have an item with a name-value pair with the name "name" and the value "The Castle". The only difference is that if the user drags the caption out of the document, in the former case, the item will be included in the drag-and-drop data. In neither case is the image in any way associated with the item.

5.1.3 Typed items

This section is non-normative.

The examples in the previous section show how information could be marked up on a page that doesn't expect its microdata to be re-used. Microdata is most useful, though, when it is used in contexts where other authors and readers are able to cooperate to make new uses of the markup.

For this purpose, it is necessary to give each item a type, such as "https://example.com/person", or "https://example.org/cat", or "https://band.example.net/". Types are identified as URLs.

The type for an item is given as the value of an `itemtype` attribute on the same element as the `itemscope` attribute.

Example

Here, the item's type is "https://example.org/animals#cat":

```html
<section itemscope itemtype="https://example.org/animals#cat">
  <h1 itemprop="name">Hedral</h1>
  <p itemprop="desc">Hedral is a male american domestic shorthair, with a fluffy black fur with white paws and belly.</p>
  <img itemprop="img" src="hedral.jpeg" alt="" title="Hedral, age 18 months">
</section>
```

In this example the "https://example.org/animals#cat" item has three properties, a "name" ("Hedral"), a "desc" ("Hedral is...") , and an "img" ("hedral.jpeg").

The type gives the context for the properties, thus selecting a vocabulary: a property named "class" given for an item with the type "https://census.example/person" might refer to the economic class of an individual, while a property named "class" given for an item with the type "https://example.com/school/teacher" might refer to the classroom a teacher has been assigned. Several types can share a vocabulary. For example, the types "https://example.org/people/teacher" and "https://example.org/people/engineer" could be defined to use the same vocabulary (though maybe some properties would not be especially useful in both cases, e.g. maybe the "https://example.org/people/engineer" type might not typically be used with the "classroom" property). Multiple types defined to use the same vocabulary can be given for a single item by listing the URLs as a space-separated list in the attribute' value. An item cannot be given two types if they do not use the same vocabulary, however.
5.1.4 Global identifiers for items

This section is non-normative.

Sometimes, an item gives information about a topic that has a global identifier. For example, books can be identified by their ISBN number.

Vocabularies (as identified by the itemtype attribute) can be designed such that items get associated with their global identifier in an unambiguous way by expressing the global identifiers as URLs given in an itemid attribute.

The exact meaning of the URLs given in itemid attributes depends on the vocabulary used.

Example

Here, an item is talking about a particular book:

```html
<dl itemscope itemtype="https://vocab.example.net/book"
    itemid="urn:isbn:0-330-34032-8">
    <dt>Title
    <dd itemprop="title">The Reality Dysfunction
    <dt>Author
    <dd itemprop="author">Peter F. Hamilton
    <dt>Publication date
    <dd><time itemprop="pubdate" datetime="1996-01-26">26 January 1996</time>
</dl>
```

The "https://vocab.example.net/book" vocabulary in this example would define that the itemid attribute takes a \texttt{urn: URL} pointing to the ISBN of the book.

5.1.5 Selecting names when defining vocabularies

This section is non-normative.

Using microdata means using a vocabulary. For some purposes, an ad-hoc vocabulary is adequate. For others, a vocabulary will need to be designed. Where possible, authors are encouraged to re-use existing vocabularies, as this makes content re-use easier.

When designing new vocabularies, identifiers can be created either using URLs, or, for properties, as plain words (without dots or colons). For URLs, conflicts with other vocabularies can be avoided by only using identifiers that correspond to pages that the author has control over.

Example

For instance, if Jon and Adam both write content at example.com, at https://example.com/~jon/... and https://example.com/~adam/... respectively, then they could select identifiers of the form "https://example.com/~jon/name" and "https://example.com/~adam/name" respectively.

Properties whose names are just plain words can only be used within the context of the types for which they are intended; properties named using URLs can be reused in items of any type. If an item has no type, and is not part of another item, then if its properties have names that are just plain words, they are not intended to be globally unique, and are instead only intended for limited use. Generally speaking, authors are encouraged to use either properties with globally unique names (URLs) or ensure that their items are typed.

Example

Here, an item is an "https://example.org/animals#cat", and most of the properties have names that are words defined in the context of that type. There are also a few additional properties whose names come from other vocabularies.

```html
<section itemscope itemtype="https://example.org/animals#cat">
    <h1 itemprop="name https://example.com/fn">Hedral</h1>
    <p itemprop="desc">Hedral is a male American domestic</p>
</section>
```
The microdata model consists of groups of name-value pairs known as items. Each group is known as an item. Each item can have item types, a global identifier (if the vocabulary specified by the item types support global identifiers for items), and a list of name-value pairs. Each name in the name-value pair is known as a property, and each property has one or more values. Each value is either a string or itself a group of name-value pairs (an item). The names are unordered relative to each other, but if a particular name has multiple values, they do have a relative order.

Every HTML element may have an itemscope attribute specified. The itemscope attribute is a boolean attribute.

An element with the itemscope attribute specified creates a new item, a group of name-value pairs.

Elements with an itemscope attribute may have an itemtype attribute specified, to give the item types of the item.

The itemtype attribute, if specified, must have a value that is an unordered set of unique space-separated tokens, none of which are identical to another token and each of which is a valid URL string that is an absolute URL, and all of which are defined to use the same vocabulary. The attribute's value must have at least one token.

The item types of an item are the tokens obtained by splitting the element's itemtype attribute's value on ASCII whitespace. If the itemtype attribute is missing or parsing it in this way finds no tokens, the item is said to have no item types.

The item types must all be types defined in applicable specifications and must all be defined to use the same vocabulary.

Except if otherwise specified by that specification, the URLs given as the item types should not be automatically dereferenced.

Note

A specification could define that its item type can be dereferenced to provide the user with help information, for example. In fact, vocabulary authors are encouraged to provide useful information at the given URL.

Item types are opaque identifiers, and user agents must not dereference unknown item types, or otherwise deconstruct them, in order to determine how to process items, that use them.

The itemtype attribute must not be specified on elements that do not have an itemscope attribute specified.

This example has one item with the type "https://example.org/animals#cat" and the following properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>Hedral</td>
</tr>
<tr>
<td>desc</td>
<td>Hedral is a male American domestic shorthair, with a fluffy black fur with white paws and belly.</td>
</tr>
<tr>
<td><a href="https://example.com/fn">https://example.com/fn</a></td>
<td>Hedral</td>
</tr>
<tr>
<td><a href="https://example.com/color">https://example.com/color</a></td>
<td>black</td>
</tr>
<tr>
<td><a href="https://example.com/color">https://example.com/color</a></td>
<td>white</td>
</tr>
<tr>
<td>img</td>
<td>.../hedral.jpeg</td>
</tr>
</tbody>
</table>

5.2 Encoding microdata

5.2.1 The microdata model

The microdata model consists of groups of name-value pairs known as items.

Each group is known as an item. Each item can have item types, a global identifier (if the vocabulary specified by the item types support global identifiers for items), and a list of name-value pairs. Each name in the name-value pair is known as a property, and each property has one or more values. Each value is either a string or itself a group of name-value pairs (an item). The names are unordered relative to each other, but if a particular name has multiple values, they do have a relative order.

5.2.2 Items

Every HTML element may have an itemscope attribute specified. The itemscope attribute is a boolean attribute.

An element with the itemscope attribute specified creates a new item, a group of name-value pairs.

Elements with an itemscope attribute may have an itemtype attribute specified, to give the item types of the item.

The itemtype attribute, if specified, must have a value that is an unordered set of unique space-separated tokens, none of which are identical to another token and each of which is a valid URL string that is an absolute URL, and all of which are defined to use the same vocabulary. The attribute's value must have at least one token.

The item types of an item are the tokens obtained by splitting the element's itemtype attribute's value on ASCII whitespace. If the itemtype attribute is missing or parsing it in this way finds no tokens, the item is said to have no item types.

The item types must all be types defined in applicable specifications and must all be defined to use the same vocabulary.

Except if otherwise specified by that specification, the URLs given as the item types should not be automatically dereferenced.
An item is said to be a typed item when either it has an item type, or it is the value of a property of a typed item.

The relevant types for a typed item is the item's item types, if it has any, or else is the relevant types of the item for which it is a property's value.

Elements with an itemscope attribute and an itemtype attribute that references a vocabulary that is defined to support global identifiers for items may also have an itemid attribute specified, to give a global identifier for the item, so that it can be related to other items on pages elsewhere on the web.

The itemid attribute, if specified, must have a value that is a valid URL potentially surrounded by spaces.

The global identifier of an item is the value of its element's itemid attribute, if it has one, parsed relative to the node document of the element on which the attribute is specified. If the itemid attribute is missing or if parsing it returns failure, it is said to have no global identifier.

The itemid attribute must not be specified on elements that do not have both an itemscope attribute and an itemtype attribute specified, and must not be specified on elements with an itemscope attribute whose itemtype attribute specifies a vocabulary that does not support global identifiers for items, as defined by that vocabulary's specification.

The exact meaning of a global identifier is determined by the vocabulary's specification. It is up to such specifications to define whether multiple items with the same global identifier (whether on the same page or on different pages) are allowed to exist, and what the processing rules for that vocabulary are with respect to handling the case of multiple items with the same ID.

Elements with an itemscope attribute may have an itemref attribute specified, to give a list of additional elements to crawl to find the name-value pairs of the item.

The itemref attribute, if specified, must have a value that is an unordered set of unique space-separated tokens none of which are identical to another token and consisting of IDs of elements in the same tree.

The itemref attribute must not be specified on elements that do not have an itemscope attribute specified.

Note

The itemref attribute is not part of the microdata data model. It is merely a syntactic construct to aid authors in adding annotations to pages where the data to be annotated does not follow a convenient tree structure. For example, it allows authors to mark up data in a table so that each column defines a separate item, while keeping the properties in the cells.

Example

This example shows a simple vocabulary used to describe the products of a model railway manufacturer. The vocabulary has just five property names:

**product-code**
An integer that names the product in the manufacturer's catalog.

**name**
A brief description of the product.

**scale**
One of "HO", "1", or "Z" (potentially with leading or trailing whitespace), indicating the scale of the product.

**digital**
If present, one of "Digital", "Delta", or "Systems" (potentially with leading or trailing whitespace) indicating that the product has a digital decoder of the given type.

**track-type**
For track-specific products, one of "K", "M", "C" (potentially with leading or trailing whitespace) indicating the type of track for which the product is intended.

This vocabulary has four defined item types:

**https://md.example.com/loco**
Rolling stock with an engine
https://md.example.com/passengers
   Passenger rolling stock

https://md.example.com/track
   Track pieces

https://md.example.com/lighting
   Equipment with lighting

Each item that uses this vocabulary can be given one or more of these types, depending on what the product is.

Thus, a locomotive might be marked up as:

```html
<dl itemscope itemtype="https://md.example.com/loco
   https://md.example.com/lighting">
   <dt>Name:  
   <dd itemprop="name">Tank Locomotive (DB 80)
   <dt>Product code: 
   <dd itemprop="product-code">33041
   <dt>Scale: 
   <dd itemprop="scale">HO
   <dt>Digital: 
   <dd itemprop="digital">Delta
</dl>
```

A turnout lantern retrofit kit might be marked up as:

```html
<dl itemscope itemtype="https://md.example.com/track
   https://md.example.com/lighting">
   <dt>Name:  
   <dd itemprop="name">Turnout Lantern Kit
   <dt>Product code: 
   <dd itemprop="product-code">74470
   <dt>Purpose: 
   <dd>For retrofitting 2 <span itemprop="track-type">C</span> Track turnouts. <meta itemprop="scale" content="HO">
</dl>
```

A passenger car with no lighting might be marked up as:

```html
<dl itemscope itemtype="https://md.example.com/passengers">
   <dt>Name:  
   <dd itemprop="name">Express Train Passenger Car (DB Am 203)
   <dt>Product code: 
   <dd itemprop="product-code">8710
   <dt>Scale: 
   <dd itemprop="scale">Z
</dl>
```

Great care is necessary when creating new vocabularies. Often, a hierarchical approach to types can be taken that results in a vocabulary where each item only ever has a single type, which is generally much simpler to manage.

5.2.3 Names: the itemprop attribute

Every HTML element may have an itemprop attribute specified, if doing so adds one or more properties to one or more items (as defined below).

The itemprop attribute, if specified, must have a value that is an unordered set of unique space-separated tokens none of which
are identical to another token, representing the names of the name-value pairs that it adds. The attribute's value must have at least one token.

Each token must be either:

- If the item is a typed item: a defined property name allowed in this situation according to the specification that defines the relevant types for the item, or
- A valid URL string that is an absolute URL defined as an item property name allowed in this situation by a vocabulary specification, or
- A valid URL string that is an absolute URL, used as a proprietary item property name (i.e. one used by the author for private purposes, not defined in a public specification), or
- If the item is not a typed item: a string that contains no U+002E FULL STOP characters (.) and no U+003A COLON characters (:), used as a proprietary item property name (i.e. one used by the author for private purposes, not defined in a public specification).

Specifications that introduce defined property names must ensure all such property names contain no U+002E FULL STOP characters (.), no U+003A COLON characters (:) and no ASCII whitespace.

**Note**
The rules above disallow U+003A COLON characters (:) in non-URL values because otherwise they could not be distinguished from URLs. Values with U+002E FULL STOP characters (.) are reserved for future extensions. ASCII whitespace are disallowed because otherwise the values would be parsed as multiple tokens.

When an element with an itemprop attribute adds a property to multiple items, the requirement above regarding the tokens applies for each item individually.

The property names of an element are the tokens that the element's itemprop attribute is found to contain when its value is split on ASCII whitespace, with the order preserved but with duplicates removed (leaving only the first occurrence of each name).

Within an item, the properties are unordered with respect to each other, except for properties with the same name, which are ordered in the order they are given by the algorithm that defines the properties of an item.

**Example**
In the following example, the "a" property has the values "1" and "2", in that order, but whether the "a" property comes before the "b" property or not is not important:

```html
<div itemscope>
<p itemprop="a">1</p>
<p itemprop="a">2</p>
<p itemprop="b">test</p>
</div>
```

Thus, the following is equivalent:

```html
<div itemscope>
<p itemprop="b">test</p>
<p itemprop="a">1</p>
<p itemprop="a">2</p>
</div>
```

As is the following:

```html
<div itemscope>
<p itemprop="a">1</p>
<p itemprop="b">test</p>
<p itemprop="a">2</p>
</div>
```
5.2.4 Values

The property value of a name-value pair added by an element with an `itemprop` attribute is as given for the first matching case in the following list:

- **If the element also has an `itemscope` attribute**
  The value is the item created by the element.

- **If the element is a `meta` element**
  The value is the value of the element's `content` attribute, if any, or the empty string if there is no such attribute.

- **If the element is an `audio`, `embed`, `iframe`, `img`, `source`, `track`, or `video` element**
  The value is the result of encoding-parsing-and-serializing a URL given the element's `src` attribute's value, relative to the element's node document, at the time the attribute is set, or the empty string if there is no such attribute or the result is failure.

- **If the element is an `a`, `area`, or `link` element**
  The value is the result of encoding-parsing-and-serializing a URL given the element's `href` attribute's value, relative to the element's node document, at the time the attribute is set, or the empty string if there is no such attribute or the result is failure.

- **If the element is an `object` element**
  The value is the result of encoding-parsing-and-serializing a URL given the element's `data` attribute's value, relative to the element's node document, at the time the attribute is set, or the empty string if there is no such attribute or the result is failure.

- **If the element is a `data` element**
  The value is the value of the element's `value` attribute, if it has one, or the empty string otherwise.

- **If the element is a `meter` element**
  The value is the value of the element's `value` attribute, if it has one, or the empty string otherwise.

- **If the element is a `time` element**
  The value is the element's `datetime` value.

- **Otherwise**
  The value is the element's descendant text content.

The URL property elements are the `a`, `area`, `audio`, `embed`, `iframe`, `img`, `source`, `track`, and `video` elements.

If a property's `value`, as defined by the property's definition, is an absolute URL, the property must be specified using a URL property element.

**Note**

These requirements do not apply just because a property value happens to match the syntax for a URL. They only apply if the property is explicitly defined as taking such a value.
To find the properties of an item defined by the element root, the user agent must run the following steps. These steps are also used to flag microdata errors.

1. Let results, memory, and pending be empty lists of elements.
2. Add the element root to memory.
3. Add the child elements of root, if any, to pending.
4. If root has an itemref attribute, split the value of that itemref attribute on ASCII whitespace. For each resulting token ID, if there is an element in the tree of root with the ID ID, then add the first such element to pending.
5. While pending is not empty:
   1. Remove an element from pending and let current be that element.
   2. If current is already in memory, there is a microdata error; continue.
   3. Add current to memory.
   4. If current does not have an itemscope attribute, then: add all the child elements of current to pending.
   5. If current has an itemprop attribute specified and has one or more property names, then add current to results.
6. Sort results in tree order.
7. Return results.

A document must not contain any items for which the algorithm to find the properties of an item finds any microdata errors. An item is a top-level microdata item if its element does not have an itemprop attribute.

All itemref attributes in a Document must be such that there are no cycles in the graph formed from representing each item in the Document as a node in the graph and each property of an item whose value is another item as an edge in the graph connecting those two items.

A document must not contain any elements that have an itemprop attribute that would not be found to be a property of any of the items in that document were their properties all to be determined.

Example 5.2.5 Associating names with items

To find the properties of an item defined by the element root, the user agent must run the following steps. These steps are also used to flag microdata errors.

1. Let results, memory, and pending be empty lists of elements.
2. Add the element root to memory.
3. Add the child elements of root, if any, to pending.
4. If root has an itemref attribute, split the value of that itemref attribute on ASCII whitespace. For each resulting token ID, if there is an element in the tree of root with the ID ID, then add the first such element to pending.
5. While pending is not empty:
   1. Remove an element from pending and let current be that element.
   2. If current is already in memory, there is a microdata error; continue.
   3. Add current to memory.
   4. If current does not have an itemscope attribute, then: add all the child elements of current to pending.
   5. If current has an itemprop attribute specified and has one or more property names, then add current to results.
6. Sort results in tree order.
7. Return results.

A document must not contain any items for which the algorithm to find the properties of an item finds any microdata errors. An item is a top-level microdata item if its element does not have an itemprop attribute.

All itemref attributes in a Document must be such that there are no cycles in the graph formed from representing each item in the Document as a node in the graph and each property of an item whose value is another item as an edge in the graph connecting those two items.

A document must not contain any elements that have an itemprop attribute that would not be found to be a property of any of the items in that document were their properties all to be determined.

Example

In this example, a single license statement is applied to two works, using itemref from the items representing the works:

```html
<!DOCTYPE HTML>
<html lang="en">
<head>
  <title>Photo gallery</title>
</head>
<body>
  <h1>My photos</h1>
  <figure itemscope itemtype="http://n.whatwg.org/work" itemref="licenses">
    <img itemprop="work" src="images/house.jpeg" alt="A white house, boarded up, sits in a forest.">
    <figcaption itemprop="title">The house I found.</figcaption>
  </figure>
</body>
</html>
```
Currently, the `itemscope` and `itemprop` attributes are only defined for HTML elements. This means that attributes with the literal names "itemscope", "itemprop", etc, do not cause microdata processing to occur on elements in other namespaces, such as SVG.

The vocabularies in this section are primarily intended to demonstrate how a vocabulary is specified, though they are also usable in their own right.

5.2.6 Microdata and other namespaces

Currently, the `itemscope` and `itemprop` attributes are only defined for HTML elements. This means that attributes with the literal names "itemscope", "itemprop", etc, do not cause microdata processing to occur on elements in other namespaces, such as SVG.

Example

Thus, in the following example there is only one item, not two.

```html
<p itemscope></p> <!-- this is an item (with no properties and no type) -->
<svg itemscope></svg> <!-- this is not, it's just an SVG svg element with an invalid unknown attribute -->
```

5.3 Sample microdata vocabularies

The vocabularies in this section are primarily intended to demonstrate how a vocabulary is specified, though they are also usable in their own right.
An item with the [item type](http://microformats.org/profile/hcard) represents a person's or organization's contact information. This vocabulary does not [support global identifiers for items](http://microformats.org/profile/hcard).

The following are the type's [defined property names](http://microformats.org/profile/hcard). They are based on the vocabulary defined in [vCard Format Specification (vCard)](http://microformats.org/profile/hcard) and its extensions, where more information on how to interpret the values can be found. [RFC6350](http://microformats.org/profile/hcard)

### kind

Describes what kind of contact the item represents.

The `value` must be text that is [identical to](http://microformats.org/profile/hcard) one of the [kind strings](http://microformats.org/profile/hcard).

A single property with the name `kind` may be present within each item with the type `http://microformats.org/profile/hcard`.

### fn

Gives the formatted text corresponding to the name of the person or organization.

The `value` must be text.

Exactly one property with the name `fn` must be present within each item with the type `http://microformats.org/profile/hcard`.

### n

Gives the structured name of the person or organization.

The `value` must be an item with zero or more of each of the `family-name`, `given-name`, `additional-name`, `honorific-prefix`, and `honorific-suffix` properties.

Exactly one property with the name `n` must be present within each item with the type `http://microformats.org/profile/hcard`.

#### family-name (inside n)

Gives the family name of the person, or the full name of the organization.

The `value` must be text.

Any number of properties with the name `family-name` may be present within the item that forms the `value` of the `n` property of an item with the type `http://microformats.org/profile/hcard`.

#### given-name (inside n)

Gives the given-name of the person.

The `value` must be text.

Any number of properties with the name `given-name` may be present within the item that forms the `value` of the `n` property of an item with the type `http://microformats.org/profile/hcard`.

#### additional-name (inside n)

Gives the any additional names of the person.

The `value` must be text.

Any number of properties with the name `additional-name` may be present within the item that forms the `value` of the `n` property of an item with the type `http://microformats.org/profile/hcard`.

#### honorific-prefix (inside n)

Gives the honorific prefix of the person.

The `value` must be text.

Any number of properties with the name `honorific-prefix` may be present within the item that forms the `value` of the `n` property of an item with the type `http://microformats.org/profile/hcard`.
honorific-suffix (inside n)

Gives the honorific suffix of the person.

The value must be text.

Any number of properties with the name honorific-suffix may be present within the item that forms the value of the n property of an item with the type http://microformats.org/profile/hcard.

nickname

Gives the nickname of the person or organization.

Note

The nickname is the descriptive name given instead of or in addition to the one belonging to a person, place, or thing. It can also be used to specify a familiar form of a proper name specified by the fn or n properties.

The value must be text.

Any number of properties with the name nickname may be present within each item with the type http://microformats.org/profile/hcard.

photo

Gives a photograph of the person or organization.

The value must be an absolute URL.

Any number of properties with the name photo may be present within each item with the type http://microformats.org/profile/hcard.

bday

Gives the birth date of the person or organization.

The value must be a valid date string.

A single property with the name bday may be present within each item with the type http://microformats.org/profile/hcard.

anniversary

Gives the birth date of the person or organization.

The value must be a valid date string.

A single property with the name anniversary may be present within each item with the type http://microformats.org/profile/hcard.

sex

Gives the biological sex of the person.

The value must be one of F, meaning "female", M, meaning "male", N, meaning "none or not applicable", O, meaning "other", or U, meaning "unknown".

A single property with the name sex may be present within each item with the type http://microformats.org/profile/hcard.

gender-identity

Gives the gender identity of the person.

The value must be text.

A single property with the name gender-identity may be present within each item with the type http://microformats.org/profile/hcard.
adr
Gives the delivery address of the person or organization.

The value\(^{{791}}\) must be an item\(^{{787}}\) with zero or more type\(^{{796}}\), post-office-box\(^{{796}}\), extended-address\(^{{796}}\), and street-address\(^{{796}}\) properties, and optionally a locality\(^{{796}}\) property, optionally a region\(^{{796}}\) property, optionally a postal-code\(^{{797}}\) property, and optionally a country-name\(^{{797}}\) property.

If no type\(^{{796}}\) properties are present within an item\(^{{787}}\) that forms the value\(^{{791}}\) of an adr\(^{{796}}\) property of an item\(^{{787}}\) with the type http://microformats.org/profile/hcard\(^{{794}}\), then the address type string\(^{{801}}\) work\(^{{801}}\) is implied.

Any number of properties with the name adr\(^{{796}}\) may be present within each item\(^{{787}}\) with the type http://microformats.org/profile/hcard\(^{{794}}\).

type (inside adr\(^{{796}}\))
Gives the type of delivery address.

The value\(^{{791}}\) must be text that is identical to one of the address type strings\(^{{801}}\).

Any number of properties with the name type\(^{{796}}\) may be present within the item\(^{{787}}\) that forms the value\(^{{791}}\) of an adr\(^{{796}}\) property of an item\(^{{787}}\) with the type http://microformats.org/profile/hcard\(^{{794}}\), but within each such ad\(^{{796}}\) property item\(^{{787}}\) there must only be one type\(^{{796}}\) property per distinct value.

post-office-box (inside adr\(^{{796}}\))
Gives the post office box component of the delivery address of the person or organization.

The value\(^{{791}}\) must be text.

Any number of properties with the name post-office-box\(^{{796}}\) may be present within the item\(^{{787}}\) that forms the value\(^{{791}}\) of an adr\(^{{796}}\) property of an item\(^{{787}}\) with the type http://microformats.org/profile/hcard\(^{{794}}\).

extended-address (inside adr\(^{{796}}\))
Gives an additional component of the delivery address of the person or organization.

The value\(^{{791}}\) must be text.

Any number of properties with the name extended-address\(^{{796}}\) may be present within the item\(^{{787}}\) that forms the value\(^{{791}}\) of an adr\(^{{796}}\) property of an item\(^{{787}}\) with the type http://microformats.org/profile/hcard\(^{{794}}\).

street-address (inside adr\(^{{796}}\))
Gives the street address component of the delivery address of the person or organization.

The value\(^{{791}}\) must be text.

Any number of properties with the name street-address\(^{{796}}\) may be present within the item\(^{{787}}\) that forms the value\(^{{791}}\) of an adr\(^{{796}}\) property of an item\(^{{787}}\) with the type http://microformats.org/profile/hcard\(^{{794}}\).

locality (inside adr\(^{{796}}\))
Gives the locality component (e.g. city) of the delivery address of the person or organization.

The value\(^{{791}}\) must be text.

A single property with the name locality\(^{{796}}\) may be present within the item\(^{{787}}\) that forms the value\(^{{791}}\) of an adr\(^{{796}}\) property of an item\(^{{787}}\), with the type http://microformats.org/profile/hcard\(^{{794}}\).

region (inside adr\(^{{796}}\))
Gives the region component (e.g. state or province) of the delivery address of the person or organization.
The value must be text.

A single property with the name region may be present within the item that forms the value of an adr property of an item with the type http://microformats.org/profile/hcard.

**postal-code (inside adr)**

Gives the postal code component of the delivery address of the person or organization.

The value must be text.

A single property with the name postal-code may be present within the item that forms the value of an adr property of an item with the type http://microformats.org/profile/hcard.

**country-name (inside adr)**

Gives the country name component of the delivery address of the person or organization.

The value must be text.

A single property with the name country-name may be present within the item that forms the value of an adr property of an item with the type http://microformats.org/profile/hcard.

**tel**

Gives the telephone number of the person or organization.

The value must be either text that can be interpreted as a telephone number as defined in the CCITT specifications E.163 and X.121, or an item with zero or more type properties and exactly one value property. [E163] [X121]

If no type properties are present within an item that forms the value of a tel property of an item with the type http://microformats.org/profile/hcard, or if the value of such a tel property is text, then the telephone type string voice is implied.

Any number of properties with the name tel may be present within each item with the type http://microformats.org/profile/hcard.

**type (inside tel)**

Gives the type of telephone number.

The value must be text that is identical to one of the telephone type strings.

Any number of properties with the name type may be present within the item that forms the value of a tel property of an item with the type http://microformats.org/profile/hcard, but within each such tel property item there must only be one type property per distinct value.

**value (inside tel)**

Gives the actual telephone number of the person or organization.

The value must be text that can be interpreted as a telephone number as defined in the CCITT specifications E.163 and X.121. [E163] [X121]

Exactly one property with the name value must be present within the item that forms the value of a tel property of an item with the type http://microformats.org/profile/hcard.

**email**

Gives the email address of the person or organization.

The value must be text.

Any number of properties with the name email may be present within each item with the type http://microformats.org/profile/hcard.

**impp**

Gives a URL for instant messaging and presence protocol communications with the person or organization.

The value must be an absolute URL.
Any number of properties with the name `impp` may be present within each `item` with the type `http://microformats.org/profile/hcard`.

**lang**

Gives a language understood by the person or organization.

The `value` must be a valid BCP 47 language tag. [BCP47]

Any number of properties with the name `lang` may be present within each `item` with the type `http://microformats.org/profile/hcard`.

**tz**

Gives the time zone of the person or organization.

The `value` must be text and must match the following syntax:

1. Either a U+002B PLUS SIGN character (+) or a U+002D HYPHEN-MINUS character (-).
2. A valid non-negative integer that is exactly two digits long and that represents a number in the range 00..23.
3. A U+003A COLON character (:).
4. A valid non-negative integer that is exactly two digits long and that represents a number in the range 00..59.

Any number of properties with the name `tz` may be present within each `item` with the type `http://microformats.org/profile/hcard`.

**geo**

Gives the geographical position of the person or organization.

The `value` must be text and must match the following syntax:

1. Optionally, either a U+002B PLUS SIGN character (+) or a U+002D HYPHEN-MINUS character (-).
2. One or more ASCII digits.
3. Optionally*, a U+002E FULL STOP character (%) followed by one or more ASCII digits.
4. A U+003B SEMICOLON character (;).
5. Optionally, either a U+002B PLUS SIGN character (+) or a U+002D HYPHEN-MINUS character (-).
6. One or more ASCII digits.
7. Optionally*, a U+002E FULL STOP character (%) followed by one or more ASCII digits.

The optional components marked with an asterisk (*) should be included, and should have six digits each.

**title**

Gives the job title, functional position or function of the person or organization.

The `value` must be text.

Any number of properties with the name `title` may be present within each `item` with the type `http://microformats.org/profile/hcard`.

**role**

Gives the role, occupation, or business category of the person or organization.

Note

The value specifies latitude and longitude, in that order (i.e., "LAT LON" ordering), in decimal degrees. The longitude represents the location east and west of the prime meridian as a positive or negative real number, respectively. The latitude represents the location north and south of the equator as a positive or negative real number, respectively.
The `value` must be text.

Any number of properties with the name `role` may be present within each `item` with the type `http://microformats.org/profile/hcard`.

**logo**

Gives the logo of the person or organization.

The `value` must be an absolute URL.

Any number of properties with the name `logo` may be present within each `item` with the type `http://microformats.org/profile/hcard`.

**agent**

Gives the contact information of another person who will act on behalf of the person or organization.

The `value` must be either an `item` with the type `http://microformats.org/profile/hcard`, or an absolute URL, or text.

Any number of properties with the name `agent` may be present within each `item` with the type `http://microformats.org/profile/hcard`.

**org**

Gives the name and units of the organization.

The `value` must be either text or an `item` with one `organization-name` property and zero or more `organization-unit` properties.

Any number of properties with the name `org` may be present within each `item` with the type `http://microformats.org/profile/hcard`.

**organization-name** (inside `org`)

Gives the name of the organization.

The `value` must be text.

Exactly one property with the name `organization-name` must be present within the `item` that forms the `value` of an `org` property of an `item` with the type `http://microformats.org/profile/hcard`.

**organization-unit** (inside `org`)

Gives the name of the organization unit.

The `value` must be text.

Any number of properties with the name `organization-unit` may be present within the `item` that forms the `value` of the `org` property of an `item` with the type `http://microformats.org/profile/hcard`.

**member**

Gives a URL that represents a member of the group.

The `value` must be an absolute URL.

Any number of properties with the name `member` may be present within each `item` with the type `http://microformats.org/profile/hcard` if the `item` also has a property with the name `kind` whose value is "group".

**related**

Gives a relationship to another entity.

The `value` must be an `item` with one `url` property and one `rel` properties.

Any number of properties with the name `related` may be present within each `item` with the type `http://microformats.org/profile/hcard`.

**url** (inside `related`)

Gives the URL for the related entity.
The value must be an absolute URL.

Exactly one property with the name `url` must be present within the `item` that forms the value of a related property of an `item`, with the type `http://microformats.org/profile/hcard`.

**rel (inside related)**

Gives the relationship between the entity and the related entity.

The value must be text that is identical to one of the relationship strings.

Exactly one property with the name `rel` must be present within the `item` that forms the value of a related property of an `item`, with the type `http://microformats.org/profile/hcard`.

**categories**

Gives the name of a category or tag that the person or organization could be classified as.

The value must be text.

Any number of properties with the name `categories` may be present within each `item` with the type `http://microformats.org/profile/hcard`.

**note**

Gives supplemental information or a comment about the person or organization.

The value must be text.

Any number of properties with the name `note` may be present within each `item` with the type `http://microformats.org/profile/hcard`.

**rev**

Gives the revision date and time of the contact information.

The value must be text that is a valid global date and time string.

Any number of properties with the name `rev` may be present within each `item` with the type `http://microformats.org/profile/hcard`.

**sound**

Gives a sound file relating to the person or organization.

The value must be an absolute URL.

Any number of properties with the name `sound` may be present within each `item` with the type `http://microformats.org/profile/hcard`.

**uid**

Gives a globally unique identifier corresponding to the person or organization.

The value must be text.

A single property with the name `uid` may be present within each `item` with the type `http://microformats.org/profile/hcard`.

**url**

Gives a URL relating to the person or organization.

The value must be an absolute URL.

Any number of properties with the name `url` may be present within each `item` with the type `http://microformats.org/profile/hcard`.
The **kind strings** are:

**individual**
- Indicates a single entity (e.g. a person).

**group**
- Indicates multiple entities (e.g. a mailing list).

**org**
- Indicates a single entity that is not a person (e.g. a company).

**location**
- Indicates a geographical place (e.g. an office building).

The **address type strings** are:

**home**
- Indicates a delivery address for a residence.

**work**
- Indicates a delivery address for a place of work.

The **telephone type strings** are:

**home**
- Indicates a residential number.

**work**
- Indicates a telephone number for a place of work.

**text**
- Indicates that the telephone number supports text messages (SMS).

**voice**
- Indicates a voice telephone number.

**fax**
- Indicates a facsimile telephone number.

**cell**
- Indicates a cellular telephone number.

**video**
- Indicates a video conferencing telephone number.

**pager**
- Indicates a paging device telephone number.

**textphone**
- Indicates a telecommunication device for people with hearing or speech difficulties.

The **relationship strings** are:

**emergency**
- An emergency contact.

**agent**
- Another entity that acts on behalf of this entity.
Has the meaning defined in XFN.  [XFN]\[^{p1464}\]

5.3.1.1 Conversion to vCard  \[^{p802}\]

Given a list of nodes \texttt{nodes} in a Document\[^{p138}\], a user agent must run the following algorithm to extract any vCard data represented by those nodes (only the first vCard is returned):

1. If none of the nodes in \texttt{nodes} are \texttt{items} with the \texttt{item type} \[^{p787}\] http://microformats.org/profile/hcard\[^{p794}\], then there is no vCard. Abort the algorithm, returning nothing.

2. Let \texttt{node} be the first node in \texttt{nodes} that is an \texttt{item} with the \texttt{item type} \[^{p787}\] http://microformats.org/profile/hcard\[^{p794}\].

3. Let \texttt{output} be an empty string.

4. Add a vCard line\[^{p804}\] with the type "BEGIN" and the value "VCARD" to \texttt{output}.

5. Add a vCard line\[^{p804}\] with the type "PROFILE" and the value "VCARD" to \texttt{output}.

6. Add a vCard line\[^{p804}\] with the type "VERSION" and the value "4.0" to \texttt{output}.

7. Add a vCard line\[^{p804}\] with the type "SOURCE" and the result of escaping the vCard text string\[^{p805}\] that is the document's URL as the value to \texttt{output}.

8. If the \texttt{title element} is not null, add a vCard line\[^{p804}\] with the type "NAME" and with the result of escaping the vCard text string\[^{p805}\] obtained from the \texttt{title element}'s descendant text content as the value to \texttt{output}.

9. Let \texttt{sex} be the empty string.

10. Let \texttt{gender-identity} be the empty string.

11. For each element \texttt{element} that is a property of the \texttt{item} \[^{p783}\] \texttt{node}: for each name \texttt{name} in \texttt{element}'s property names\[^{p790}\], run the following substeps:

    1. Let \texttt{parameters} be an empty set of name-value pairs.

    2. Run the appropriate set of substeps from the following list. The steps will set a variable \texttt{value}, which is used in the next step.

       If the property's value\[^{p791}\] is an \texttt{item} subitem and name is \[^{p794}\]

       1. Let \texttt{value} be the empty string.

       2. Append to \texttt{value} the result of collecting the first vCard subproperty\[^{p805}\] named \texttt{family-name}\[^{p794}\] in \texttt{subitem}.  

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3. Append a U+003B SEMICOLON character (;) to value.

4. Append to value the result of collecting the first vCard subproperty named given-name in subitem.

5. Append a U+003B SEMICOLON character (;) to value.

6. Append to value the result of collecting the first vCard subproperty named additional-name in subitem.

7. Append a U+003B SEMICOLON character (;) to value.

8. Append to value the result of collecting the first vCard subproperty named honorific-prefix in subitem.

9. Append a U+003B SEMICOLON character (;) to value.

10. Append to value the result of collecting the first vCard subproperty named honorific-suffix in subitem.

If the property's value is an item subitem and name is adr

1. Let value be the empty string.

2. Append to value the result of collecting vCard subproperties named post-office-box in subitem.

3. Append a U+003B SEMICOLON character (;) to value.

4. Append to value the result of collecting vCard subproperties named extended-address in subitem.

5. Append a U+003B SEMICOLON character (;) to value.

6. Append to value the result of collecting vCard subproperties named street-address in subitem.

7. Append a U+003B SEMICOLON character (;) to value.

8. Append to value the result of collecting the first vCard subproperty named locality in subitem.

9. Append a U+003B SEMICOLON character (;) to value.

10. Append to value the result of collecting the first vCard subproperty named region in subitem.

11. Append a U+003B SEMICOLON character (;) to value.

12. Append to value the result of collecting the first vCard subproperty named postal-code in subitem.

13. Append a U+003B SEMICOLON character (;) to value.

14. Append to value the result of collecting the first vCard subproperty named country-name in subitem.

15. If there is a property named type in subitem, and the first such property has a value that is not an item, and whose value consists only of ASCII alphanumerics, then add a parameter named "TYPE" whose value is the value of that property to parameters.

If the property's value is an item subitem and name is org

1. Let value be the empty string.

2. Append to value the result of collecting the first vCard subproperty named organization-name in subitem.

3. For each property named organization-unit in subitem, run the following steps:

   1. If the value of the property is an item, then skip this property.
2. Append a U+003B SEMICOLON character (;) to value.

3. Append the result of escaping the vCard text string given by the value of the property to value.

If the property’s value is an item subitem with the item type http://microformats.org/profile/hcard and name is related

1. Let value be the empty string.

2. If there is a property named url, and its element is a URL property element, then append the result of escaping the vCard text string given by the value of the first such property to value, and add a parameter with the name "VALUE" and the value "URI" to parameters.

3. If there is a property named rel, and the first such property has a value that is not an item and whose value consists only of ASCII alphanumeric, then add a parameter named "RELATION" whose value is the value of that property to parameters.

If the property's value is an item and name is none of the above

1. Let value be the result of collecting the first vCard subproperty named value in subitem.

2. If there is a property named type in subitem, and the first such property has a value that is not an item and whose value consists only of ASCII alphanumeric, then add a parameter named "TYPE" whose value is the value of that property to parameters.

If the property's value is not an item and its name is sex

If this is the first such property to be found, set sex to the property's value.

If the property's value is not an item and its name is gender-identity

If this is the first such property to be found, set gender-identity to the property's value.

Otherwise (the property's value is not an item)

1. Let value be the property's value.

2. If element is one of the URL property elements, add a parameter with the name "VALUE" and the value "URI" to parameters.

3. Otherwise, if name is bday or anniversary and the value is a valid date string, add a parameter with the name "VALUE" and the value "DATE" to parameters.

4. Otherwise, if name is rev and the value is a valid global date and time string, add a parameter with the name "VALUE" and the value "DATE-TIME" to parameters.

5. Prefix every U+005C REVERSE SOLIDUS character (\) in value with another U+005C REVERSE SOLIDUS character (\\).

6. Prefix every U+002C COMMA character (,) in value with a U+002C REVERSE SOLIDUS character (\\).

7. Unless name is geo, prefix every U+003B SEMICOLON character (;) in value with a U+003B REVERSE SOLIDUS character (\\).

8. Replace every U+000D CARRIAGE RETURN U+000A LINE FEED character pair (CRLF) in value with a U+005C REVERSE SOLIDUS character (\\) followed by a U+006E LATIN SMALL LETTER N character (n).

9. Replace every remaining U+000D CARRIAGE RETURN (CR) or U+000A LINE FEED (LF) character in value with a U+005C REVERSE SOLIDUS character (\\) followed by a U+006E LATIN SMALL LETTER N character (n).

3. Add a vCard line with the type name, the parameters parameters, and the value value to output.

12. If either sex or gender-identity has a value that is not the empty string, add a vCard line with the type "GENDER" and the value consisting of the concatenation of sex, a U+003B SEMICOLON character (;) and gender-identity to output.

13. Add a vCard line with the type "END" and the value "VCARD" to output.

When the above algorithm says that the user agent is to add a vCard line consisting of a type type, optionally some parameters, and a value value to a string output, it must run the following steps:
Let \textit{line} be an empty string.

Append \texttt{type}, converted to ASCII uppercase, to \textit{line}.

If there are any parameters, then for each parameter, in the order that they were added, run these substeps:

1. Append a U+003B SEMICOLON character (;) to \textit{line}.
2. Append the parameter's name to \textit{line}.
3. Append a U+003D EQUALS SIGN character (=) to \textit{line}.
4. Append the parameter's value to \textit{line}.

Append a U+003A COLON character (:) to \textit{line}.

Append \texttt{value} to \textit{line}.

Let maximum length be 75.

While \textit{line}'s code point length is greater than maximum length:

1. Append the first maximum length code points of \textit{line} to output.
2. Remove the first maximum length code points from \textit{line}.
3. Append a U+000D CARRIAGE RETURN character (CR) to output.
4. Append a U+000A LINE FEED character (LF) to output.
5. Append a U+0020 SPACE character to output.

Let maximum length be 74.

Append (what remains of) \textit{line} to output.

Append a U+000D CARRIAGE RETURN character (CR) to output.

Append a U+000A LINE FEED character (LF) to output.

When the steps above require the user agent to obtain the result of collecting vCard subproperties named \texttt{subname} in \textit{subitem}, the user agent must run the following steps:

1. Let \texttt{value} be the empty string.
2. For each property named \texttt{subname} in the item \textit{subitem}, run the following substeps:
   1. If the \texttt{value} of the property is itself an \texttt{item}, then skip this property.
   2. If this is not the first property named \texttt{subname} in \textit{subitem} (ignoring any that were skipped by the previous step), then append a U+002C COMMA character (,) to \texttt{value}.
   3. Append the result of \texttt{escaping the vCard text string} given by the \texttt{value} of the property to \texttt{value}.
3. Return \texttt{value}.

When the steps above require the user agent to obtain the result of collecting the first vCard subproperty named \texttt{subname} in \textit{subitem}, the user agent must run the following steps:

1. If there are no properties named \texttt{subname} in \textit{subitem}, then return the empty string.
2. If the \texttt{value} of the first property named \texttt{subname} in \textit{subitem} is an \texttt{item}, then return the empty string.
3. Return the result of \texttt{escaping the vCard text string} given by the \texttt{value} of the first property named \texttt{subname} in \textit{subitem}.

When the above algorithms say the user agent is to escape the vCard text string \texttt{value}, the user agent must use the following steps:

1. Prefix every U+005C REVERSE SOLIDUS character (\) in \texttt{value} with another U+005C REVERSE SOLIDUS character (\).
2. Prefix every U+002C COMMA character (,) in \texttt{value} with a U+005C REVERSE SOLIDUS character (\).

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3. Prefix every U+003B SEMICOLON character (;) in value with a U+005C REVERSE SOLIDUS character (\).

4. Replace every U+000D CARRIAGE RETURN U+000A LINE FEED character pair (CRLF) in value with a U+005C REVERSE SOLIDUS character (\) followed by a U+006E LATIN SMALL LETTER N character (n).

5. Replace every remaining U+000D CARRIAGE RETURN (CR) or U+000A LINE FEED (LF) character in value with a U+005C REVERSE SOLIDUS character (\) followed by a U+006E LATIN SMALL LETTER N character (n).

6. Return the mutated value.

Note
This algorithm can generate invalid vCard output, if the input does not conform to the rules described for the http://microformats.org/profile/hcard item type and defined property names.

5.3.1.2 Examples
This section is non-normative.

Example
Here is a long example vCard for a fictional character called "Jack Bauer":

```html
<section id="jack" itemscope itemtype="http://microformats.org/profile/hcard">
  <h1 itemprop="fn">
    <span itemprop="n" itemscope>
      <span itemprop="given-name">Jack</span>
      <span itemprop="family-name">Bauer</span>
    </span>
  </h1>
  <img itemprop="photo" alt="" src="jack-bauer.jpg">
  <p itemprop="org">
    <span itemprop="organization-name">Counter-Terrorist Unit</span>
    <span itemprop="organization-unit">Los Angeles Division</span>
  </p>
  <p>
    <span itemprop="adr">
      <span itemprop="street-address">10201 W. Pico Blvd.</span>
      <span itemprop="locality">Los Angeles</span>,
      <span itemprop="region">CA</span>
    </span>
    <span itemprop="postal-code">90064</span>
    <span itemprop="country-name">United States</span>
  </p>
  <span itemprop="geo">34.052339;-118.410623</span>
</section>

<h2>Assorted Contact Methods</h2>
<ul>
  <li itemprop="tel" itemscope>
    +1 (310) 597 3781 <span itemprop="type">work</span>
    <meta itemprop="type" content="voice">
  </li>
  <li itemprop="email"><a href="mailto:j.bauer@la.ctu.gov.invalid">j.bauer@la.ctu.gov.invalid</a></li>
  <li itemprop="tel" itemscope>
    +1 (310) 555 3781 <span itemprop="value">mobile phone</span>
  </li>
</ul>
<ins datetime="2008-07-20 21:00:00+01:00"></ins>
```
An item with the item type p787 \url{http://microformats.org/profile/hcalendar#vevent} represents an event.

This vocabulary does not support global identifiers for items.

The following are the type's defined property names. They are based on the vocabulary defined in \textit{Internet Calendaring and Scheduling Core Object Specification (iCalendar)}, where more information on how to interpret the values can be found. [RFC5545]

\begin{verbatim}
BEGIN:VCARD
PROFILE:VCARD
VERSION:4.0
SOURCE: document's address
FN:George Washington
N:George;;Washington;
END:VCARD
\end{verbatim}

5.3.2 vEvent

An item with the item type \url{http://microformats.org/profile/hcalendar#vevent} represents an event.

This vocabulary does not support global identifiers for items.

The following are the type's defined property names. They are based on the vocabulary defined in \textit{Internet Calendaring and Scheduling Core Object Specification (iCalendar)}, where more information on how to interpret the values can be found. [RFC5545]

\textbf{Note}

Only the parts of the iCalendar vocabulary relating to events are used here; this vocabulary cannot express a complete iCalendar instance.
**attach**
Gives the address of an associated document for the event.

The *value* must be an absolute URL.

Any number of properties with the name `attach` may be present within each item with the type `http://microformats.org/profile/hcalendar#vevent`.

**categories**
Gives the name of a category or tag that the event could be classified as.

The *value* must be text.

Any number of properties with the name `categories` may be present within each item with the type `http://microformats.org/profile/hcalendar#vevent`.

**class**
Gives the access classification of the information regarding the event.

The *value* must be text with one of the following values:

- public
- private
- confidential

⚠️ Warning!
This is merely advisory and cannot be considered a confidentiality measure.

A single property with the name `class` may be present within each item with the type `http://microformats.org/profile/hcalendar#vevent`.

**comment**
Gives a comment regarding the event.

The *value* must be text.

Any number of properties with the name `comment` may be present within each item with the type `http://microformats.org/profile/hcalendar#vevent`.

**description**
Gives a detailed description of the event.

The *value* must be text.

A single property with the name `description` may be present within each item with the type `http://microformats.org/profile/hcalendar#vevent`.

**geo**
Gives the geographical position of the event.

The *value* must be text and must match the following syntax:

1. Optionally, either a U+002B PLUS SIGN character (+) or a U+002D HYPHEN-MINUS character (-).
2. One or more ASCII digits.
3. Optionally*, a U+002E FULL STOP character (.) followed by one or more ASCII digits.
4. A U+003B SEMICOLON character (;).
5. Optionally, either a U+002B PLUS SIGN character (+) or a U+002D HYPHEN-MINUS character (-).
6. One or more ASCII digits.
7. Optionally*, a U+002E FULL STOP character (.) followed by one or more ASCII digits.
The optional components marked with an asterisk (*) should be included, and should have six digits each.

### Note
The value specifies latitude and longitude, in that order (i.e., "LAT LON" ordering), in decimal degrees. The longitude represents the location east and west of the prime meridian as a positive or negative real number, respectively. The latitude represents the location north and south of the equator as a positive or negative real number, respectively.

A single property with the name `geo` may be present within each `item` with the type `http://microformats.org/profile/hcalendar#vevent`.

### location
Gives the location of the event.

The `value` must be text.

A single property with the name `location` may be present within each `item` with the type `http://microformats.org/profile/hcalendar#vevent`.

### resources
Gives a resource that will be needed for the event.

The `value` must be text.

Any number of properties with the name `resources` may be present within each `item` with the type `http://microformats.org/profile/hcalendar#vevent`.

### status
Gives the confirmation status of the event.

The `value` must be text with one of the following values:

- tentative
- confirmed
- canceled

A single property with the name `status` may be present within each `item` with the type `http://microformats.org/profile/hcalendar#vevent`.

### summary
Gives a short summary of the event.

The `value` must be text.

User agents should replace U+000A LINE FEED (LF) characters in the value by U+0020 SPACE characters when using the value.

A single property with the name `summary` may be present within each `item` with the type `http://microformats.org/profile/hcalendar#vevent`.

### dtend
Gives the date and time by which the event ends.

If the property with the name `dtend` is present within an `item` with the type `http://microformats.org/profile/hcalendar#vevent` that has a property with the name `dtstart` whose value is a valid date string, then the `value` of the property with the name `dtend` must be text that is a valid date string also. Otherwise, the `value` of the property must be text that is a valid global date and time string.

In either case, the `value` be later in time than the value of the `dtstart` property of the same `item`.

### Note
The time given by the `dtend` property is not inclusive. For day-long events, therefore, the `dtend` property's `value` will be the day after the end of the event.

A single property with the name `dtend` may be present within each `item` with the type `http://microformats.org/profile/hcalendar#vevent`.
hcalendar#vevent, so long as that http://microformats.org/profile/hcalendar#vevent does not have a property with the name duration.

dtstart
Gives the date and time at which the event starts.

The value must be text that is either a valid date string or a valid global date and time string.

Exactly one property with the name dtstart must be present within each item with the type http://microformats.org/profile/hcalendar#vevent.

duration
Gives the duration of the event.

The value must be text that is a valid vevent duration string.

The duration represented is the sum of all the durations represented by integers in the value.

A single property with the name duration may be present within each item with the type http://microformats.org/profile/hcalendar#vevent, so long as that http://microformats.org/profile/hcalendar#vevent does not have a property with the name dtend.

transp
Gives whether the event is to be considered as consuming time on a calendar, for the purpose of free-busy time searches.

The value must be text with one of the following values:

- opaque
- transparent

A single property with the name transp may be present within each item with the type http://microformats.org/profile/hcalendar#vevent.

contact
Gives the contact information for the event.

The value must be text.

Any number of properties with the name contact may be present within each item with the type http://microformats.org/profile/hcalendar#vevent.

url
Gives a URL for the event.

The value must be an absolute URL.

A single property with the name url may be present within each item with the type http://microformats.org/profile/hcalendar#vevent.

uid
Gives a globally unique identifier corresponding to the event.

The value must be text.

A single property with the name uid may be present within each item with the type http://microformats.org/profile/hcalendar#vevent.

exdate
Gives a date and time at which the event does not occur despite the recurrence rules.

The value must be text that is either a valid date string or a valid global date and time string.

Any number of properties with the name exdate may be present within each item with the type http://microformats.org/profile/hcalendar#vevent.
**rdate**
Gives a date and time at which the event recurs.

The value must be text that is one of the following:

- A valid date string.
- A valid global date and time string.
- A valid global date and time string followed by a U+002F SOLIDUS character (/) followed by a second valid global date and time string representing a later time.
- A valid global date and time string followed by a U+002F SOLIDUS character (/) followed by a valid vevent duration string.

Any number of properties with the name `rdate` may be present within each `item` with the type `http://microformats.org/profile/hcalendar#vevent`.

**rrule**
Gives a rule for finding dates and times at which the event occurs.

The value must be text that matches the RECUR value type defined in iCalendar. [RFC5545]

A single property with the name `rrule` may be present within each `item` with the type `http://microformats.org/profile/hcalendar#vevent`.

**created**
Gives the date and time at which the event information was first created in a calendaring system.

The value must be text that is a valid global date and time string.

A single property with the name `created` may be present within each `item` with the type `http://microformats.org/profile/hcalendar#vevent`.

**last-modified**
Gives the date and time at which the event information was last modified in a calendaring system.

The value must be text that is a valid global date and time string.

A single property with the name `last-modified` may be present within each `item` with the type `http://microformats.org/profile/hcalendar#vevent`.

**sequence**
Gives a revision number for the event information.

The value must be text that is a valid non-negative integer.

A single property with the name `sequence` may be present within each `item` with the type `http://microformats.org/profile/hcalendar#vevent`.

A string is a valid vevent duration string if it matches the following pattern:

1. A U+0050 LATIN CAPITAL LETTER P character (P).
2. One of the following:
   - A valid non-negative integer followed by a U+0057 LATIN CAPITAL LETTER W character (W). The integer represents a duration of that number of weeks.
   - At least one, and possible both in this order, of the following:
     1. A valid non-negative integer followed by a U+0044 LATIN CAPITAL LETTER D character (D). The integer represents a duration of that number of days.
     2. A U+0054 LATIN CAPITAL LETTER T character (T) followed by any one of the following, or the first and second of the following in that order, or the second and third of the following in that order, or all three of
the following in this order:

1. A valid non-negative integer followed by a U+0048 LATIN CAPITAL LETTER H character (H). The integer represents a duration of that number of hours.
2. A valid non-negative integer followed by a U+004D LATIN CAPITAL LETTER M character (M). The integer represents a duration of that number of minutes.
3. A valid non-negative integer followed by a U+0053 LATIN CAPITAL LETTER S character (S). The integer represents a duration of that number of seconds.

5.3.2.1 Conversion to iCalendar

Given a list of nodes nodes in a Document, a user agent must run the following algorithm to extract any vEvent data represented by those nodes:

1. If none of the nodes in nodes are items with the type http://microformats.org/profile/hcalendar#vevent, then there is no vEvent data. Abort the algorithm, returning nothing.
2. Let output be an empty string.
3. Add an iCalendar line with the type "BEGIN" and the value "VCALENDAR" to output.
4. Add an iCalendar line with the type "PRODID" and the value equal to a user-agent-specific string representing the user agent to output.
5. Add an iCalendar line with the type "VERSION" and the value "2.0" to output.
6. For each node node in nodes that is an item with the type http://microformats.org/profile/hcalendar#vevent, run the following steps:
   1. Add an iCalendar line with the type "BEGIN" and the value "VEVENT" to output.
   2. Add an iCalendar line with the type "DTSTAMP" and a value consisting of an iCalendar DATE-TIME string representing the current date and time, with the annotation "VALUE=DATE-TIME", to output. [RFC5545]
   3. For each element element that is a property of the item node: for each name name in element's property names, run the appropriate set of substeps from the following list:
      - If the property's value is an item, skip the property.
      - If the property is dtend then add an iCalendar line with the type name and the value to output, with the annotation "VALUE=DATE".
      - If the property is dtstart then add an iCalendar line with the type name and the value to output, with the annotation "VALUE=DATE-TIME".
      - If the property is exdate then add an iCalendar line with the type name and the value to output, with the annotation "VALUE=DATE-TIME".
      - If the property is rdate then add an iCalendar line with the type name and the value to output, with the annotation "VALUE=DATE-TIME".
      - Otherwise skip the property.
      - Otherwise add an iCalendar line with the type name and the property's value to output.
   4. Add an iCalendar line with the type "END" and the value "VEVENT" to output.
7. Add an iCalendar line with the type "END" and the value "VCALENDAR" to output.

When the above algorithm says that the user agent is to add an iCalendar line consisting of a type type, a value value, and optionally an annotation, to a string output, it must run the following steps:

1. Let line be an empty string.
2. Append type, converted to ASCII uppercase, to line.
3. If there is an annotation:
   1. Append a U+003B SEMICOLON character (;) to line.
   2. Append the annotation to line.
4. Append a U+003A COLON character (:) to line.
5. Prefix every U+005C REVERSE SOLIDUS character (\) in value with another U+005C REVERSE SOLIDUS character (\).
6. Prefix every U+002C COMMA character (,) in value with a U+005C REVERSE SOLIDUS character (\).
7. Prefix every U+003B SEMICOLON character (;) in value with a U+005C REVERSE SOLIDUS character (\).
8. Replace every U+000D CARRIAGE RETURN U+000A LINE FEED character pair (CRLF) in value with a U+005C REVERSE SOLIDUS character (\) followed by a U+006E LATIN SMALL LETTER N character (n).
9. Replace every remaining U+000D CARRIAGE RETURN (CR) or U+000A LINE FEED (LF) character in value with a U+005C REVERSE SOLIDUS character (\) followed by a U+006E LATIN SMALL LETTER N character (n).
10. Append value to line.
11. Let maximum length be 75.
12. While line’s code point length is greater than maximum length:
   1. Append the first maximum length code points of line to output.
   2. Remove the first maximum length code points from line.
   3. Append a U+000D CARRIAGE RETURN character (CR) to output.
   4. Append a U+000A LINE FEED character (LF) to output.
   5. Append a U+0020 SPACE character to output.
   6. Let maximum length be 74.
13. Append (what remains of) line to output.
14. Append a U+000D CARRIAGE RETURN character (CR) to output.
15. Append a U+000A LINE FEED character (LF) to output.

Note
This algorithm can generate invalid iCalendar output, if the input does not conform to the rules described for the http://microformats.org/profile/hcalendar#vevent item type and defined property names.

5.3.2.2 Examples
This section is non-normative.

Example
Here is an example of a page that uses the vEvent vocabulary to mark up an event:

```html
<body itemscope itemtype="http://microformats.org/profile/hcalendar#vevent">
...
```
5.3.3 Licensing works §4

An item with the \texttt{item type} \url{http://n.whatwg.org/work} represents a work (e.g. an article, an image, a video, a song, etc.). This type is primarily intended to allow authors to include licensing information for works.

The following are the type's \texttt{defined property names}.

\textbf{work}\footnote{\url{http://n.whatwg.org/work}}

Identifies the work being described.

The \texttt{value} must be an \texttt{absolute URL}.

Exactly one property with the name \texttt{work} must be present within each \texttt{item} with the type \url{http://n.whatwg.org/work}.

\textbf{title}\footnote{\url{http://n.whatwg.org/work}}

Gives the name of the work.

A single property with the name \texttt{title} may be present within each \texttt{item} with the type \url{http://n.whatwg.org/work}.

\textbf{author}\footnote{\url{http://n.whatwg.org/work}}

Gives the name or contact information of one of the authors or creators of the work.

The \texttt{value} must be either an \texttt{item} with the type \url{http://microformats.org/profile/hcard}, or text.

Any number of properties with the name \texttt{author} may be present within each \texttt{item} with the type \url{http://n.whatwg.org/work}. 

\newpage
license

Identifies one of the licenses under which the work is available.

The value must be an absolute URL.

Any number of properties with the name license may be present within each item with the type http://n.whatwg.org/work.

5.3.3.1 Examples

This section is non-normative.

Example

This example shows an embedded image entitled My Pond, licensed under the Creative Commons Attribution-Share Alike 4.0 International License and the MIT license simultaneously.

```
<figure itemscope itemtype=http://n.whatwg.org/work>
  <img itemprop="work" src="mypond.jpeg">
  <figcaption>
    <p><cite itemprop="title">My Pond</cite></p>
    <p><small>Licensed under the <a itemprop="license" href="https://creativecommons.org/licenses/by-sa/4.0/">Creative Commons Attribution-Share Alike 4.0 International License</a> and the <a itemprop="license" href="http://www.opensource.org/licenses/mit-license.php">MIT license</a>.</small>
  </figcaption>
</figure>
```

5.4 Converting HTML to other formats

5.4.1 JSON

Given a list of nodes nodes in a Document, a user agent must run the following algorithm to extract the microdata from those nodes into a JSON form:

1. Let result be an empty object.
2. Let items be an empty array.
3. For each node in nodes, check if the element is a top-level microdata item, and if it is then get the object for that element and add it to items.
4. Add an entry to result called "items" whose value is the array items.
5. Return the result of serializing result to JSON in the shortest possible way (meaning no whitespace between tokens, no unnecessary zero digits in numbers, and only using Unicode escapes in strings for characters that do not have a dedicated escape sequence), and with a lowercase "e" used, when appropriate, in the representation of any numbers.

Note

This algorithm returns an object with a single property that is an array, instead of just returning an array, so that it is possible to extend the algorithm in the future if necessary.

When the user agent is to get the object for an item item, optionally with a list of elements memory, it must run the following substeps:

1. Let result be an empty object.
2. If no memory was passed to the algorithm, let memory be an empty list.

3. Add item to memory.

4. If the item has any item types, add an entry to result called "type" whose value is an array listing the item types of item, in the order they were specified on the itemtype attribute.

5. If the item has a global identifier, add an entry to result called "id" whose value is the global identifier of item.

6. Let properties be an empty object.

7. For each element element that has one or more property names and is one of the properties of the item item, in the order those elements are given by the algorithm that returns the properties of an item, run the following substeps:
   1. Let value be the property value of element.
   2. If value is an item, then: If value is in memory, then let value be the string "ERROR". Otherwise, get the object for value, passing a copy of memory, and then replace value with the object returned from those steps.
   3. For each name name in element's property names, run the following substeps:
      1. If there is no entry named name in properties, then add an entry named name to properties whose value is an empty array.
      2. Append value to the entry named name in properties.

8. Add an entry to result called "properties" whose value is the object properties.

9. Return result.

Example

For example, take this markup:

```html
<!DOCTYPE HTML>
<html lang="en">
<title>My Blog</title>
<article itemscope itemtype="http://schema.org/BlogPosting">
 <header>
  <h1 itemprop="headline">Progress report</h1>
  <p><time itemprop="datePublished" datetime="2013-08-29">today</time></p>
  <link itemprop="url" href="#c1"/>
 </header>
<p>All in all, he's doing well with his swim lessons. The biggest thing was he had trouble putting his head in, but we got it down.</p>
<section>
 <h1>Comments</h1>
<article itemprop="comment" itemscope itemtype="http://schema.org/UserComments" id="c1">
 <link itemprop="url" href="#c1"/>
 <footer>
  <p>Posted by: <span itemprop="creator" itemscope itemtype="http://schema.org/Person">Greg</span></p>
  <p>15 minutes ago</p>
 </footer>
<p>Ha!</p>
 </article>
<article itemprop="comment" itemscope itemtype="http://schema.org/UserComments" id="c2">
 <link itemprop="url" href="#c2"/>
 <footer>
  <p>Posted by: <span itemprop="creator" itemscope itemtype="http://schema.org/Person">Charlotte</span></p>
  <p>5 minutes ago</p>
 </footer>
<p>When you say "we got it down"...</p>
</article>
</section>
</article>
</html>
```
It would be turned into the following JSON by the algorithm above (supposing that the page's URL was https://blog.example.com/progress-report):

```json
{
  "items": [
    {
      "type": [ "http://schema.org/BlogPosting" ],
      "properties": {
        "headline": [ "Progress report" ],
        "datePublished": [ "2013-08-29" ],
        "url": [ "https://blog.example.com/progress-report?comments=0" ],
        "comment": [
          {
            "type": [ "http://schema.org/UserComments" ],
            "properties": {
              "url": [ "https://blog.example.com/progress-report#c1" ],
              "creator": [
                {
                  "type": [ "http://schema.org/Person" ],
                  "properties": {
                    "name": [ "Greg" ]
                  }
                },
              ],
              "commentTime": [ "2013-08-29" ]
            }
          },
          {
            "type": [ "http://schema.org/UserComments" ],
            "properties": {
              "url": [ "https://blog.example.com/progress-report#c2" ],
              "creator": [
                {
                  "type": [ "http://schema.org/Person" ],
                  "properties": {
                    "name": [ "Charlotte" ]
                  }
                },
              ],
              "commentTime": [ "2013-08-29" ]
            }
          }
        ]
    }
  ]
}
```
6 User interaction

6.1 The hidden attribute

All HTML elements may have the hidden content attribute set. The hidden attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>hidden</td>
<td>hidden</td>
<td>Will not be rendered.</td>
</tr>
<tr>
<td>(the empty string)</td>
<td>hidden until found</td>
<td>Will not be rendered, but content inside will be accessible to find-in-page and fragment navigation.</td>
</tr>
</tbody>
</table>

The attribute’s missing value default is the not hidden state, and its invalid value default is the hidden state.

When an element has the hidden attribute in the hidden state, it indicates that the element is not yet, or is no longer, directly relevant to the page’s current state, or that it is being used to declare content to be reused by other parts of the page as opposed to being directly accessed by the user. User agents should not render elements that are in the hidden state. This requirement may be implemented indirectly through the style layer. For example, a web browser could implement these requirements using the rules suggested in the Rendering section.

When an element has the hidden attribute in the hidden until found state, it indicates that the element is hidden like the hidden state but the content inside the element will be accessible to find-in-page and fragment navigation. When these features attempt to scroll to a target which is in the element’s subtree, the user agent will remove the hidden attribute in order to reveal the content before scrolling to it. In addition to removing the hidden attribute, an event named beforematch is also fired on the element before the hidden attribute is removed.

Web browsers will use ‘content-visibility: hidden’ instead of ‘display: none’ when the hidden attribute is in the hidden until found state, as specified in the Rendering section.

Note

Because this attribute is typically implemented using CSS, it’s also possible to override it using CSS. For instance, a rule that applies ‘display: block’ to all elements will cancel the effects of the hidden state. Authors therefore have to take care when writing their style sheets to make sure that the attribute is still styled as expected. In addition, legacy user agents which don’t support the hidden until found state will have ‘display: none’ instead of ‘content-visibility: hidden’, so authors are encouraged to make sure that their style sheets don’t change the ‘display’ or ‘content-visibility’ properties of hidden until found elements.

Since elements with the hidden attribute in the hidden until found state use ‘content-visibility: hidden’ instead of ‘display: none’, there are two caveats of the hidden until found state that make it different from the hidden state:

1. The element needs to be affected by layout containment in order to be revealed by find-in-page. This means that if the element in the hidden until found state has a ‘display’ value of ‘none’, ‘contents’, or ‘inline’, then the element will not be revealed by find-in-page.
2. The element will still have a generated box when in the hidden until found state, which means that borders, margin, and padding will still be rendered around the element.

Example

In the following skeletal example, the attribute is used to hide the web game’s main screen until the user logs in:

```html
<h1>The Example Game</h1>
<section id="login">
<h2>Login</h2>
<form>
...<br/>
<!-- calls login() once the user’s credentials have been checked -->
</form>
<script>
```
The `hidden` attribute must not be used to hide content that could legitimately be shown in another presentation. For example, it is incorrect to use `hidden` to hide panels in a tabbed dialog, because the tabbed interface is merely a kind of overflow presentation — one could equally well just show all the form controls in one big page with a scrollbar. It is similarly incorrect to use this attribute to hide content just from one presentation — if something is marked `hidden`, it is hidden from all presentations, including, for instance, screen readers.

Elements that are not themselves `hidden` must not hyperlink to elements that are `hidden`. The `for` attributes of `label` and `output` elements that are not themselves `hidden` must similarly not refer to elements that are `hidden`. In both cases, such references would cause user confusion.

Elements and scripts may, however, refer to elements that are `hidden` in other contexts.

**Example**

For example, it would be incorrect to use the `href` attribute to link to a section marked with the `hidden` attribute. If the content is not applicable or relevant, then there is no reason to link to it.

It would be fine, however, to use the ARIA `aria-describedby` attribute to refer to descriptions that are themselves `hidden`. While hiding the descriptions implies that they are not useful alone, they could be written in such a way that they are useful in the specific context of being referenced from the elements that they describe.

Similarly, a `canvas` element with the `hidden` attribute could be used by a scripted graphics engine as an off-screen buffer, and a form control could refer to a hidden `form` element using its `form` attribute.

Elements in a section hidden by the `hidden` attribute are still active, e.g. scripts and form controls in such sections still execute and submit respectively. Only their presentation to the user changes.

The `hidden` getter steps are:

1. If the `hidden` attribute is in the `hidden until found` state, then return "until-found".
2. If the `hidden` attribute is set, then return true.
3. Return false.

The `hidden` setter steps are:

1. If the given value is a string that is an ASCII case-insensitive match for "until-found", then set the `hidden` attribute to "until-found".
2. Otherwise, if the given value is false, then remove the `hidden` attribute.
3. Otherwise, if the given value is the empty string, then remove the `hidden` attribute.
4. Otherwise, if the given value is null, then remove the `hidden` attribute.
5. Otherwise, if the given value is 0, then remove the `hidden` attribute.
6. Otherwise, if the given value is NaN, then remove the `hidden` attribute.
7. Otherwise, set the `hidden` attribute to the empty string.

The ancestor hidden-until-found revealing algorithm is to run the following steps on `currentNode`:

```javascript
function login() {
  // switch screens
  document.getElementById('login').hidden = true;
  document.getElementById('game').hidden = false;
}
</script>
</section>
<section id="game" hidden>
  ...
</section>
```
1. While `currentNode` has a parent node within the flat tree:
   1. If `currentNode` has the `hidden` attribute in the `hidden until found` state, then:
      1. Fire an event named `beforematch` at `currentNode`.
      2. Remove the `hidden` attribute from `currentNode`.
   2. Set `currentNode` to the parent node of `currentNode` within the flat tree.

### 6.2 Page visibility

A traversable navigable's system visibility state, including its initial value upon creation, is determined by the user agent. It represents, for example, whether the browser window is minimized, a browser tab is currently in the background, or a system element such as a task switcher obscures the page.

When a user-agent determines that the system visibility state for traversable has changed to `newState`, it must run the following steps:

1. Let `navigables` be the inclusive descendant navigables of traversable's active document.
2. For each `navigable` of `navigables` in what order?
   1. Let `document` be `navigable`'s active document.
   2. Queue a global task on the user interaction task source given `document`'s relevant global object to update the visibility state of `document` with `newState`.

A Document has a visibility state, which is either "hidden" or "visible", initially set to "hidden".

The `visibilityState` getter steps are to return this's `visibility state`.

The `hidden` getter steps are to return true if this's `visibility state` is "hidden", otherwise false.

To update the `visibility state` of Document to `visibilityState`:

1. If `document`'s `visibility state` equals `visibilityState`, then return.
2. Set `document`'s `visibility state` to `visibilityState`.
3. Queue a new `VisibilityStateEntry` whose `visibility state` is `visibilityState` and whose `timestamp` is the current high resolution time given `document`'s relevant global object.
4. Run the screen orientation change steps with `document`.
5. Run the view transition page visibility change steps with `document`.
6. Run any page visibility change steps which may be defined in other specifications, with `visibility state` and `document`.
7. Fire an event named `visibilitychange` at `document`, with its `bubbles` attribute initialized to true.

### 6.2.1 The `VisibilityStateEntry` interface

The `VisibilityStateEntry` interface exposes visibility changes to the document, from the moment the document becomes active.
For example, this allows JavaScript code in the page to examine correlation between visibility changes and paint timing:

```javascript
function wasHiddenBeforeFirstContentfulPaint() {
    const fcpEntry = performance.getEntriesByName("first-contentful-paint")[0];
    const visibilityStateEntries = performance.getEntriesByType("visibility-state");
    return visibilityStateEntries.some(e =>
        e.startTime < fcpEntry.startTime &&
        e.name === "hidden";
}
```

The `VisibilityStateEntry` has an associated `DOMHighResTimeStamp` timestamp.

The `VisibilityStateEntry` has an associated "visible" or "hidden" visibility state.

The `name` getter steps are to return this's visibility state.

The `entryType` getter steps are to return "visibility-state".

The `startTime` getter steps are to return this's timestamp.

The `duration` getter steps are to return zero.

### 6.3 Inert subtrees

Note

See also [inert](#) for an explanation of the attribute of the same name.

A node (in particular elements and text nodes) can be inert. When a node is inert:

- Hit-testing must act as if the `pointer-events` CSS property were set to 'none'.
- Text selection functionality must act as if the `user-select` CSS property were set to 'none'.
- If it is editable, the node behaves as if it were non-editable.
- The user agent should ignore the node for the purposes of find-in-page.

Note

Inert nodes generally cannot be focused, and user agents do not expose the inert nodes to accessibility APIs or assistive technologies. Inert nodes that are commands will become inoperable to users, in the manner described above.

User agents may allow the user to override the restrictions on find-in-page and text selection, however.

By default, a node is not inert.
6.3.1 Modal dialogs and inert subtrees

A Document is blocked by a modal dialog subject if subject is the topmost dialog element in document's top layer. While document is so blocked, every node that is connected to document, with the exception of the subject element and its flat tree descendants, must become inert.

subject can additionally become inert via the inert attribute, but only if specified on subject itself (i.e., subject escapes inertness of ancestors); subject's flat tree descendants can become inert in a similar fashion.

Note
The dialog element's showModal() method causes this mechanism to trigger, by adding the dialog element to its node document's top layer.

6.3.2 The inert attribute

The inert attribute is a boolean attribute that indicates, by its presence, that the element and all its flat tree descendants which don't otherwise escape inertness (such as modal dialogs) are to be made inert by the user agent.

An inert subtree should not contain any content or controls which are critical to understanding or using aspects of the page which are not in the inert state. Content in an inert subtree will not be perceivable by all users, or interactive. Authors should not specify elements as inert unless the content they represent are also visually obscured in some way. In most cases, authors should not specify the inert attribute on individual form controls. In these instances, the disabled attribute is probably more appropriate.

Example
The following example shows how to mark partially loaded content, visually obscured by a "loading" message, as inert.

```html
<section aria-labelledby=s1>
  <h3 id=s1>Population by City</h3>
  <div class=container>
    <div class=loading><p>Loading...</p></div>
    <div inert>
      <form>
        <fieldset>
          <legend>Date range</legend>
          <div>
            <label for=start>Start</label>
            <input type=date id=start>
          </div>
          <div>
            <label for=end>End</label>
            <input type=date id=end>
          </div>
          <div>
            <button>Apply</button>
          </div>
        </fieldset>
      </form>
    </div>
  </div>
</section>
```

```
<table>
  <caption>From 20-- to 20---</caption>
  <thead>
    <tr>
      <th>City</th>
      <th>State</th>
      <th>20-- Population</th>
      <th>20-- Population</th>
      <th>Percentage change</th>
    </tr>
  </thead>
  <tbody>
  </tbody>
```

The inert IDL attribute must reflect the content attribute of the same name.

To prevent abuse of certain APIs that could be annoying to users (e.g., opening popups or vibrating phones), user agents allow these APIs only when the user is actively interacting with the web page or has interacted with the page at least once. This "active interaction" state is maintained through the mechanisms defined in this section.

For the purpose of tracking user activation, each Window \( W \) has two relevant values:

- A last activation timestamp, which is either a DOMHighResTimeStamp, positive infinity (indicating that \( W \) has never been activated), or negative infinity (indicating that the activation has been consumed). Initially positive infinity.

- A last history-action activation timestamp, which is either a DOMHighResTimeStamp or positive infinity, initially positive infinity.

A user agent also defines a transient activation duration, which is a constant number indicating how long a user activation is available for certain user activation-gated APIs (e.g., for opening popups).
We then have the following boolean user activation states for $W$:

**Sticky activation**

When the current high resolution time given $W$ is greater than or equal to the last activation timestamp $p823$ in $W$, $W$ is said to have sticky activation $p824$.

This is $W$'s historical activation state, indicating whether the user has ever interacted in $W$. It starts false, then changes to true (and never changes back to false) when $W$ gets the very first activation notification $p824$ $W$ gets.

**Transient activation**

When the current high resolution time given $W$ is greater than or equal to the last activation timestamp $p823$ in $W$, and less than the last activation timestamp $p823$ in $W$ plus the transient activation duration $p823$, then $W$ is said to have transient activation $p824$.

This is $W$'s current activation state, indicating whether the user has interacted in $W$ recently. This starts with a false value, and remains true for a limited time after every activation notification $p824$ $W$ gets.

The transient activation $p824$ state is considered expired if it becomes false because the transient activation duration $p823$ time has elapsed since the last user activation. Note that it can become false even before the expiry time through an activation consumption $p825$.

**History-action activation**

When the last history-action activation timestamp $p823$ of $W$ is not equal to the last activation timestamp $p823$ of $W$, then $W$ is said to have history-action activation $p824$.

This is a special variant of user activation, used to allow access to certain session history APIs which, if used too frequently, would make it harder for the user to traverse back using browser UI $p1058$. It starts with a false value, and becomes true whenever the user interacts with $W$, but is reset to false through history-action activation consumption $p825$. This ensures such APIs cannot be used multiple times in a row without an intervening user activation. But unlike transient activation $p824$, there is no time limit within which such APIs must be used.

---

**Note**

The transient activation duration $p823$ is expected be at most a few seconds, so that the user can possibly perceive the link between an interaction with the page and the page calling the activation-gated API.

---

6.4.2 Processing model

When a user interaction causes firing of an activation triggering input event $p825$ in a Document $p128$ document, the user agent must perform the following activation notification steps before dispatching the event:

1. Assert: document is fully active $p992$.
2. Let windows be « document's relevant global object $p1071».
3. Extend windows with the active window $p976$ of each of document's ancestor navigables $p983$.
4. Extend windows with the active window $p976$ of each of document's descendant navigables $p983$, filtered to include only those navigables $p978$ whose active document $p978$'s origin is same origin $p891$ with document's origin.
5. For each window in windows:
   1. Set window's last activation timestamp $p823$ to the current high resolution time.
   2. Notify the close watcher manager about user activation $p857$ given window.
An **activation triggering input event** is any event whose `isTrusted` attribute is true and whose `type` is one of:

- "keydown", provided the key is neither the Esc key nor a shortcut key reserved by the user agent;
- "mousedown";
- "pointerdown", provided the event's `PointerType` is "mouse";
- "pointerup", provided the event's `PointerType` is not "mouse"; or
- "touchend".

**Activation consuming APIs** defined in this and other specifications can **consume user activation** by performing the following steps, given a `Window` `W`:

1. If `W`'s `navigable` is null, then return.
2. Let `top` be `W`'s `navigable`'s `top-level traversable`.
3. Let `navigables` be the inclusive descendant navigables of `top`'s `active document`.
4. Let `windows` be the list of `Window` objects constructed by taking the `active window` of each item in `navigables`.
5. For each `window` in `windows`, if `window`'s `last activation timestamp` is not positive infinity, then set `window`'s `last activation timestamp` to negative infinity.

**History-action activation-consuming APIs** can **consume history-action user activation** by performing the following steps, given a `Window` `W`:

1. If `W`'s `navigable` is null, then return.
2. Let `top` be `W`'s `navigable`'s `top-level traversable`.
3. Let `navigables` be the inclusive descendant navigables of `top`'s `active document`.
4. Let `windows` be the list of `Window` objects constructed by taking the `active window` of each item in `navigables`.
5. For each `window` in `windows`, set `window`'s `last history-action activation timestamp` to `window`'s `last activation timestamp`.

---

**Note**

The asymmetry in the sets of **browsing contexts** in the page that are affected by an **activation notification** vs an **activation consumption**, an activation consumption changes (to false) the **transient activation** states for all browsing contexts in the page, but an activation notification changes (to true) the states for a subset of those browsing contexts. The exhaustive nature of consumption here is deliberate: it prevents malicious sites from making multiple calls to an **activation consuming API** from a single user activation (possibly by exploiting a deep hierarchy of `iframe` s).

---

### 6.4.3 APIs gated by user activation

APIs that are dependent on user activation are classified into different levels:

**Sticky activation-gated APIs**

These APIs require the **sticky activation** state to be true, so they are blocked until the very first user activation.

**Transient activation-gated APIs**

These APIs require the **transient activation** state to be true, but they don't **consume** it, so multiple calls are allowed per user activation until the transient state **expires**.

**Transient activation-consuming APIs**

These APIs require the **transient activation** state to be true, and they **consume user activation** in each call to prevent multiple calls per user activation.

**History-action activation-consuming APIs**

These APIs require the **history-action activation** state to be true, and they **consume history-action user activation** in each call.
to prevent multiple calls per user activation.

### 6.4.4 The UserActivation interface

Each Window has an associated UserActivation, which is a UserActivation object. Upon creation of the Window object, its associated UserActivation must be set to a new UserActivation object created in the Window object's relevant realm.

```idl
[Exposed=Window]
interface UserActivation {
    readonly attribute boolean hasBeenActive;
    readonly attribute boolean isActive;
};

partial interface Navigator {
    [SameObject] readonly attribute UserActivation userActivation;
};
```

The `userActivation` getter steps are to return this's relevant global object's associated UserActivation.

The `hasBeenActive` getter steps are to return true if this's relevant global object has sticky activation, and false otherwise.

The `isActive` getter steps are to return true if this's relevant global object has transient activation, and false otherwise.

### 6.5 Activation behavior of elements

Certain elements in HTML have an activation behavior, which means that the user can activate them. This is always caused by a click event.

The user agent should allow the user to manually trigger elements that have an activation behavior, for instance using keyboard or voice input, or through mouse clicks. When the user triggers an element with a defined activation behavior in a manner other than
clicking it, the default action of the interaction event must be to fire a `click` event\(^\text{p1129}\) at the element.

For web developers (non-normative)

```
  element.click\(^\text{p827}\)
 Acts as if the element was clicked.
```

Each element has an associated **click in progress flag**, which is initially unset.

The `click()` method must run the following steps:

1. If this element is a form control that is `disabled`\(^\text{p597}\), then return.
2. If this element's **click in progress flag**\(^\text{p827}\) is set, then return.
3. Set this element's **click in progress flag**\(^\text{p827}\).
4. Fire a synthetic pointer event\(^\text{p1129}\) named `click` at this element, with the `not trusted flag` set.
5. Unset this element's **click in progress flag**\(^\text{p827}\).

### 6.5.1 The **ToggleEvent**\(^\text{p827}\) interface

```
interface ToggleEvent : Event {
  constructor(DOMString type, optional ToggleEventInit eventInitDict = {});
  readonly attribute DOMString oldState;
  readonly attribute DOMString newState;
};

dictionary ToggleEventInit : EventInit {
  DOMString oldState = "";
  DOMString newState = "";
};
```

For web developers (non-normative)

```
  event.oldState\(^\text{p827}\)
  Set to "closed" when transitioning from closed to open, or set to "open" when transitioning from open to closed.

  event.newState\(^\text{p827}\)
  Set to "open" when transitioning from closed to open, or set to "closed" when transitioning from open to closed.
```

The `oldState` and `newState` attributes must return the values they are initialized to.

A **toggle task tracker** is a `struct` which has:

- `task`
  - A `task`\(^\text{p110}\) which fires a `ToggleEvent`\(^\text{p827}\).

- `old state`
  - A string which represents the `task`\(^\text{p827}\)'s event's value for the `oldState`\(^\text{p827}\) attribute.

### 6.6 Focus

### 6.6.1 Introduction

This section is non-normative.

An HTML user interface typically consists of multiple interactive widgets, such as form controls, scrollable regions, links, dialog boxes,
browser tabs, and so forth. These widgets form a hierarchy, with some (e.g. browser tabs, dialog boxes) containing others (e.g. links, form controls).

When interacting with an interface using a keyboard, key input is channeled from the system, through the hierarchy of interactive widgets, to an active widget, which is said to be focused.

Example
Consider an HTML application running in a browser tab running in a graphical environment. Suppose this application had a page with some text controls and links, and was currently showing a modal dialog, which itself had a text control and a button.

The hierarchy of focusable widgets, in this scenario, would include the browser window, which would have, amongst its children, the browser tab containing the HTML application. The tab itself would have as its children the various links and text controls, as well as the dialog. The dialog itself would have as its children the text control and the button.

If the widget with focus in this example was the text control in the dialog box, then key input would be channeled from the graphical system to: ① the web browser, then to ② the tab, then to ③ the dialog, and finally to ④ the text control.

Keyboard events are always targeted at this focused element.

6.6.2 Data model
A top-level traversable has system focus when it can receive keyboard input channeled from the operating system, possibly targeted at one of its active document's descendant navigables.

A top-level traversable has user attention when its system visibility state is "visible", and it either has system focus or user agent widgets directly related to it can receive keyboard input channeled from the operating system.

Note
User attention is lost when a browser window loses focus, whereas system focus might also be lost to other system widgets in the browser window such as a location bar.

A Document is a fully active descendant of a top-level traversable with user attention when d is fully active and d's node navigable's top-level traversable has user attention.
The term **focusable area** is used to refer to regions of the interface that can further become the target of such keyboard input. Focusable areas can be elements, parts of elements, or other regions managed by the user agent.

Each **focusable area** has a **DOM anchor**, which is a Node object that represents the position of the focusable area in the DOM. (When the focusable area is itself a Node, it is its own DOM anchor.) The DOM anchor is used in some APIs as a substitute for the focusable area when there is no other DOM object to represent the focusable area.

The following table describes what objects can be focusable areas. The cells in the left column describe objects that can be focusable areas; the cells in the right column describe the DOM anchors for those elements. (The cells that span both columns are non-normative examples.)

<table>
<thead>
<tr>
<th>Focusable area</th>
<th>Examples</th>
<th>DOM anchor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elements that meet all the following criteria:</td>
<td></td>
<td>The element itself.</td>
</tr>
<tr>
<td>• the element's tabindex value is non-null, or the element is determined by the user agent to be focusable;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• the element is either not a shadow host, or has a shadow root whose delegates focus is false;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• the element is not actually disabled;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• the element is not inert;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• the element is either being rendered, delegating its rendering to its children, or being used as relevant canvas fallback content.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The shapes of area elements in an image map associated with an img element that is being rendered and is not inert.</td>
<td></td>
<td>The img element.</td>
</tr>
<tr>
<td>The user-agent provided subwidgets of elements that are being rendered and are not actually disabled or inert.</td>
<td></td>
<td>The element for which the focusable area is a subwidget.</td>
</tr>
<tr>
<td>The scrollable regions of elements that are being rendered and are not inert.</td>
<td></td>
<td>The element for which the box that the scrollable region was created.</td>
</tr>
<tr>
<td>The CSS overflow property's 'scroll' value typically creates a scrollable region.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The viewport of a Document that has a non-null browsing context and is not inert.</td>
<td></td>
<td>The Document for which the viewport was created.</td>
</tr>
<tr>
<td>The contents of an iframe.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any other element or part of an element determined by the user agent to be a focusable area, especially to aid with accessibility or to better match platform conventions.</td>
<td></td>
<td>The element.</td>
</tr>
</tbody>
</table>
Examples

Example
A user agent could make all list item bullets sequentially focusable, so that a user can more easily navigate lists.

Example
Similarly, a user agent could make all elements with title attributes sequentially focusable, so that their advisory information can be accessed.

Note
A navigable container (e.g. an iframe) is a focusable area, but key events routed to a navigable container get immediately routed to its content navigable's active document. Similarly, in sequential focus navigation a navigable container essentially acts merely as a placeholder for its content navigable's active document.

Note
Even if a document is not fully active and not shown to the user, it can still have a focused area of the document. If a document's fully active state changes, its focused area of the document will stay the same.

One focusable area in each Document is designated the focused area of the document. Which control is so designated changes over time, based on algorithms in this specification.

The currently focused area of a top-level traversable is the focusable area of that traversable, if traversable is non-null, or an empty list otherwise.

An element that is the DOM anchor of a focusable area is said to gain focus when that focusable area becomes the currently focused area of a top-level traversable. When an element is the DOM anchor of a focusable area of the currently focused area of a top-level traversable, it is focused.

The focus chain of a focusable area subject is the ordered list constructed as follows:

1. Let output be an empty list.
2. Let currentObject be subject.
3. While true:
   1. Append currentObject to output.
   2. If currentObject is an area element's shape, then append that area element to output.
      Otherwise, if currentObject's DOM anchor is an element that is not currentObject itself, then append currentObject's DOM anchor to output.
   3. If currentObject is a focusable area, then set currentObject to currentObject's DOM anchor's node document.
      Otherwise, if currentObject is a Document whose node navigable's parent is non-null, then set currentObject to currentObject's node navigable's parent.
      Otherwise, break.

A user agent could make all list item bullets sequentially focusable, so that a user can more easily navigate lists.

Similarly, a user agent could make all elements with title attributes sequentially focusable, so that their advisory information can be accessed.

A navigable container (e.g. an iframe) is a focusable area, but key events routed to a navigable container get immediately routed to its content navigable's active document. Similarly, in sequential focus navigation a navigable container essentially acts merely as a placeholder for its content navigable's active document.

Even if a document is not fully active and not shown to the user, it can still have a focused area of the document. If a document's fully active state changes, its focused area of the document will stay the same.

The currently focused area of a top-level traversable is the focusable area of that traversable, if traversable is non-null, or an empty list otherwise.

An element that is the DOM anchor of a focusable area is said to gain focus when that focusable area becomes the currently focused area of a top-level traversable. When an element is the DOM anchor of a focusable area of the currently focused area of a top-level traversable, it is focused.

The focus chain of a focusable area subject is the ordered list constructed as follows:

1. Let output be an empty list.
2. Let currentObject be subject.
3. While true:
   1. Append currentObject to output.
   2. If currentObject is an area element's shape, then append that area element to output.
      Otherwise, if currentObject's DOM anchor is an element that is not currentObject itself, then append currentObject's DOM anchor to output.
   3. If currentObject is a focusable area, then set currentObject to currentObject's DOM anchor's node document.
      Otherwise, if currentObject is a Document whose node navigable's parent is non-null, then set currentObject to currentObject's node navigable's parent.
      Otherwise, break.
4. Return output.

All elements that are focusable areas are said to be focusable.

There are two special types of focusability for focusable areas:

• A focusable area is said to be sequentially focusable if it is included in its Document's sequential focus navigation order and the user agent determines that it is sequentially focusable.

• A focusable area is said to be click focusable if the user agent determines that it is click focusable. User agents should consider focusable areas with non-null tabindex values to be click focusable.

A node is a focus navigation scope owner if it is a Document, a shadow host, a slot, or an element in the popover showing state which also has a popover invoker set.

Each focus navigation scope owner has a focus navigation scope, which is a list of elements. Its contents are determined as follows:

Every element element has an associated focus navigation owner, which is either null or a focus navigation scope owner. It is determined by the following algorithm:

1. If element's parent is null, then return null.
2. If element's parent is a shadow host, then return element's assigned slot.
3. If element's parent is a shadow root, then return the parent's host.
4. If element's parent is the document element, then return the parent's node document.
5. If element is in the `popover showing state` and has a `popover invoker` set, then return element.

6. Return element’s parent’s `associated focus navigation owner`.

Then, the contents of a given `focus navigation scope owner` owner’s `focus navigation scope` are all elements whose `associated focus navigation owner` is owner.

**Note**

The order of elements within a `focus navigation scope` does not impact any of the algorithms in this specification. Ordering only becomes important for the `tabindex-ordered focus navigation scope` and `flattened tabindex-ordered focus navigation scope` concepts defined below.

A `tabindex-ordered focus navigation scope` is a list of `focusable areas` and `focus navigation scope owners`. Every `focus navigation scope owner` owner has a `tabindex-ordered focus navigation scope`, whose contents are determined as follows:

- It contains all elements in owner’s `focus navigation scope` that are themselves `focus navigation scope owners`, except the elements whose `tabindex value` is a negative integer.
- It contains all of the `focusable areas` whose `DOM anchor` is an element in owner’s `focus navigation scope`, except the `focusable areas` whose `tabindex value` is a negative integer.

The order within a `tabindex-ordered focus navigation scope` is determined by each element’s `tabindex value`, as described in the section below.

**Note**

The rules there do not give a precise ordering, as they are composed mostly of “should” statements and relative orderings.

A `flattened tabindex-ordered focus navigation scope` is a list of `focusable areas`. Every `focus navigation scope owner` owner owns a distinct `flattened tabindex-ordered focus navigation scope`, whose contents are determined by the following algorithm:

1. Let result be a clone of owner’s `tabindex-ordered focus navigation scope`.
2. For each item of result:
   1. If item is not a `focus navigation scope owner`, then continue.
   2. If item is not a `focusable area`, then replace item with all of the items in item’s `flattened tabindex-ordered focus navigation scope`.
   3. Otherwise, insert the contents of item’s `flattened tabindex-ordered focus navigation scope` after item.

6.6.3 The `tabindex` attribute

The `tabindex` content attribute allows authors to make an element and regions that have the element as its `DOM anchor` be `focusable areas`, allow or prevent them from being `sequentially focusable`, and determine their relative ordering for `sequential focus navigation`.

The name “tab index” comes from the common use of the Tab key to navigate through the focusable elements. The term “tabbing” refers to moving forward through sequentially focusable `focusable areas`.

The `tabindex` attribute, if specified, must have a value that is a valid integer. Positive numbers specify the relative position of the element’s `focusable areas` in the `sequential focus navigation order`, and negative numbers indicate that the control is not sequentially focusable.

Developers should use caution when using values other than 0 or −1 for their `tabindex` attributes as this is complicated to do correctly.

**Note**

The following provides a non-normative summary of the behaviors of the possible `tabindex` attribute values.
The **tabindex** value of an element is the value of its **tabindex** attribute, parsed using the rules for parsing integers. If parsing fails or the attribute is not specified, then the **tabindex** value is null.

**omitted (or non-integer values)**

The user agent will decide whether the element is **focusable**, and if it is, whether it is **sequentially focusable** or **click focusable** (or both).

**−1 (or other negative integer values)**

Causes the element to be **focusable**, and indicates that the author would prefer the element to be **click focusable** but not **sequentially focusable**. The user agent might ignore this preference for click and sequential focusability, e.g., for specific element types according to platform conventions, or for keyboard-only users.

**0**

Causes the element to be **focusable**, and indicates that the author would prefer the element to be both **click focusable** and **sequentially focusable**. The user agent might ignore this preference for click and sequential focusability.

**positive integer values**

Behaves the same as 0, but in addition creates a relative ordering within a **tabindex-ordered focus navigation scope**, so that elements with higher **tabindex** attribute value come later.

Note that the **tabindex** attribute cannot be used to make an element non-focusable. The only way a page author can do that is by disabling the element, or making it **inert**.

The **tabindex** value of an element is the value of its **tabindex** attribute, parsed using the rules for parsing integers. If parsing fails or the attribute is not specified, then the **tabindex** value is null.

The **tabindex** value of a **focusable area** is the **tabindex** value of its **DOM anchor**.

The **tabindex** value of an element must be interpreted as follows:

**If the value is null**

The user agent should follow platform conventions to determine if the element should be considered as a **focusable area** and if so, whether the element and any **focusable areas** that have the element as their **DOM anchor** are **sequentially focusable**, and if so, what their relative position in their **tabindex-ordered focus navigation scope** is to be. If the element is a **focus navigation scope owner**, it must be included in its **tabindex-ordered focus navigation scope** even if it is not a **focusable area**.

The relative ordering within a **tabindex-ordered focus navigation scope** for elements and **focusable areas** that belong to the same **focus navigation scope** and whose **tabindex value** is null should be in **shadow-including tree order**.

Modulo platform conventions, it is suggested that the following elements should be considered as **focusable areas** and be **sequentially focusable**:

- **a** elements that have an **href** attribute
- **button** elements
- **input** elements whose **type** attribute are not in the **Hidden** state
- **select** elements
- **textarea** elements
- **summary** elements that are the first **summary** child of a **details** element
- Elements with a **draggable** attribute set, if that would enable the user agent to allow the user to begin drag operations for those elements without the use of a pointing device
- **Editing hosts**
- **Navigable containers**

**If the value is a negative integer**

The user agent must consider the element as a **focusable area**, but should omit the element from any **tabindex-ordered focus navigation scope**.
If the value is a zero

The user agent must allow the element to be considered as a focusable area⁸₂⁹ and should allow the element and any focusable areas⁸₂⁸ that have the element as their DOM anchor⁸₂⁹ to be sequentially focusable⁸₃₁.

The relative ordering within a tabindex-ordered focus navigation scope⁸₃₂ for elements and focusable areas⁸₂⁹ that belong to the same focus navigation scope⁸₃₁ and whose tabindex value⁸₃₃ is zero should be in shadow-including tree order.

If the value is greater than zero

The user agent must allow the element to be considered as a focusable area⁸₂⁹ and should allow the element and any focusable areas⁸₂⁸ that have the element as their DOM anchor⁸₂⁹ to be sequentially focusable⁸₃₁, and should place the element — referenced as candidate below — and the aforementioned focusable areas⁸₂⁹ in the tabindex-ordered focus navigation scope⁸₃₂ where the element is a part of so that, relative to other elements and focusable areas⁸₂⁹ that belong to the same focus navigation scope⁸₃₁, they are:

- before any focusable area⁸₂⁹ whose DOM anchor⁸₂⁹ is an element whose tabindex attribute has been omitted or whose value, when parsed, returns an error,
- before any focusable area⁸₂⁹ whose DOM anchor⁸₂⁹ is an element whose tabindex attribute has a value less than or equal to zero,
- after any focusable area⁸₂⁹ whose DOM anchor⁸₂⁹ is an element whose tabindex attribute has a value greater than zero but less than the value of the tabindex attribute on candidate,
- after any focusable area⁸₂⁹ whose DOM anchor⁸₂⁹ is an element whose tabindex attribute has a value equal to the value of the tabindex attribute on candidate but that is located earlier than candidate in shadow-including tree order,
- before any focusable area⁸₂⁹ whose DOM anchor⁸₂⁹ is an element whose tabindex attribute has a value equal to the value of the tabindex attribute on candidate but that is located later than candidate in shadow-including tree order, and
- before any focusable area⁸₂⁹ whose DOM anchor⁸₂⁹ is an element whose tabindex attribute has a value greater than the value of the tabindex attribute on candidate.

The tabIndex IDL attribute must reflect the value of the tabindex content attribute. The default value¹⁰⁵ is 0 if the element is an area⁴₆₈, button⁵₆₁, frame⁴¹₄, iframe⁴₃₇, input⁵₁₇, object⁹₉₈, select⁶₄, textarea⁵₇₅ or SVG a element, or is a summary element that is a summary for its parent details⁶₃⁹. The default value¹⁰⁵ is −1 otherwise.

Note

The varying default value based on element type is a historical artifact.

6.6.4 Processing model

To get the focusable area for a focus target that is either an element that is not a focusable area⁸₂⁹, or is a navigable⁹⁷₈, given an optional string focus trigger (default "other"), run the first matching set of steps from the following list:

- If focus target is an area⁴₆₈ element with one or more shapes that are focusable areas⁸₂⁹
  Return the shape corresponding to the first img⁴₃⁴ element in tree order that uses the image map to which the area⁴₆₈ element belongs.

- If focus target is an element with one or more scrollable regions that are focusable areas⁸₂⁹
  Return the element's first scrollable region, according to a pre-order, depth-first traversal of the flat tree. [CSSSCOPING]¹⁴₅⁷

- If focus target is the document element of its Document⁸₁₂⁹
  Return the Document⁸₁₂⁹'s viewport.
If focus target is a navigable, return the navigable's active document.

If focus target is a navigable container with a non-null content navigable, return the navigable container's content navigable's active document.

If focus target is a shadow host whose shadow root's delegates focus is true:

1. Let focusedElement be the currently focused area of a top-level traversable's DOM anchor.
2. If focus target is a shadow-including inclusive ancestor of focusedElement, then return focusedElement.
3. Return the focus delegate for focus target given focus trigger.

Otherwise return null.

The focus delegate for a focusTarget, given an optional string focusTrigger (default "other"), is given by the following steps:

1. If focusTarget is a shadow host and its shadow root's delegates focus is false, then return null.
2. Let whereToLook be focusTarget.
3. If whereToLook is a shadow host, then set whereToLook to whereToLook's shadow root.
4. Let autofocusDelegate be the autofocus delegate for whereToLook given focusTrigger.
5. If autofocusDelegate is not null, then return autofocusDelegate.
6. For each descendant of whereToLook's descendants, in tree order:
   1. Let focusableArea be null.
   2. If focusTarget is a dialog element and descendant is sequentially focusable, then set focusableArea to descendant.
   3. Otherwise, if focusTarget is not a dialog and descendant is a focusable area, set focusableArea to descendant.
   4. Otherwise, set focusableArea to the result of getting the focusable area for descendant given focusTrigger.
      This step can end up recursing, i.e., the get the focusable area steps might return the focus delegate of descendant.
5. If focusableArea is not null, then return focusableArea.

   It's important that we are not looking at the shadow-including descendants here, but instead only at the descendants. Shadow hosts are instead handled by the recursive case mentioned above.

The above algorithm essentially returns the first suitable focusable area where the path between its DOM anchor and focusTarget delegates focus at any shadow tree boundaries.

The autofocus delegate for a focus target given a focus trigger is given by the following steps:

1. For each descendant descendant of focus target, in tree order:
1. If descendant does not have an autofocus content attribute, then continue.

2. Let focusable area be descendant, if descendant is a focusable area, otherwise let focusable area be the result of getting the focusable area for descendant given focus trigger.

3. If focusable area is null, then continue.

4. If focusable area is not click focusable and focus trigger is "click", then continue.

5. Return focusable area.

2. Return null.

The focusing steps for an object new focus target that is either a focusable area, or an element that is not a focusable area or a navigable, are as follows. They can optionally be run with a fallback target and a string focus trigger.

1. If new focus target is not a focusable area, then set new focus target to the result of getting the focusable area for new focus target, given focus trigger if it was passed.

2. If new focus target is null, then:
   1. If no fallback target was specified, then return.
   2. Otherwise, set new focus target to the fallback target.

3. If new focus target is a navigable container with non-null content navigable, then set new focus target to the content navigable's active document.

4. If new focus target is a focusable area and its DOM anchor is inert, then return.

5. If new focus target is the currently focused area of a top-level traversable, then return.

6. Let old chain be the current focus chain of the top-level traversable in which new focus target finds itself.

7. Let new chain be the focus chain of new focus target.

8. Run the focus update steps with old chain, new chain, and new focus target respectively.

User agents must immediately run the focusing steps for a focusable area or navigable candidate whenever the user attempts to move the focus to candidate.

The unfocusing steps for an object old focus target that is either a focusable area or an element that is not a focusable area are as follows:

1. If old focus target is a shadow host whose shadow root's delegates focus is true, and old focus target's shadow root is a shadow-including inclusive ancestor of the currently focused area of a top-level traversable's DOM anchor, then set old focus target to that currently focused area of a top-level traversable.

2. If old focus target is inert, then return.

3. If old focus target is an area element and one of its shapes is the currently focused area of a top-level traversable, or, if old focus target is an element with one or more scrollable regions, and one of them is the currently focused area of a top-level traversable, then let old focus target be that currently focused area of a top-level traversable.

4. Let old chain be the current focus chain of the top-level traversable in which old focus target finds itself.

5. If old focus target is not one of the entries in old chain, then return.

6. If old focus target is not a focusable area, then return.

7. Let topDocument be old chain's last entry.

8. If topDocument's node navigable has system focus, then run the focusing steps for topDocument's viewport.

   Otherwise, apply any relevant platform-specific conventions for removing system focus from topDocument's node navigable, and run the focus update steps given old chain, an empty list, and null.

Note: The unfocusing steps do not always result in the focus changing, even when applied to the currently focused area of a top-level.
The focus update steps, given an old chain, a new chain, and a new focus target respectively, are as follows:

1. If the last entry in old chain and the last entry in new chain are the same, pop the last entry from old chain and the last entry from new chain and redo this step.

2. For each entry entry in old chain, in order, run these substeps:
   1. If entry is an input element, and the change event applies to the element, and the element does not have a defined activation behavior, and the user has changed the element’s value or its list of selected files while the control was focused without committing that change (such that it is different to what it was when the control was first focused), then:
      1. Set entry’s user validity to true.
      2. Fire an event named change at the element, with the bubbles attribute initialized to true.
   2. If entry is an element, let blur event target be entry.
      If entry is a Document object, let blur event target be that Document object’s relevant global object.
      Otherwise, let blur event target be null.
   3. If entry is the last entry in old chain, and entry is an Element, and the last entry in new chain is also an Element, then let related blur target be the last entry in new chain. Otherwise, let related blur target be null.
   4. If blur event target is not null, fire a focus event named blur at blur event target, with related blur target as the related target.

3. Apply any relevant platform-specific conventions for focusing new focus target. (For example, some platforms select the contents of a text control when that control is focused.)

4. For each entry entry in new chain, in reverse order, run these substeps:
   1. If entry is a focusable area, and the focused area of the document is not entry:
      1. Set document’s relevant global object’s navigation API’s focus changed during ongoing navigation to true.
      2. Designate entry as the focused area of the document.
   2. If entry is an element, let focus event target be entry.
      If entry is a Document object, let focus event target be that Document object’s relevant global object.
      Otherwise, let focus event target be null.
   3. If entry is the last entry in new chain, and entry is an Element, and the last entry in old chain is also an Element, then let related focus target be the last entry in old chain. Otherwise, let related focus target be null.
   4. If focus event target is not null, fire a focus event named focus at focus event target, with related focus target as the related target.

   Note: In some cases, e.g., if entry is an area element’s shape, a scrollable region, or a viewport, no event is fired.

To fire a focus event named e at an element t with a given related target r, fire an event named e at t, using FocusEvent, with the relatedTarget attribute initialized to r, the view attribute initialized to t’s node document’s relevant global object, and the composed flag set.
When a key event is to be routed in a **top-level traversable**\(^{p979}\), the user agent must run the following steps:

1. Let **target area** be the currently focused area of the top-level traversable\(^{p830}\).
2. **Assert**: target area is not null, since key events are only routed to **top-level traversables**\(^{p979}\) that have system focus\(^{p828}\). Therefore, target area is a **focusable area**\(^{p829}\).
3. Let target node be target area's **DOM anchor**\(^{p829}\).
4. If target node is a **Document**\(^{p128}\) that has a **body element**\(^{p134}\), then let target node be the body element\(^{p134}\) of that Document\(^{p128}\).
   
   Otherwise, if target node is a Document\(^{p128}\) object that has a non-null document element, then let target node be that document element.
5. If target node is not inert\(^{p821}\), then:
   
   1. Let canHandle be the result of dispatching the key event at target node.
   2. If canHandle is true, then let target area handle the key event. This might include firing a click event\(^{p1129}\) at target node.

**has focus steps**, given a **Document**\(^{p128}\) object target, are as follows:

1. If target's node navigable\(^{p979}\)'s top-level traversable\(^{p980}\) does not have system focus\(^{p828}\), then return false.
2. Let candidate be target's node navigable\(^{p979}\)'s top-level traversable\(^{p980}\)'s active document\(^{p987}\).
3. While true:
   
   1. If candidate is target, then return true.
   2. If the focused area\(^{p830}\) of candidate is a navigable container\(^{p981}\) with a non-null content navigable\(^{p981}\), then set candidate to the active document\(^{p978}\) of that navigable container\(^{p981}\)'s content navigable\(^{p981}\).
   3. Otherwise, return false.

**6.6.5 Sequential focus navigation** \(^{5 \text{p83}}\)

Each **Document**\(^{p128}\) has a sequential focus navigation order, which orders some or all of the focusable areas\(^{p829}\) in the **Document**\(^{p128}\) relative to each other. Its contents and ordering are given by the flattened tabindex-ordered focus navigation scope\(^{p832}\) of the Document\(^{p128}\).

**Note**

*Per the rules defining the flattened tabindex-ordered focus navigation scope\(^{p832}\), the ordering is not necessarily related to the tree order of the **Document**\(^{p128}\).*

If a focusable area\(^{p829}\) is omitted from the sequential focus navigation order\(^{p838}\) of its **Document**\(^{p128}\), then it is unreachable via sequential focus navigation\(^{p838}\).

There can also be a sequential focus navigation starting point. It is initially unset. The user agent may set it when the user indicates that it should be moved.

**Example**

For example, the user agent could set it to the position of the user's click if the user clicks on the document contents.

**Note**

*User agents are required to set the sequential focus navigation starting point\(^{p838}\) to the target element\(^{p1043}\) when navigating to a fragment\(^{p1020}\).*

When the user requests that focus move from the currently focused area of a top-level traversable\(^{p979}\) to the next or previous focusable
area\textsuperscript{9829} (e.g. as the default action of pressing the tab key), or when the user requests that focus sequentially move to a top-level traversable\textsuperscript{9979} in the first place (e.g. from the browser’s location bar), the user agent must use the following algorithm:

1. Let starting point be the currently focused area of a top-level traversable\textsuperscript{9830}, if the user requested to move focus sequentially from there, or else the top-level traversable\textsuperscript{9979} itself, if the user instead requested to move focus from outside the top-level traversable\textsuperscript{9979}.

2. If there is a sequential focus navigation starting point\textsuperscript{9838} defined and it is inside starting point, then let starting point be the sequential focus navigation starting point\textsuperscript{9838} instead.

3. Let direction be forward if the user requested the next control, and backward if the user requested the previous control.

\textbf{Note}

Typically, pressing tab requests the next control, and pressing shift + tab requests the previous control.

4. Loop: Let selection mechanism be sequential if the starting point is a navigable\textsuperscript{9978} or if starting point is in its Document\textsuperscript{9228}'s sequential focus navigation order\textsuperscript{9838}.

Otherwise, starting point is not in its Document\textsuperscript{9128}'s sequential focus navigation order\textsuperscript{9838}; let selection mechanism be DOM.

5. Let candidate be the result of running the sequential navigation search algorithm\textsuperscript{9839} with starting point, direction, and selection mechanism as the arguments.

6. If candidate is not null, then run the focusing steps\textsuperscript{9836} for candidate and return.

7. Otherwise, unset the sequential focus navigation starting point\textsuperscript{9838}.

8. If starting point is a top-level traversable\textsuperscript{9979}, or a focusable area\textsuperscript{9939} in the top-level traversable\textsuperscript{9979}, the user agent should transfer focus to its own controls appropriately (if any), honouring direction, and then return.

\textbf{Example}

For example, if direction is backward, then the last sequentially focusable\textsuperscript{9831} control before the browser’s rendering area would be the control to focus.

If the user agent has no sequentially focusable\textsuperscript{9831} controls — a kiosk-mode browser, for instance — then the user agent may instead restart these steps with the starting point being the top-level traversable\textsuperscript{9979} itself.

9. Otherwise, starting point is a focusable area\textsuperscript{9929} in a child navigable\textsuperscript{9981}. Set starting point to that child navigable\textsuperscript{9981}'s parent\textsuperscript{9938} and return to the step labeled loop.

The sequential navigation search algorithm consists of the following steps. This algorithm takes three arguments: starting point, direction, and selection mechanism.

1. Pick the appropriate cell from the following table, and follow the instructions in that cell.

The appropriate cell is the one that is from the column whose header describes direction and from the first row whose header describes starting point and selection mechanism.

<table>
<thead>
<tr>
<th>starting point is a navigable\textsuperscript{9978}</th>
<th>direction is forward</th>
<th>direction is backward</th>
</tr>
</thead>
<tbody>
<tr>
<td>Let candidate be the first suitable sequentially focusable area\textsuperscript{9939} in starting point's active document\textsuperscript{9994}, if any; or else null</td>
<td>Let candidate be the last suitable sequentially focusable area\textsuperscript{9939} in starting point's active document\textsuperscript{9994}, if any; or else null</td>
<td></td>
</tr>
<tr>
<td>Let candidate be the first suitable sequentially focusable area\textsuperscript{9939} in the home document\textsuperscript{9994} following starting point, if any; or else null</td>
<td>Let candidate be the last suitable sequentially focusable area\textsuperscript{9939} in the home document\textsuperscript{9994} preceding starting point, if any; or else null</td>
<td></td>
</tr>
<tr>
<td>Let candidate be the first suitable sequentially focusable area\textsuperscript{9939} in the home sequential focus navigation order\textsuperscript{9939} following starting point, if any; or else null</td>
<td>Let candidate be the last suitable sequentially focusable area\textsuperscript{9939} in the home sequential focus navigation order\textsuperscript{9939} preceding starting point, if any; or else null</td>
<td></td>
</tr>
</tbody>
</table>

A suitable sequentially focusable area is a focusable area\textsuperscript{9929} whose DOM anchor\textsuperscript{9829} is not inert\textsuperscript{9921} and is sequentially focusable\textsuperscript{9831}.

The home document is the Document\textsuperscript{9128} to which starting point belongs.

The home sequential focus navigation order is the sequential focus navigation order\textsuperscript{9838} to which starting point belongs.
2. If `candidate` is a navigable container with a non-null content navigable, then let `new candidate` be the result of running the sequential navigation search algorithm with `candidate`'s content navigable as the first argument, direction as the second, and sequential as the third.

If `new candidate` is null, then let `starting point` be `candidate`, and return to the top of this algorithm. Otherwise, let `candidate` be `new candidate`.

3. Return `candidate`.

### 6.6.6 Focus management APIs

```idl
dictionary FocusOptions {
  boolean preventScroll = false;
  boolean focusVisible;
};
```

For web developers (non-normative)

**documentOrShadowRoot.activeElement**

Returns the deepest element in the document through which or to which key events are being routed. This is, roughly speaking, the focused element in the document.

For the purposes of this API, when a child navigable is focused, its container is focused within its parent's active document. For example, if the user moves the focus to a text control in an iframe, the iframe's element returned by the `activeElement` API in the iframe's node document.

Similarly, when the focused element is in a different node tree than `documentOrShadowRoot`, the element returned will be the host that's located in the same node tree as `documentOrShadowRoot` if `documentOrShadowRoot` is a shadow-including inclusive ancestor of the focused element, and null if not.

**document.hasFocus**

Returns true if key events are being routed through or to the document; otherwise, returns false. Roughly speaking, this corresponds to the document, or a document nested inside this one, being focused.

**window.focus**

Moves the focus to the window's navigable, if any.

**element.focus**([ { preventScroll: true } ])

Moves the focus to the element.

If the element is a navigable container, moves the focus to its content navigable instead.

By default, this method also scrolls the element into view. Providing the `preventScroll` option and setting it to true prevents this behavior.

**element.blur**

Moves the focus to the viewport. Use of this method is discouraged; if you want to focus the viewport, call the `focus()` method on the Document's document element.

Do not use this method to hide the focus ring if you find the focus ring unsightly. Instead, use the `:focus-visible` pseudo-class to override the 'outline' property, and provide a different way to show what element is focused. Be aware that if an alternative focusing style isn't made available, the page will be significantly less usable for people who primarily navigate pages using a keyboard, or those with reduced vision who use focus outlines to help them navigate the page.

Example

For example, to hide the outline from textarea elements and instead use a yellow background to indicate focus, you could use:
The `activeElement` attribute’s getter must run these steps:

1. Let `candidate` be the `DOM anchor` of the focused area of this `DocumentOrShadowRoot`'s node document.
2. Set `candidate` to the result of retargeting `candidate` against this `DocumentOrShadowRoot`.
3. If `candidate`'s root is not this `DocumentOrShadowRoot`, then return null.
4. If `candidate` is not a `Document` object, then return `candidate`.
5. If `candidate` has a body element, then return that body element.
6. If `candidate`'s document element is non-null, then return that document element.
7. Return null.

The `hasFocus()` method on the `Document` object, when invoked, must return the result of running the `has focus steps` with the `Document` object as the argument.

The `focus()` method, when invoked, must run these steps:

1. Let `current` be this `Window` object's navigable.
2. If `current` is null, then return.
3. Run the focusing steps with `current`.
4. If `current` is a top-level traversable, user agents are encouraged to trigger some sort of notification to indicate to the user that the page is attempting to gain focus.

The `blur()` method steps are to do nothing.

**Note**

Historically, the `focus()` and `blur()` methods actually affected the system-level focus of the system widget (e.g., tab or window) that contained the navigable, but hostile sites widely abuse this behavior to the user's detriment.

The `focus(options)` method on elements, when invoked, must run the following steps:

1. If the element is marked as `locked for focus`, then return.
2. Mark the element as `locked for focus`.
3. Run the focusing steps for the element.
4. If the value of the `focusVisible` dictionary member of `options` is true, or is not present but in an implementation-defined way the user agent determines it would be best to do so, then indicate focus.
5. If the value of the `preventScroll` dictionary member of `options` is false, then scroll the element into view given "auto", "center", and "center".
6. Unmark the element as `locked for focus`.

The `blur()` method, when invoked, should run the unfocusing steps for the element on which the method was called. User agents may selectively or uniformly ignore calls to this method for usability reasons.

---

For example, if the `blur()` method is unwisely being used to remove the focus ring for aesthetics reasons, the page would become unusable by keyboard users. Ignoring calls to this method would thus allow keyboard users to interact with the page.
The **autofocus** attribute allows the author to indicate that an element is to be focused as soon as the page is loaded, allowing the user to just start typing without having to manually focus the main element.

When the **autofocus** attribute is specified on an element inside `dialog` elements or `HTML elements` whose `popover` attribute is set, then it will be focused when the dialog or popover becomes shown.

The **autofocus** attribute is a boolean attribute.

To find the nearest ancestor autofocus scoping root element given an `Element` element:

1. If `element` is a `dialog` element, then return `element`.
2. If `element`'s `popover` attribute is not in the `no popover state`, then return `element`.
3. Let `ancestor` be `element`.
4. While `ancestor` has a parent element:
   1. Set `ancestor` to `ancestor`'s parent element.
   2. If `ancestor` is a `dialog` element, then return `ancestor`.
   3. If `ancestor`'s `popover` attribute is not in the `no popover state`, then return `ancestor`.
5. Return `ancestor`.

There must not be two elements with the same nearest ancestor autofocus scoping root element that both have the autofocus attribute specified.

Each `Document` has an autofocus candidates list, initially empty.

Each `Document` has an autofocus processed flag boolean, initially false.

When an element with the autofocus attribute specified is inserted into a document, run the following steps:

1. If the user has indicated (for example, by starting to type in a form control) that they do not wish focus to be changed, then optionally return.
2. Let `target` be the element's node document.
3. If `target` is not fully active, then return.
4. If `target`'s active sandboxing flag set has the sandboxed automatic features browsing context flag, then return.
5. For each ancestorNavigable of target's ancestor navigables: if ancestorNavigable's active document's origin is not same origin with `target`'s origin, then return.
7. If topDocument's autofocus processed flag is false, then remove the element from topDocument's autofocus candidates, and append the element to topDocument's autofocus candidates.

**Note**

We do not check if an element is a focusable area before storing it in the autofocus candidates list, because even if it is not a focusable area when it is inserted, it could become one by the time flush autofocus candidates sees it.

To flush autofocus candidates for a document `topDocument`, run these steps:

1. If `topDocument`'s autofocus processed flag is true, then return.
2. Let candidates be `topDocument`'s autofocus candidates.
3. If candidates is empty, then return.
4. If `topDocument`'s focused area is not `topDocument` itself, or `topDocument` has non-null target element, then:
1. **Empty candidates.**
2. Set `topDocument`'s **autofocus processed flag**[^842] to true.
3. Return.

5. While `candidates` is not **empty**:
   1. Let `element` be `candidates[0]`.
   2. Let `doc` be `element`'s **node document**.
   3. If `doc` is not **fully active**[^992], then remove `element` from `candidates`, and **continue**.
   4. If `doc`'s **node navigable**[^979]'s **top-level traversable**[^980] is not the same as `topDocument`'s **node navigable**[^979], then remove `element` from `candidates`, and **continue**.
   5. If `doc`'s script-blocking style sheet set[^201] is not **empty**, then return.
   6. Remove `element` from `candidates`.
   7. Let `inclusiveAncestorDocuments` be a **list** consisting of the **active document**[^993] of `doc`'s **inclusive ancestor navigables**[^983].
   8. If any **Document**[^128] in `inclusiveAncestorDocuments` has non-null `target element`[^1043], then continue.
   9. Let `target be element`.
10. If `target` is not a **focusable area**[^829], then set `target` to the result of **getting the focusable area**[^834] for `target`.

**Note**
*In this case, element is the currently-best candidate, but doc is not ready for autofocusing. We’ll try again next time flush autofocus candidates[^842] is called.*

6. **Remove** `element` from `candidates`.
7. Let `inclusiveAncestorDocuments` be a **list** consisting of the **active document**[^993] of `doc`'s **inclusive ancestor navigables**[^983].
8. If any **Document**[^128] in `inclusiveAncestorDocuments` has non-null `target element`[^1043], then continue.
9. Let `target be element`.
10. If `target` is not a **focusable area**[^829], then set `target` to the result of **getting the focusable area**[^834] for `target`.

**Note**
*Autofocus candidates[^842] can contain elements which are not focusable areas[^829]. In addition to the special cases handled in the **get the focusable area**[^834] algorithm, this can happen because a non-focusable area[^829] element with an **autofocus**[^842] attribute was inserted into a document[^46] and it never became focusable, or because the element was focusable but its status changed while it was stored in **autofocus candidates**[^842].

11. If `target` is not null, then:
   1. **Empty** `candidates`.
   2. Set `topDocument`'s **autofocus processed flag**[^842] to true.
   3. Run the **focusing steps**[^836] for `target`.

**Note**
*This handles the automatic focusing during document load. The **show()**[^644] and **showModal()**[^645] methods of **dialog**[^642] elements also processes the **autofocus**[^842] attribute.*

**Note**
*Focusing the element does not imply that the user agent has to focus the browser window if it has lost focus.*

The **autofocus** IDL attribute must **reflect**[^132] the content attribute of the same name.

**Example**

In the following snippet, the text control would be focused when the document was loaded.

```html
<input maxlength="256" name="q" value="" autofocus>
<input type="submit" value="Search">
```
Each element that can be activated or focused can be assigned a single key combination to activate it, using the `accesskey` attribute.

The exact shortcut is determined by the user agent, based on information about the user's keyboard, what keyboard shortcuts already exist on the platform, and what other shortcuts have been specified on the page, using the information provided in the `accesskey` attribute as a guide.

In order to ensure that a relevant keyboard shortcut is available on a wide variety of input devices, the author can provide a number of alternatives in the `accesskey` attribute. Each alternative consists of a single character, such as a letter or digit.

User agents can provide users with a list of the keyboard shortcuts, but authors are encouraged to do so also. The `accessKeyLabel` IDL attribute returns a string representing the actual key combination assigned by the user agent.

In this example, an author has provided a button that can be invoked using a shortcut key. To support full keyboards, the author has provided "C" as a possible key. To support devices equipped only with numeric keypads, the author has provided "1" as another possible key.

```html
<input type=button value=Collect onclick="collect()"
accesskey="C 1" id=c>
```

To tell the user what the shortcut key is, the author has this script here opted to explicitly add the key combination to the button's label:

```javascript
function addShortcutKeyLabel(button) {
    if (button.accessKeyLabel !== '')
        button.value += '(' + button.accessKeyLabel + ')';
}
addShortcutKeyLabel(document.getElementById('c'));
```

Browsers on different platforms will show different labels, even for the same key combination, based on the convention prevalent on that platform. For example, if the key combination is the Control key, the Shift key, and the letter C, a Windows browser might display "Ctrl+Shift+C", whereas a Mac browser might display "⌥C", while an Emacs browser might just display "C-C". Similarly, if the key combination is the Alt key and the Escape key, Windows might use "Alt+Esc", Mac might use "⌥Esc", and an Emacs browser might use "M-ESC" or "ESC ESC".

In general, therefore, it is unwise to attempt to parse the value returned from the `accessKeyLabel` IDL attribute.

6.7 The `accesskey` attribute

All HTML elements may have the `accesskey` content attribute set. The `accesskey` attribute's value is used by the user agent.
as a guide for creating a keyboard shortcut that activates or focuses the element.

If specified, the value must be an ordered set of unique space-separated tokens\(^\text{983}\) none of which are identical to another token and each of which must be exactly one code point in length.

**Example**

In the following example, a variety of links are given with access keys so that keyboard users familiar with the site can more quickly navigate to the relevant pages:

```
<nav>
  ...<a title="Consortium Activities" accesskey="A" href="/Consortium/activities">Activities</a> | ...
</nav>
```

**Example**

In the following example, the search field is given two possible access keys, "s" and "0" (in that order). A user agent on a device with a full keyboard might pick Ctrl + Alt + S as the shortcut key, while a user agent on a small device with just a numeric keypad might pick just the plain unadorned key 0:

```
<form action="/search">
  ...<input type="search" name="q" accesskey="s 0"></label>
  <input type="submit">
</form>
```

**Example**

In the following example, a button has possible access keys described. A script then tries to update the button's label to advertise the key combination the user agent selected.

```
<input type=submit accesskey="N @ 1" value="Compose">
...<script>
  function labelButton(button) {
    if (button.accessKeyLabel) 
      button.value += ' (' + button.accessKeyLabel + ')';
  }
  var inputs = document.getElementsByTagName('input');
  for (var i = 0; i < inputs.length; i++) {
    if (inputs[i].type == "submit")
      labelButton(inputs[i]);
  }
</script>
```

On one user agent, the button's label might become "Compose (⌘N)". On another, it might become "Compose (Alt+⇧+1)". If the user agent doesn't assign a key, it will be just "Compose". The exact string depends on what the assigned access key\(^\text{984}\) is, and on how the user agent represents that key combination.

### 6.7.3 Processing model

An element's **assigned access key** is a key combination derived from the element's accesskey\(^\text{984}\) content attribute. Initially, an element must not have an assigned access key\(^\text{984}\).
Whenever an element's `accesskey` attribute is set, changed, or removed, the user agent must update the element's `assigned access key` by running the following steps:

1. If the element has no `accesskey` attribute, then skip to the `fallback` step below.
2. Otherwise, split the attribute's value on ASCII whitespace, and let keys be the resulting tokens.
3. For each value in keys in turn, in the order the tokens appeared in the attribute's value, run the following substeps:
   1. If the value is not a string exactly one code point in length, then skip the remainder of these steps for this value.
   2. If the value does not correspond to a key on the system's keyboard, then skip the remainder of these steps for this value.
   3. If the user agent can find a mix of zero or more modifier keys that, combined with the key that corresponds to the value given in the attribute, can be used as the access key, then the user agent may assign that combination of keys as the element's `assigned access key` and return.
4. `Fallback`: Optionally, the user agent may assign a key combination of its choosing as the element's `assigned access key` and then return.
5. If this step is reached, the element has no `assigned access key`.

Once a user agent has selected and assigned an access key for an element, the user agent should not change the element's `assigned access key` unless the `accesskey` content attribute is changed or the element is moved to another `Document`.

When the user presses the key combination corresponding to the `assigned access key` for an element, if the element defines a command, the command's `Hidden State` facet is false (visible), the command's `Disabled State` facet is also false (enabled), the element is in a document that has a non-null `browsing context`, and neither the element nor any of its ancestors has a `hidden` attribute specified, then the user agent must trigger the `Action` of the command.

**Note:** User agents might expose elements that have an `accesskey` attribute in other ways as well, e.g. in a menu displayed in response to a specific key combination.

The `accessKey` IDL attribute must reflect the `accesskey` content attribute.

The `accessKeyLabel` IDL attribute must return a string that represents the element's `assigned access key`, if any. If the element does not have one, then the IDL attribute must return the empty string.

### 6.8 Editing

#### 6.8.1 Making document regions editable: The `contenteditable` content attribute

**IDL**

```
interface mixin ElementContentEditable {
  [CEReactions] attribute DOMString contentEditable;
  [CEReactions] attribute DOMString enterKeyHint;
  readonly attribute boolean isContentEditable;
  [CEReactions] attribute DOMString inputMode;
};
```

The `contenteditable` content attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>true</td>
<td>true</td>
<td>The element is editable.</td>
</tr>
<tr>
<td>(the empty string)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>false</td>
<td>false</td>
<td>The element is not editable.</td>
</tr>
<tr>
<td>plaintext-only</td>
<td>plaintext-only</td>
<td>Only the element's raw text content is editable; rich formatting is disabled.</td>
</tr>
</tbody>
</table>

The attribute's missing value default and invalid value default are both the `inherit` state. The inherit state indicates that the
element is editable (or not) based on the parent element's state.

**Example**

For example, consider a page that has a *form* and a *textarea* to publish a new article, where the user is expected to write the article using HTML:

```html
<form method=POST>
  <fieldset>
    <legend>New article</legend>
    <textarea name=article>&lt;p&gt;Hello world.&lt;/p&gt;</textarea>
  </fieldset>
  <p><button>Publish</button></p>
</form>
```

When scripting is enabled, the *textarea* element could be replaced with a rich text control instead, using the *contenteditable* attribute:

```html
<form method=POST>
  <fieldset>
    <legend>New article</legend>
    <textarea id=textarea name=article>&lt;p&gt;Hello world.&lt;/p&gt;</textarea>
    <div id=div style="white-space: pre-wrap" hidden><p>Hello world.&lt;/p&gt;</div>
    <script>
      let textarea = document.getElementById("textarea");
      let div = document.getElementById("div");
      textarea.hidden = false;
      div.hidden = true;
      div.contentEditable = "true";
      div.oninput = (e) =&gt; {
        textarea.value = div.innerHTML;
      };
    </script>
  </fieldset>
  <p><button>Publish</button></p>
</form>
```

Features to enable, e.g., inserting links, can be implemented using the `document.execCommand()` API, or using `Selection` APIs and other DOM APIs. [EXECCOMMAND][1] [SELECTION] [DOM]

**Example**

The *contenteditable* attribute can also be used to great effect:

```html
<!doctype html>
<html lang=en>
<title>Live CSS editing!</title>
<style>
  html { margin:.2em; font-size:2em; color:lime; background:purple }
  head, title, style { display:block }
  body { display:none }
</style>
</html>
```

**For web developers (non-normative)**

`element.contentEditable` [ = value ]

Returns "true", "plaintext-only", "false", or "inherit", based on the state of the *contenteditable* attribute. Can be set, to change that state. Throws a *SyntaxError* DOMException if the new value isn't one of those strings.
The `isContentEditable` IDL attribute, on getting, must return the string "true" if the content attribute is set to the `true` state, "plaintext-only" if the content attribute is set to the `plaintext-only` state, "false" if the content attribute is set to the `false` state, and "inherit" otherwise. On setting, if the new value is an ASCII case-insensitive match for the string "inherit" then the content attribute must be removed, if the new value is an ASCII case-insensitive match for the string "true" then the content attribute must be set to the string "true", if the new value is an ASCII case-insensitive match for the string "plaintext-only" then the content attribute must be set to the string "plaintext-only", if the new value is an ASCII case-insensitive match for the string "false" then the content attribute must be set to the string "false", and otherwise the attribute setter must throw an "SyntaxError" `DOMException`.

The `isContentEditable` IDL attribute, on getting, must return true if the element is either an editing host or editable, and false otherwise.

### 6.8.2 Making entire documents editable: the `designMode` getter and setter

The `designMode` getter steps are to return "on" if this's `design mode enabled` is true; otherwise "off".

The `designMode` getter steps are:

1. Let `value` be the given value, converted to ASCII lowercase.
2. If `value` is "on" and this's `design mode enabled` is false, then:
   1. Set this's `design mode enabled` to true.
   2. Reset this's active range's start and end boundary points to be at the start of this.
   3. Run the focusing steps for this's document element, if non-null.
3. If `value` is "off", then set this's `design mode enabled` to false.

### 6.8.3 Best practices for in-page editors

Authors are encouraged to set the 'white-space' property on editing hosts and on markup that was originally created through these editing mechanisms to the value 'pre-wrap'. Default HTML whitespace handling is not well suited to WYSIWYG editing, and line wrapping will not work correctly in some corner cases if 'white-space' is left at its default value.

#### Example

As an example of problems that occur if the default 'normal' value is used instead, consider the case of the user typing "yellow␣ ␣ball", with two spaces (here represented by "␣") between the words. With the editing rules in place for the default value of 'white-space' ('normal'), the resulting markup will either consist of "yellow␣ ball" or "yellow &nbsp;ball"; i.e., there will be a non-breaking space between the two words in addition to the regular space. This is necessary because the 'normal' value for 'white-space' requires adjacent regular spaces to be collapsed together.

In the former case, "yellow␣" might wrap to the next line ("␣" being used here to represent a non-breaking space) even though "yellow" alone might fit at the end of the line; in the latter case, "␣ball", if wrapped to the start of the line, would have visible indentation from the non-breaking space.
When 'white-space' is set to 'pre-wrap', however, the editing rules will instead simply put two regular spaces between the words, and should the two words be split at the end of a line, the spaces would be neatly removed from the rendering.

6.8.4 Editing APIs

An editing host is either an HTML element with its contenteditable attribute in the true state or plaintext-only state, or a child HTML element of a Document whose design mode enabled is true.

The definition of the terms active range, editing host of, and editable, the user interface requirements of elements that are editing hosts or editable, the execCommand(), queryCommandEnabled(), queryCommandIndeterm(), queryCommandState(), queryCommandSupported(), and queryCommandValue() methods, text selections, and the delete the selection algorithm are defined in execCommand. [EXECCOMMAND]

6.8.5 Spelling and grammar checking

User agents can support the checking of spelling and grammar of editable text, either in form controls (such as the value of textarea elements), or in elements in an editing host (e.g. using contenteditable).

For each element, user agents must establish a default behavior, either through defaults or through preferences expressed by the user. There are three possible default behaviors for each element:

true-by-default
- The element will be checked for spelling and grammar if its contents are editable and spellchecking is not explicitly disabled through the spellcheck attribute.

false-by-default
- The element will never be checked for spelling and grammar unless spellchecking is explicitly enabled through the spellcheck attribute.

inherit-by-default
- The element's default behavior is the same as its parent element's. Elements that have no parent element cannot have this as their default behavior.

The spellcheck attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>true</td>
<td>true</td>
<td>Spelling and grammar will be checked.</td>
</tr>
<tr>
<td>(the empty string)</td>
<td>false</td>
<td>Spelling and grammar will not be checked.</td>
</tr>
<tr>
<td>false</td>
<td>false</td>
<td></td>
</tr>
</tbody>
</table>

The attribute's missing value default and invalid value default are both the default state. The default state indicates that the element is to act according to a default behavior, possibly based on the parent element's own spellcheck state, as defined below.

For web developers (non-normative)

```javascript
element.spellcheck [ = value ]
```

Returns true if the element is to have its spelling and grammar checked; otherwise, returns false.

Can be set, to override the default and set the spellcheck content attribute.

The spellcheck IDL attribute, on getting, must return true if the element's spellcheck content attribute is in the true state, or if the element's spellcheck content attribute is in the default state and the element's default behavior is true-by-default, or if the element's spellcheck content attribute is in the default state and the element's default behavior is inherit-by-default and the element's parent element's spellcheck IDL attribute would return true; otherwise, if none of those conditions applies, then the attribute must instead return false.
On setting, if the new value is true, then the element's `spellcheck` content attribute must be set to "true", otherwise it must be set to "false".

User agents should only consider the following pieces of text as checkable for the purposes of this feature:

- The value of `input` elements whose `type` attributes are in the `Text`, `Search`, `URL`, or `Email` states and that are `mutable` (i.e. that do not have the `readonly` attribute specified and that are not `disabled`).
- The value of `textarea` elements that do not have a `readonly` attribute and that are not `disabled`.
- Text in `Text` nodes that are children of `editing hosts` or `editable` elements.
- Text in attributes of `editable` elements.

For text that is part of a `Text` node, the element with which the text is associated is the element that is the immediate parent of the first character of the word, sentence, or other piece of text. For text in attributes, it is the attribute's element. For the values of `input` and `textarea` elements, it is the element itself.

To determine if a word, sentence, or other piece of text in an applicable element (as defined above) is to have spelling- and grammar-checking enabled, the UA must use the following algorithm:

1. If the user has disabled the checking for this text, then the checking is disabled.
2. Otherwise, if the user has forced the checking for this text to always be enabled, then the checking is enabled.
3. Otherwise, if the element with which the text is associated has a `spellcheck` content attribute, then: if that attribute is in the `true` state, then checking is enabled; otherwise, if that attribute is in the `false` state, then checking is disabled.
4. Otherwise, if there is an ancestor element with a `spellcheck` content attribute that is not in the `default` state, then: if the nearest such ancestor's `spellcheck` content attribute is in the `true` state, then checking is enabled; otherwise, checking is disabled.
5. Otherwise, if the element's `default behavior` is `true-by-default`, then checking is enabled.
6. Otherwise, if the element's `default behavior` is `false-by-default`, then checking is disabled.
7. Otherwise, if the element's parent element has its checking enabled, then checking is enabled.
8. Otherwise, checking is disabled.

If the checking is enabled for a word/sentence/text, the user agent should indicate spelling and grammar errors in that text. User agents should take into account the other semantics given in the document when suggesting spelling and grammar corrections. User agents may use the language of the element to determine what spelling and grammar rules to use, or may use the user’s preferred language settings. UAs should use `input` element attributes such as `pattern` to ensure that the resulting value is valid, where possible.

If checking is disabled, the user agent should not indicate spelling or grammar errors for that text.

**Example**

The element with ID "a" in the following example would be the one used to determine if the word "Hello" is checked for spelling errors. In this example, it would not be.

```html
<div contenteditable="true">
  <span spellcheck="false" id="a">Hell</span><em>o!</em>
</div>
```

The element with ID "b" in the following example would have checking enabled (the leading space character in the attribute's value on the `input` element causes the attribute to be ignored, so the ancestor's value is used instead, regardless of the default).
6.8.6 Writing suggestions

User agents offer writing suggestions as users type into editable regions, either in form controls (e.g., the `textarea` element) or in elements in an editing host.

The `writingsuggestions` content attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>true</code></td>
<td><code>true</code></td>
<td>Writing suggestions should be offered on this element.</td>
</tr>
<tr>
<td><code>(The empty string)</code></td>
<td><code>false</code></td>
<td>Writing suggestions should not be offered on this element.</td>
</tr>
</tbody>
</table>

The attribute's missing value default is the default state. The default state indicates that the element is to act according to a default behavior, possibly based on the parent element's own `writingsuggestions` state, as defined below.

The attribute's invalid value default is the `true` state.

For web developers (non-normative)

```javascript
function writingSuggestions(element) {
  return element.writingSuggestions;
}
```

Returns "true" if the user agent is to offer writing suggestions under the scope of the element; otherwise, returns "false". Can be set, to override the default and set the `writingsuggestions` content attribute.

The computed writing suggestions value of a given `element` is determined by running the following steps:

1. If `element`'s `writingsuggestions` content attribute is in the `false` state, return "false".
2. If `element`'s `writingsuggestions` content attribute is in the default state, `element` has a parent element, and the computed writing suggestions value of `element`'s parent element is "false", then return "false".
3. Return "true".

The `writingSuggestions` getter steps are:

1. Return this's `computed writing suggestions value`.

Note

The `writingSuggestions` IDL attribute is not affected by user preferences that override the `writingsuggestions` content attribute, and therefore might not reflect the actual writing suggestions state.

The `writingSuggestions` setter steps are:

1. Set this's `writingsuggestions` content attribute to the given value.

User agents should only offer suggestions within an element's scope if the result of running the following algorithm given `element` returns true:

1. If the user has disabled writing suggestions, then return false.
2. If none of the following conditions are true:
   - element is an input element whose type attribute is in either the Text, Search, Telephone, URL, or Email state and is mutable;
   - element is a textarea element that is mutable;
   - element is an editing host or is editable

   then return false.

3. If element has an inclusive ancestor with a writingsuggestions content attribute that's not in the default and the nearest such ancestor's writingsuggestions content attribute is in the false state, then return false.

4. Otherwise, return true.

---

Note

This specification does not define the user interface for writing suggestions. A user agent could offer on-demand suggestions, continuous suggestions as the user types, inline suggestions, autofill-like suggestions in a popup, or could use other interfaces.

---

6.8.7 Autocapitalization

Some methods of entering text, for example virtual keyboards on mobile devices, and also voice input, often assist users by automatically capitalizing the first letter of sentences (when composing text in a language with this convention). A virtual keyboard that implements autocapitalization might automatically switch to showing uppercase letters (but allow the user to toggle it back to lowercase) when a letter that should be autocapitalized is about to be typed. Other types of input, for example voice input, may perform autocapitalization in a way that does not give users an option to intervene first. The autocapitalize attribute allows authors to control such behavior.

The autocapitalize attribute, as typically implemented, does not affect behavior when typing on a physical keyboard. (For this reason, as well as the ability for users to override the autocapitalization behavior in some cases or edit the text after initial input, the attribute must not be relied on for any sort of input validation.)

The autocapitalize attribute can be used on an editing host to control autocapitalization behavior for the hosted editable region, on an input or textarea element to control the behavior for inputting text into that element, or on a form element to control the default behavior for all autocapitalize-inheriting elements associated with the form element.

The autocapitalize attribute never causes autocapitalization to be enabled for input elements whose type attribute is in one of the URI, Email, or Password states. (This behavior is included in the used autocapitalization hint algorithm below.)

The autocapitalization processing model is based on selecting among five autocapitalization hints, defined as follows:

- **default**
  The user agent and input method should use make their own determination of whether or not to enable autocapitalization.

- **none**
  No autocapitalization should be applied (all letters should default to lowercase).

- **sentences**
  The first letter of each sentence should default to a capital letter; all other letters should default to lowercase.

- **words**
  The first letter of each word should default to a capital letter; all other letters should default to lowercase.

- **characters**
  All letters should default to uppercase.

The autocapitalize attribute is an enumerated attribute whose states are the possible autocapitalization hints. The autocapitalization hint specified by the attribute’s state combines with other considerations to form the used autocapitalization hint, which informs the behavior of the user agent. The keywords for this attribute and their state mappings are as follows:
The attribute’s `missing value default` is the `default` state, and its `invalid value default` is the `sentences` state.

To compute the `own autocapitalization hint` of an element `element`, run the following steps:

1. If the `autocapitalize` content attribute is present on `element`, and its value is not the empty string, return the state of the attribute.
2. If `element` is an `autocapitalize-inheriting element` and has a non-null `form owner`, return the `own autocapitalization hint` of `element`'s `form owner`.
3. Return `default`.

The `autocapitalize` getter steps are to:

1. Let state be the `own autocapitalization hint` of `this`.
2. If state is `default`, then return the empty string.
3. If state is `none`, then return "none".
4. If state is `sentences`, then return "sentences".
5. Return the keyword value corresponding to state.

The `autocapitalize` setter steps are to set the `autocapitalize` content attribute to the given value.

User agents that support customizable autocapitalization behavior for a text input method and wish to allow web developers to control this functionality should, during text input into an element, compute the `used autocapitalization hint` for the element. This will be an `autocapitalization hint` that describes the recommended autocapitalization behavior for text input into the element.

User agents or input methods may choose to ignore or override the `used autocapitalization hint` in certain circumstances.

The `used autocapitalization hint` for an element `element` is computed using the following algorithm:

1. If `element` is an `input` element whose `type` attribute is in one of the `URL`, `Email`, or `Password` states, then return `default`.
2. If `element` is an `input` element or a `textarea` element, then return `element`'s `own autocapitalization hint`.
3. If `element` is an `editing host` or an `editable` element, then return the `own autocapitalization hint` of the `editing host of element`.
4. **Assert**: this step is never reached, since text input only occurs in elements that meet one of the above criteria.
6.8.8 Input modalities: the inputmode\(^{854}\) attribute \(^{585}\)\(^{4}\)

User agents can support the inputmode\(^{854}\) attribute on form controls (such as the value of textarea\(^{975}\) elements, or in elements in an editing host\(^{896}\) (e.g., using contenteditable\(^{846}\)).

The inputmode content attribute is an enumerated attribute\(^{874}\) that specifies what kind of input mechanism would be most helpful for users entering content.

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>The user agent should not display a virtual keyboard. This keyword is useful for content that renders its own keyboard control.</td>
</tr>
<tr>
<td>text</td>
<td>The user agent should display a virtual keyboard capable of text input in the user's locale.</td>
</tr>
<tr>
<td>tel</td>
<td>The user agent should display a virtual keyboard capable of telephone number input. This should include keys for the digits 0 to 9, the &quot;#&quot; character, and the &quot;+&quot; character. In some locales, this can also include alphabetic mnemonic labels (e.g., in the US, the key labeled &quot;2&quot; is historically also labeled with the letters A, B, and C).</td>
</tr>
<tr>
<td>url</td>
<td>The user agent should display a virtual keyboard capable of text input in the user's locale, with keys for aiding in the input of URLs, such as that for the &quot;@&quot; and &quot;.&quot; characters and for quick input of strings commonly found in domain names such as &quot;www. &quot; or &quot;.com&quot;.</td>
</tr>
<tr>
<td>email</td>
<td>The user agent should display a virtual keyboard capable of text input in the user's locale, with keys for aiding in the input of email addresses, such as that for the the &quot;@&quot; character and the &quot;.&quot; character.</td>
</tr>
<tr>
<td>numeric</td>
<td>The user agent should display a virtual keyboard capable of numeric input. This keyword is useful for PIN entry.</td>
</tr>
<tr>
<td>decimal</td>
<td>The user agent should display a virtual keyboard capable of fractional numeric input. Numeric keys and the format separator for the locale should be shown.</td>
</tr>
<tr>
<td>search</td>
<td>The user agent should display a virtual keyboard optimized for search.</td>
</tr>
</tbody>
</table>

The inputMode IDL attribute must reflect\(^{102}\) the inputmode\(^{854}\) content attribute, limited to only known values\(^{8103}\).

When inputmode\(^{854}\) is unspecified (or is in a state not supported by the user agent), the user agent should determine the default virtual keyboard to be shown. Contextual information such as the input type\(^{912}\) or pattern\(^{949}\) attributes should be used to determine which type of virtual keyboard should be presented to the user.

6.8.9 Input modalities: the enterkeyhint\(^{854}\) attribute \(^{585}\)\(^{4}\)

User agents can support the enterkeyhint\(^{854}\) attribute on form controls (such as the value of textarea\(^{975}\) elements, or in elements in an editing host\(^{896}\) (e.g., using contenteditable\(^{846}\)).

The enterkeyhint content attribute is an enumerated attribute\(^{874}\) that specifies what action label (or icon) to present for the enter key on virtual keyboards. This allows authors to customize the presentation of the enter key in order to make it more helpful for users.

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>enter</td>
<td>The user agent should present a cue for the operation 'enter', typically inserting a new line.</td>
</tr>
<tr>
<td>done</td>
<td>The user agent should present a cue for the operation 'done', typically meaning there is nothing more to input and the input method editor (IME) will be closed.</td>
</tr>
<tr>
<td>go</td>
<td>The user agent should present a cue for the operation 'go', typically meaning to take the user to the target of the text they typed.</td>
</tr>
<tr>
<td>next</td>
<td>The user agent should present a cue for the operation 'next', typically taking the user to the next field that will accept text.</td>
</tr>
<tr>
<td>previous</td>
<td>The user agent should present a cue for the operation 'previous', typically taking the user to the previous field that will accept text.</td>
</tr>
<tr>
<td>search</td>
<td>The user agent should present a cue for the operation 'search', typically taking the user to the results of searching for the text they have typed.</td>
</tr>
<tr>
<td>send</td>
<td>The user agent should present a cue for the operation 'send', typically delivering the text to its target.</td>
</tr>
</tbody>
</table>

The enterKeyHint IDL attribute must reflect\(^{102}\) the enterkeyhint\(^{854}\) content attribute, limited to only known values\(^{8103}\).

When enterkeyhint\(^{854}\) is unspecified (or is in a state not supported by the user agent), the user agent should determine the default action label (or icon) to present. Contextual information such as the inputmode\(^{854}\), type\(^{919}\), or pattern\(^{949}\) attributes should be used to determine which action label (or icon) to present on the virtual keyboard.

6.9 Find-in-page \(^{585}\)\(^{4}\)

6.9.1 Introduction \(^{585}\)\(^{4}\)

This section defines find-in-page — a common user-agent mechanism which allows users to search through the contents of the page
for particular information.

Access to the `find-in-page` feature is provided via a `find-in-page interface`. This is a user-agent provided user interface, which allows the user to specify input and the parameters of the search. This interface can appear as a result of a shortcut or a menu selection.

A combination of text input and settings in the `find-in-page interface` represents the user `query`. This typically includes the text that the user wants to search for, as well as optional settings (e.g., the ability to restrict the search to whole words only).

The user-agent processes page contents for a given `query`, and identifies zero or more `matches`, which are content ranges that satisfy the user `query`.

One of the `matches` is identified to the user as the `active match`. It is highlighted and scrolled into view. The user can navigate through the `matches` by advancing the `active match` using the `find-in-page interface`.

---

**Issue #3539** tracks standardizing how `find-in-page` underlies the currently-unspecified `window.find()` API.

---

### 6.9.2 Interaction with `details` and `hidden=until-found`

When `find-in-page` begins searching for matches, all `details` elements in the page which do not have their `open` attribute set should have the `skipped contents` of their second slot become accessible, without modifying the `open` attribute, in order to make `find-in-page` able to search through it. Similarly, all HTML elements with the `hidden` attribute in the `hidden until found` state should have their `skipped contents` become accessible without modifying the `hidden` attribute in order to make `find-in-page` able to search through them. After `find-in-page` finishes searching for matches, the `details` elements and the elements with the `hidden` attribute in the `hidden until found` state should have their contents become skipped again. This entire process must happen synchronously (and so is not observable to users or to author code).

When `find-in-page` chooses a new `active match`, perform the following steps:

1. Let `node` be the first node in the `active match`.
2. Queue a global task on the `user interaction task source` given `node`'s `relevant global object` to run the following steps:
   1. Run the `ancestor details revealing algorithm` on `node`.
   2. Run the `ancestor hidden-until-found revealing algorithm` on `node`.

---

⚠ **Warning!**

When `find-in-page` auto-expands a `details` element like this, it will fire a `toggle` event. As with the separate `scroll` event that `find-in-page` fires, this event could be used by the page to discover what the user is typing into the `find-in-page` dialog. If the page creates a tiny scrollable area with the current search term and every possible next character the user could type separated by a gap, and observes which one the browser scrolls to, it can add that character to the search term and update the scrollable area to incrementally build the search term. By wrapping each possible next match in a closed `details` element, the page could listen to `toggle` events instead of `scroll` events. This attack could be addressed for both events by not acting on every character the user types into the `find-in-page` dialog.

---

### 6.9.3 Interaction with selection

The `find-in-page` process is invoked in the context of a document, and may have an effect on the `selection` of that document. Specifically, the range that defines the `active match` can dictate the current selection. These selection updates, however, can happen at different times during the `find-in-page` process (e.g. upon the `find-in-page interface` dismissal or upon a change in the `active match` range).
6.10 Close requests and close watchers

6.10.1 Close requests

In an implementation-defined (and likely device-specific) manner, a user can send a close request to the user agent. This indicates that the user wishes to close something that is currently being shown on the screen, such as a popover, menu, dialog, picker, or display mode.

Example

Some example close requests are:

- The Esc key on desktop platforms.
- The back button or gesture on certain mobile platforms such as Android.
- Any assistive technology's dismiss gesture, such as iOS VoiceOver's two-finger scrub "z" gesture.
- A game controller's canonical "back" button, such as the circle button on a DualShock gamepad.

Whenever the user agent receives a potential close request targeted at a Document, it must queue a global task on the user interaction task source given document's relevant global object to perform the following close request steps:

1. If document's fullscreen element is not null, then:
   1. Fully exit fullscreen given document's node navigable's top-level traversable's active document.
   2. Return.

   Note
   This does not fire any relevant event, such as keydown; it only causes fullscreenchange to be eventually fired.

2. Optionally, skip to the step labeled alternative processing.

   Note
   For example, if the user agent detects user frustration at repeated close request interception by the current web page, it might take this path.

3. Fire any relevant events, per UI Events or other relevant specifications. [UIEVENTS]

Example

An example of relevant events in the UI Events model would be the keydown and keyup sequence that UI Events suggests firing when the user presses the Esc key on their keyboard. On most platforms with keyboards, this is treated as a close request, and so would trigger these close request steps.

Example

An example of relevant events that are outside of the model given in UI Events would be assistive technology synthesizing an Esc keydown and keyup sequence when the user sends a close request by using a dismiss gesture.

4. Let event be null if no such events are fired, or the Event object representing one of the fired events otherwise. If multiple events are fired, which one is chosen is implementation-defined, except that if keydown and keyup events were fired for the Esc key, the user agent must pick the keydown event.

5. If event is not null, and its canceled flag is set, then return.

6. If document is not fully active, then return.

   Note
   This step is necessary because, if event is not null, then an event listener might have caused document to no longer be fully active.

7. Let closedSomething be the result of processing close watchers on document's relevant global object.

8. If closedSomething is true, then return.
9. **Alternative processing**: Otherwise, there was nothing watching for a close request\[p856]. The user agent may instead interpret this interaction as some other action, instead of interpreting it as a close request.

### Example

On platforms where Esc is the close request\[p856], the user agent will first fire an appropriately-initialized keydown and keyup event sequence. If the web developer cancels the keyup event by calling preventDefault(), then nothing further happens. But if the event fires without being canceled, then the user agent proceeds to process close watchers\[p859].

### Example

On platforms where a back button is a potential close request\[p856], no event is involved, so when the back button is pressed, the user agent proceeds directly to process close watchers\[p859]. If there is an active\[p858] close watcher\[p857], then that will get triggered. If there is not, then the user agent can interpret the back button press in another way, for example a request to traverse the history by a delta\[p1016] of −1.

### 6.10.2 Close watcher infrastructure

Each Window\[p913] has a close watcher manager, which is a struct with the following items:

- **Groups**, a list of lists of close watchers\[p857], initially empty.
- **Allowed number of groups**, a number, initially 1.
- **Next user interaction allows a new group**, a boolean, initially true.

Most of the complexity of the close watcher manager\[p857] comes from anti-abuse protections designed to prevent developers from disabling users' history traversal abilities, for platforms where a close request\[p856]s fallback action\[p857] is the main mechanism of history traversal. In particular:

The grouping of close watchers\[p857] is designed so that if multiple close watchers are created without history-action activation\[p824], they are grouped together, so that a user-triggered close request\[p858] will close all of the close watchers in a group. This ensures that web developers can’t intercept an unlimited number of close requests by creating close watchers; instead they can create a number equal to at most 1 + the number of times the user activates the page\[p823].

The next user interaction allows a new group\[p857] boolean encourages web developers to create close watchers\[p857] in a way that is tied to individual user activations\[p823]. Without it, each user activation would increase the allowed number of groups\[p857], even if the web developer isn’t “using” those user activations to create close watchers. In short:

- Allowed: user interaction; create a close watcher in its own group; user interaction; create a close watcher in a second independent group.
- Disallowed: user interaction; user interaction; create a close watcher in its own group; create a close watcher in a second independent group.
- Allowed: user interaction; user interaction; create a close watcher in its own group; create a close watcher grouped with the previous one.

This protection is not important for upholding our desired invariant of creating at most (1 + the number of times the user activates the page\[p823]) groups. A determined abuser will just create one close watcher per user interaction, “banking” them for future abuse. But this system causes more predictable behavior for the normal case, and encourages non-abusive developers to create close watchers directly in response to user interactions.

To notify the close watcher manager about user activation given a Window\[p913] window:

1. Let manager be window’s close watcher manager\[p857].
2. If manager’s next user interaction allows a new group\[p857] is true, then increment manager’s allowed number of groups\[p857].
3. Set manager’s next user interaction allows a new group\[p857] to false.

A close watcher is a struct with the following items:
• A window, a `Window`.

• A cancel action, an algorithm accepting a boolean argument and returning a boolean. The argument indicates whether or not the cancel action algorithm can prevent the close request from proceeding via the algorithm's return value. If the boolean argument is true, then the algorithm can return either true to indicate that the caller will proceed to the close action, or false to indicate that the caller will bail out. If the argument is false, then the return value is always false. This algorithm can never throw an exception.

• A close action, an algorithm accepting no arguments and returning nothing. This algorithm can never throw an exception.

• An is running cancel action boolean.

A close watcher is active if closeWatcher's window's close watcher manager contains any list which contains closeWatcher.

To establish a close watcher given a `Window` window, a list of steps cancelAction, and a list of steps closeAction:

1. Assert: window's associated Document is fully active.

2. Let closeWatcher be a new close watcher, with
   - window
   - cancel action
   - close action
   - is running cancel action
   - false

3. Let manager be window's close watcher manager.

4. If manager's groups's size is less than manager's allowed number of groups, then append « closeWatcher » to manager's groups.

5. Otherwise:
   1. Assert: manager's groups's size is at least 1 in this branch, since manager's allowed number of groups is always at least 1.
   2. Append closeWatcher to manager's groups's last item.

6. Set manager's next user interaction allows a new group to true.

7. Return closeWatcher.

To request to close a close watcher closeWatcher:

1. If closeWatcher is not active, then return true.

2. If closeWatcher's is running cancel action is true, then return true.

3. Let window be closeWatcher's window.

4. If window's associated Document is not fully active, then return true.

5. Let canPreventClose be true if window's close watcher manager's groups's size is less than window's close watcher manager's allowed number of groups, and window has history-action activation; otherwise false.

6. Set closeWatcher's is running cancel action to true.

7. Let shouldContinue be the result of running closeWatcher's cancel action given canPreventClose.

8. Set closeWatcher's is running cancel action to false.

9. If shouldContinue is false, then:
   1. Assert: canPreventClose is true.
2. **Consume history-action user activation** given window.

3. Return false.

Note

*Note that since these substeps consume history-action user activation, requesting to close a close watcher twice without any intervening user activation will result in canPreventClose being false the second time.*

10. **Close** closeWatcher.

11. Return true.

To **close** a close watcher, closeWatcher:

1. If closeWatcher is not active, then return.

2. If closeWatcher's window's associated Document is not fully active, then return.

3. **Destroy** closeWatcher.

4. Run closeWatcher's close action.

To **destroy** a close watcher, closeWatcher:

1. Let manager be closeWatcher's window's close watcher manager.

2. **For each** group of manager's groups, remove closeWatcher from group.

3. **Remove** any item from manager's groups that is empty.

To **process close watchers** given a Window window:

1. Let processedACloseWatcher be false.

2. If window's close watcher manager's groups is not empty:
   1. Let group be the last item in window's close watcher manager's groups.
   2. **For each** closeWatcher of group, in reverse order:
      1. Set processedACloseWatcher to true.
      2. Let shouldProceed be the result of requesting to close closeWatcher.
      3. If shouldProceed is false, then **break**.
   3. If window's close watcher manager's allowed number of groups is greater than 1, decrement it by 1.


6.10.3 The **CloseWatcher** interface

```
[Exposed=Window]
interface CloseWatcher : EventTarget {
  constructor(optional CloseWatcherOptions options = {});
  undefined requestClose();
  undefined close();
  undefined destroy();

  attribute EventHandler oncancel;
  attribute EventHandler onclose;
};
```
dictionary CloseWatcherOptions {
    AbortSignal signal;
};

For web developers (non-normative)

watcher = new CloseWatcher()

watcher = new CloseWatcher({ signal })

Creates a new CloseWatcher instance.

If the signal option is provided, then watcher can be destroyed (as if by watcher.destroy() by aborting the given AbortSignal.

If any close watcher is already active, and the Window does not have history-action activation, then the resulting CloseWatcher will be closed together with that already-active close watcher in response to any close request. (This already-active close watcher does not necessarily have to be a CloseWatcher object; it could be a modal dialog element, or a popover generated by an element with the popover attribute.)

watcher.requestClose()

Acts as if a close request was sent targeting watcher, by first firing a cancel event, and if that event is not canceled with preventDefault(), proceeding to fire a close event before deactivating the close watcher as if watcher.destroy() was called.

This is a helper utility that can be used to consolidate cancelation and closing logic into the cancel and close event handlers, by having all non-close request closing affordances call this method.

watcher.close()

Immediately fires the close event, and then deactivates the close watcher as if watcher.destroy() was called.

This is a helper utility that can be used to trigger the closing logic into the close event handler, skipping any logic in the cancel event handler.

watcher.destroy()

Deactivates watcher, so that it will no longer receive close events and so that new independent CloseWatcher instances can be constructed.

This is intended to be called if the relevant UI element is torn down in some other way than being closed.

Each CloseWatcher instance has an internal close watcher, which is a close watcher.

The new CloseWatcher(options) constructor steps are:

1. If this's relevant global object's associated Document is not fully active, then throw an "InvalidStateError" DOMException.

2. Let closeWatcher be the result of establishing a close watcher given this's relevant global object, with:
   a. cancelAction given canPreventClose being to return the result of firing an event named cancel at this, with the cancelable attribute initialized to canPreventClose.
   b. closeAction being to fire an event named close at this.

3. If options["signal"] exists, then:
   a. If options["signal"] is aborted, then destroy closeWatcher.
   b. Add the following steps to options["signal"]:
      1. Destroy closeWatcher.

4. Set this's internal close watcher to closeWatcher.

The requestClose() method steps are to request to close this's internal close watcher.

The close() method steps are to close this's internal close watcher.

The destroy() method steps are to destroy this's internal close watcher.

The following are the event handlers (and their corresponding event handler event types) that must be supported, as event
handler IDL attributes, by all objects implementing the `CloseWatcher` interface:

<table>
<thead>
<tr>
<th>Event handler</th>
<th>Event handler event type</th>
</tr>
</thead>
<tbody>
<tr>
<td>oncancen</td>
<td>cancel</td>
</tr>
<tr>
<td>onclose</td>
<td>close</td>
</tr>
</tbody>
</table>

### Example

If one wanted to implement a custom picker control, which closed itself on a user-provided `close request` as well as when a close button is pressed, the following code shows how one would use the `CloseWatcher` API to process close requests:

```javascript
const watcher = new CloseWatcher();
const picker = setUpAndShowPickerDOMElement();

let chosenValue = null;

watcher.onClose = () => {
  chosenValue = picker.querySelector('input').value;
  picker.remove();
};

picker.querySelector('.close-button').onclick = () => watcher.requestClose();
```

Note how the logic to gather the chosen value is centralized in the `CloseWatcher` object's close event handler, with the `click` event handler for the close button delegating to that logic by calling `requestClose()`. 

### Example

The `cancel` event on `CloseWatcher` objects can be used to prevent the `close` event from firing, and the `CloseWatcher` from being destroying. A typical use case is as follows:

```javascript
watcher.oncancel = async (e) => {
  if (hasUnsavedData && e.cancellable) {
    e.preventDefault();

    const userReallyWantsToClose = await askForConfirmation("Are you sure you want to close?");
    if (userReallyWantsToClose) {
      hasUnsavedData = false;
      watcher.close();
    }
  }
};
```

For abuse prevention purposes, this event is only cancellable if the page has `history-action activation`, which will be lost after any given `close request`. This ensures that if the user sends a close request twice in a row without any intervening user activation, the request definitely succeeds; the second request ignores any cancel event handler's attempt to call `preventDefault()` and proceeds to close the `CloseWatcher`.

Combined, the above two examples show how `requestClose()` and `close()` differ. Because we used `requestClose()` in the `click` event handler for the close button, clicking that button will trigger the `CloseWatcher`'s `cancel` event, and thus potentially ask the user for confirmation if there is unsaved data. If we had used `close()`, then this check would be skipped.

Sometimes that is appropriate, but usually `requestClose()` is the better option for user-triggered close requests.

### Example

In addition to the `user activation` restrictions for `cancel` events, there is a more subtle form of user activation gating for `CloseWatcher` construction. If one creates more than one `CloseWatcher` without user activation, then the newly-created one will get grouped together with the most-recently-created `CloseWatcher`, so that a single `close request` will close them both:

```javascript
window.onload = () => {
  // This will work as normal: it is the first close watcher created without user activation.
```
This section defines an event-based drag-and-drop mechanism.

This specification does not define exactly what a drag-and-drop operation actually is.

On a visual medium with a pointing device, a drag operation could be the default action of a mousedown event that is followed by a series ofmousemove events, and the drop could be triggered by the mouse being released.

When using an input modality other than a pointing device, users would probably have to explicitly indicate their intention to perform a drag-and-drop operation, stating what they wish to drag and where they wish to drop it, respectively.

However it is implemented, drag-and-drop operations must have a starting point (e.g. where the mouse was clicked, or the start of the selection or element that was selected for the drag), may have any number of intermediate steps (elements that the mouse moves over during a drag, or elements that the user picks as possible drop points as they cycle through possibilities), and must either have an end point (the element above which the mouse button was released, or the element that was finally selected), or be canceled. The end point must be the last element selected as a possible drop point before the drop occurs (so if the operation is not canceled, there must be at least one element in the middle step).

6.11 Drag and drop

This section defines an event-based drag-and-drop mechanism.

This specification does not define exactly what a drag-and-drop operation actually is.

On a visual medium with a pointing device, a drag operation could be the default action of a mousedown event that is followed by a series ofmousemove events, and the drop could be triggered by the mouse being released.

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However it is implemented, drag-and-drop operations must have a starting point (e.g. where the mouse was clicked, or the start of the selection or element that was selected for the drag), may have any number of intermediate steps (elements that the mouse moves over during a drag, or elements that the user picks as possible drop points as they cycle through possibilities), and must either have an end point (the element above which the mouse button was released, or the element that was finally selected), or be canceled. The end point must be the last element selected as a possible drop point before the drop occurs (so if the operation is not canceled, there must be at least one element in the middle step).

6.11.1 Introduction

This section is non-normative.

To make an element draggable, give the element a draggable attribute, and set an event listener for dragstart that stores the data being dragged.

The event handler typically needs to check that it's not a text selection that is being dragged, and then needs to store data into the DataTransfer object and set the allowed effects (copy, move, link, or some combination).

For example:

```html
<p>What fruits do you like?</p>
<ol ondragstart="dragStartHandler(event)"
    draggable="true" data-value="fruit-apple">Apples</li>
    <li draggable="true" data-value="fruit-orange">Oranges</li>
    <li draggable="true" data-value="fruit-pear">Pears</li>
</ol>
<script>
```
To accept a drop, the drop target has to listen to the following events:

1. The `dragenter` event handler reports whether or not the drop target is potentially willing to accept the drop, by canceling the event.

2. The `dragover` event handler specifies what feedback will be shown to the user, by setting the `dropEffect` attribute of the `DataTransfer` associated with the event. This event also needs to be canceled.

3. The `drop` event handler has a final chance to accept or reject the drop. If the drop is accepted, the event handler must perform the drop operation on the target. This event needs to be canceled, so that the `dropEffect` attribute's value can be used by the source. Otherwise, the drop operation is rejected.

For example:

```html
<p>Drop your favorite fruits below:</p>
<ol ondragenter="dragEnterHandler(event)" ondragover="dragOverHandler(event)"
    ondrop="dropHandler(event)"
</ol>
<script>
    var internalDNDType = 'text/x-example'; // set this to something specific to your site

    function dragEnterHandler(event) {
        var items = event.dataTransfer.items;
        for (var i = 0; i < items.length; ++i) {
            var item = items[i];
            if (item.kind == 'string' && item.type == internalDNDType) {
                event.preventDefault();
                return;
            }
        }
    }

    function dragOverHandler(event) {
        event.dataTransfer.dropEffect = 'move';
        event.preventDefault();
    }

    function dropHandler(event) {
        var li = document.createElement('li');
        var data = event.dataTransfer.getData(internalDNDType);
        if (data == 'fruit-apple') {
            li.textContent = 'Apples';
        } else if (data == 'fruit-orange') {
            li.textContent = 'Oranges';
        } else if (data == 'fruit-pear') {
            li.textContent = 'Pears';
        } else {
            li.textContent = 'Unknown Fruit';
        }
        event.target.appendChild(li);
    }
</script>
```
To remove the original element (the one that was dragged) from the display, the `dragend` event can be used.

For our example here, that means updating the original markup to handle that event:

```html
<p>What fruits do you like?</p>
<ol ondragstart="dragStartHandler(event)" ondragend="dragEndHandler(event)"
    ...
</ol>
<script>
    function dragStartHandler(event) {
        // ...as before...
    }
    function dragEndHandler(event) {
        if (event.dataTransfer.dropEffect == 'move') {
            // remove the dragged element
            event.target.parentNode.removeChild(event.target);
        }
    }
</script>
```

### 6.11.2 The drag data store

The data that underlies a drag-and-drop operation, known as the **drag data store**, consists of the following information:

- A **drag data store item list**, which is a list of items representing the dragged data, each consisting of the following information:
  - **The drag data item kind**
    - The kind of data:
      - **Text**
        - Text.
      - **File**
        - Binary data with a filename.
  - **The drag data item type string**
    - A Unicode string giving the type or format of the data, generally given by a [MIME type](#). Some values that are not [MIME types](#) are special-cased for legacy reasons. The API does not enforce the use of [MIME types](#); other values can be used as well. In all cases, however, the values are all converted to ASCII lowercase by the API.
    
    There is a limit of one text item per **item type string**.
  - **The actual data**
    - A Unicode or binary string, in some cases with a filename (itself a Unicode string), as per **the drag data item kind**.
    - The **drag data store item list** is ordered in the order that the items were added to the list; most recently added last.

- The following information, used to generate the UI feedback during the drag:
  - User-agent-defined default feedback information, known as the **drag data store default feedback**.
  - Optionally, a bitmap image and the coordinate of a point within that image, known as the **drag data store bitmap** and **drag data store hot spot coordinate**.

- A **drag data store mode**, which is one of the following:
  - **Read/write mode**
    - For the `dragstart` event. New data can be added to the **drag data store**.
  - **Read-only mode**
    - For the `drop` event. The list of items representing dragged data can be read, including the data. No new data can be
Added.

**Protected mode**
For all other events. The formats and kinds in the drag data store list of items representing dragged data can be enumerated, but the data itself is unavailable and no new data can be added.

- A drag data store allowed effects state, which is a string.

When a drag data store is created, it must be initialized such that its drag data store item list is empty, it has no drag data store default feedback, it has no drag data store bitmap and drag data store hot spot coordinate, its drag data store mode is protected mode, and its drag data store allowed effects state is the string "uninitialized."

### 6.11.3 The DataTransfer interface

DataTransfer objects are used to expose the drag data store that underlies a drag-and-drop operation.

**IDL**

```idl
[Exposed=Window]
interface DataTransfer {
    constructor();
    attribute DOMString dropEffect;
    attribute DOMString effectAllowed;
    [SameObject] readonly attribute DataTransferItemList items;
    undefined setDragImage(Element image, long x, long y);
    /* old interface */
    readonly attribute FrozenArray<DOMString> types;
    DOMString getData(DOMString format);
    undefined setData(DOMString format, DOMString data);
    undefined clearData(optional DOMString format);
    [SameObject] readonly attribute FileList files;
}
```

**For web developers (non-normative)**

```javascript
dataTransfer = new DataTransfer()
    Creates a new DataTransfer object with an empty drag data store.

dataTransfer.dropEffect [ = value ]
    Returns the kind of operation that is currently selected. If the kind of operation isn't one of those that is allowed by the effectAllowed attribute, then the operation will fail.
    Can be set, to change the selected operation.
    The possible values are "none", "copy", "link", and "move".

dataTransfer.effectAllowed [ = value ]
    Returns the kinds of operations that are to be allowed.
    Can be set (during the dragstart event), to change the allowed operations.
    The possible values are "none", "copy", "copyLink", "copyMove", "link", "linkMove", "move", "all", and "uninitialized."

dataTransfer.items
    Returns a DataTransferItemList object, with the drag data.

dataTransfer.setDragImage(element, x, y)
    Uses the given element to update the drag feedback, replacing any previously specified feedback.

dataTransfer.types
    Returns a frozen array listing the formats that were set in the dragstart event. In addition, if any files are being dragged,
then one of the types will be the string "Files".

\[\text{data} = \text{dataTransfer}.\text{getData}(\text{format})\]

Returns the specified data. If there is no such data, returns the empty string.

\[\text{dataTransfer}.\text{setData}(\text{format}, \text{data})\]

Adds the specified data.

\[\text{dataTransfer}.\text{clearData}([ \text{format} ])\]

Removes the data of the specified formats. Removes all data if the argument is omitted.

\[\text{dataTransfer}.\text{files}\]

Returns a FileList of the files being dragged, if any.

\[\text{DataTransfer}\]

objects that are created as part of drag-and-drop events are only valid while those events are being fired.

A DataTransfer object is associated with a drag data store while it is valid.

A DataTransfer object has an associated types array, which is a FrozenArray, initially empty. When the contents of the DataTransfer object's drag data store item list change, or when the DataTransfer object becomes no longer associated with a drag data store, run the following steps:

1. Let \( L \) be an empty sequence.
2. If the DataTransfer object is still associated with a drag data store, then:
   1. For each item in the DataTransfer object's drag data store item list whose kind is text, add an entry to \( L \) consisting of the item's type string.
   2. If there are any items in the DataTransfer object's drag data store item list whose kind is File, then add an entry to \( L \) consisting of the string "Files". (This value can be distinguished from the other values because it is not lowercase.)
3. Set the DataTransfer object's types array to the result of creating a frozen array from \( L \).

The DataTransfer constructor, when invoked, must return a newly created DataTransfer object initialized as follows:

1. Set the drag data store's item list to be an empty list.
2. Set the drag data store's mode to read/write mode.
3. Set the dropEffect and effectAllowed to "none".

The dropEffect attribute controls the drag-and-drop feedback that the user is given during a drag-and-drop operation. When the DataTransfer object is created, the dropEffect attribute is set to a string value. On getting, it must return its current value. On setting, if the new value is one of "none", "copy", "link", or "move", then the attribute's current value must be set to the new value. Other values must be ignored.

The effectAllowed attribute is used in the drag-and-drop processing model to initialize the dropEffect attribute during the dragenter and dragover events. When the DataTransfer object is created, the effectAllowed attribute is set to a string value. On getting, it must return its current value. On setting, if the drag data store's mode is the read/write mode and the new value is one of "none", "copy", "copyLink", "copyMove", "link", "linkMove", "move", "all", or "initialized", then the attribute's current value must be set to the new value. Otherwise it must be left unchanged.

The items attribute must return a DataTransferItemList object associated with the DataTransfer object.

The setDragImage(image, x, y) method must run the following steps:

1. If the DataTransfer object is no longer associated with a drag data store, return. Nothing happens.
2. If the drag data store's mode is not the read/write mode, return. Nothing happens.
3. If image is an element, then set the drag data store bitmap to the element's image (at its natural size); otherwise, set the drag data store bitmap to an image generated from the given element (the exact mechanism for doing so is not currently specified).
4. Set the drag data store hot spot coordinate to the given x, y coordinate.

The types attribute must return this DataTransfer object's types array.

The getdata(format) method must run the following steps:

1. If the DataTransfer object is no longer associated with a drag data store, then return the empty string.
2. If the drag data store's mode is the protected mode, then return the empty string.
3. Let format be the first argument, converted to ASCII lowercase.
4. Let convert-to-URL be false.
5. If format equals "text", change it to "text/plain".
6. If format equals "url", change it to "text/uri-list" and set convert-to-URL to true.
7. If there is no item in the drag data store item list whose kind is text and whose type string is equal to format, return the empty string.
8. Let result be the data of the item in the drag data store item list whose kind is Plain Unicode string and whose type string is equal to format.
9. If convert-to-URL is true, then parse result as appropriate for text/uri-list data, and then set result to the first URL from the list, if any, or the empty string otherwise. [RFC2483]
10. Return result.

The setdata(format, data) method must run the following steps:

1. If the DataTransfer object is no longer associated with a drag data store, return. Nothing happens.
2. If the drag data store's mode is not the read/write mode, return. Nothing happens.
3. Let format be the first argument, converted to ASCII lowercase.
4. If format equals "text", change it to "text/plain".
   If format equals "url", change it to "text/uri-list".
5. Remove the item in the drag data store item list whose kind is text and whose type string is equal to format, if there is one.
6. Add an item to the drag data store item list whose kind is text, whose type string is equal to format, and whose data is the string given by the method's second argument.

The clearData(format) method must run the following steps:

1. If the DataTransfer object is no longer associated with a drag data store, return. Nothing happens.
2. If the drag data store's mode is not the read/write mode, return. Nothing happens.
3. If the method was called with no arguments, remove each item in the drag data store item list whose kind is Plain Unicode string, and return.
4. Set format to format, converted to ASCII lowercase.
5. If format equals "text", change it to "text/plain".
   If format equals "url", change it to "text/uri-list".
6. Remove the item in the drag data store item list whose kind is text and whose type string is equal to format, if there is one.

Note
The clearData() method does not affect whether any files were included in the drag, so the types attribute's list might still not be empty after calling clearData() (it would still contain the "Files" string if any files were included in the drag).
The `files` attribute must return a live `FileList` sequence consisting of `File` objects representing the files found by the following steps. Furthermore, for a given `FileList` object and a given underlying file, the same `File` object must be used each time.

1. Start with an empty list \( L \).
2. If the `DataTransfer` object is no longer associated with a `drag data store`, the `FileList` is empty. Return the empty list \( L \).
3. If the `drag data store`'s `mode` is the `protected mode`, Return the empty list \( L \).
4. For each item in the `drag data store item list` whose `kind` is `File`, add the item's data (the file, in particular its name and contents, as well as its `type`) to the list \( L \).
5. The files found by these steps are those in the list \( L \).

**Note**

This version of the API does not expose the types of the files during the drag.

### 6.11.3.1 The `DataTransferItemList` interface

Each `DataTransfer` object is associated with a `DataTransferItemList` object.

```idl
[Exposed=Window]
interface DataTransferItemList {
  readonly attribute unsigned long length;
  getter DataTransferItem (unsigned long index);
  DataTransferItem? add(DOMString data, DOMString type);
  DataTransferItem? add(File data);
  undefined remove(unsigned long index);
  undefined clear();
};
```

For web developers (non-normative)

- `items.length` Returns the number of items in the `drag data store`.
- `items[index]` Returns the `DataTransferItem` object representing the `index`th entry in the `drag data store`.
- `items.remove(index)` Removes the `index`th entry in the `drag data store`.
- `items.clear()` Removes all the entries in the `drag data store`.
- `items.add(data)` Adds a new entry for the given data to the `drag data store`. If the data is plain text then a `type` string has to be provided also.

While the `DataTransferItemList` object's `DataTransfer` object is associated with a `drag data store`, the `DataTransferItemList` object's `mode` is the same as the `drag data store mode`. When the `DataTransferItemList` object's `DataTransfer` object is not associated with a `drag data store`, the `DataTransferItemList` object's `mode` is the `disabled mode`. The `drag data store` referenced in this section (which is used only when the `DataTransferItemList` object is not in the `disabled mode`) is the `drag data store` with which the `DataTransferItemList` object's `DataTransfer` object is associated.

The `length` attribute must return zero if the object is in the `disabled mode`; otherwise it must return the number of items in the `drag data store item list`.

When a `DataTransferItemList` object is not in the `disabled mode`, its `supported property indices` are the `indices` of the `drag data store item list`.
To determine the value of an indexed property \( i \) of a `DataTransferItemList` object, the user agent must return a `DataTransferItem` object representing the \( i \)th item in the drag data store. The same object must be returned each time a particular item is obtained from this `DataTransferItemList` object. The `DataTransferItem` object must be associated with the same `DataTransfer` object as the `DataTransferItemList` object when it is first created.

The `add()` method must run the following steps:

1. If the `DataTransferItemList` object is not in the read/write mode, return null.
2. Jump to the appropriate set of steps from the following list:

   - **If the first argument to the method is a string**
     - If there is already an item in the drag data store list whose `kind` is text and whose `type string` is equal to the value of the method's second argument, throw a "NotSupportedException" DOMException.
     - Otherwise, add an item to the drag data store list whose `kind` is text, whose `type string` is equal to the value of the method's second argument, converted to ASCII lowercase, and whose data is the string given by the method's first argument.

   - **If the first argument to the method is a `File`**
     - Add an item to the drag data store list whose `kind` is `File`, whose `type string` is the `type` of the `File`, converted to ASCII lowercase, and whose data is the same as the `File`'s data.

   3. Determine the value of the indexed property corresponding to the newly added item, and return that value (a newly created `DataTransferItem` object).

The `remove(index)` method must run these steps:

1. If the `DataTransferItemList` object is not in the read/write mode, throw an "InvalidStateError" DOMException.
2. If the drag data store does not contain an index\( \text{th} \) item, then return.
3. Remove the index\( \text{th} \) item from the drag data store.

The `clear()` method, if the `DataTransferItemList` object is in the read/write mode, must remove all the items from the drag data store. Otherwise, it must do nothing.

### 6.11.3.2 The `DataTransferItem` interface

Each `DataTransferItem` object is associated with a `DataTransfer` object.

```idl
[Exposed=Window]
interface DataTransferItem {
  readonly attribute DOMString kind;
  readonly attribute DOMString type;
  undefined getAsString(FunctionStringCallback? _callback);
  File? getAsFile();
};
```

**For web developers (non-normative)**

- `item.kind`
  - Returns the drag data item kind, one of: "string", "file".

- `item.type`
  - Returns the drag data item type string.

- `item.getAsString(callback)`
  - Invokes the callback with the string data as the argument, if the drag data item kind is text.
file = item.getAsFile()

Returns a File object, if the drag data item kind is File.

While the DataTransferItem object's DataTransfer object is associated with a drag data store and that drag data store's drag data store item list still contains the item that the DataTransferItem object represents, the DataTransferItem object's mode is the same as the drag data store mode. When the DataTransferItem object's DataTransfer object is not associated with a drag data store, or if the item that the DataTransferItem object represents has been removed from the relevant drag data store item list, the DataTransferItem object's mode is the disabled mode. The drag data store referenced in this section (which is used only when the DataTransferItem object is not in the disabled mode) is the drag data store with which the DataTransferItem object's DataTransfer object is associated.

The kind attribute must return the empty string if the DataTransferItem object is in the disabled mode; otherwise it must return the string given in the cell from the second column of the following table from the row whose cell in the first column contains the drag data item kind of the item represented by the DataTransferItem object:

<table>
<thead>
<tr>
<th>Kind</th>
<th>String</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text</td>
<td>&quot;string&quot;</td>
</tr>
<tr>
<td>File</td>
<td>&quot;file&quot;</td>
</tr>
</tbody>
</table>

The type attribute must return the empty string if the DataTransferItem object is in the disabled mode; otherwise it must return the drag data item type string of the item represented by the DataTransferItem object.

The getString(callback) method must run the following steps:

1. If the callback is null, return.
2. If the DataTransferItem object is not in the read/write mode or the read-only mode, return. The callback is never invoked.
3. If the drag data item kind is not text, then return. The callback is never invoked.
4. Otherwise, queue a task to invoke callback, passing the actual data of the item represented by the DataTransferItem object as the argument.

The getFile() method must run the following steps:

1. If the DataTransferItem object is not in the read/write mode or the read-only mode, then return null.
2. If the drag data item kind is not File, then return null.
3. Return a new File object representing the actual data of the item represented by the DataTransferItem object.

6.11.4 The DragEvent interface

The drag-and-drop processing model involves several events. They all use the DragEvent interface.

```idl
[Exposed=Window]
interface DragEvent : MouseEvent {
    constructor(DOMString type, optional DragEventInit eventInitDict = {});

    readonly attribute DataTransfer? dataTransfer;
};

dictionary DragEventInit : MouseEventInit {
    DataTransfer? dataTransfer = null;
};
```

For web developers (non-normative)
event.dataTransfer

Returns the DataTransfer object for the event.

**Note**

Although, for consistency with other event interfaces, the DragEvent interface has a constructor, it is not particularly useful. In particular, there’s no way to create a useful DataTransfer object from script, as DataTransfer objects have a processing and security model that is coordinated by the browser during drag-and-drops.

The dataTransfer attribute of the DragEvent interface must return the value it was initialized to. It represents the context information for the event.

When a user agent is required to fire a DND event named e at an element, using a particular drag data store, and optionally with a specific related target, the user agent must run the following steps:

1. Let dataDragStoreWasChanged be false.
2. If no specific related target was provided, set related target to null.
3. Let window be the relevant global object of the Document object of the specified target element.
4. If e is dragstart, then set the drag data store mode to the read/write mode and set dataDragStoreWasChanged to true. If e is drop, set the drag data store mode to the read-only mode.
5. Let dataTransfer be a newly created DataTransfer object associated with the given drag data store.
6. Set the effectAllowed attribute to the drag data store’s drag data store allowed effects state.
7. Set the dropEffect attribute to “none” if e is dragstart, drag, or dragleave; to the value corresponding to the current drag operation if e is drop or dragend, and to a value based on the effectAllowed attribute’s value and the drag-and-drop source, as given by the following table, otherwise (i.e. if e is dragenter or dragover):

<table>
<thead>
<tr>
<th>effectAllowed</th>
<th>dropEffect</th>
</tr>
</thead>
<tbody>
<tr>
<td>“none”</td>
<td>“none”</td>
</tr>
<tr>
<td>“copy”</td>
<td>“copy”</td>
</tr>
<tr>
<td>“copyLink”</td>
<td>“copyLink”</td>
</tr>
<tr>
<td>“copyMove”</td>
<td>“copyMove”</td>
</tr>
<tr>
<td>“all”</td>
<td>“all”</td>
</tr>
<tr>
<td>“link”</td>
<td>“link”</td>
</tr>
<tr>
<td>“linkMove”</td>
<td>“linkMove”</td>
</tr>
<tr>
<td>“move”</td>
<td>“move”</td>
</tr>
<tr>
<td>“uninitialized” when what is being dragged is a selection from a text control</td>
<td>“move”, or, if appropriate, “copy” or “link”</td>
</tr>
<tr>
<td>“uninitialized” when what is being dragged is a selection</td>
<td>“copy”, or, if appropriate, “link” or “move”</td>
</tr>
<tr>
<td>“uninitialized” when what is being dragged is an a element with an href attribute</td>
<td>“link”, or, if appropriate, “copy” or “move”</td>
</tr>
<tr>
<td>Any other case</td>
<td>“copy”, or, if appropriate, “link” or “move”</td>
</tr>
</tbody>
</table>

Where the table above provides possibly appropriate alternatives, user agents may instead use the listed alternative values if platform conventions dictate that the user has requested those alternate effects.

**Example**

For example, Windows platform conventions are such that dragging while holding the "alt" key indicates a preference for linking the data, rather than moving or copying it. Therefore, on a Windows system, if "link" is an option according to the table above while the "alt" key is depressed, the user agent could select that instead of "copy" or "move".

8. Let event be the result of creating an event using DragEvent.
9. Initialize event's type attribute to e, its bubbles attribute to true, its view attribute to window, its relatedTarget attribute to related target, and its dataTransfer attribute to dataTransfer.

10. If e is not dragleave or dragend, then initialize event's cancelable attribute to true.

11. Initialize event's mouse and key attributes initialized according to the state of the input devices as they would be for user interaction events.

   If there is no relevant pointing device, then initialize event's screenX, screenY, clientX, clientY, and button attributes to 0.

12. Dispatch event at the specified target element.

13. Set the drag data store allowed effects state to the current value of dataTransfer's effectAllowed attribute. (It can only have changed value if e is dragstart.)

14. If dataDragStoreWasChanged is true, then set the drag data store back to the protected mode.

15. Break the association between dataTransfer and the drag data store.

6.11.5 Processing model

When the user attempts to begin a drag operation, the user agent must run the following steps. User agents must act as if these steps were run even if the drag actually started in another document or application and the user agent was not aware that the drag was occurring until it intersected with a document under the user agent's purview.

1. Determine what is being dragged, as follows:

   If the drag operation was invoked on a selection, then it is the selection that is being dragged.

   Otherwise, if the drag operation was invoked on a Document, it is the first element, going up the ancestor chain, starting at the node that the user tried to drag, that has the IDL attribute draggable set to true. If there is no such element, then nothing is being dragged; return, the drag-and-drop operation is never started.

   Otherwise, the drag operation was invoked outside the user agent's purview. What is being dragged is defined by the document or application where the drag was started.

   Note: img elements and a elements with an href attribute have their draggable attribute set to true by default.

2. Create a drag data store. All the DND events fired subsequently by the steps in this section must use this drag data store.

3. Establish which DOM node is the source node, as follows:

   If it is a selection that is being dragged, then the source node is the Text node that the user started the drag on (typically the Text node that the user originally clicked). If the user did not specify a particular node, for example if the user just told the user agent to begin a drag of "the selection", then the source node is the first Text node containing a part of the selection.

   Otherwise, if it is an element that is being dragged, then the source node is the element that is being dragged.

   Otherwise, the source node is part of another document or application. When this specification requires that an event be dispatched at the source node in this case, the user agent must instead follow the platform-specific conventions relevant to that situation.

   Note: Multiple events are fired on the source node during the course of the drag-and-drop operation.

4. Determine the list of dragged nodes, as follows:

   If it is a selection that is being dragged, then the list of dragged nodes contains, in tree order, every node that is partially or completely included in the selection (including all their ancestors).

   Otherwise, the list of dragged nodes contains only the source node, if any.
5. If it is a selection that is being dragged, then add an item to the drag data store item list, with its properties set as follows:

**The drag data item type string** "text/plain"

**The drag data item kind** Text

**The actual data**

The text of the selection

Otherwise, if any files are being dragged, then add one item per file to the drag data store item list, with their properties set as follows:

**The drag data item type string** The MIME type of the file, if known, or "application/octet-stream" otherwise.

**The drag data item kind** File

**The actual data**

The file's contents and name.

---

**Note**

Dragging files can currently only happen from outside a navigable, for example from a file system manager application.

If the drag initiated outside of the application, the user agent must add items to the drag data store item list as appropriate for the data being dragged, honoring platform conventions where appropriate; however, if the platform conventions do not use MIME types to label dragged data, the user agent must make a best-effort attempt to map the types to MIME types, and, in any case, all the drag data item type strings must be converted to ASCII lowercase.

User agents may also add one or more items representing the selection or dragged element(s) in other forms, e.g. as HTML.

6. If the list of dragged nodes is not empty, then extract the microdata from those nodes into a JSON form, and add one item to the drag data store item list, with its properties set as follows:

**The drag data item type string** application/microdata+json

**The drag data item kind** Text

**The actual data**

The resulting JSON string.

7. Run the following substeps:

1. Let urls be « ».

2. For each node in the list of dragged nodes:

   **If the node is an a element with an href attribute**
   Add to urls the result of encoding-parsing-and-serializing a URL given element's href content attribute's value, relative to the element's node document.

   **If the node is an img element with a src attribute**
   Add to urls the result of encoding-parsing-and-serializing a URL given element's src content attribute's value, relative to the element's node document.

3. If urls is still empty, then return.

4. Let url string be the result of concatenating the strings in urls, in the order they were added, separated by a U+000D CARRIAGE RETURN U+000A LINE FEED character pair (CRLF).

5. Add one item to the drag data store item list, with its properties set as follows:
The drag data item type string

| text/uri-list |

The drag data item kind

| Text |

The actual data

url string

8. Update the drag data store default feedback as appropriate for the user agent (if the user is dragging the selection, then the selection would likely be the basis for this feedback; if the user is dragging an element, then that element's rendering would be used; if the drag began outside the user agent, then the platform conventions for determining the drag feedback should be used).

9. Fire a DND event named dragstart at the source node.

If the event is canceled, then the drag-and-drop operation should not occur; return.

Note

Since events with no event listeners registered are, almost by definition, never canceled, drag-and-drop is always available to the user if the author does not specifically prevent it.

10. Fire a pointer event at the source node named pointercancel, and fire any other follow-up events as required by Pointer Events.

11. Initiate the drag-and-drop operation in a manner consistent with platform conventions, and as described below.

The drag-and-drop feedback must be generated from the first of the following sources that is available:

1. The drag data store bitmap, if any. In this case, the drag data store hot spot coordinate should be used as hints for where to put the cursor relative to the resulting image. The values are expressed as distances in CSS pixels from the left side and from the top side of the image respectively. [CSS]

2. The drag data store default feedback.

From the moment that the user agent is to initiate the drag-and-drop operation, until the end of the drag-and-drop operation, device input events (e.g. mouse and keyboard events) must be suppressed.

During the drag operation, the element directly indicated by the user as the drop target is called the immediate user selection. (Only elements can be selected by the user; other nodes must not be made available as drop targets.) However, the immediate user selection is not necessarily the current target element, which is the element currently selected for the drop part of the drag-and-drop operation.

The immediate user selection changes as the user selects different elements (either by pointing at them with a pointing device, or by selecting them in some other way). The current target element changes when the immediate user selection changes, based on the results of event listeners in the document, as described below.

Both the current target element and the immediate user selection can be null, which means no target element is selected. They can also both be elements in other (DOM-based) documents, or other (non-web) programs altogether. (For example, a user could drag text to a word-processor.) The current target element is initially null.

In addition, there is also a current drag operation, which can take on the values "none", "copy", "link", and "move". Initially, it has the value "none". It is updated by the user agent as described in the steps below.

User agents must, as soon as the drag operation is initiated and every 350ms (±200ms) thereafter for as long as the drag operation is ongoing, queue a task to perform the following steps in sequence:

1. If the user agent is still performing the previous iteration of the sequence (if any) when the next iteration becomes due, return for this iteration (effectively "skipping missed frames" of the drag-and-drop operation).

2. Fire a DND event named drag at the source node. If this event is canceled, the user agent must set the current drag operation to "none" (no drag operation).

3. If the drag event was not canceled and the user has not ended the drag-and-drop operation, check the state of the drag-and-drop operation, as follows:

   1. If the user is indicating a different immediate user selection than during the last iteration (or if this is the first
iteration), and if this immediate user selection is not the same as the current target element, then update the current target element as follows:

1. If the new immediate user selection is null
   Set the current target element to null also.

2. If the new immediate user selection is in a non-DOM document or application
   Set the current target element to the immediate user selection.

3. Otherwise
   Fire a DND event named dragenter at the immediate user selection.
   If the event is canceled, then set the current target element to the immediate user selection.
   Otherwise, run the appropriate step from the following list:
   
   - If the immediate user selection is a text control (e.g., textarea, or an input element whose type attribute is in the Text state) or an editing host or editable element, and the drag data store item list has an item with the drag data item type string "text/plain" and the drag data item kind text
     Set the current target element to the immediate user selection anyway.
   
   - If the immediate user selection is the body element
     Leave the current target element unchanged.

4. Otherwise
   Fire a DND event named dragenter at the body element, if there is one, or at the Document object, if not. Then, set the current target element to the body element, regardless of whether that event was canceled or not.

5. If the previous step caused the current target element to change, and if the previous target element was not null or a part of a non-DOM document, then fire a DND event named dragleave at the previous target element, with the new current target element as the specific related target.

6. If the current target element is a DOM element, then fire a DND event named dragover at this current target element.
   If the dragover event is not canceled, run the appropriate step from the following list:
   
   - If the current target element is a text control (e.g., textarea, or an input element whose type attribute is in the Text state) or an editing host or editable element, and the drag data store item list has an item with the drag data item type string "text/plain" and the drag data item kind text
     Set the current drag operation to either "copy" or "move", as appropriate given the platform conventions.

   - Otherwise
     Reset the current drag operation to "none".

   Otherwise (if the dragover event is canceled), set the current drag operation based on the values of the effectAllowed and dropEffect attributes of the DragEvent object's dataTransfer object as they stood after the event dispatch finished, as per the following table:

<table>
<thead>
<tr>
<th>EffectAllowed</th>
<th>DropEffect</th>
<th>Drag Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;uninitialized&quot;, &quot;copy&quot;, &quot;copyLink&quot;, &quot;copyMove&quot;, or &quot;all&quot;</td>
<td>&quot;copy&quot;</td>
<td>&quot;copy&quot;</td>
</tr>
<tr>
<td>&quot;uninitialized&quot;, &quot;link&quot;, &quot;copyLink&quot;, &quot;copyMove&quot;, or &quot;all&quot;</td>
<td>&quot;link&quot;</td>
<td>&quot;link&quot;</td>
</tr>
<tr>
<td>&quot;uninitialized&quot;, &quot;move&quot;, &quot;copyMove&quot;, &quot;linkMove&quot;, or &quot;all&quot;</td>
<td>&quot;move&quot;</td>
<td>&quot;move&quot;</td>
</tr>
<tr>
<td>Any other case</td>
<td></td>
<td>&quot;none&quot;</td>
</tr>
</tbody>
</table>

7. Otherwise, if the current target element is not a DOM element, use platform-specific mechanisms to determine what drag operation is being performed (none, copy, link, or move), and set the current drag operation accordingly.

8. Update the drag feedback (e.g. the mouse cursor) to match the current drag operation, as follows:
4. Otherwise, if the user ended the drag-and-drop operation (e.g. by releasing the mouse button in a mouse-driven drag-and-drop interface), or if the drag event was canceled, then this will be the last iteration. Run the following steps, then stop the drag-and-drop operation:

1. If the current drag operation is "none" (no drag operation), or, if the user ended the drag-and-drop operation by canceling it (e.g. by hitting the Escape key), or if the current target element is null, then the drag operation failed. Run these substeps:

   1. Let dropped be false.

   2. If the current target element is a DOM element, fire a DND event named dragleave at it; otherwise, if it is not null, use platform-specific conventions for drag cancelation.

   3. Set the current drag operation to "none".

Otherwise, the drag operation might be a success; run these substeps:

1. Let dropped be true.

2. If the current target element is a DOM element, fire a DND event named drop at it; otherwise, use platform-specific conventions for indicating a drop.

3. If the event is canceled, set the current drag operation to the value of the dropEffect attribute of the DragEvent object’s dataTransfer object as it stood after the event dispatch finished.

Otherwise, the event is not canceled; perform the event’s default action, which depends on the exact target as follows:

- If the current target element is a text control (e.g., textarea, or an input element whose type attribute is in the Text state) or an editing host or editable element, and the drag data store item list has an item with the drag data item type string of "text/plain" and the drag data item kind text

   Insert the actual data of the first item in the drag data store item list to have a drag data item type string of "text/plain" and a drag data item kind that is text into the text control or editing host, or editable element in a manner consistent with platform-specific conventions (e.g. inserting it at the current mouse cursor position, or inserting it at the end of the field).

- Otherwise

   Reset the current drag operation to "none".

2. Fire a DND event named dragend at the source node.

3. Run the appropriate steps from the following list as the default action of the dragend event:

   - If dropped is true, the current target element is a text control (see below), the current drag operation is "move", and the source of the drag-and-drop operation is a selection in the DOM that is entirely contained within an editing host

     Delete the selection.

   - If dropped is true, the current target element is a text control (see below), the current drag operation is "move", and the source of the drag-and-drop operation is a selection in a text control

     The user agent should delete the dragged selection from the relevant text control.

   - If dropped is false or if the current drag operation is "none"

     The drag was canceled. If the platform conventions dictate that this be represented to the user (e.g. by animating the dragged selection going back to the source of the drag-and-drop operation), then do so.
Otherwise

The event has no default action.

For the purposes of this step, a text control is a `textarea` element or an `input` element whose `type` attribute is in one of the `Text`, `Search`, `Tel`, `URL`, `Email`, `Password`, or `Number` states.

**Note**

User agents are encouraged to consider how to react to drags near the edge of scrollable regions. For example, if a user drags a link to the bottom of the `viewport` on a long page, it might make sense to scroll the page so that the user can drop the link lower on the page.

**Note**

This model is independent of which `Document` object the nodes involved are from; the events are fired as described above and the rest of the processing model runs as described above, irrespective of how many documents are involved in the operation.

### 6.11.6 Events summary

This section is non-normative.

The following events are involved in the drag-and-drop model.

<table>
<thead>
<tr>
<th>Event name</th>
<th>Target</th>
<th>Cancelable?</th>
<th>Drag data store mode</th>
<th><code>dropEffect</code></th>
<th>Default Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>dragstart</td>
<td>Source node</td>
<td>✓ Cancelable</td>
<td>Read/write mode</td>
<td>&quot;none&quot;</td>
<td>Initiate the drag-and-drop operation</td>
</tr>
<tr>
<td>drag</td>
<td>Source node</td>
<td>✓ Cancelable</td>
<td>Protected mode</td>
<td>&quot;none&quot;</td>
<td>Continue the drag-and-drop operation</td>
</tr>
<tr>
<td>dragenter</td>
<td>Immediate user selection or the body element</td>
<td>✓ Cancelable</td>
<td>Protected mode</td>
<td>Based on <code>effectAllowed</code> value</td>
<td>Reject immediate user selection as potential target element</td>
</tr>
<tr>
<td>dragleave</td>
<td>Previous target element</td>
<td>—</td>
<td>Protected mode</td>
<td>&quot;none&quot;</td>
<td>None</td>
</tr>
<tr>
<td>dragover</td>
<td>Current target element</td>
<td>✓ Cancelable</td>
<td>Protected mode</td>
<td>Based on <code>effectAllowed</code> value</td>
<td>Reset the current drag operation to &quot;none&quot;</td>
</tr>
<tr>
<td>drop</td>
<td>Current target element</td>
<td>✓ Cancelable</td>
<td>Read-only mode</td>
<td>Current drag operation</td>
<td>Varies</td>
</tr>
<tr>
<td>dragend</td>
<td>Source node</td>
<td>—</td>
<td>Protected mode</td>
<td>Current drag operation</td>
<td>Varies</td>
</tr>
</tbody>
</table>

All of these events bubble, are composed, and the `effectAllowed` attribute always has the value it had after the `dragstart` event, defaulting to "uninitialized" in the `dragstart` event.

### 6.11.7 The `draggable` attribute

All `HTML_element` may have the `draggable` content attribute set. The `draggable` attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>true</td>
<td>true</td>
<td>The element will be draggable.</td>
</tr>
<tr>
<td>false</td>
<td>false</td>
<td>The element will not be draggable.</td>
</tr>
</tbody>
</table>

The attribute's `missing value default` and `invalid value default` are both the `auto` state. The auto state uses the default behavior of the user agent.

An element with a `draggable` attribute should also have a `title` attribute that names the element for the purpose of non-visual interactions.
The `draggable` IDL attribute, whose value depends on the content attribute's in the way described below, controls whether or not the element is draggable. Generally, only text selections are draggable, but elements whose `draggable` IDL attribute is true become draggable as well.

If an element's `draggable` content attribute has the state `true`, the `draggable` IDL attribute must return true.

Otherwise, if the element's `draggable` content attribute has the state `false`, the `draggable` IDL attribute must return false.

Otherwise, the element's `draggable` content attribute has the state `auto`. If the element is an `img` element, an `object` element that represents an image, or an `a` element with an `href` content attribute, the `draggable` IDL attribute must return true; otherwise, the `draggable` IDL attribute must return false.

If the `draggable` IDL attribute is set to the value false, the `draggable` content attribute must be set to the literal value "false". If the `draggable` IDL attribute is set to the value true, the `draggable` content attribute must be set to the literal value "true".

### 6.11.8 Security risks in the drag-and-drop model

User agents must not make the data added to the `DataTransfer` object during the `dragstart` event available to scripts until the `drop` event, because otherwise, if a user were to drag sensitive information from one document to a second document, crossing a hostile third document in the process, the hostile document could intercept the data.

For the same reason, user agents must consider a drop to be successful only if the user specifically ended the drag operation — if any scripts end the drag operation, it must be considered unsuccessful (canceled) and the `drop` event must not be fired.

User agents should take care to not start drag-and-drop operations in response to script actions. For example, in a mouse-and-window environment, if a script moves a window while the user has their mouse button depressed, the UA would not consider that to start a drag. This is important because otherwise UAs could cause data to be dragged from sensitive sources and dropped into hostile documents without the user's consent.

User agents should filter potentially active (scripted) content (e.g. HTML) when it is dragged and when it is dropped, using a safelist of known-safe features. Similarly, relative URLs should be turned into absolute URLs to avoid references changing in unexpected ways. This specification does not specify how this is performed.

**Example**

Consider a hostile page providing some content and getting the user to select and drag and drop (or indeed, copy and paste) that content to a victim page's `contenteditable` region. If the browser does not ensure that only safe content is dragged, potentially unsafe content such as scripts and event handlers in the selection, once dropped (or pasted) into the victim site, get the privileges of the victim site. This would thus enable a cross-site scripting attack.

### 6.12 The `popover` attribute

All HTML elements may have the `popover` content attribute set. When specified, the element won't be rendered until it becomes shown, at which point it will be rendered on top of other page content.

**Example**

The `popover` attribute is a global attribute that allows authors flexibility to ensure popover functionality can be applied to elements with the most relevant semantics.

The following demonstrates how one might create a popover sub-navigation list of links, within the global navigation for a website.

```html
<ul>
</ul>
```
When using `popover` on elements without accessibility semantics, for instance the `div` element, authors should use the appropriate ARIA attributes to ensure the popover is accessible.

**Example**

The following shows the baseline markup to create a custom menu popover, where the first menuitem will receive keyboard focus when the popover is invoked due to the use of the `autofocus` attribute. Navigating the menuitems with arrow keys and activation behaviors would still need author scripting. Additional requirements for building custom menus widgets are defined in the WAI-ARIA specification.

```html
<button popovertarget=m>Actions</button>
<div role=menu id=m popover>
  <button role=menuitem tabindex=-1 autofocus>Edit</button>
  <button role=menuitem tabindex=-1 autofocus>Hide</button>
  <button role=menuitem tabindex=-1 autofocus>Delete</button>
</div>
```

A popover can be useful for rendering a status message, confirming the action performed by the user. The following demonstrates how one could reveal a popover in an `output` element.

```html
<button id=submit>Submit</button>
<p><output><span popover=manual></span></output></p>
<script>
const sBtn = document.getElementById("submit");
const outSpan = document.querySelector("output [popover=manual]");
let successMessage;
let errorMessage;

/* define logic for determining success of action and determining the appropriate success or error messages to use */
sBtn.addEventListener("click", () => {
  if (success) {
    outSpan.textContent = successMessage;
  } else {
    outSpan.textContent = errorMessage;
  }
  outSpan.showPopover();
  setTimeout(function () {
    outSpan.hidePopover();
  }, 10000);
});
```

Example 879
The `popover` attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>auto</td>
<td>auto</td>
<td>Closes other popovers when opened; has light dismiss and responds to close requests.</td>
</tr>
<tr>
<td>(the empty string)</td>
<td>manual</td>
<td>Does not close other popovers; does not light dismiss or respond to close requests.</td>
</tr>
</tbody>
</table>

The attribute's missing value default is the no popover state, and its invalid value default is the manual state.

The `popover` IDL attribute must reflect the `popover` attribute, limited to only known values.

Every HTML element has a `popover visibility state`, initially hidden, with these potential values:

- hidden
- showing

The Document has a `popover pointerdown target`, which is an HTML element or null, initially null.

Every HTML element has a `popover invoker`, which is an HTML element or null, initially set to null.

Every HTML element has a `popover showing or hiding`, which is a boolean, initially set to false.

Every HTML element has a `popover toggle task tracker`, which is a toggle task tracker or null, initially null.

Every HTML element has a `popover close watcher`, which is a close watcher or null, initially null.

The following attribute change steps, given element, `localName`, `oldValue`, `value`, and `namespace`, are used for all HTML elements:

1. If `namespace` is not null, then return.
2. If `localName` is not `popover`, then return.
3. If `element's` `popover visibility state` is in the `showing state` and `oldValue` and `value` are in different states, then run the `hide popover algorithm` given `element`, true, true, and false.

For web developers (non-normative)

```javascript
element.showPopover() // Shows the popover element by adding it to the top layer. If element's `popover` attribute is in the `auto` state, then this will also close all other `auto` popovers unless they are an ancestor of `element` according to the `topmost popover ancestor` algorithm.

element.hidePopover() // Hides the popover element by removing it from the top layer and applying `display: none` to it.

element.togglePopover() // If the popover element is not showing, then this method shows it. Otherwise, this method hides it. This method returns true if the popover is open after calling it, otherwise false.
```

The `showPopover()` method steps are to run `show popover` given `this`, true, and null.

To show popover, given an HTML element, a boolean `throwExceptions`, and an HTML element or null `invoker`:

```javascript
// Inserting a popover element into an output element will generally cause screen readers to announce the content when it becomes visible. Depending on the complexity or frequency of the content, this could be either useful or annoying to users of these assistive technologies. Keep this in mind when using the output element or other ARIA live regions to ensure the best user experience.
```
1. If the result of running `check popover validity` given `element`, `false`, `throwExceptions`, and `null` is false, then return.

2. Let `document` be `element``s` `node document`.

3. **Assert:** `element``s` `popover invoker` is null.

4. **Assert:** `element` is not in `document``s` `top layer`.

5. Let `nestedShow` be `element``s` `popover showing or hiding`.

6. Set `element``s` `popover showing or hiding` to true.

7. Let `cleanupShowingFlag` be the following steps:
   1. If `nestedShow` is false, then set `element``s` `popover showing or hiding` to false.

8. If the result of firing an event named `beforetoggle`, using `ToggleEvent`, with the `cancelable` attribute initialized to true, the `oldState` attribute initialized to "closed", and the `newState` attribute initialized to "open" at `element` is false, then run `cleanupShowingFlag` and return.

9. If the result of running `check popover validity` given `element`, `false`, `throwExceptions`, and `document` is false, then run `cleanupShowingFlag` and return.

10. Let `shouldRestoreFocus` be false.

11. If `element``s` `popover` attribute is in the `auto` state, then:
   1. Let `originalType` be the value of `element``s` `popover` attribute.
   2. Let `ancestor` be the result of running the `topmost popover ancestor` algorithm given `element`, `invoker`, and `true`.
   3. If `ancestor` is null, then set `ancestor` to `document`.
   4. Run `hide all popovers until` given `ancestor`, `false`, and not `nestedShow`.
   5. If `originalType` is not equal to the value of `element``s` `popover` attribute, then throw a "`InvalidStateError`" `DOMException`.
   6. If the result of running `check popover validity` given `element`, `false`, `throwExceptions`, and `document` is false, then run `cleanupShowingFlag` and return.

12. Set `element``s` `previously focused element` to null.

13. Let `originallyFocusedElement` be `document``s` `focused area of the document``s` `DOM anchor`.

14. Add an element to the top layer given `element`.

15. Set `element``s` `popover visibility state` to `showing`.
16. Set element's `popover invoker` to invoker.
17. Run the `popover focusing steps` given element.
18. If `shouldRestoreFocus` is true and element's `popover` attribute is not in the `no popover` state, then set element's `previously focused element` to `originallyFocusedElement`.
19. Queue a popover toggle event task given element, "closed", and "open".
20. Run cleanupShowingFlag.

To queue a popover toggle event task given an element `element`, a string `oldState`, and a string `newState`:

1. If `element`'s `popover toggle task tracker` is null, then:
   1. Set `oldState` to `element`'s `popover toggle task tracker`'s `old state`.
   2. Remove `element`'s `popover toggle task tracker`'s `task` from its `task queue`.
   3. Set `element`'s `popover toggle task tracker` to null.
2. Queue an element task given the DOM manipulation task source and `element` to run the following steps:
   1. Fire an event named `toggle` at `element`, using `ToggleEvent`, with the `oldState` attribute initialized to `oldState` and the `newState` attribute initialized to `newState`.
   2. Set `element`'s `popover toggle task tracker` to null.
3. Set `element`'s `popover toggle task tracker` to a struct with `task` set to the just-queued `task` and `old state` set to `oldState`.

The `hidePopover()` method steps are:

1. Run the `hide popover algorithm` given this, true, true, and true.

To hide a popover given an HTML element, a boolean `focusPreviousElement`, a boolean `fireEvents`, and a boolean `throwExceptions`:

1. If the result of running `check popover validity` given element, true, `throwExceptions`, and null is false, then return.
2. Let `document` be element's `node document`.
3. Let `nestedHide` be element's `popover showing or hiding`.
4. Set `element`'s `popover showing or hiding` to true.
5. If `nestedHide` is true, then set `fireEvents` to false.
6. Let `cleanupSteps` be the following steps:
   1. If `nestedHide` is false, then set `element`'s `popover showing or hiding` to false.
   2. If `element`'s `popover close watcher` is null, then:
      1. Destroy `element`'s `popover close watcher`.
      2. Set `element`'s `popover close watcher` to null.
7. If `element`'s `popover` attribute is in the `auto` state, then:
   1. Run `hide all popovers until` given element, `focusPreviousElement`, and `fireEvents`.
   2. If the result of running `check popover validity` given element, true, and `throwExceptions` is false, then run `cleanupSteps` and return.

Note: `Check popover validity` is called again because running `hide all popovers until` could have disconnected element or changed its `popover` attribute.

8. Let `autoPopoverListContainsElement` be true if `document`'s `showing auto popover list`'s last item is `element`, otherwise...
false.
9. Set element's popover invoker to null.
10. If fireEvents is true:
   1. Fire an event named **beforetoggle** using **ToggleEvent**, with the oldState attribute initialized to "open" and the nowState attribute initialized to "closed" at element.
   2. If autoPopoverListContainsElement is true and document's showing auto popover list's last item is not element, then run hide all popovers until given element, focusPreviousElement, and false.
   3. If the result of running check popover validity given element, true, throwExceptions, and null is false, then run cleanupSteps and return.

4. Request an element to be removed from the top layer given element.
11. Otherwise, remove an element from the top layer immediately given element.
12. Set element's popover visibility state to hidden.
13. If fireEvents is true, then queue a popover toggle event task given element, "open", and "closed".
14. Let previouslyFocusedElement be element's previously focused element.
15. If previouslyFocusedElement is not null, then:
   1. Set element's previously focused element to null.
   2. If focusPreviousElement is true and document's focused area of the document's DOM anchor is a shadow-including inclusive descendant of element, then run the focusing steps for previouslyFocusedElement; the viewport should not be scrolled by doing this step.
16. Run cleanupSteps.

The togglePopover(force) method steps are:

1. If this's popover visibility state is showing, and force is not present or false, then run the hide popover algorithm given this, true, true, and true.
2. Otherwise, if force is not present or true, then run show popover given this true, and null.
3. Otherwise:
   1. Let expectedToBeShowing be true if this's popover visibility state is showing, otherwise false.
   2. Run check popover validity given expectedToBeShowing, true, and null.
4. Return true if this's popover visibility state is showing, otherwise false.

To hide all popovers until, given an HTML element or Document endpoint, a boolean focusPreviousElement, and a boolean fireEvents:

1. If endpoint is an HTML element and endpoint is not in the popover showing state, then return.
2. Let document be endpoint's node document.
3. Let closeAllOpenPopovers be an algorithm which performs the following steps:
   1. Let popover be document's topmost auto popover.
   2. While popover is not null:
      1. Run the hide popover algorithm given popover, focusPreviousElement, fireEvents, and false.
      2. Set popover to document's topmost auto popover.
4. If endpoint is a Document, then run closeAllOpenPopovers and return.

5. Assert: endpoint's popover attribute is in the auto state.

6. Let repeatingHide be false.

7. Perform the following steps at least once:
   1. Let lastToHide be null.
   2. Let foundEndpoint be false.
   3. For each popover of document's showing auto popover list:
      1. If popover is endpoint, then set foundEndpoint to true.
      2. Otherwise, if foundEndpoint is true, then set lastToHide to popover and break.
   4. If foundEndpoint is false, then run closeAllOpenPopovers and return.
   5. While lastToHide is not null and lastToHide's popover visibility state is showing and document's showing auto popover list is not empty:
      1. Run the hide popover algorithm given document's showing auto popover list's last element, focusPreviousElement, fireEvents, and false.
   6. Set repeatingHide to true if document's showing auto popover list contains endpoint and document's showing auto popover list's last element is not endpoint, otherwise false.
   7. If repeatingHide is true, then set fireEvents to false.

and keep performing them while repeatingHide is true.

Note

The hide all popovers until algorithm is used in several cases to hide all popovers that don't stay open when something happens. For example, during light-dismiss of a popover, this algorithm ensures that we close only the popovers that aren't related to the node clicked by the user.

To find the topmost popover ancestor, given a Node newPopoverOrTopLayerElement, an HTML element or null invoker, and a boolean isPopover, perform the following steps. They return an HTML element or null.

Note

The topmost popover ancestor algorithm will return the topmost (latest in the showing auto popover list) ancestor popover for the provided popover or top layer element. Popovers can be related to each other in several ways, creating a tree of popovers. There are two paths through which one popover (call it the "child" popover) can have a topmost ancestor popover (call it the "parent" popover):

1. The popovers are nested within each other in the node tree. In this case, the descendant popover is the "child" and its topmost ancestor popover is the "parent".

2. An invoking element (e.g., a button) has a popovertarget attribute pointing to a popover. In this case, the popover is the "child", and the popover subtree the invoking element is in is the "parent". The invoker has to be in a popover and reference an open popover.

In each of the relationships formed above, the parent popover has to be strictly earlier in the showing auto popover list than the child popover, or it does not form a valid ancestral relationship. This eliminates non-showing popovers and self-pointers (e.g., a popover containing an invoking element that points back to the containing popover), and it allows for the construction of a well-formed tree from the (possibly cyclic) graph of connections. Only auto popovers are considered.

If the provided element is a top layer element such as a dialog which is not showing as a popover, then topmost popover ancestor will only look in the node tree to find the first popover.

1. If isPopover is true:
   1. Assert: newPopoverOrTopLayerElement is an HTML element.
2. **Assert**: `newPopoverOrTopLayerElement`'s `popover` attribute is not in the `no popover state` or the `manual` state.

3. **Assert**: `newPopoverOrTopLayerElement`'s `popover visibility state` is not in the `popover showing state`.

2. Otherwise:
   1. **Assert**: `invoker` is null.

3. Let `popoverPositions` be an empty ordered map.

4. Let `index` be 0.

5. Let `document` be `newPopoverOrTopLayerElement`'s `node document`.

6. For each `popover` of `document`'s `showing auto popover list`:
   1. Set `popoverPositions[popover]` to `index`.
   2. Increment `index` by 1.

7. If `isPopover` is true, then set `popoverPositions[newPopoverOrTopLayerElement]` to `index`.

8. Increment `index` by 1.

9. Let `topmostPopoverAncestor` be null.

10. Let `checkAncestor` be an algorithm which performs the following steps given `candidate`:
    1. If `candidate` is null, then return.
    2. Let `candidateAncestor` be the result of running `nearest inclusive open popover` given `candidate`.
    3. If `candidateAncestor` is null, then return.
    5. If `topmostPopoverAncestor` is null or `popoverPositions[topmostPopoverAncestor]` is less than `candidatePosition`, then set `topmostPopoverAncestor` to `candidateAncestor`.

11. Run `checkAncestor` given `newPopoverOrTopLayerElement`'s parent node within the flat tree.

12. Run `checkAncestor` given `invoker`.


To find the **nearest inclusive open popover** given a `Node` node, perform the following steps. They return an `HTML element` or null.

1. Let `currentNode` be `node`.

2. While `currentNode` is not null:
   1. If `currentNode`'s `popover` attribute is in the `auto` state and `currentNode`'s `popover visibility state` is `showing`, then return `currentNode`.
   2. Set `currentNode` to `currentNode`'s parent in the flat tree.

3. Return null.

To find the **topmost auto popover** given a `Document` `document`, perform the following steps. They return an `HTML element` or null.

1. If `document`'s `showing auto popover list` is not empty, then return `document`'s `showing auto popover list`'s last element.

2. Return null.

To perform the **popover focusing steps** for an `HTML element` subject:
1. If subject is a dialog element, then run the dialog focusing steps given subject and return.
2. If subject has the autofocus attribute, then let control be subject.
3. Otherwise, let control be the autofocus delegate for subject given "other".
4. If control is null, then return.
5. Run the focusing steps given control.
7. If control's node document's origin is not the same as the origin of topDocument, then return.
8. Empty topDocument's autofocus candidates.
9. Set topDocument's autofocus processed flag to true.

To check popover validity for an HTML element given a boolean expectedToBeShowing, a boolean throwExceptions, and a Document or null expectedDocument perform the following steps. They throw an exception or return a boolean.

1. If element's popover attribute is in the no popover state, then:
   1. If throwExceptions is true, then throw a "NotSupportedError" DOMException.
   2. Return false.
2. If any of the following are true:
   ◦ expectedToBeShowing is true and element's popover visibility state is not showing; or
   ◦ expectedToBeShowing is false and element's popover visibility state is not hidden,

   then return false.
3. If any of the following are true:
   ◦ element is not connected;
   ◦ expectedDocument is not null and element's node document is not expectedDocument;
   ◦ element is a dialog element and its is modal flag is set to true; or
   ◦ element's fullscreen flag is set,

   then:
   1. If throwExceptions is true, then throw a "InvalidStateError" DOMException.
   2. Return false.
4. Return true.

To get the showing auto popover list for a Document document:

1. Let popovers be « ».
2. For each Element element in document's top layer: if element's popover attribute is in the auto state and element's popover visibility state is showing, then append element to popovers.
3. Return popovers.

### 6.12.1 The popover target attributes

Buttons may have the following content attributes:

- popovertarget
If specified, the `popovertarget` attribute value must be the ID of an element with a `popover` attribute in the same tree as the button with the `popovertarget` attribute.

The `popovertargetaction` attribute is an enumerated attribute with the following keywords and states:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>toggle</td>
<td>toggle</td>
<td>Shows or hides the targeted popover element.</td>
</tr>
<tr>
<td>show</td>
<td>show</td>
<td>Shows the targeted popover element.</td>
</tr>
<tr>
<td>hide</td>
<td>hide</td>
<td>Hides the targeted popover element.</td>
</tr>
</tbody>
</table>

The attribute's missing value default and invalid value default are both the `toggle` state.

**Note**

Whenever possible ensure the popover element is placed immediately after its triggering element in the DOM. Doing so will help ensure that the popover is exposed in a logical programmatic reading order for users of assistive technology, such as screen readers.

**Example**

The following shows how the `popovertarget` attribute in combination with the `popovertargetaction` attribute can be used to show and close a popover:

```html
<button popovertarget="foo" popovertargetaction="show">  
    Show a popover  
</button>

<article popover="auto" id="foo">  
    This is a popover article!  
    <button popovertarget="foo" popovertargetaction="hide">Close</button>  
</article>
```

If a `popovertargetaction` attribute is not specified, the default action will be to toggle the associated popover. The following shows how only specifying the `popovertarget` attribute on its invoking button can toggle a manual popover between its opened and closed states. A manual popover will not respond to light dismiss or close requests:

```html
<input type="button" popovertarget="foo" value="Toggle the popover">  
<div popover=manual id="foo">  
    This is a popover!  
</div>
```

**DOM interface.**

```javascript
IDL interface mixin PopoverInvokerElement {
    [CEReactions] attribute Element? popovertargetElement;
    [CEReactions] attribute DOMString popovertargetAction;
};
```

The `popovertargetElement` IDL attribute must reflect the `popovertarget` attribute.

The `popovertargetAction` IDL attribute must reflect the `popovertargetaction` attribute, limited to only known values.

To run the `popover target attribute activation behavior` given a Node `node`:

1. Let `popover` be `node`'s `popovertarget element`.
2. If `popover` is null, then return.
3. If `node`'s `popovertargetaction` attribute is in the `show` state and `popover`'s `popover visibility state` is `showing`, then return.
4. If node's `popovertargetaction` attribute is in the `hide` state and popover's `popover visibility state` is `hidden`, then return.

5. If popover's `popover visibility state` is `showing`, then run the `hide popover algorithm` given popover, true, true, and false.

6. Otherwise, if popover's `popover visibility state` is `hidden` and the result of running `check popover validity` given popover, false, false, and null is true, then run `show popover` given popover, false, and node.

To get the `popover target element` given a `Node` node, perform the following steps. They return an `HTML element` or null.

1. If node is not a `button`, then return null.
2. If node is `disabled`, then return null.
3. If node has a `form owner` and node is a `submit button`, then return null.
4. Let `popoverElement` be the result of running node's `get the popovertarget-associated element`.
5. If `popoverElement` is null, then return null.
6. If `popoverElement`'s `popover` attribute is in the `no popover` state, then return null.
7. Return `popoverElement`.

### 6.12.2 Popover light dismiss

"Light dismiss" means that clicking outside of a popover whose `popover` attribute is in the `auto` state will close the popover. This is in addition to how such popovers respond to `close requests`.

To light dismiss open popovers, given an `Event` event:

1. Assert: event's `isTrusted` attribute is true.
2. Let target be event's `target`.
3. Let document be target's `node document`.
4. Let `topmostPopover` be the result of running `topmost auto popover` given document.
5. If `topmostPopover` is null, then return.
6. If event is a `PointerEvent` and event's type is "pointerdown", then: set document's `popover pointerdown target` to the result of running `topmost clicked popover` given target.
7. If event is a `PointerEvent` and event's type is "pointerup", then:
   1. Let ancestor be the result of running `topmost clicked popover` given target.
   2. Let `sameTarget` be true if ancestor is document's `popover pointerdown target`.
   3. Set document's `popover pointerdown target` to null.
   4. If ancestor is null, then set ancestor to document.
   5. If `sameTarget` is true, then run `hide all popovers until` given ancestor, false, and true.

Light dismiss open popovers will be called by the Pointer Events spec when the user clicks or touches anywhere on the page.

To find the `topmost clicked popover`, given a `Node` node:

1. Let `clickedPopover` be the result of running `nearest inclusive open popover` given node.
2. Let `invokerPopover` be the result of running `nearest inclusive target popover for invoker` given node.
3. Let getStackPosition be an algorithm which performs the following steps given an HTML element popover:
   1. Let popoverList be popover's node document's showing auto popover list.
   2. If popover is in popoverList, then return the index of popover in popoverList + 1.
   3. Return 0.
   4. If the result of running getStackPosition given clickedPopover is greater than the result of running getStackPosition given invokerPopover, then return clickedPopover.
   5. Return invokerPopover.

To find the nearest inclusive target popover for invoker given a Node node:
   1. Let currentNode be node.
   2. While currentNode is not null:
      1. Let targetPopover be currentNode's popover target element.
      2. If targetPopover is not null and targetPopover's popover attribute is in the auto state and targetPopover's popover visibility state is showing, then return targetPopover.
      3. Set currentNode to currentNode's ancestor in the flat tree.
7 Loading web pages

This section describes features that apply most directly to web browsers. Having said that, except where specified otherwise, the requirements defined in this section do apply to all user agents, whether they are web browsers or not.

7.1 Supporting concepts

7.1.1 Origins

Origins are the fundamental currency of the web's security model. Two actors in the web platform that share an origin are assumed to trust each other and to have the same authority. Actors with differing origins are considered potentially hostile versus each other, and are isolated from each other to varying degrees.

Example

For example, if Example Bank's web site, hosted at bank.example.com, tries to examine the DOM of Example Charity's web site, hosted at charity.example.org, a "SecurityError" DOMException will be raised.

An origin is one of the following:

An opaque origin

An internal value, with no serialization it can be recreated from (it is serialized as "null" per serialization of an origin), for which the only meaningful operation is testing for equality.

A tuple origin

A tuple consists of:

- A scheme (an ASCII string).
- A host (a host).
- A port (null or a 16-bit unsigned integer).
- A domain (null or a domain). Null unless stated otherwise.

Note

Origins can be shared, e.g., among multiple Document objects. Furthermore, origins are generally immutable. Only the domain of a tuple origin can be changed, and only through the document.domain API.

The effective domain of an origin, origin, is computed as follows:

1. If origin is an opaque origin, then return null.
2. If origin's domain is non-null, then return origin's domain.
3. Return origin's host.

The serialization of an origin is the string obtained by applying the following algorithm to the given origin origin:

1. If origin is an opaque origin, then return "null".
2. Otherwise, let result be origin's scheme.
3. Append ":/" to result.
4. Append origin's host, serialized, to result.
5. If origin's port is non-null, append a U+003A COLON character (:) and origin's port, serialized, to result.
6. Return result.
Two origins, A and B, are said to be same origin if the following algorithm returns true:

1. If A and B are the same opaque origin, then return true.
2. If A and B are both tuple origins and their schemes, hosts, and port are identical, then return true.
3. Return false.

Two origins, A and B, are said to be same origin-domain if the following algorithm returns true:

1. If A and B are the same opaque origin, then return true.
2. If A and B are both tuple origins, run these substeps:
   1. If A and B's schemes are identical, and their domains are identical and non-null, then return true.
   2. Otherwise, if A and B are same origin and their domains are identical and null, then return true.
3. Return false.

A scheme-and-host is a tuple of a scheme (an ASCII string) and a host.

A site is an opaque origin or a scheme-and-host.

To obtain a site, given an origin, run these steps:

1. If origin is an opaque origin, then return origin.
2. If origin's host's registrable domain is null, then return (origin's scheme, origin's host).
3. Return (origin's scheme, origin's host's registrable domain).

Two sites, A and B, are said to be same site if the following algorithm returns true:

1. If A and B are the same opaque origin, the return true.
2. If A or B is an opaque origin, then return false.
3. If A's and B's scheme values are different, then return false.
4. If A's and B's host values are not equal, then return false.
5. Return true.

The serialization of a site is the string obtained by applying the following algorithm to the given site:

Example

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>same origin</th>
<th>same origin-domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>(&quot;https&quot;, &quot;example.org&quot;, null, null)</td>
<td>(&quot;https&quot;, &quot;example.org&quot;, null, null)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(&quot;https&quot;, &quot;example.org&quot;, 314, null)</td>
<td>(&quot;https&quot;, &quot;example.org&quot;, 420, null)</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>(&quot;https&quot;, &quot;example.org&quot;, 314, &quot;example.org&quot;)</td>
<td>(&quot;https&quot;, &quot;example.org&quot;, 420, &quot;example.org&quot;)</td>
<td>x</td>
<td>✓</td>
</tr>
<tr>
<td>(&quot;https&quot;, &quot;example.org&quot;, null, null)</td>
<td>(&quot;https&quot;, &quot;example.org&quot;, null, &quot;example.org&quot;)</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>(&quot;https&quot;, &quot;example.org&quot;, null, &quot;example.org&quot;)</td>
<td>(&quot;http&quot;, &quot;example.org&quot;, null, &quot;example.org&quot;)</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

7.1.1.1 Sites

A scheme-and-host is a tuple of a scheme (an ASCII string) and a host (a host).

A site is an opaque origin or a scheme-and-host.

To obtain a site, given an origin, run these steps:

1. If origin is an opaque origin, then return origin.
2. If origin's host's registrable domain is null, then return (origin's scheme, origin's host).
3. Return (origin's scheme, origin's host's registrable domain).

Two sites, A and B, are said to be same site if the following algorithm returns true:

1. If A and B are the same opaque origin, the return true.
2. If A or B is an opaque origin, then return false.
3. If A's and B's scheme values are different, then return false.
4. If A's and B's host values are not equal, then return false.
5. Return true.

The serialization of a site is the string obtained by applying the following algorithm to the given site:

Example
1. If site is an opaque origin, then return "null".
2. Let result be site[0].
3. Append "://" to result.
4. Append site[1], serialized, to result.
5. Return result.

⚠ Warning!
It needs to be clear from context that the serialized value is a site, not an origin, as there is not necessarily a syntactic difference between the two. For example, the origin ("https", "shop.example", null, null) and the site ("https", "shop.example") have the same serialization: "https://shop.example".

Two origins, A and B, are said to be schemelessly same site if the following algorithm returns true:

1. If A and B are the same opaque origin, then return true.
2. If A and B are both tuple origins, then:
   1. Let hostA be A’s host, and let hostB be B’s host.
   2. If hostA equals hostB and hostA’s registrable domain is null, then return true.
   3. If hostA’s registrable domain equals hostB’s registrable domain and is non-null, then return true.
3. Return false.

Two origins, A and B, are said to be same site if the following algorithm returns true:

1. Let siteA be the result of obtaining a site given A.
2. Let siteB be the result of obtaining a site given B.
3. If siteA is same site with siteB, then return true.
4. Return false.

⚠ Warning!
Unlike the same origin and same origin-domain concepts, for schemelessly same site and same site, the port and domain components are ignored.

⚠ Warning!
For the reasons explained in URL, the same site and schemelessly same site concepts should be avoided when possible, in favor of same origin checks.

Example

Given that wildlife.museum, museum, and com are public suffixes and that example.com is not:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>schemelessly same site</th>
<th>same site</th>
</tr>
</thead>
<tbody>
<tr>
<td>(&quot;https&quot;, &quot;example.com&quot;)</td>
<td>(&quot;https&quot;, &quot;sub.example.com&quot;)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(&quot;https&quot;, &quot;example.com&quot;)</td>
<td>(&quot;https&quot;, &quot;sub.other.example.com&quot;)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(&quot;https&quot;, &quot;example.com&quot;)</td>
<td>(&quot;https&quot;, &quot;non-secure.example.com&quot;)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(&quot;https&quot;, &quot;r.wildlife.museum&quot;)</td>
<td>(&quot;https&quot;, &quot;sub.r.wildlife.museum&quot;)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(&quot;https&quot;, &quot;r.wildlife.museum&quot;)</td>
<td>(&quot;https&quot;, &quot;sub.other.r.wildlife.museum&quot;)</td>
<td>✓</td>
<td>✔</td>
</tr>
<tr>
<td>(&quot;https&quot;, &quot;r.wildlife.museum&quot;)</td>
<td>(&quot;https&quot;, &quot;other.wildlife.museum&quot;)</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>(&quot;https&quot;, &quot;r.wildlife.museum&quot;)</td>
<td>(&quot;https&quot;, &quot;wildlife.museum&quot;)</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>(&quot;https&quot;, &quot;wildlife.museum&quot;)</td>
<td>(&quot;https&quot;, &quot;wildlife.museum&quot;)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(&quot;https&quot;, &quot;example.com&quot;)</td>
<td>(&quot;https&quot;, &quot;example.com&quot;)</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

(Here we have omitted the port and domain components since they are not considered.)
Avoid using the `document.domain` setter. It undermines the security protections provided by the same-origin policy. This is especially acute when using shared hosting; for example, if an untrusted third party is able to host an HTTP server at the same IP address but on a different port, then the same-origin protection that normally protects two different sites on the same host will fail, as the ports are ignored when comparing origins after the `document.domain` setter has been used.

Because of these security pitfalls, this feature is in the process of being removed from the web platform. (This is a long process that takes many years.)

Instead, use `postMessage()` or `MessageChannel` objects to communicate across origins in a safe manner.

The `domain` getter steps are:

1. Let `effectiveDomain` be `this`'s origin's `effective domain`.
2. If `effectiveDomain` is null, then return the empty string.
3. Return `effectiveDomain`, serialized.

The `domain` setter steps are:

1. If `this`'s `browsing context` is null, then throw a "SecurityError" DOMException.
2. If `this`'s active sandboxing flag set has its `sandboxed document domain browsing context` flag set, then throw a "SecurityError" DOMException.
3. Let `effectiveDomain` be `this`'s origin's `effective domain`.
4. If `effectiveDomain` is null, then throw a "SecurityError" DOMException.
5. If the given value is not a registrable domain suffix of and is not equal to `effectiveDomain`, then throw a "SecurityError" DOMException.
6. If the surrounding agent's agent cluster's is origin-keyed is true, then return.
7. Set `this`'s `domain` to the result of parsing the given value.

To determine if a scalar value string `hostSuffixString` is a registrable domain suffix of or is equal to a host `originalHost`:

1. If `hostSuffixString` is the empty string, then return false.
2. Let `hostSuffix` be the result of parsing `hostSuffixString`.
3. If `hostSuffix` is failure, then return false.
4. If `hostSuffix` does not equal `originalHost`, then:
   1. If `hostSuffix` or `originalHost` is not a `domain`, then return false.
   2. If `hostSuffix`, prefixed by U+002E (.), does not match the end of `originalHost`, then return false.
3. If any of the following are true:
   - `hostSuffix` equals `hostSuffix`
   - `hostSuffix`, prefixed by U+002E (.), matches the end of `originalHost`

   then return false. \([URL]^{1462}\)

4. Assert: `originalHost`'s public suffix, prefixed by U+002E (.), matches the end of `hostSuffix`.

5. Return true.

### Example

<table>
<thead>
<tr>
<th><code>hostSuffixString</code></th>
<th><code>originalHost</code></th>
<th><code>is a registrable domain suffix of or is equal to</code></th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;0.0.0.0&quot;</td>
<td>0.0.0.0</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>&quot;0x10203&quot;</td>
<td>0.1.2.3</td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>&quot;[0::1]&quot;</td>
<td>::1</td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>&quot;example.com&quot;</td>
<td>example.com</td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>&quot;example.com&quot;</td>
<td>example.com</td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>&quot;example.com&quot;</td>
<td>example.com</td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>&quot;example.com&quot;</td>
<td><a href="http://www.example.com">www.example.com</a></td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>&quot;com&quot;</td>
<td>example.com</td>
<td>✗</td>
<td>At the time of writing, com is a public suffix.</td>
</tr>
<tr>
<td>&quot;example&quot;</td>
<td>example</td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>&quot;compute.amazonaws.com&quot;</td>
<td>example.compute.amazonaws.com</td>
<td>✗</td>
<td>At the time of writing, *.compute.amazonaws.com is a public suffix.</td>
</tr>
<tr>
<td>&quot;example.compute.amazonaws.com&quot;</td>
<td><a href="http://www.example.compute.amazonaws.com">www.example.compute.amazonaws.com</a></td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>&quot;amazonaws.com&quot;</td>
<td><a href="http://www.example.compute.amazonaws.com">www.example.compute.amazonaws.com</a></td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>&quot;amazonaws.com&quot;</td>
<td>test.amazonaws.com</td>
<td>✗</td>
<td>At the time of writing, amazonaws.com is a registrable domain.</td>
</tr>
</tbody>
</table>

### 7.1.2 Origin-keyed agent clusters \(\S^{p89}\)

For web developers (non-normative)

`window.originAgentCluster`\(^{p895}\)

Returns true if this `Window`\(^ {p913}\) belongs to an agent cluster which is `origin`\(^{p900}\)keyed\(^{p1061}\), in the manner described in this section.

A `Document`\(^{p129}\) delivered over a secure context\(^ {p1071}\) can request that it be placed in an `origin`\(^{p900}\)keyed\(^{p1061}\) agent cluster, by using the `Origin-Agent-Cluster` HTTP response header. This header is a structured header whose value must be a boolean, \([STRUCTURED-FIELDS]^{p1462}\).

Per the processing model in the `create and initialize a new Document object`\(^ {p1044}\) values that are not the structured header boolean true value (i.e., `\`?\`\`) will be ignored.

The consequences of using this header are that the resulting `Document`\(^ {p129}\)’s agent cluster key\(^ {p1061}\) is its `origin`, instead of the corresponding site\(^ {p989}\). In terms of observable effects, this means that attempting to relax the same-origin restriction\(^ {p893}\) using `document.domain`\(^ {p893}\) will instead do nothing, and it will not be possible to send `WebAssembly.Module` objects to cross-origin `Document`\(^ {p129}\)s (even if they are same site\(^ {p989}\)). Behind the scenes, this isolation can allow user agents to allocate implementation-specific resources corresponding to agent clusters, such as processes or threads, more efficiently.

Note that within a `browsing context group`\(^ {p991}\), the `Origin-Agent-Cluster`\(^ {p894}\) header can never cause same-origin `Document`\(^ {p129}\) objects to end up in different agent clusters, even if one sends the header and the other doesn’t. This is prevented by means of the `historical agent cluster key map`\(^ {p991}\).

**Note**

This means that the `originAgentCluster`\(^ {p895}\) getter can return false, even if the header is set, if the header was omitted on a previously-loaded same-origin page in the same `browsing context group`\(^ {p991}\). Similarly, it can return true even when the header is not set.

894
The `originAgentCluster` getter steps are to return the surrounding agent’s agent cluster’s is origin-keyed.

---

**Note**

Document’s with an opaque origin can be considered unconditionally origin-keyed; for them the header has no effect, and the `originAgentCluster` getter will always return true.

---

**Note**

Similarly, Document’s whose agent cluster’s cross-origin isolation mode is not “none” are automatically origin-keyed. The ‘Origin-Agent-Cluster’ header might be useful as an additional hint to implementations about resource allocation, since the ‘Cross-Origin-Opener-Policy’ and ‘Cross-Origin-Embedder-Policy’ headers used to achieve cross-origin isolation are more about ensuring that everything in the same address space opts in to being there. But adding it would have no additional observable effects on author code.

---

### 7.1.3 Cross-origin opener policies

A cross-origin opener policy value allows a document which is navigated to in a top-level browsing context to force the creation of a new top-level browsing context, and a corresponding group. The possible values are:

- **"unsafe-none"**

  This is the (current) default and means that the document will occupy the same top-level browsing context as its predecessor, unless that document specified a different cross-origin opener policy.

- **"same-origin-allow-popups"**

  This forces the creation of a new top-level browsing context for the document, unless its predecessor specified the same cross-origin opener policy and they are same origin.

- **"same-origin"**

  This behaves the same as "same-origin-allow-popups", with the addition that any auxiliary browsing context created needs to contain same origin documents that also have the same cross-origin opener policy or it will appear closed to the opener.

- **"same-origin-plus-COEP"**

  This behaves the same as "same-origin" with the addition that it sets the (new) top-level browsing context’s group’s cross-origin isolation mode to one of "logical" or "concrete".

---

**Note**

"same-origin-plus-COEP" cannot be directly set via the ‘Cross-Origin-Opener-Policy’ header, but results from a combination of setting both ‘Cross-Origin-Opener-Policy’; same-origin; and a ‘Cross-Origin-Embedder-Policy’ header whose value is compatible with cross-origin isolation together.

---

A cross-origin opener policy consists of:

- A value, which is a cross-origin opener policy value, initially "unsafe-none".

- A reporting endpoint, which is a string or null, initially null.

- A report-only value, which is a cross-origin opener policy value, initially "unsafe-none".

- A report-only reporting endpoint, which is a string or null, initially null.

To match cross-origin opener policy values, given a cross-origin opener policy value A, an origin originA, a cross-origin opener policy value B, and an origin originB:

1. If A is "unsafe-none" and B is "unsafe-none", then return true.
2. If A is "unsafe-none" or B is "unsafe-none", then return false.
3. If A is B and originA is same origin with originB, then return true.
4. Return false.
7.1.3.1 The headers

A Document's cross-origin opener policy is derived from the `Cross-Origin-Opener-Policy` and `Cross-Origin-Opener-Policy-Report-Only` HTTP response headers. These headers are structured headers whose value must be a token. [STRUCTURED-FIELDS]

The valid token values are the opener policy values. The token may also have attached parameters; of these, the "report-to" parameter can have a valid URL string identifying an appropriate reporting endpoint. [REPORTING]

Note

Per the processing model described below, user agents will ignore this header if it contains an invalid value. Likewise, user agents will ignore this header if the value cannot be parsed as a token.

To obtain a cross-origin opener policy given a response response and an environment reservedEnvironment:

1. Let policy be a new cross-origin opener policy.
2. If reservedEnvironment is a non-secure context, then return policy.
3. Let parsedItem be the result of getting a structured field value given `Cross-Origin-Opener-Policy` and "item" from response's header list.
4. If parsedItem is not null, then:
   1. If parsedItem[0] is "same-origin", then:
      1. Let coep be the result of obtaining a cross-origin embedder policy from response and reservedEnvironment.
      2. If coep's value is compatible with cross-origin isolation, then set policy's value to "same-origin-plus-COEP".
      3. Otherwise, set policy's value to "same-origin".
   2. If parsedItem[0] is "same-origin-allow-popups", then set policy's value to "same-origin-allow-popups".
   3. If parsedItem[1]["report-to"] exists and it is a string, then set policy's reporting endpoint to parsedItem[1]["report-to"].
5. Set parsedItem to the result of getting a structured field value given `Cross-Origin-Opener-Policy-Report-Only` and "item" from response's header list.
6. If parsedItem is not null, then:
   1. If parsedItem[0] is "same-origin", then:
      1. Let coep be the result of obtaining a cross-origin embedder policy from response and reservedEnvironment.
      2. If coep's value is compatible with cross-origin isolation or coep's report-only value is compatible with cross-origin isolation, then set policy's report-only value to "same-origin-plus-COEP".
      3. Otherwise, set policy's report-only value to "same-origin".
   2. If parsedItem[0] is "same-origin-allow-popups", then set policy's report-only value to "same-origin-allow-popups".
   3. If parsedItem[1]["report-to"] exists and it is a string, then set policy's report-only reporting endpoint to parsedItem[1]["report-to"].

Note

Report only COOP also considers report-only COEP to assign the special "same-origin-plus-COEP" value. This allows developers more freedom in the order of deployment of COOP and COEP.
7. Return policy.

### 7.1.3.2 Browsing context group switches due to cross-origin opener policy

To check if COOP values require a browsing context group switch, given a boolean `isInitialAboutBlank`, two `origins` `responseOrigin` and `activeDocumentNavigationOrigin`, and two `cross-origin opener policy values` `responseCOOPValue` and `activeDocumentCOOPValue`:

1. If the result of matching activeDocumentCOOPValue, activeDocumentNavigationOrigin, responseCOOPValue, and `responseOrigin` is true, return false.

2. If all of the following are true:
   - `isInitialAboutBlank`;
   - activeDocumentCOOPValue's `value` is "same-origin-allow-popups"; and
   - `responseCOOPValue` is "unsafe-none",

   then return false.

3. Return true.

To check if enforcing report-only COOP would require a browsing context group switch, given a boolean `isInitialAboutBlank`, two `origins` `responseOrigin`, `activeDocumentNavigationOrigin`, and two `cross-origin opener policies` `responseCOOP` and `activeDocumentCOOP`:

1. If the result of checking if COOP values require a browsing context group switch given `isInitialAboutBlank`, `responseOrigin`, `activeDocumentNavigationOrigin`, `responseCOOP`'s `report-only value` and `activeDocumentCOOPReportOnly`'s `report-only value` is false, then return false.

   **Note**
   Matching report-only policies allows a website to specify the same report-only cross-origin opener policy on all its pages and not receive violation reports for navigations between these pages.

2. If the result of checking if COOP values require a browsing context group switch given `isInitialAboutBlank`, `responseOrigin`, `activeDocumentNavigationOrigin`, `responseCOOP`'s `value` and `activeDocumentCOOPReportOnly`'s `value` is true, then return true.

3. If the result of checking if COOP values require a browsing context group switch given `isInitialAboutBlank`, `responseOrigin`, `activeDocumentNavigationOrigin`, `responseCOOP`'s `report-only value` and `activeDocumentCOOPReportOnly`'s `value` is true, then return true.

4. Return false.

A cross-origin opener policy enforcement result is a `struct` with the following `items`:

- A boolean `needs a browsing context group switch`, initially false.
- A boolean `would need a browsing context group switch due to report-only`, initially false.
- A `URL` `url`.
- An `origin` `origin`.
- A `cross-origin opener policy` `cross-origin opener policy`.
- A boolean `current context is navigation source`, initially false.

To enforce a response's cross-origin opener policy, given a `browsing context` `browsingContext`, a `URL` `responseURL`, an `origin` `responseOrigin`, a `cross-origin opener policy` `responseCOOP`, a `cross-origin opener policy enforcement result` `currentCOOPEnforcementResult`, and a `referrer` `referrer`:

1. Let `newCOOPEnforcementResult` be a new `cross-origin opener policy enforcement result` with
needs a browsing context group switch

currentCOOPEnforcementResult's needs a browsing context group switch

would need a browsing context group switch due to report-only

currentCOOPEnforcementResult's would need a browsing context group switch due to report-only

url

responseURL

origin

responseOrigin

cross-origin opener policy

responseCOOP

current context is navigation source

true

2. Let isInitialAboutBlank be browsingContext's active document's is initial about blank.

3. If isInitialAboutBlank is true and browsingContext's initial URL is null, set browsingContext's initial URL to responseURL.

4. If the result of checking if COOP values require a browsing context group switch, given isInitialAboutBlank, currentCOOPEnforcementResult's cross-origin opener policy's value, currentCOOPEnforcementResult's origin, responseCOOP's value, and responseOrigin is true, then:

1. Set newCOOPEnforcementResult's needs a browsing context group switch to true.

2. If browsingContext's group's browsing context set's size is greater than 1, then:

   1. Queue a violation report for browsing context group switch when navigating to a COOP response with responseCOOP, "enforce", responseURL, currentCOOPEnforcementResult's url, currentCOOPEnforcementResult's origin, responseOrigin, and referrer.

   2. Queue a violation report for browsing context group switch when navigating away from a COOP response with currentCOOPEnforcementResult's cross-origin opener policy's value, currentCOOPEnforcementResult's origin, responseOrigin, and currentCOOPEnforcementResult's current context is navigation source.

5. If the result of checking if enforcing report-only COOP would require a browsing context group switch, given isInitialAboutBlank, responseOrigin, currentCOOPEnforcementResult's origin, responseCOOP, and currentCOOPEnforcementResult's cross-origin opener policy, is true, then:

1. Set result's would need a browsing context group switch due to report-only to true.

2. If browsingContext's group's browsing context set's size is greater than 1, then:

   1. Queue a violation report for browsing context group switch when navigating to a COOP response with responseCOOP, "reporting", responseURL, currentCOOPEnforcementResult's url, currentCOOPEnforcementResult's origin, responseOrigin, and referrer.

   2. Queue a violation report for browsing context group switch when navigating away from a COOP response with currentCOOPEnforcementResult's cross-origin opener policy's value, currentCOOPEnforcementResult's origin, responseOrigin, and currentCOOPEnforcementResult's current context is navigation source.

6. Return newCOOPEnforcementResult.

To obtain a browsing context to use for a navigation response, given a browsing context browsingContext, a sandboxing flag set sandboxFlags, a cross-origin opener policy navigationCOOP, and a cross-origin opener policy enforcement result, coopEnforcementResult:

1. If browsingContext is not a top-level browsing context, then return browsingContext.

2. If coopEnforcementResult's needs a browsing context group switch is false, then:

   1. If coopEnforcementResult's would need a browsing context group switch due to report-only is true, set browsing context's virtual browsing context group ID to a new unique identifier.

   2. Return browsingContext.
3. Let `newBrowsingContext` be the first return value of `creating a new top-level browsing context and document`.

**Note**

In this case we are going to perform a browsing context group swap. `browsingContext` will not be used by the new `Document` that we are about to `create`. If it is not used by other `Document`s either (such as ones in the back/forward cache), then the user agent might `destroy` at this point.

4. If `navigationCOOP`'s `value` is "same-origin-plus-COEP", then set `newBrowsingContext`'s `group`'s `cross-origin isolation mode` to either "logical" or "concrete". The choice of which is implementation-defined.

**Note**

It is difficult on some platforms to provide the security properties required by the `cross-origin isolated capability`. "concrete" grants access to it and "logical" does not.

5. If `sandboxFlags` is not empty, then:
   1. Assert `navigationCOOP`'s `value` is "unsafe-none".
   2. Assert: `newBrowsingContext`'s `popup sandboxing flag set` is empty.
   3. Set `newBrowsingContext`'s `popup sandboxing flag set` to a `clone` of `sandboxFlags`.


7.1.3.3 Reporting

An **accessor-accessed relationship** is an enum that describes the relationship between two `browsing contexts` between which an access happened. It can take the following values:

**accessor is opener**

The accessor `browsing context` or one of its `ancestors` is the opener `browsing context` of the accessed `browsing context`'s top-level `browsing context`.

**accessor is openee**

The accessed `browsing context` or one of its `ancestors` is the opener `browsing context` of the accessor `browsing context`'s top-level `browsing context`.

**none**

There is no opener relationship between the accessor `browsing context`, the accessor `browsing context`, or any of their `ancestors`.

To check if an access between two `browsing contexts` should be reported, given two `browsing contexts` accessor and accessed, a JavaScript property name `P`, and an `environment settings object` environment:

1. If `P` is not a `cross-origin accessible window property name`, then return.
2. Assert: accessor's `active document` and accessed's `active document` are both `fully active`.
3. Let `accessorTopDocument` be accessor's top-level `browsing context`'s `active document`.
4. Let `accessorInclusiveAncestorOrigins` be the list obtained by taking the `origin` of the `active document` of each of accessor's `active document`'s inclusive ancestor navigables.
7. If any of `accessorInclusiveAncestorOrigins` are not `same origin` with `accessorTopDocument`'s `origin`, or if any of `accessedInclusiveAncestorOrigins` are not `same origin` with `accessedTopDocument`'s `origin`, then return.

**Note**

This avoids leaking information about cross-origin iframes to a top level frame with cross-origin opener policy reporting.
8. If accessor's top-level browsing context’s virtual browsing context group ID is accessed's top-level browsing context's virtual browsing context group ID, then return.


10. If accessed's top-level browsing context's opener browsing context is accessor or is an ancestor of accessor, then set accessorAccessedRelationship to accessor is opener.

11. If accessor's top-level browsing context's opener browsing context is accessor or is an ancestor of accessor, then set accessorAccessedRelationship to accessor is opener.


To sanitize a URL to send in a report given a URL url:

1. Let sanitizedURL be a copy of url.
2. Set the username given sanitizedURL and the empty string.
3. Set the password given sanitizedURL and the empty string.
4. Return the serialization of sanitizedURL with exclude fragment set to true.

To queue a violation report for browsing context group switch when navigating to a COOP response given a cross-origin opener policy, coop, a string disposition, a URL coopURL, a URL previousResponseURL, two origins, coopOrigin and previousResponseOrigin, and a referrer referrer:

1. If coop's reporting endpoint is null, return.
2. Let coopValue be coop's value.
3. If disposition is "reporting", then set coopValue to coop's report-only value.
4. Let serializedReferrer be an empty string.
5. If referrer is a URL, set serializedReferrer to the serialization of referrer.
6. Let body be a new object containing the following properties:

<table>
<thead>
<tr>
<th>key</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>disposition</td>
<td>disposition</td>
</tr>
<tr>
<td>effectivePolicy</td>
<td>coopValue</td>
</tr>
<tr>
<td>previousResponseURL</td>
<td>If coopOrigin and previousResponseOrigin are same-origin, this is the sanitization of previousResponseURL, null otherwise.</td>
</tr>
<tr>
<td>referrer</td>
<td>serializedReferrer</td>
</tr>
<tr>
<td>type</td>
<td>&quot;navigation-to-response&quot;</td>
</tr>
</tbody>
</table>

7. Queue body as "coop" for coop's reporting endpoint with coopURL.

To queue a violation report for browsing context group switch when navigating away from a COOP response given a cross-origin opener policy, coop, a string disposition, a URL coopURL, a URL nextResponseURL, two origins, coopOrigin and nextResponseOrigin, and a boolean isCOOPResponseNavigationSource:

1. If coop's reporting endpoint is null, return.
2. Let coopValue be coop's value.
3. If disposition is "reporting", then set coopValue to coop's report-only value.
4. Let body be a new object containing the following properties:

<table>
<thead>
<tr>
<th>key</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>disposition</td>
<td>disposition</td>
</tr>
</tbody>
</table>
5. Queue body as "coop" for coop's reporting endpoint with coopURL.

To queue violation reports for accesses, given an accessor-accessed relationship, accessorCOOP and accessedCOOP, four URLs accessorURL, accessedURL, accessorInitialURL, accessedInitialURL, four origins accessorOrigin, accessedOrigin, accessorCreatorOrigin and accessedCreatorOrigin, two referrers accessorReferrer and accessedReferrer, a string propertyName, and an environment settings object environment:

1. If coop's reporting endpoint is null, return.
2. Let coopValue be coop's value.
3. If disposition is "reporting", then set coopValue to coop's report-only value.
4. If accessorAccessedRelationship is accessor is opener:
   1. Queue a violation report for access to an opened window, given accessorCOOP, accessorURL, accessedURL, accessorInitialURL, accessorOrigin, accessedOrigin, accessorCreatorOrigin, propertyName, and environment.
5. Otherwise, if accessorAccessedRelationship is accessor is opener:
   1. Queue a violation report for access to the opener, given accessorCOOP, accessorURL, accessedURL, accessorOrigin, accessedOrigin, propertyName, accessorReferrer, and environment.
   2. Queue a violation report for access from the opener, given accessedCOOP, accessedURL, accessorURL, accessorInitialURL, accessorOrigin, accessorCreatorOrigin, and propertyName.
6. Otherwise:
   1. Queue a violation report for access to another window, given accessorCOOP, accessorURL, accessedURL, accessorOrigin, accessedOrigin, propertyName, and environment
   2. Queue a violation report for access from another window, given accessedCOOP, accessedURL, accessorURL, accessedOrigin, accessorOrigin, and propertyName.

To queue a violation report for access to the opener, given a cross-origin opener policy coop, two URLs coopURL and openerURL, two origins coopOrigin and openerOrigin, a string propertyName, a referrer referrer, and an environment settings object environment:

1. Let sourceFile, lineNumber and columnNumber be the relevant script URL and problematic position which triggered this report.
2. Let serializedReferrer be an empty string.
3. If referrer is a URL, set serializedReferrer to the serialization of referrer.
4. Let body be a new object containing the following properties:

<table>
<thead>
<tr>
<th>key</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>disposition</td>
<td>&quot;reporting&quot;</td>
</tr>
<tr>
<td>effectivePolicy</td>
<td>coop's report-only value</td>
</tr>
<tr>
<td>property</td>
<td>propertyName</td>
</tr>
<tr>
<td>openerURL</td>
<td>if coopOrigin and openerOrigin are same origin, this is the sanitization of openerURL, null otherwise.</td>
</tr>
<tr>
<td>referrer</td>
<td>serializedReferrer</td>
</tr>
<tr>
<td>sourceFile</td>
<td>sourceFile</td>
</tr>
<tr>
<td>lineNumber</td>
<td>lineNumber</td>
</tr>
<tr>
<td>columnNumber</td>
<td>columnNumber</td>
</tr>
<tr>
<td>type</td>
<td>&quot;access-to-opener&quot;</td>
</tr>
</tbody>
</table>
5. Queue body as "coop" for coop's reporting endpoint with coopURL and environment.

To queue a violation report for access to an opened window, given a cross-origin opener policy coop, three URLs coopURL, openedWindowURL and initialWindowURL, three origins coopOrigin, openedWindowOrigin, and openerInitialOrigin, a string propertyName, and an environment settings object environment:

1. Let sourceFile, lineNumber and columnNumber be the relevant script URL and problematic position which triggered this report.

2. Let body be a new object containing the following properties:

<table>
<thead>
<tr>
<th>key</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>disposition</td>
<td>&quot;reporting&quot;</td>
</tr>
<tr>
<td>effectivePolicy</td>
<td>coop's report-only value</td>
</tr>
<tr>
<td>property</td>
<td>propertyName</td>
</tr>
<tr>
<td>openedWindowURL</td>
<td>If coopOrigin and openedWindowOrigin are same origin, this is the sanitization of openedWindowURL, null otherwise.</td>
</tr>
<tr>
<td>openedWindowInitialURL</td>
<td>If coopOrigin and openerInitialOrigin are same origin, this is the sanitization of initialWindowURL, null otherwise.</td>
</tr>
<tr>
<td>sourceFile</td>
<td>sourceFile</td>
</tr>
<tr>
<td>lineNumber</td>
<td>lineNumber</td>
</tr>
<tr>
<td>columnNumber</td>
<td>columnNumber</td>
</tr>
<tr>
<td>type</td>
<td>&quot;access-to-opener&quot;</td>
</tr>
</tbody>
</table>

3. Queue body as "coop" for coop's reporting endpoint with coopURL and environment.

To queue a violation report for access to another window, given a cross-origin opener policy coop, two URLs coopURL and otherURL, two origins coopOrigin and otherOrigin, a string propertyName, and an environment settings object environment:

1. Let sourceFile, lineNumber and columnNumber be the relevant script URL and problematic position which triggered this report.

2. Let body be a new object containing the following properties:

<table>
<thead>
<tr>
<th>key</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>disposition</td>
<td>&quot;reporting&quot;</td>
</tr>
<tr>
<td>effectivePolicy</td>
<td>coop's report-only value</td>
</tr>
<tr>
<td>property</td>
<td>propertyName</td>
</tr>
<tr>
<td>otherURL</td>
<td>If coopOrigin and otherOrigin are same origin, this is the sanitization of otherURL, null otherwise.</td>
</tr>
<tr>
<td>sourceFile</td>
<td>sourceFile</td>
</tr>
<tr>
<td>lineNumber</td>
<td>lineNumber</td>
</tr>
<tr>
<td>columnNumber</td>
<td>columnNumber</td>
</tr>
<tr>
<td>type</td>
<td>&quot;access-to-opener&quot;</td>
</tr>
</tbody>
</table>

3. Queue body as "coop" for coop's reporting endpoint with coopURL and environment.

To queue a violation report for access from the opener, given a cross-origin opener policy coop, two URLs coopURL and openerURL, two origins coopOrigin and openerOrigin, a string propertyName, and a referrer:

1. If coop's reporting endpoint is null, return.
2. Let serializedReferrer be an empty string.
3. If referrer is a URL, set serializedReferrer to the serialization of referrer.
4. Let body be a new object containing the following properties:

<table>
<thead>
<tr>
<th>key</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>disposition</td>
<td>&quot;reporting&quot;</td>
</tr>
<tr>
<td>effectivePolicy</td>
<td>coop's report-only value</td>
</tr>
<tr>
<td>property</td>
<td>propertyName</td>
</tr>
<tr>
<td>openerURL</td>
<td>If coopOrigin and openerOrigin are same origin, this is the sanitization of openerURL, null otherwise.</td>
</tr>
<tr>
<td>referrer</td>
<td>serializedReferrer</td>
</tr>
<tr>
<td>type</td>
<td>&quot;access-to-opener&quot;</td>
</tr>
</tbody>
</table>
5. Queue body as "coop" for coop's reporting endpoint with coopURL.

To queue a violation report for access from an opened window, given a cross-origin opener policy coop, three URLs coopURL, openedWindowURL and initialWindowURL, three origins coopOrigin, openedWindowOrigin, and openerInitialOrigin, and a string propertyName:

1. If coop's reporting endpoint is null, return.
2. Let body be a new object containing the following properties:

<table>
<thead>
<tr>
<th>key</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>disposition</td>
<td>&quot;reporting&quot;</td>
</tr>
<tr>
<td>effectivePolicy</td>
<td>coopValue</td>
</tr>
<tr>
<td>property</td>
<td>coop's report-only value</td>
</tr>
<tr>
<td>openedWindowURL</td>
<td>If coopOrigin and openedWindowOrigin are same origin, this is the sanitization of openedWindowURL, null otherwise.</td>
</tr>
<tr>
<td>openedWindowInitialURL</td>
<td>If coopOrigin and openerInitialOrigin are same origin, this is the sanitization of initialWindowURL, null otherwise.</td>
</tr>
<tr>
<td>type</td>
<td>&quot;access-to-opener&quot;</td>
</tr>
</tbody>
</table>

3. Queue body as "coop" for coop's reporting endpoint with coopURL.

To queue a violation report for access from another window, given a cross-origin opener policy coop, two URLs coopURL and otherURL, two origins coopOrigin and otherOrigin, and a string propertyName:

1. If coop's reporting endpoint is null, return.
2. Let body be a new object containing the following properties:

<table>
<thead>
<tr>
<th>key</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>disposition</td>
<td>&quot;reporting&quot;</td>
</tr>
<tr>
<td>effectivePolicy</td>
<td>coop's report-only value</td>
</tr>
<tr>
<td>property</td>
<td>propertyName</td>
</tr>
<tr>
<td>otherURL</td>
<td>If coopOrigin and otherOrigin are same origin, this is the sanitization of otherURL, null otherwise.</td>
</tr>
<tr>
<td>type</td>
<td>access-to-opener</td>
</tr>
</tbody>
</table>

3. Queue body as "coop" for coop's reporting endpoint with coopURL.

### 7.1.4 Cross-origin embedder policies

An embedder policy value is one of three strings that controls the fetching of cross-origin resources without explicit permission from resource owners.

"unsafe-none"

This is the default value. When this value is used, cross-origin resources can be fetched without giving explicit permission through the CORS protocol or the `Cross-Origin-Resource-Policy` header.

"require-corp"

When this value is used, fetching cross-origin resources requires the server's explicit permission through the CORS protocol or the `Cross-Origin-Resource-Policy` header.

"credentialless"

When this value is used, fetching cross-origin no-CORS resources omits credentials. In exchange, an explicit `Cross-Origin-Resource-Policy` header is not required. Other requests sent with credentials require the server's explicit permission through the CORS protocol or the `Cross-Origin-Resource-Policy` header.

⚠️ Warning!

Before supporting "credentialless", implementers are strongly encouraged to support both:

- Private Network Access
- Opaque Response Blocking

Otherwise, it would allow attackers to leverage the client's network position to read non public resources, using the...
An embedder policy value is compatible with cross-origin isolation if it is "credentialless" or "require-corp".

An embedder policy consists of:

- A value, which is an embedder policy value, initially "unsafe-none".
- A reporting endpoint string, initially the empty string.
- A report only value, which is an embedder policy value, initially "unsafe-none".
- A report only reporting endpoint string, initially the empty string.

The "coep" report type is a report type whose value is "coep". It is visible to ReportingObservers.

7.1.4.1 The headers

The `Cross-Origin-Embedder-Policy` and `Cross-Origin-Embedder-Policy-Report-Only` HTTP response headers allow a server to declare an embedder policy for an environment settings object. These headers are structured headers whose values must be token. [STRUCTURED-FIELDS]

The valid token values are the embedder policy values. The token may also have attached parameters; of these, the "report-to" parameter can have a valid URL string identifying an appropriate reporting endpoint. [REPORTING]

Note

The processing model fails open (by defaulting to "unsafe-none") in the presence of a header that cannot be parsed as a token. This includes inadvertent lists created by combining multiple instances of the `Cross-Origin-Embedder-Policy` header present in a given response:

<table>
<thead>
<tr>
<th><code>Cross-Origin-Embedder-Policy</code></th>
<th>Final embedder policy value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No header delivered</td>
<td>&quot;unsafe-none&quot;</td>
</tr>
<tr>
<td>'require-corp'</td>
<td>&quot;require-corp&quot;</td>
</tr>
<tr>
<td>'unknown-value'</td>
<td>&quot;unsafe-none&quot;</td>
</tr>
<tr>
<td>'require-corp, unknown-value'</td>
<td>&quot;unsafe-none&quot;</td>
</tr>
<tr>
<td>'unknown-value, unknown-value'</td>
<td>&quot;unsafe-none&quot;</td>
</tr>
<tr>
<td>'unknown-value, require-corp'</td>
<td>&quot;unsafe-none&quot;</td>
</tr>
<tr>
<td>'require-corp, require-corp'</td>
<td>&quot;unsafe-none&quot;</td>
</tr>
</tbody>
</table>

(The same applies to `Cross-Origin-Embedder-Policy-Report-Only`.)

To obtain an embedder policy from a `response` response and an environment environment:

1. Let policy be a new embedder policy.
2. If environment is a non-secure context, then return policy.
3. Let parsedItem be the result of getting a structured field value with `Cross-Origin-Embedder-Policy` and "item" from response's header list.
4. If parsedItem is non-null and parsedItem[0] is compatible with cross-origin isolation:
   1. Set policy's value to parsedItem[0].
   2. If parsedItem[1]["report-to"] exists, then set policy's endpoint to parsedItem[1]["report-to"].
5. Set parsedItem to the result of getting a structured field value with `Cross-Origin-Embedder-Policy-Report-Only` and "item" from response's header list.
6. If `parsedItem` is non-null and `parsedItem[0]` is compatible with cross-origin isolation:
   
   1. Set policy’s report only value to `parsedItem[0]`.
   
   2. If `parsedItem[1]"report-to"]` exists, then set policy’s endpoint to `parsedItem[1]"report-to"]`.

7. Return policy.

7.1.4.2 Embedder policy checks

To check a navigation response’s adherence to its embedder policy given a `response` response, a `navigable` navigable, and an `embedder policy` `responsePolicy`:

1. If `navigable` is not a child navigable, then return true.

2. Let `parentPolicy` be `navigable`’s container document’s policy container’s embedder policy.

3. If `parentPolicy`’s report only value is compatible with cross-origin isolation and `responsePolicy`’s value is not, then queue a cross-origin embedder policy inheritance violation with `response`, ”navigation”, `parentPolicy`’s report only reporting endpoint, ”reporting”, and `navigable`’s container document’s relevant settings object.

4. If `parentPolicy`’s value is not compatible with cross-origin isolation or `responsePolicy`’s value is compatible with cross-origin isolation, then return true.

5. Queue a cross-origin embedder policy inheritance violation with `response`, ”navigation”, `parentPolicy`’s reporting endpoint, ”enforce”, and `navigable`’s container document’s relevant settings object.

6. Return false.

To check a global object’s embedder policy given a `WorkerGlobalScope` `workerGlobalScope`, an `environment settings object` `owner`, and a `response` response:

1. If `workerGlobalScope` is not a `DedicatedWorkerGlobalScope` object, then return true.

2. Let policy be `workerGlobalScope`’s embedder policy.

3. Let `ownerPolicy` be `owner`’s policy container’s embedder policy.

4. If `ownerPolicy`’s report only value is compatible with cross-origin isolation and policy’s value is not, then queue a cross-origin embedder policy inheritance violation with `response`, ”worker initialization”, `ownerPolicy`’s report only reporting endpoint, ”reporting”, and `owner`.

5. If `ownerPolicy`’s value is not compatible with cross-origin isolation or policy’s value is compatible with cross-origin isolation, then return true.

6. Queue a cross-origin embedder policy inheritance violation with `response`, ”worker initialization”, `ownerPolicy`’s reporting endpoint, ”enforce”, and `owner`.

7. Return false.

To queue a cross-origin embedder policy inheritance violation given a `response` response, a string `type`, a string `endpoint`, a string `disposition`, and an `environment settings object` settings:

1. Let serialized be the result of serializing a response URL for reporting with `response`.

2. Let `body` be a new object containing the following properties:

<table>
<thead>
<tr>
<th>key</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>type</td>
<td>type</td>
</tr>
<tr>
<td>blockedURL</td>
<td>serialized</td>
</tr>
<tr>
<td>disposition</td>
<td>disposition</td>
</tr>
</tbody>
</table>

3. Queue `body` as the "coep" report type for `endpoint` on `settings`.

7.1.4.3 Embedder policy checks

To check a global object’s embedder policy given a `WorkerGlobalScope` `workerGlobalScope`, an `environment settings object` `owner`, and a `response` response:

1. If `workerGlobalScope` is not a `DedicatedWorkerGlobalScope` object, then return true.

2. Let policy be `workerGlobalScope`’s embedder policy.

3. Let `ownerPolicy` be `owner`’s policy container’s embedder policy.

4. If `ownerPolicy`’s report only value is compatible with cross-origin isolation and policy’s value is not, then queue a cross-origin embedder policy inheritance violation with `response`, ”worker initialization”, `ownerPolicy`’s report only reporting endpoint, ”reporting”, and `owner`.

5. If `ownerPolicy`’s value is not compatible with cross-origin isolation or policy’s value is compatible with cross-origin isolation, then return true.

6. Queue a cross-origin embedder policy inheritance violation with `response`, ”worker initialization”, `ownerPolicy`’s reporting endpoint, ”enforce”, and `owner`.

7. Return false.

To queue a cross-origin embedder policy inheritance violation given a `response` response, a string `type`, a string `endpoint`, a string `disposition`, and an `environment settings object` settings:

1. Let serialized be the result of serializing a response URL for reporting with `response`.

2. Let `body` be a new object containing the following properties:

<table>
<thead>
<tr>
<th>key</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>type</td>
<td>type</td>
</tr>
<tr>
<td>blockedURL</td>
<td>serialized</td>
</tr>
<tr>
<td>disposition</td>
<td>disposition</td>
</tr>
</tbody>
</table>

3. Queue `body` as the "coep" report type for `endpoint` on `settings`.
A sandboxing flag set is a set of zero or more of the following flags, which are used to restrict the abilities that potentially untrusted resources have:

**The sandboxed navigation browsing context flag**

This flag prevents content from navigating browsing contexts other than the sandboxed browsing context itself (or browsing contexts further nested inside it), auxiliary browsing contexts (which are protected by the sandboxed auxiliary navigation browsing context flag defined next), and the top-level browsing context (which is protected by the sandboxed top-level navigation without user activation browsing context flag and sandboxed top-level navigation with user activation browsing context flag defined below).

If the sandboxed auxiliary navigation browsing context flag is not set, then in certain cases the restrictions nonetheless allow popups (new top-level browsing contexts) to be opened. These browsing contexts always have one permitted sandboxed navigator, set when the browsing context is created, which allows the browsing context that created them to actually navigate them. (Otherwise, the sandboxed navigation browsing context flag would prevent them from being navigated even if they were opened.)

**The sandboxed auxiliary navigation browsing context flag**

This flag prevents content from creating new auxiliary browsing contexts, e.g. using the `target` attribute or the `window.open()` method.

**The sandboxed top-level navigation without user activation browsing context flag**

This flag prevents content from navigating their top-level browsing context and prevents content from closing their top-level browsing context. It is consulted only when the sandboxed browsing context's active window does not have transient activation.

When the sandboxed top-level navigation without user activation browsing context flag is not set, content can navigate its top-level browsing context, but other browsing contexts are still protected by the sandboxed navigation browsing context flag and possibly the sandboxed auxiliary navigation browsing context flag.

**The sandboxed top-level navigation with user activation browsing context flag**

This flag prevents content from navigating their top-level browsing context and prevents content from closing their top-level browsing context. It is consulted only when the sandboxed browsing context's active window has transient activation.

As with the sandboxed top-level navigation without user activation browsing context flag, this flag only affects the top-level browsing context; if it is not set, other browsing contexts might still be protected by other flags.

**The sandboxed origin browsing context flag**

This flag forces content into an opaque origin, thus preventing it from accessing other content from the same origin.

This flag also prevents script from reading from or writing to the `document.cookie` IDL attribute, and blocks access to `localStorage`.

**The sandboxed forms browsing context flag**

This flag blocks form submission.

**The sandboxed pointer lock browsing context flag**

This flag disables the Pointer Lock API.

**The sandboxed scripts browsing context flag**

This flag blocks script execution.

**The sandboxed automatic features browsing context flag**

This flag blocks features that trigger automatically, such as automatically playing a video or automatically focusing a form control.

**The sandboxed document.domain browsing context flag**

This flag prevents content from using the `document.domain` setter.

**The sandbox propagates to auxiliary browsing contexts flag**

This flag prevents content from escaping the sandbox by ensuring that any auxiliary browsing context it creates inherits the content's active sandboxing flag set.
The sandboxed modals flag
This flag prevents content from using any of the following features to produce modal dialogs:

- `window.alert()` \(^{p148}\)
- `window.confirm()` \(^{p148}\)
- `window.print()` \(^{p149}\)
- `window.prompt()` \(^{p149}\)
- the `beforeunload` \(^{p1451}\) event

The sandboxed orientation lock browsing context flag
This flag disables the ability to lock the screen orientation. [SCREENORIENTATION] \(^{p1462}\)

The sandboxed presentation browsing context flag
This flag disables the Presentation API. [PRESENTATION] \(^{p1461}\)

The sandboxed downloads browsing context flag
This flag prevents content from initiating or instantiating downloads, whether through downloading hyperlinks \(^{p107}\) or through navigation \(^{p1020}\) that gets handled as a download \(^{p107}\).

The sandboxed custom protocols navigation browsing context flag
This flag prevents navigations toward non-fetch schemes from being handed off to external software \(^{p1013}\).

When the user agent is to parse a sandboxing directive, given a string `input`, a `sandboxing flag set` \(^{p906}\) output, it must run the following steps:

1. Split `input` on ASCII whitespace, to obtain tokens.
2. Let `output` be empty.
3. Add the following flags to `output`:

   - The sandboxed navigation browsing context flag \(^{p906}\).
   - The sandboxed auxiliary navigation browsing context flag \(^{p906}\), unless `tokens` contains the `allow-popups` keyword.
   - The sandboxed top-level navigation without user activation browsing context flag \(^{p906}\), unless `tokens` contains the `allow-top-navigation` keyword.
   - The sandboxed top-level navigation with user activation browsing context flag \(^{p906}\), unless `tokens` contains either the `allow-top-navigation-by-user-activation` keyword or the `allow-top-navigation` \(^{p907}\) keyword.

Note
This means that if the `allow-top-navigation` \(^{p907}\) is present, the `allow-top-navigation-by-user-activation` \(^{p907}\) keyword will have no effect. For this reason, specifying both is a document conformance error.

- The sandboxed origin browsing context flag \(^{p906}\), unless the `tokens` contains the `allow-same-origin` keyword.

Note
The `allow-same-origin` \(^{p907}\) keyword is intended for two cases.

First, it can be used to allow content from the same site to be sandboxed to disable scripting, while still allowing access to the DOM of the sandboxed content.

Second, it can be used to embed content from a third-party site, sandboxed to prevent that site from opening popups, etc, without preventing the embedded page from communicating back to its originating site, using the database APIs to store data, etc.

- The sandboxed forms browsing context flag \(^{p906}\), unless `tokens` contains the `allow-forms` keyword.
- The sandboxed pointer lock browsing context flag \(^{p906}\), unless `tokens` contains the `allow-pointer-lock` keyword.
- The sandboxed scripts browsing context flag \(^{p906}\), unless `tokens` contains the `allow-scripts` keyword.
The sandboxed automatic features browsing context flag, unless tokens contains the allow-scripts keyword (defined above).

The sandboxed document.domain browsing context flag.

The sandbox propagates to auxiliary browsing contexts flag, unless tokens contains the allow-popups-to-escape-sandbox keyword.

The sandboxed modals flag, unless tokens contains the allow-modals keyword.

The sandboxed orientation lock browsing context flag, unless tokens contains the allow-orientation-lock keyword.

The sandboxed presentation browsing context flag, unless tokens contains the allow-presentation keyword.

The sandboxed downloads browsing context flag, unless tokens contains the allow-downloads keyword.

The sandboxed custom protocols navigation browsing context flag, unless tokens contains either the allow-top-navigation-to-custom-protocols keyword, the allow-popups keyword, or the allow-top-navigation keyword.

Every top-level browsing context has a popup sandboxing flag set, which is a sandboxing flag set. When a browsing context is created, its popup sandboxing flag set must be empty. It is populated by the rules for choosing a navigable and the obtain a browsing context to use for a navigation response algorithm.

Every iframe element has an iframe sandboxing flag set, which is a sandboxing flag set. Which flags in an iframe sandboxing flag set are set at any particular time is determined by the iframe element's sandbox attribute.

Every Document has an active sandboxing flag set, which is a sandboxing flag set. When the Document is created, its active sandboxing flag set must be empty. It is populated by the navigation algorithm.

Every CSP list has CSP-derived sandboxing flags, which is a sandboxing flag set. It is the return value of the following algorithm:

1. Let directives be an empty ordered set.
2. For each policy in csplList:
   1. If policy's disposition is not "enforce", then continue.
   2. If policy's directive set contains a directive whose name is "sandbox", then append that directive to directives.
3. If directives is empty, then return an empty sandboxing flag set.
4. Let directive be directives[size − 1].
5. Return the result of parsing the sandboxing directive.

To determine the creation sandboxing flags for a browsing context browsing context, given null or an element embedder, return the union of the flags that are present in the following sandboxing flag sets:

- If embedder is null, then: the flags set on browsing context's popup sandboxing flag set.
- If embedder is an element, then: the flags set on embedder's iframe sandboxing flag set.
- If embedder is an element, then: the flags set on embedder's node document's active sandboxing flag set.
A policy container is a struct containing policies that apply to a Document, a WorkerGlobalScope, or a WorkletGlobalScope. It has the following items:

- A CSP list, which is a CSP list. It is initially empty.
- An embedder policy, which is an embedder policy. It is initially a new embedder policy.
- A referrer policy, which is a referrer policy. It is initially the default referrer policy.

Move other policies into the policy container.

To clone a policy container given a policy container policyContainer:

1. Let clone be a new policy container.
2. For each policy in policyContainer’s CSP list, append a copy of policy into clone’s CSP list.
3. Set clone’s embedder policy to a copy of policyContainer’s embedder policy.
4. Set clone’s referrer policy to policyContainer’s referrer policy.
5. Return clone.

To determine whether a URL url requires storing the policy container in history:

1. If url’s scheme is "blob", then return false.
2. If url is local, then return true.
3. Return false.

To create a policy container from a fetch response given a response response and an environment-or-null environment:

1. If response’s URL’s scheme is "blob", then return a clone of response’s URL’s blob URL entry’s environment’s policy container.
2. Let result be a new policy container.
3. Set result’s CSP list to the result of parsing a response’s Content Security Policies given response.
4. If environment is non-null, then set result’s embedder policy to the result of obtaining an embedder policy given response and environment. Otherwise, set it to "unsafe-none".
5. Set result’s referrer policy to the result of parsing the `Referrer-Policy` header given response. [REFERRERPOLICY]
6. Return result.

To determine navigation params policy container given a URL responseURL and four policy container-or-nulls historyPolicyContainer, InitiatorPolicyContainer, parentPolicyContainer, and responsePolicyContainer:

1. If historyPolicyContainer is not null, then:
   1. Assert: responseURL requires storing the policy container in history.
   2. Return a clone of historyPolicyContainer.
2. If responseURL is about:srcdoc, then:
   1. Assert: parentPolicyContainer is not null.
   2. Return a clone of parentPolicyContainer.
3. If responseURL is local and initiatorPolicyContainer is not null, then return a clone of initiatorPolicyContainer.
4. If responsePolicyContainer is not null, then return responsePolicyContainer.
5. Return a new policy container.
To initialize a worker global scope's policy container given a `WorkerGlobalScope` "workerGlobalScope", a `response` "response", and an `environment` "environment":

1. If `workerGlobalScope`'s `url` is local but its `scheme` is not "blob":
   1. Assert: `workerGlobalScope`'s `owner set`'s `size` is 1.
   2. Set `workerGlobalScope`'s `policy container` to a `clone` of `workerGlobalScope`'s `owner set`'[0]'s `relevant settings object`'s `policy container`.
2. Otherwise, set `workerGlobalScope`'s `policy container` to the result of creating a policy container from a fetch response given `response` and `environment`.

### 7.2 APIs related to navigation and session history

#### 7.2.1 Security infrastructure for `Window` and `Location` objects

Although typically objects cannot be accessed across origins, the web platform would not be true to itself if it did not have some legacy exceptions to that rule that the web depends upon.

This section uses the terminology and typographic conventions from the JavaScript specification. [[JAVASCRIPT]]

#### 7.2.1.1 Integration with IDL

When `perform a security check` is invoked, with a `platformObject`, `identifier`, and `type`, run these steps:

1. If `platformObject` is not a `Window` or `Location` object, then return.
2. For each `e` of `CrossOriginProperties`(`platformObject`):
   1. If `SameValue(e[['Property']], identifier)` is true, then:
      1. If `type` is "method" and `e` has neither `[[NeedsGet]]` nor `[[NeedsSet]]`, then return.
      2. Otherwise, if `type` is "getter" and `e.[[NeedsGet]]` is true, then return.
      3. Otherwise, if `type` is "setter" and `e.[[NeedsSet]]` is true, then return.
   3. If `IsPlatformObjectSameOrigin`(`platformObject`) is false, then throw a "SecurityError" `DOMException`.

#### 7.2.1.2 Shared internal slot: `[[CrossOriginPropertyDescriptorMap]]`

`Window` and `Location` objects both have a `[[CrossOriginPropertyDescriptorMap]]` internal slot, whose value is initially an empty map.

The `[[CrossOriginPropertyDescriptorMap]]` internal slot contains a map with entries whose keys are (currentGlobal, objectGlobal, propertyKey)-tuples and values are property descriptors, as a memoization of what is visible to scripts when currentGlobal inspects a `Window` or `Location` object from objectGlobal. It is filled lazily by `CrossOriginGetOwnPropertyHelper`, which consults it on future lookups.

User agents should allow a value held in the map to be garbage collected along with its corresponding key when nothing holds a reference to any part of the value. That is, as long as garbage collection is not observable.

**Example**

For example, with `const href = Object.getOwnPropertyDescriptor(crossOriginLocation, "href").set the value and its corresponding key in the map cannot be garbage collected as that would be observable.

User agents may have an optimization whereby they remove key-value pairs from the map when `document.domain` is set. This is not observable as `document.domain` cannot revisit an earlier value.
1. **Assert**: $O$ is a `Location` or `Window` object.

2. If $O$ is a `Location` object, then return `{ [[Property]]: "href", [[NeedsGet]]: false, [[NeedsSet]]: true }, { [[Property]]: "replace" }`.


### Note

This abstract operation does not return a Completion Record.

A JavaScript property name $P$ is a cross-origin accessible window property name if it is "window", "self", "location", "close", "closed", "focus", "blur", "frames", "length", "top", "opener", "parent", "postMessage", or an array index property name.

### 7.2.1.3.2 CrossOriginPropertyFallback ( $P$ )

1. If $P$ is "then", `@toStringTag`, `@hasInstance`, or `@isConcatSpreadable`, then return `PropertyDescriptor` with `[[Value]]` undefined, `[[Writable]]` false, `[[Enumerable]]` false, `[[Configurable]]` true.

2. Throw a "SecurityError" DOMException.

### 7.2.1.3.3 IsPlatformObjectSameOrigin ( $O$ )

1. Return true if the current settings object’s `origin` is same origin-domain with $O$’s relevant settings object’s `origin`, and false otherwise.

### Note

This abstract operation does not return a Completion Record.

Here the current settings object roughly corresponds to the "caller", because this check occurs before the execution context for the getter/setter/method in question makes its way onto the JavaScript execution context stack. For example, in the code `w.document`, this step is invoked before the `document` getter is reached as part of the [[Get]] algorithm for the `WindowProxy` object.
1. Let crossOriginKey be a tuple consisting of the current settings object, O’s relevant settings object, and P.

2. For each e of CrossOriginProperties(O):
   1. If SameValue(e.[[Property]], P) is true, then:
      1. If the value of the [[CrossOriginPropertyDescriptorMap]] internal slot of O contains an entry whose key is crossOriginKey, then return that entry’s value.
      2. Let originalDesc be OrdinaryGetOwnProperty(O, P).
      3. Let crossOriginDesc be undefined.
      4. If e.[[NeedsGet]] and e.[[NeedsSet]] are absent, then:
         1. Let value be originalDesc.[[Value]].
         2. If IsCallable(value) is true, then set value to an anonymous built-in function, created in the current realm, that performs the same steps as the IDL operation P on object O.
         3. Set crossOriginGet to PropertyDescriptor{ [[Value]]: value, [[Enumerable]]: false, [[Writable]]: false, [[Configurable]]: true }.
      5. Otherwise:
         1. Let crossOriginGet be undefined.
         2. If e.[[NeedsGet]] is true, then set crossOriginGet to an anonymous built-in function, created in the current realm, that performs the same steps as the getter of the IDL attribute P on object O.
         3. Let crossOriginSet be undefined.
         4. If e.[[NeedsSet]] is true, then set crossOriginSet to an anonymous built-in function, created in the current realm, that performs the same steps as the setter of the IDL attribute P on object O.
         5. Set crossOriginDesc to PropertyDescriptor{ [[Get]]: crossOriginGet, [[Set]]: crossOriginSet, [[Enumerable]]: false, [[Configurable]]: true }.
      6. Create an entry in the value of the [[CrossOriginPropertyDescriptorMap]] internal slot of O with key crossOriginKey and value crossOriginDesc.
   7. Return crossOriginDesc.

3. Return undefined.
7.2.1.3.5 CrossOriginGet (O, P, Receiver) §p91
1. Let desc be O.[[GetOwnProperty]](P).
2. Assert: desc is not undefined.
3. If IsDataDescriptor(desc) is true, then return desc.[[Value]].
4. Assert: IsAccessorDescriptor(desc) is true.
5. Let getter be desc.[[Get]].
6. If getter is undefined, then throw a "SecurityError" DOMException.

7.2.1.3.6 CrossOriginSet (O, P, V, Receiver) §p92
1. Let desc be O.[[GetOwnProperty]](P).
2. Assert: desc is not undefined.
3. If desc.[[Set]] is present and its value is not undefined, then:
   1. Perform ? Call(setter, Receiver, « V »).
   2. Return true.
4. Throw a "SecurityError" DOMException.

7.2.1.3.7 CrossOriginOwnPropertyKeys (O) §p92
1. Let keys be a new empty List.
2. For each e of CrossOriginProperties(O), append e.[[Property]] to keys.
3. Return the concatenation of keys and « "then", @@toStringTag, @@hasInstance, @@isConcatSpreadable ».

Note
This abstract operation does not return a Completion Record.

7.2.2 The Window object §p91
[Global=Window, Exposed=Window, LegacyUnenumerableNamedProperties]
interface Window : EventTarget {
   // the current browsing context
   [LegacyUnforgeable] readonly attribute WindowProxy window;
   [Replaceable] readonly attribute WindowProxy self;
   [LegacyUnforgeable] readonly attribute Document document;
   attribute DOMString name;
   [PutForwards=href, LegacyUnforgeable] readonly attribute Location location;
   readonly attribute History history;
   readonly attribute Navigation navigation;
   readonly attribute CustomElementRegistry customElements;
   [Replaceable] readonly attribute BarProp locationbar;
   [Replaceable] readonly attribute BarProp menubar;
[Replaceable] readonly attribute BarProp personalbar;
[Replaceable] readonly attribute BarProp scrollbars;
[Replaceable] readonly attribute BarProp statusbar;
[Replaceable] readonly attribute BarProp toolbar;
attribute DOMString status;
undefined close();
readonly attribute boolean closed;
undefined stop();
undefined focus();
undefined blur();

// other browsing contexts
[Replaceable] readonly attribute WindowProxy frames;
[Replaceable] readonly attribute unsigned long length;
[LegacyUnforgeable] readonly attribute WindowProxy? top;
attribute any opener;
[Replaceable] readonly attribute WindowProxy? parent;
readonly attribute Element? frameElement;
WindowProxy? open(optional USVString url = "", optional DOMString target = "_blank", optional
[LegacyNullToEmptyString] DOMString features = "");

// Since this is the global object, the IDL named getter adds a NamedPropertiesObject exotic
// object on the prototype chain. Indeed, this does not make the global object an exotic object.
// Indexed access is taken care of by the WindowProxy exotic object.
getter object (DOMString name);

// the user agent
readonly attribute Navigator navigator;
[Replaceable] readonly attribute Navigator clientInformation; // legacy alias of .navigator
readonly attribute boolean originAgentCluster:

// user prompts
undefined alert();
undefined alert(DOMString message);
boolean confirm(optional DOMString message = "");
DOMString? prompt(optional DOMString message = "");
undefined print();
undefined postMessage(any message, USVString targetOrigin, optional sequence<object> transfer = []);
undefined postMessage(any message, optional WindowPostMessageOptions options = {});

// also has obsolete members
};
Window includes GlobalEventHandlers;
Window includes WindowEventHandlers;
dictionary WindowPostMessageOptions : StructuredSerializeOptions {
  USVString targetOrigin = "/";
};

For web developers (non-normative)
window.window
window.frames
window.self
These attributes all return window.
window.document
Returns the Document associated with window.
Returns the `Window` associated with `document`, if there is one, or null otherwise.

The `Window` object has an associated `Document`, which is a `Document` object. It is set when the `Window` object is created, and only ever changed during navigation from the initial `about:blank` Document.

A `Window`'s browsing context is its associated `Document`'s browsing context. Note that it is either null or a browsing context.

A `Window`'s navigable is the navigable whose active document is the `Window`'s associated `Document`'s, or null if there is no such navigable.

The `window`, `frames`, and `self` getter steps are to return this's relevant realm. [[GlobalEnv]].[[GlobalThisValue]].

The `document` getter steps are to return this's associated `Document`.

The defaultView getter steps are:

1. If this's browsing context is null, then return null.
2. Return this's browsing context's `WindowProxy` object.

For historical reasons, `Window` objects must also have a writable, configurable, non-enumerable property named `HTMLDocument` whose value is the `Document` interface object.

For web developers (non-normative)

```javascript
window = window.open([ url [, target [, features ] ] ])
```

Opens a window to show `url` (defaults to `"about:blank"`), and returns it. `target` (defaults to `_blank`) gives the name of the new window. If a window already exists with that name, it is reused. The `features` argument can contain a set of comma-separated tokens:

"noopener"

"noreferrer"

These behave equivalently to the `noopen` and `noreferrer` link types on hyperlinks.

"popup"

Encourages user agents to provide a minimal web browser user interface for the new window. (Impacts the `visible` getter on all `BarProp` objects as well.)

```javascript
Example

globalThis.open("https://email.example/message/CA00kF8898r978ytg=5sW9g78Gmp4suVX9085y88vNRqMjuc5PXg", undefined, "noopener,popup");
```

```javascript
window.name [ = value ]
```

Returns the name of the window.

Can be set, to change the name.

```javascript
window.close()
```

Closes the window.
The **window open steps**, given a string `url`, a string `target`, and a string `features`, are as follows:

1. If the event loop’s termination nesting level is nonzero, return null.
2. Let `sourceDocument` be the entry global object’s associated `Document`.
3. If `target` is the empty string, then set `target` to "_blank".
4. Let `tokenizedFeatures` be the result of tokenizing `features`.
5. Let `noopener` and `noreferrer` be false.
6. If `tokenizedFeatures`["noopener"] exists, then:
   1. Set `noopener` to the result of parsing `tokenizedFeatures`["noopener"] as a boolean feature.
   2. Remove `tokenizedFeatures`["noopener"].
7. If `tokenizedFeatures`["noreferrer"] exists, then:
   1. Set `noreferrer` to the result of parsing `tokenizedFeatures`["noreferrer"] as a boolean feature.
   2. Remove `tokenizedFeatures`["noreferrer"].
8. Let `referrerPolicy` be the empty string.
9. If `noreferrer` is true, then set `noopener` to true and set `referrerPolicy` to "no-referrer".
10. Let `targetNavigable` and `windowType` be the result of applying the rules for choosing a navigable given `target`, `sourceDocument`’s node navigable, and `noopener`.
11. If `targetNavigable` is null, then return null.
12. If `windowType` is either "new and unrestricted" or "new with no opener", then:
    1. Set `targetNavigable`’s active browsing context’s is popup to the result of checking if a popup window is requested, given `tokenizedFeatures`.
    2. Set up browsing context features for `targetNavigable`’s active browsing context given `tokenizedFeatures`.[CSSOMVIEW]
    3. Let `urlRecord` be the URL record about:blank.
    4. If `url` is not the empty string, then set `urlRecord` to the result of encoding-parsing a URL given `url`, relative to the entry settings object.
    5. If `urlRecord` is failure, then throw a "SyntaxError" DOMException.
    6. If `urlRecord` matches about:blank, then perform the URL and history update steps given `targetNavigable`’s active document and `urlRecord`.
    7. Otherwise, navigate targetNavigable to `urlRecord` using `sourceDocument`, with `referrerPolicy` set to...
referrerPolicy and exceptionsEnabled\textsuperscript{p1003} set to true.

13. Otherwise:
   
   1. If url is not the empty string, then:
      
      1. Let urlRecord be the result of encoding-parsing a URL\textsuperscript{p96} url, relative to the entry settings object\textsuperscript{p1067}.
      2. If urlRecord is failure, then throw a "SyntaxError" DOMException.
      3. Navigate\textsuperscript{p1003} targetNavigable to urlRecord using sourceDocument, with referrerPolicy\textsuperscript{p1003} set to referrerPolicy and exceptionsEnabled\textsuperscript{p1003} set to true.
   
   2. If noopenener is false, then set targetNavigable's active browsing context\textsuperscript{p978} s opener browsing context\textsuperscript{p987} to sourceDocument's browsing context\textsuperscript{p988}.

14. If noopenener is true or windowType is "new with no opener", then return null.

15. Return targetNavigable's active WindowProxy\textsuperscript{p978}.

The open(url, target, features) method steps are to run the window open steps\textsuperscript{p916} with url, target, and features.

\textbf{Note}

The method provides a mechanism for navigating\textsuperscript{p1003} an existing browsing context\textsuperscript{p987} or opening and navigating an auxiliary browsing context\textsuperscript{p987}.

To tokenize the features argument:

1. Let tokenizedFeatures be a new ordered map.
2. Let position point at the first code point of features.
3. While position is not past the end of features:
   
   1. Let name be the empty string.
   2. Let value be the empty string.
   3. Collect a sequence of code points that are feature separators\textsuperscript{p918} from features given position. This skips past leading separators before the name.
   4. Collect a sequence of code points that are not feature separators\textsuperscript{p918} from features given position. Set name to the collected characters, converted to ASCII lowercase.
   5. Set name to the result of normalizing the feature name\textsuperscript{p918} name.
   6. While position is not past the end of features and the code point at position in features is not U+003D (=):
      
      1. If the code point at position in features is U+002C (,), or if it is not a feature separator\textsuperscript{p918}, then break.
      2. Advance position by 1.

\textbf{Note}

This skips to the first U+003D (=) but does not skip past a U+002C (,) or a non-separator.

7. If the code point at position in features is a feature separator\textsuperscript{p918}:
   
   1. While position is not past the end of features and the code point at position in features is a feature separator\textsuperscript{p918}:
      
      1. If the code point at position in features is U+002C (,), then break.
      2. Advance position by 1.

\textbf{Note}

This skips to the first non-separator but does not skip past a U+002C (,).
2. Collect a sequence of code points that are not feature separators code points from features given position. Set value to the collected code points, converted to ASCII lowercase.

8. If name is not the empty string, then set tokenizedFeatures[name] to value.

4. Return tokenizedFeatures.

To check if a window feature is set, given tokenizedFeatures, featureName, and defaultValue:

1. If tokenizedFeatures[featureName] exists, then return the result of parsing tokenizedFeatures[featureName] as a boolean feature.
2. Return defaultValue.

To check if a popup window is requested, given tokenizedFeatures:

1. If tokenizedFeatures is empty, then return false.
2. If tokenizedFeatures["popup"] exists, then return the result of parsing tokenizedFeatures["popup"] as a boolean feature.
3. Let location be the result of checking if a window feature is set, given tokenizedFeatures, "location", and false.
4. Let toolbar be the result of checking if a window feature is set, given tokenizedFeatures, "toolbar", and false.
5. If location and toolbar are both false, then return true.
6. Let menubar be the result of checking if a window feature is set, given tokenizedFeatures, "menubar", and false.
7. If menubar is false, then return true.
8. Let resizable be the result of checking if a window feature is set, given tokenizedFeatures, "resizable", and true.
9. If resizable is false, then return true.
10. Let scrollbars be the result of checking if a window feature is set, given tokenizedFeatures, "scrollbars", and false.
11. If scrollbars is false, then return true.
12. Let status be the result of checking if a window feature is set, given tokenizedFeatures, "status", and false.
13. If status is false, then return true.

A code point is a feature separator if it is ASCII whitespace, U+003D (=), or U+002C (,).

For legacy reasons, there are some aliases of some feature names. To normalize a feature name name, switch on name:

↩ "screenx"
Return "left".

↩ "screeny"
Return "top".

↩ "innerwidth"
Return "width".

↩ "innerheight"
Return "height".

↩ Anything else
Return name.

To parse a boolean feature given a string value:

1. If value is the empty string, then return true.
2. If value is "yes", then return true.
3. If value is "true", then return true.
4. Let \( \text{parsed} \) be the result of \textit{parsing value as an integer}.

5. If \( \text{parsed} \) is an error, then set it to 0.

6. Return false if \( \text{parsed} \) is 0, and true otherwise.

The \texttt{name} getter steps are:

1. If \( \text{this's navigation} \) is null, then return the empty string.

2. Return \( \text{this's navigation} \)'s \texttt{target name}.

The \texttt{name} setter steps are:

1. If \( \text{this's navigation} \) is null, then return.

2. Set \( \text{this's navigation} \)'s \texttt{active session history entry}'s \texttt{document state}'s \texttt{ navigable target name} to the given value.

\textbf{Note}

The name \texttt{gets reset} when the navigable is \texttt{navigated} to another \texttt{origin}.

The \texttt{close()} method steps are:

1. Let \( \text{thisTraversable} \) be null.

2. For each \texttt{top-level traversable} of the user agent's \texttt{top-level traversable set}: if \( \text{traversable's active document}'s relevant global object \) equals \( \text{this} \), then set \( \text{thisTraversable} \) to \( \text{traversable} \) and \textbf{break}.

3. If \( \text{thisTraversable} \) is null, then return.

\textbf{Note}

In this case the method is being called on a \texttt{Window} that does not correspond to a \texttt{top-level traversable}, and so closing is not allowed.

4. If \( \text{thisTraversable's is closing} \) is true, then return.

5. Let \( \text{browsingContext} \) be \( \text{thisTraversable's active browsing context} \).

6. Let \( \text{sourceSnapshotParams} \) be the result of \texttt{snapshotting source snapshot params} given \( \text{thisTraversable's active document} \).

7. If all the following are true:

   \( \text{thisTraversable is script-closable} \);  
   \( \text{the incumbent global object's browsing context is familiar with browsingContext}; \) and  
   \( \text{the incumbent global object's node navigable is allowed by sandboxing to navigate thisTraversable, given sourceSnapshotParams} \)

   then:

   1. Set \( \text{thisTraversable's is closing} \) to true.

   2. \textbf{Queue a task} on the \texttt{DOM manipulation task source} to \texttt{close thisTraversable}.

A \texttt{navigable} is \texttt{script-closable} if its \texttt{active browsing context} is an \texttt{auxiliary browsing context} that was created by a script (as opposed to by an action of the user), or if it is a \texttt{top-level traversable} whose \texttt{session history entries}' size is 1.

The \texttt{closed} getter steps are to return true if \( \text{this's browsing context} \) is null or its \texttt{is closing} is true; otherwise false.

The \texttt{stop()} method steps are:

1. If \( \text{this's navigable} \) is null, then return.
2. Stop loading this's navigable.

### 7.2.2.2 Indexed access on the `window` object

**For web developers (non-normative)**

`window.length`

Returns the number of document-tree child navigables.

`window[index]`

Returns the `WindowProxy` corresponding to the indicated document-tree child navigables.

The `length` getter steps are to return this's associated `Document`'s document-tree child navigables' size.

**Note**

Indexed access to document-tree child navigables is defined through the `[[GetOwnProperty]]` internal method of the `WindowProxy` object.

### 7.2.2.3 Named access on the `window` object

**For web developers (non-normative)**

`window[name]`

Returns the indicated element or collection of elements.

As a general rule, relying on this will lead to brittle code. Which IDs end up mapping to this API can vary over time, as new features are added to the web platform, for example. Instead of this, use `document.getElementById()` or `document.querySelector()`.

The document-tree child navigable target name property set of a `window` object `window` is the return value of running these steps:

1. Let `children` be the document-tree child navigables of `window`'s associated `Document`.
2. Let `firstNamedChildren` be an empty ordered set.
3. **For each** navigable of `children`:
   1. Let `name` be navigable's target name.
   2. If `name` is the empty string, then continue.
   3. If `firstNamedChildren` contains a navigable whose target name is `name`, then continue.
   4. Append navigable to `firstNamedChildren`.
4. Let `names` be an empty ordered set.
5. **For each** navigable of `firstNamedChildren`:
   1. Let `name` be navigable's target name.
   2. If navigable's active document's origin is same origin with `window`'s relevant settings object's `origin`, then append `name` to `names`.
6. Return `names`.

**Example**

The two separate iterations mean that in the following example, hosted on https://example.org/, assuming https://elsewhere.example/ sets `window.name` to "spices", evaluating `window.spices` after everything has loaded will yield `undefined`.
The `Window` object supports named properties. The supported property names of a `Window` object `window` at any moment consist of the following, in tree order according to the element that contributed them, ignoring later duplicates:

- `window`'s document-tree child navigable target name property set;
- the value of the `name` content attribute for all `embed`, `form`, `img`, and `object` elements that have a non-empty `name` content attribute and are in a document tree with `window`'s associated `Document` as their root; and
- the value of the `id` content attribute for all HTML elements that have a non-empty `id` content attribute and are in a document tree with `window`'s associated `Document` as their root.

To determine the value of a named property `name` in a `Window` object, the user agent must return the value obtained using the following steps:

1. Let `objects` be the list of named objects of `window` with the name `name`.

   **Note**
   There will be at least one such object, since the algorithm would otherwise not have been invoked by Web IDL.

2. If `objects` contains a navigable, then:
   
   1. Let `container` be the first navigable container in `window`'s associated `Document`'s descendants whose content navigable is in `objects`.
   2. Return `container`'s content navigable's active `WindowProxy`.

3. Otherwise, if `objects` has only one element, return that element.

4. Otherwise return an `HTMLCollection` rooted at `window`'s associated `Document`, whose filter matches only named objects of `window` with the name `name`. (By definition, these will all be elements.)

**Named objects** of `Window` object `window` with the name `name`, for the purposes of the above algorithm, consist of the following:

- document-tree child navigables of `window`'s associated `Document` whose `target name` is `name`;
- `embed`, `form`, `img`, or `object` elements that have a `name` content attribute whose value is `name` and are in a document tree with `window`'s associated `Document` as their root; and
- HTML elements that have an `id` content attribute whose value is `name` and are in a document tree with `window`'s associated `Document` as their root.

**Note**
Since the `Window` interface has the `[Global]` extended attribute, its named properties follow the rules for named properties objects rather than legacy platform objects.

### 7.2.2.4 Accessing related windows

**For web developers (non-normative)**

- `window.top` Returns the `WindowProxy` for the top-level traversable.
- `window.opener` Returns the `WindowProxy` for the opener browsing context. Returns null if there isn't one or if it has been set to null. Can be set to null.

The **top** getter steps are:

1. If this’s navigable is null, then return null.
2. Return this’s navigable’s top-level traversable’s active WindowProxy.

The **opener** getter steps are:

1. Let current be this’s browsing context.
2. If current is null, then return null.
3. If current’s opener browsing context is null, then return null.
4. Return current’s opener browsing context’s WindowProxy object.

The **opener** setter steps are:

1. If the given value is null and this’s browsing context is non-null, then set this’s browsing context’s opener browsing context to null.
2. If the given value is non-null, then perform ?DefinePropertyOrThrow(this, "opener", { [[Value]]: the given value, [[Writable]]: true, [[Enumerable]]: true, [[Configurable]]: true }).

**Note**

*Setting window.opener to null clears the opener browsing context reference. In practice, this prevents future scripts from accessing their opener browsing context’s Window object.*

By default, scripts can access their opener browsing context’s Window object through the window.opener getter. E.g., a script can set window.opener.location, causing the opener browsing context’s window to navigate.

The **parent** getter steps are:

1. Let navigable be this’s navigable.
2. If navigable is null, then return null.
3. If navigable’s parent is not null, then set navigable to navigable’s parent.
4. Return navigable’s active WindowProxy.

The **frameElement** getter steps are:

1. Let current be this’s node navigable.
2. If current is null, then return null.
3. Let container be current’s container.
4. If container is null, then return null.
5. If container’s node document’s origin is not same origin-domain with the current settings object’s origin, then return null.
6. Return container.
An example of when these properties can return null is as follows:

```html
<!DOCTYPE html>
<iframe></iframe>

<script>
"use strict";
const element = document.querySelector("iframe");
const iframeWindow = element.contentWindow;
element.remove();

console.assert(iframeWindow.top === null);
console.assert(iframeWindow.parent === null);
console.assert(iframeWindow.frameElement === null);
</script>
```

Here the browsing context's corresponding to iframeWindow was nulled out when element was removed from the document.

### 7.2.2.5 Historical browser interface element APIs

For historical reasons, the `Window` interface had some properties that represented the visibility of certain web browser interface elements.

For privacy and interoperability reasons, those properties now return values that represent whether the `Window`'s browsing context's `is popup` property is true or false.

Each interface element is represented by a `BarProp` object:

```idl
[Exposed=Window]
interface BarProp {
  readonly attribute boolean visible;
};
```

For web developers (non-normative)

- `window.locationbar.visible`
- `window.menubar.visible`
- `window.personalbar.visible`
- `window.scrollbars.visible`
- `window.statusbar.visible`
- `window.toolbar.visible`

Returns true if the `Window` is not a popup; otherwise, returns false.

The `visible` getter steps are:

1. Let `browsingContext` be this's `relevant global object`'s `browsing context`.
2. If `browsingContext` is `null`, then return `true`.
3. Return the negation of `browsingContext`'s `top-level browsing context`'s `is popup`.

The following `BarProp` objects must exist for each `Window` object:

**The location bar `BarProp object`**

Historically represented the user interface element that contains a control that displays the browser's location bar.

**The menu bar `BarProp object`**

Historically represented the user interface element that contains a list of commands in menu form, or some similar interface concept.
The personal bar BarProp object

Historically represented the user interface element that contains links to the user's favorite pages, or some similar interface concept.

The scrollbar BarProp object

Historically represented the user interface element that contains a scrolling mechanism, or some similar interface concept.

The status bar BarProp object

Historically represented a user interface element found immediately below or after the document, as appropriate for the user's media, which typically provides information about ongoing network activity or information about elements that the user's pointing device is currently indicating.

The toolbar BarProp object

Historically represented the user interface element found immediately above or before the document, as appropriate for the user's media, which typically provides session history traversal controls (back and forward buttons, reload buttons, etc.).

The locationbar attribute must return the location bar BarProp object.

The menubar attribute must return the menu bar BarProp object.

The personalbar attribute must return the personal bar BarProp object.

The scrollbars attribute must return the scrollbar BarProp object.

The statusbar attribute must return the status bar BarProp object.

The toolbar attribute must return the toolbar BarProp object.

For historical reasons, the status attribute on the window object must, on getting, return the last string it was set to, and on setting, must set itself to the new value. When the window object is created, the attribute must be set to the empty string. It does not do anything else.

7.2.2.6 Script settings for window objects

To set up a window environment settings object, given a URL creationURL, a JavaScript execution context execution context, null or an environment reservedEnvironment, a URL topLevelCreationURL, and an origin topLevelOrigin, run these steps:

1. Let realm be the value of execution context's Realm component.
2. Let window be realm's global object.
3. Let settings object be a new environment settings object whose algorithms are defined as follows:

   The realm execution context
   Return execution context.

   The module map
   Return the module map of window's associated Document.

   The API base URL
   Return the current base URL of window's associated Document.

   The origin
   Return the origin of window's associated Document.

   The policy container
   Return the policy container of window's associated Document.

   The cross-origin isolated capability
   Return true if both of the following hold, and false otherwise:
   1. realm's agent cluster's cross-origin-isolation mode is "concrete", and
2. window's associated Document is allowed to use the "cross-origin-isolated" feature.

The time origin

Return window's associated Document's load timing info's navigation start time.

4. If reservedEnvironment is non-null, then:
   1. Set settings object's id to reservedEnvironment's id, target browsing context to reservedEnvironment's target browsing context, and active service worker to reservedEnvironment's active service worker.
   2. Set reservedEnvironment's id to the empty string.

5. Otherwise, set settings object's id to a new unique opaque string, settings object's target browsing context to null, and settings object's active service worker to null.

6. Set settings object's creation URL to creationURL, settings object's top-level creation URL to topLevelCreationURL, and settings object's top-level origin to topLevelOrigin.

7. Set realm's [[HostDefined]] field to settings object.

### 7.2.3 The WindowProxy exotic object

A WindowProxy is an exotic object that wraps a Window ordinary object, indiring most operations through to the wrapped object. Each browsing context has an associated WindowProxy object. When the browsing context is navigated, the Window object wrapped by the browsing context's associated WindowProxy object is changed.

The WindowProxy exotic object must use the ordinary internal methods except where it is explicitly specified otherwise below.

There is no WindowProxy interface object.

Every WindowProxy object has a [[Window]] internal slot representing the wrapped Window object.

**Note**

Although WindowProxy is named as a "proxy", it does not do polymorphic dispatch on its target's internal methods as a real proxy would, due to a desire to reuse machinery between WindowProxy and Location objects. As long as the Window object remains an ordinary object this is unobservable and can be implemented either way.

#### 7.2.3.1 [[GetPrototypeOf]] ( )

1. Let W be the value of the [[Window]] internal slot of this.
2. If IsPlatformObjectSameOrigin(W) is true, then return OrdinaryGetPrototypeOf(W).
3. Return null.

#### 7.2.3.2 [[SetPrototypeOf]] ( V )

1. Return ! SetImmutablePrototype(this, V).
7.2.3.3 [[IsExtensible]] ( ) §926

1. Return true.

7.2.3.4 [[PreventExtensions]] ( ) §926

1. Return false.

7.2.3.5 [[GetOwnProperty]] ( P ) §926

1. Let W be the value of the [[Window]]¹⁹²⁵ internal slot of this.
2. If P is an array index property name, then:
   1. Let index be ⌈ToUint32(P)⌉.
   2. Let children be the document-tree child navigables of W’s associated Document.
   3. Let value be undefined.
   4. If index is less than children’s size, then:
      1. Sort children in ascending order, with navigableA being less than navigableB if navigableA’s container was inserted into W’s associated Document earlier than navigableB’s container was.
      2. Set value to children[index]’s active WindowProxy.
   5. If value is undefined, then:
      1. If IsPlatformObjectSameOrigin(W) is true, then return undefined.
      2. Throw a "SecurityError" DOMException.
   6. Return PropertyDescriptor{ [[Value]]: value, [[Writable]]: false, [[Enumerable]]: true, [[Configurable]]: true }.
3. If IsPlatformObjectSameOrigin(W) is true, then return ! OrdinaryGetOwnProperty(W, P).

Note
This is a willful violation of the JavaScript specification’s invariants of the essential internal methods to maintain compatibility with existing web content. See tc39/ecma262 issue #672 for more information. [JAVASCRIPT]¹⁹⁴⁹

4. Let property be CrossOriginGetOwnPropertyHelper(W, P).
5. If property is not undefined, then return property.
6. If property is undefined and P is in W’s document-tree child navigable target name property set, then:
   1. Let value be the active WindowProxy of the named object of W with the name P.
   2. Return PropertyDescriptor{ [[Value]]: value, [[Enumerable]]: false, [[Writable]]: false, [[Configurable]]: true }.

Note
The reason the property descriptors are non-enumerable, despite this mismatching the same-origin behavior, is for compatibility with existing web content. See issue #3183 for details.


7.2.3.6 [[DefineOwnProperty]] ( P, Desc ) §926

1. Let W be the value of the [[Window]]¹⁹²⁵ internal slot of this.
2. If `IsPlatformObjectSameOrigin(W)` is true, then:
   1. If `P` is an array index property name, return false.
   2. Return ? `OrdinaryDefineOwnProperty(W, P, Desc)`.

   **Note**
   This is a willful violation of the JavaScript specification's invariants of the essential internal methods to maintain compatibility with existing web content. See tc39/ecma262 issue #672 for more information. [JAVASCRIPT]

3. Throw a "SecurityError" `DOMException`.

### 7.2.3.7 [[Get]] (P, Receiver) §82

1. Let `W` be the value of the `[Window]` internal slot of `this`.
2. Check if an access between two browsing contexts should be reported, given the current global object's browsing context, `W`'s browsing context, `P`, and the current settings object.
3. If `IsPlatformObjectSameOrigin(W)` is true, then return ? `OrdinaryGet(this, P, Receiver)`.

**Note**
`this` is passed rather than `W` as `OrdinaryGet` and `CrossOriginGet` will invoke the `[[GetOwnProperty]]` internal method.

### 7.2.3.8 [[Set]] (P, V, Receiver) §82

1. Let `W` be the value of the `[Window]` internal slot of `this`.
2. Check if an access between two browsing contexts should be reported, given the current global object's browsing context, `W`'s browsing context, `P`, and the current settings object.
3. If `IsPlatformObjectSameOrigin(W)` is true, then:
   1. If `P` is an array index property name, then return false.

**Note**
`this` is passed rather than `W` as `CrossOriginSet` will invoke the `[[GetOwnProperty]]` internal method.

### 7.2.3.9 [[Delete]] (P) §82

1. Let `W` be the value of the `[Window]` internal slot of `this`.
2. If `IsPlatformObjectSameOrigin(W)` is true, then:
   1. If `P` is an array index property name, then:
      1. Let `desc` be `this.[[GetOwnProperty]](P)`.
      2. If `desc` is undefined, then return true.
      3. Return false.

3. Throw a "SecurityError" DOMException.

7.2.3.10 [[OwnPropertyKeys]] ( ) §92

1. Let W be the value of the [[Window]] internal slot of this.


3. Let keys be the range 0 to maxProperties, exclusive.

4. If IsPlatformObjectSameOrigin(W) is true, then return the concatenation of keys and OrdinaryOwnPropertyKeys(W).

5. Return the concatenation of keys and ! CrossOriginOwnPropertyKeys(W).

7.2.4 The Location interface §92

Each Window object is associated with a unique instance of a Location object, allocated when the Window object is created.

⚠️ Warning! The Location exotic object is defined through a mishmash of IDL, invocation of JavaScript internal methods post-creation, and overridden JavaScript internal methods. Coupled with its scary security policy, please take extra care while implementing this excrescence.

To create a Location object, run these steps:

1. Let location be a new Location platform object.

2. Let valueOf be location's relevant realm's [[Intrinsics]].[[%Object.prototype.valueOf]].

3. Perform ! location.[[DefineOwnProperty]]("valueOf", { [[Value]]: valueOf, [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }).

4. Perform ! location.[[DefineOwnProperty]](@@toPrimitive, { [[Value]]: undefined, [[Writable]]: false, [[Enumerable]]: false, [[Configurable]]: false }).

5. Set the value of the [[DefaultProperties]] internal slot of location to location.[[OwnPropertyKeys]]().

6. Return location.

Note

The addition of valueOf and @@toPrimitive own data properties, as well as the fact that all of Location's IDL attributes are marked [LegacyUnforgeable], is required by legacy code that consulted the Location interface, or stringified it, to determine the document URL, and then used it in a security-sensitive way. In particular, the valueOf, @@toPrimitive, and [LegacyUnforgeable] stringifier mitigations ensure that code such as foo[location] = bar or location + " " cannot be misdirected.

For web developers (non-normative)

document.location = value
window.location = value

Returns a Location object with the current page's location.

Can be set, to navigate to another page.

The Document object's location getter steps are to return this's relevant global object's Location object, if this is fully active, and null otherwise.

The Window object's location getter steps are to return this's Location object.
**Location** objects provide a representation of the URL of their associated **Document**, as well as methods for navigating and reloading the associated navigable.

```idl
[Exposed=Window]
interface Location { // but see also additional creation steps and overridden internal methods
    [LegacyUnforgeable] stringifier attribute USVString href;
    [LegacyUnforgeable] readonly attribute USVString origin;
    [LegacyUnforgeable] attribute USVString protocol;
    [LegacyUnforgeable] attribute USVString host;
    [LegacyUnforgeable] attribute USVString hostname;
    [LegacyUnforgeable] attribute USVString port;
    [LegacyUnforgeable] attribute USVString pathname;
    [LegacyUnforgeable] attribute USVString search;
    [LegacyUnforgeable] attribute USVString hash;

    [LegacyUnforgeable] undefined assign(USVString url);
    [LegacyUnforgeable] undefined replace(USVString url);
    [LegacyUnforgeable] undefined reload();

    [LegacyUnforgeable, SameObject] readonly attribute DOMStringList ancestorOrigins;
};
```

### For web developers (non-normative)

**location.toString()**

- **location.href**
  - Returns the **Location** object's URL.
  - Can be set, to navigate to the given URL.

- **location.origin**
  - Returns the **Location** object's URL's origin.

- **location.protocol**
  - Returns the **Location** object's URL's scheme.
  - Can be set, to navigate to the same URL with a changed scheme.

- **location.host**
  - Returns the **Location** object's URL's host and port (if different from the default port for the scheme).
  - Can be set, to navigate to the same URL with a changed host and port.

- **location.hostname**
  - Returns the **Location** object's URL's host.
  - Can be set, to navigate to the same URL with a changed host.

- **location.port**
  - Returns the **Location** object's URL's port.
  - Can be set, to navigate to the same URL with a changed port.

- **location.pathname**
  - Returns the **Location** object's URL's path.
  - Can be set, to navigate to the same URL with a changed path.

- **location.search**
  - Returns the **Location** object's URL's query (includes leading "?" if non-empty).
  - Can be set, to navigate to the same URL with a changed query (ignores leading "?").

- **location.hash**
  - Returns the **Location** object's URL's fragment (includes leading "#" if non-empty).
  - Can be set, to navigate to the same URL with a changed fragment (ignores leading "#").
location.assign(url)
Navigates to the given URL.

location.replace(url)
Removes the current page from the session history and navigates to the given URL.

location.reload()
Reloads the current page.

location.ancestorOrigins()
Returns a DOMStringList object listing the origins of the ancestor navigables, active documents.

A Location object has an associated relevant Document, which is its relevant global object's browsing context, active document, if this Location object's relevant global object's browsing context is non-null, and null otherwise.

A Location object has an associated url, which is this Location object's relevant Document's URL, if this Location object's relevant Document is non-null, and about:blank otherwise.

A Location object has an associated ancestor origins list. When a Location object is created, its ancestor origins list must be set to a DOMStringList object whose associated list is the list of strings that the following steps would produce:

1. Let output be a new list of strings.
2. Let current be the Location object's relevant Document.
3. While current's container document is non-null:
   1. Set current to current's container document.
   2. Append the serialization of current's origin to output.
4. Return output.

To Location-object navigate a Location object location to a URL url, optionally given a NavigationHistoryBehavior historyHandling (default "auto"):

1. Let navigable be location's relevant global object's navigable.
2. Let sourceDocument be the incumbent global object's associated Document.
3. If location's relevant Document is not yet completely loaded, and the incumbent global object does not have transient activation, then set historyHandling to "replace".
4. Navigate navigable to url using sourceDocument, with exceptionsEnabled set to true and historyHandling set to historyHandling.

The href getter steps are:

1. If this's relevant Document is non-null and its origin is not same origin-domain with the entry settings object's origin, then throw a "SecurityError" DOMException.
2. Return this's url, serialized.

The href setter steps are:

1. If this's relevant Document is null, then return.
2. Let url be the result of encoding-parsing a URL given the given value, relative to the entry settings object.
3. If url is failure, then throw a "SyntaxError" DOMException.
4. Location-object navigate this to url.

Note
The href setter intentionally has no security check.
The **origin** getter steps are:

1. If this's relevant Document is non-null and its **origin** is not same origin-domain with the entry settings object's **origin**, then throw a "SecurityError" DOMException.
2. Return the serialization of this's **origin**.

The **protocol** getter steps are:

1. If this's relevant Document is non-null and its **origin** is not same origin-domain with the entry settings object's **origin**, then throw a "SecurityError" DOMException.
2. Return this's **url**'s scheme, followed by ":".

The **protocol** setter steps are:

1. If this's relevant Document is null, then return.
2. If this's relevant Document's **origin** is not same origin-domain with the entry settings object's **origin**, then throw a "SecurityError" DOMException.
3. Let copyURL be a copy of this's **url**.
4. Let possibleFailure be the result of basic URL parsing the given value, followed by ":", with copyURL as **url** and scheme start state as state override.

    **Note**
    
    *Because the URL parser ignores multiple consecutive colons, providing a value of "https:" (or even "https::") is the same as providing a value of "https".*

5. If possibleFailure is failure, then throw a "SyntaxError" DOMException.
6. If copyURL's **scheme** is not an HTTP(S) scheme, then terminate these steps.
7. Location-object navigate this to copyURL.

The **host** getter steps are:

1. If this's relevant Document is non-null and its **origin** is not same origin-domain with the entry settings object's **origin**, then throw a "SecurityError" DOMException.
2. Let **url** be this's **url**.
3. If **url**'s **host** is null, return the empty string.
4. If **url**'s **port** is null, return **url**'s **host**, serialized.
5. Return **url」s **host**, serialized, followed by ":" and **url」s **port**, serialized.

The **host** setter steps are:

1. If this's relevant Document is null, then return.
2. If this's relevant Document's **origin** is not same origin-domain with the entry settings object's **origin**, then throw a "SecurityError" DOMException.
3. Let copyURL be a copy of this's **url**.
4. If copyURL has an opaque path, then return.
5. Basic URL parse the given value, with copyURL as **url** and host state as state override.
6. Location-object navigate this to copyURL.

The hostname getter steps are:

1. If this's relevant Document is non-null and its **origin** is not same origin-domain with the entry settings object's **origin**, then throw a "SecurityError" DOMException.
2. If this's url's host is null, return the empty string.

3. Return this's url's host, serialized.

The hostname setter steps are:

1. If this's relevant Document is null, then return.
2. If this's relevant Document's origin is not same origin-domain with the entry settings object's origin, then throw a "SecurityError" DOMException.
3. Let copyURL be a copy of this's url.
4. If copyURL has an opaque path, then return.
5. Basic URL parse the given value, with copyURL as url and hostname state as state override.

The port getter steps are:

1. If this's relevant Document is non-null and its origin is not same origin-domain with the entry settings object's origin, then throw a "SecurityError" DOMException.
2. If this's url's port is null, return the empty string.
3. Return this's url's port, serialized.

The port setter steps are:

1. If this's relevant Document is null, then return.
2. If this's relevant Document's origin is not same origin-domain with the entry settings object's origin, then throw a "SecurityError" DOMException.
3. Let copyURL be a copy of this's url.
4. If copyURL cannot have a username/password/port, then return.
5. If the given value is the empty string, then set copyURL's port to null.
6. Otherwise, basic URL parse the given value, with copyURL as url and port state as state override.
7. Location-object navigate this to copyURL.

The pathname getter steps are:

1. If this's relevant Document is non-null and its origin is not same origin-domain with the entry settings object's origin, then throw a "SecurityError" DOMException.
2. Return the result of URL path serializing this Location object's url.

The pathname setter steps are:

1. If this's relevant Document is null, then return.
2. If this's relevant Document's origin is not same origin-domain with the entry settings object's origin, then throw a "SecurityError" DOMException.
3. Let copyURL be a copy of this's url.
4. If copyURL has an opaque path, then return.
5. Set copyURL's path to the empty list.
6. Basic URL parse the given value, with copyURL as url and path start state as state override.
7. Location-object navigate this to copyURL.

The search getter steps are:
1. If this's relevant Document is non-null and its origin is not same origin-domain with the entry settings object's origin, then throw a "SecurityError" DOMException.

2. If this's url's query is either null or the empty string, return the empty string.

3. Return "?", followed by this's url's query.

The search setter steps are:

1. If this's relevant Document is null, then return.

2. If this's relevant Document's origin is not same origin-domain with the entry settings object's origin, then throw a "SecurityError" DOMException.

3. Let copyURL be a copy of this's url.

4. If the given value is the empty string, set copyURL's query to null.

5. Otherwise, run these substeps:
   1. Let input be the given value with a single leading "?" removed, if any.
   2. Set copyURL's query to the empty string.
   3. Basic URL parse input, with null, the relevant Document's document's character encoding, copyURL as url, and query state as state override.

6. Location-object navigate this to copyURL.

The hash getter steps are:

1. If this's relevant Document is non-null and its origin is not same origin-domain with the entry settings object's origin, then throw a "SecurityError" DOMException.

2. If this's url's fragment is either null or the empty string, return the empty string.

3. Return "#", followed by this's url's fragment.

The hash setter steps are:

1. If this's relevant Document is null, then return.

2. If this's relevant Document's origin is not same origin-domain with the entry settings object's origin, then throw a "SecurityError" DOMException.

3. Let copyURL be a copy of this's url.

4. Let input be the given value with a single leading "#" removed, if any.

5. Set copyURL's fragment to the empty string.

6. Basic URL parse input, with copyURL as url and fragment state as state override.

7. If copyURL's fragment is this's url's fragment, then return.

8. Location-object navigate this to copyURL.

Note

This bailout is necessary for compatibility with deployed content, which redundantly sets location.hash on scroll. It does not apply to other mechanisms of fragment navigation, such as the location.href setter or location.assign().

Note

Unlike the equivalent API for the a and area elements, the hash setter does not special case the empty string, to remain compatible with deployed scripts.

The assign(url) method steps are:
1. If this’s relevant Document is null, then return.

2. If this’s relevant Document’s origin is not same origin-domain with the entry settings object’s origin, then throw a "SecurityError" DOMException.

3. Let urlRecord be the result of encoding-parsing a URL given url, relative to the entry settings object.

4. If urlRecord is failure, then throw a "SyntaxError" DOMException.

5. Location object navigate this to urlRecord.

The replace(url) method steps are:

1. If this’s relevant Document is null, then return.

2. Let urlRecord be the result of encoding-parsing a URL given url, relative to the entry settings object.

3. If urlRecord is failure, then throw a "SyntaxError" DOMException.

4. Location object navigate this to urlRecord given "replace".

The reload() method steps are:

1. Let document be this’s relevant Document.

2. If document is null, then return.

3. If document’s origin is not same origin-domain with the entry settings object’s origin, then throw a "SecurityError" DOMException.

4. Reload document’s node navigable.

The ancestorOrigins getter steps are:

1. If this’s relevant Document is null, then return an empty list.

2. If this’s relevant Document’s origin is not same origin-domain with the entry settings object’s origin, then throw a "SecurityError" DOMException.

3. Otherwise, return this’s ancestor origins list.

⚠Warning!

The details of how the ancestorOrigins attribute works are still controversial and might change. See issue #1918 for more information.

As explained earlier, the Location exotic object requires additional logic beyond IDL for security purposes. The Location object must use the ordinary internal methods except where it is explicitly specified otherwise below.

Also, every Location object has a [[DefaultProperties]] internal slot representing its own properties at time of its creation.

7.2.4.1 [[GetPrototypeOf]] ( )

1. If IsPlatformObjectSameOrigin(this) is true, then return ! OrdinaryGetPrototypeOf(this).

2. Return null.
7.2.4.2 `[[SetPrototypeOf]] ( V )`§93

1. Return `SetImmutablePrototype(this, V)`.

7.2.4.3 `[[IsExtensible]] ( )`§93

1. Return true.

7.2.4.4 `[[PreventExtensions]] ( )`§93

1. Return false.

7.2.4.5 `[[GetOwnProperty]] ( P )`§93

1. If `IsPlatformObjectSameOrigin(this)` is true, then:
   1. Let `desc` be `OrdinaryGetOwnProperty(this, P)`.
   2. If the value of the `[[DefaultProperties]]` internal slot of `this` contains `P`, then set `desc.[[Configurable]]` to true.
   3. Return `desc`.
2. Let `property` be `CrossOriginGetOwnPropertyHelper(this, P)`.
3. If `property` is not undefined, then return `property`.
4. Return `CrossOriginPropertyFallback(P)`.

7.2.4.6 `[[DefineOwnProperty]] ( P, Desc )`§93

1. If `IsPlatformObjectSameOrigin(this)` is true, then:
   1. If the value of the `[[DefaultProperties]]` internal slot of `this` contains `P`, then return false.
   2. Return `OrdinaryDefineOwnProperty(this, P, Desc)`.
2. Throw a "`SecurityError`" DOMException.

7.2.4.7 `[[Get]] ( P, Receiver )`§93

1. If `IsPlatformObjectSameOrigin(this)` is true, then return `OrdinaryGet(this, P, Receiver)`.
2. Return `CrossOriginGet(this, P, Receiver)`.

7.2.4.8 `[[Set]] ( P, V, Receiver )`§93

1. If `IsPlatformObjectSameOrigin(this)` is true, then return `OrdinarySet(this, P, V, Receiver)`.
2. Return `CrossOriginSet(this, P, V, Receiver)`.

7.2.4.9 `[[Delete]] ( P )`§93

1. If `IsPlatformObjectSameOrigin(this)` is true, then return `OrdinaryDelete(this, P)`.
2. Throw a "SecurityError" DOMException.

7.2.4.10 [[OwnPropertyKeys]]( )

1. If `IsPlatformObjectSameOrigin(this)` is true, then return `OrdinaryOwnPropertyKeys(this)`.

2. Return `CrossOriginOwnPropertyKeys(this)`.

7.2.5 The **History** interface

IDL

```idl
enum ScrollRestoration { "auto", "manual" };

[Exposed=Window]
interface History {
    readonly attribute unsigned long length;
    attribute ScrollRestoration scrollRestoration;
    readonly attribute any state;
    undefined go(optional long delta = 0);
    undefined back();
    undefined forward();
    undefined pushState(any data, DOMString unused, optional USVString? url = null);
    undefined replaceState(any data, DOMString unused, optional USVString? url = null);
};
```

**For web developers (non-normative)**

`history.length` — Returns the number of overall session history entries for the current traversable navigable.

`history.scrollRestoration` — Returns the scroll restoration mode of the active session history entry.

Set the scroll restoration mode of the active session history entry to `value`.

`history.state` — Returns the classic history API state of the active session history entry, deserialized into a JavaScript value.

`history.go()` — Reloads the current page.

`history.go(delta)` — Goes back or forward the specified number of steps in the overall session history entries list for the current traversable navigable.

A zero delta will reload the current page.

If the delta is out of range, does nothing.

`history.back()` — Goes back one step in the overall session history entries list for the current traversable navigable.

If there is no previous page, does nothing.

`history.forward()` — Goes forward one step in the overall session history entries list for the current traversable navigable.

If there is no next page, does nothing.

`history.pushState(data, "")` — Adds a new entry into session history with its classic history API state set to a serialization of `data`. The active history entry's URL will be copied over and used for the new entry's URL.
A Document has a history object, a History object.

The history getter steps are to return this's associated Document's history object.

Each History object has state, initially null.

Each History object has a length, a non-negative integer, initially 0.

Each History object has an index, a non-negative integer, initially 0.

**Note**

Although the index is not directly exposed, it can be inferred from changes to the length during synchronous navigations. In fact, that is what it’s used for.

The length getter steps are:

1. If this’s relevant global object’s associated Document is not fully active, then throw a "SecurityError" DOMException.
2. Return this’s length.

The scrollRestoration getter steps are:

1. If this’s relevant global object’s associated Document is not fully active, then throw a "SecurityError" DOMException.
2. Return this’s node navigable’s active session history entry’s scroll restoration mode.

The scrollRestoration setter steps are:

1. If this’s relevant global object’s associated Document is not fully active, then throw a "SecurityError" DOMException.
2. Set this’s node navigable’s active session history entry’s scroll restoration mode to the given value.

The state getter steps are:

1. If this’s relevant global object’s associated Document is not fully active, then throw a "SecurityError" DOMException.
2. Return this’s state.

The go(delta) method steps are to delta traverse this given delta.
The `back()` method steps are to delta traverse this given −1.

The `forward()` method steps are to delta traverse this given +1.

To delta traverse a `History` object history given an integer `delta`:

1. Let `document` be history's relevant global object's associated `Document`.
2. If `document` is not fully active, then throw a "SecurityError" `DOMException`.
3. If `delta` is 0, then reload document's node navigable, and return.
4. Traverse the history by a delta given document's node navigable's traversable navigable, delta, and with `sourceDocument` set to document.

The `pushState(data, unused, url)` method steps are to run the shared history push/replace state steps given this, data, url, and "push".

The `replaceState(data, unused, url)` method steps are to run the shared history push/replace state steps given this, data, url, and "replace".

The shared history push/replace state steps, given a `History` history, a value `data`, a scalar value string-or-null `url`, and a history handling behavior `historyHandling`, are:

1. Let `document` be history's associated `Document`.
2. If `document` is not fully active, then throw a "SecurityError" `DOMException`.
3. Optionally, return. (For example, the user agent might disallow calls to these methods that are invoked on a timer, or from event listeners that are not triggered in response to a clear user action, or that are invoked in rapid succession.)
4. Let `serializedData` be `StructuredSerializeForStorage` (data). Rethrow any exceptions.
5. Let `newURL` be `document`'s URL.
6. If `url` is not null or the empty string, then:
   1. Set `newURL` to the result of encoding-parsing a URL given `url`, relative to the relevant settings object of history.
   2. If `newURL` is failure, then throw a "SecurityError" `DOMException`.
   3. If `document` cannot have its URL rewritten to `newURL`, then throw a "SecurityError" `DOMException`.
7. Let `navigation` be history's relevant global object's navigation API.
8. Let `continue` be the result of firing a push/replace/reload navigate event at navigation with `navigationType` set to `historyHandling`, `isNewDocument` set to true, `destinationURL` set to `newURL`, and `classicHistoryAPIState` set to `serializedData`.
9. If `continue` is false, then return.
10. Run the `URL and history update steps` given `document` and `newURL`, with `serializedData` set to `serializedData` and `historyHandling` set to `historyHandling`.

User agents may limit the number of state objects added to the session history per page. If a page hits the implementation-defined limit, user agents must remove the entry immediately after the first entry for that `Document` object in the session history after having added the new entry. (Thus the state history acts as a FIFO buffer for eviction, but as a LIFO buffer for navigation.)

A `Document` document can have its URL rewritten to a `URL` `targetURL` if the following algorithm returns true:

1. Let `documentURL` be `document`'s `URL`.
2. If `targetURL` and `documentURL` differ in their `scheme`, `username`, `password`, `host`, or `port` components, then return false.

3. If `targetURL`'s `scheme` is an HTTP(S) scheme, then return true. (Differences in `path`, `query`, and `fragment` are allowed for `http:` and `https:` URLs.)

4. If `targetURL`'s `scheme` is "file", and `targetURL` and `documentURL` differ in their `path` component, then return false. (Differences in `query` and `fragment` are allowed for file: URLs.)

5. If `targetURL` and `documentURL` differ in their `path` component or `query` components, then return false. (Only differences in `fragment` are allowed for other types of URLs.)

6. Return true.

### Example

<table>
<thead>
<tr>
<th><code>document</code>'s URL</th>
<th><code>targetURL</code></th>
<th>can have its URL rewritten?</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="https://example.com/home">https://example.com/home</a></td>
<td><a href="https://example.com/home#about">https://example.com/home#about</a></td>
<td>✓</td>
</tr>
<tr>
<td><a href="https://example.com/home">https://example.com/home</a></td>
<td><a href="https://example.com/home?page=shop">https://example.com/home?page=shop</a></td>
<td>✓</td>
</tr>
<tr>
<td><a href="https://example.com/home">https://example.com/home</a></td>
<td><a href="https://example.com/shop">https://example.com/shop</a></td>
<td>✓</td>
</tr>
<tr>
<td><a href="https://example.com/home">https://example.com/home</a></td>
<td><a href="https://user:pass@example.com/home">https://user:pass@example.com/home</a></td>
<td>×</td>
</tr>
<tr>
<td><a href="https://example.com/home">https://example.com/home</a></td>
<td><a href="http://example.com/home">http://example.com/home</a></td>
<td>×</td>
</tr>
<tr>
<td>file://path/to/x</td>
<td>file://path/to/x?search</td>
<td>✓</td>
</tr>
<tr>
<td>file://path/to/x</td>
<td>file://path/to/x#hash</td>
<td>✓</td>
</tr>
<tr>
<td>about:blank</td>
<td>about:blank#hash</td>
<td>✓</td>
</tr>
<tr>
<td>about:blank</td>
<td>about:blank?search</td>
<td>×</td>
</tr>
<tr>
<td>about:blank</td>
<td>about:srdoc</td>
<td>×</td>
</tr>
<tr>
<td>data:text/html,foo</td>
<td>data:text/html,foo#hash</td>
<td>✓</td>
</tr>
<tr>
<td>data:text/html,foo</td>
<td>data:text/html,foo?search</td>
<td>×</td>
</tr>
<tr>
<td>data:text/html,foo</td>
<td>data:text/html,bar</td>
<td>×</td>
</tr>
<tr>
<td>data:text/html,foo</td>
<td>data:bar</td>
<td>×</td>
</tr>
<tr>
<td>blob:<a href="https://example.com/77becafe-657b-4fcd-8bd3-e83aaa5e8f43">https://example.com/77becafe-657b-4fcd-8bd3-e83aaa5e8f43</a></td>
<td>blob:<a href="https://example.com/77becafe-657b-4fcd-8bd3-e83aaa5e8f43#hash">https://example.com/77becafe-657b-4fcd-8bd3-e83aaa5e8f43#hash</a></td>
<td>✓</td>
</tr>
<tr>
<td>blob:<a href="https://example.com/77becafe-657b-4fcd-8bd3-e83aaa5e8f43">https://example.com/77becafe-657b-4fcd-8bd3-e83aaa5e8f43</a></td>
<td>blob:<a href="https://example.com/77becafe-657b-4fcd-8bd3-e83aaa5e8f43?search">https://example.com/77becafe-657b-4fcd-8bd3-e83aaa5e8f43?search</a></td>
<td>×</td>
</tr>
<tr>
<td>blob:<a href="https://example.com/77becafe-657b-4fcd-8bd3-e83aaa5e8f43">https://example.com/77becafe-657b-4fcd-8bd3-e83aaa5e8f43</a></td>
<td>blob:<a href="https://example.com/anything">https://example.com/anything</a></td>
<td>×</td>
</tr>
<tr>
<td>blob:<a href="https://example.com/77becafe-657b-4fcd-8bd3-e83aaa5e8f43">https://example.com/77becafe-657b-4fcd-8bd3-e83aaa5e8f43</a></td>
<td>blob:path</td>
<td>×</td>
</tr>
</tbody>
</table>

Note how only the URL of the Document matters, and not its origin. They can mismatch in cases like about:blank s with inherited origins, in sandboxed iframe s, or when the document.domain setter has been used.

### Example

Consider a game where the user can navigate along a line, such that the user is always at some coordinate, and such that the user can bookmark the page corresponding to a particular coordinate, to return to it later.

A static page implementing the x=5 position in such a game could look like the following:

```html
<!DOCTYPE HTML>
<!-- this is https://example.com/line?x=5 -->
<html lang="en">
  <title>Line Game - 5</title>
  <p>You are at coordinate 5 on the line.</p>
  <a href="?x=6">Advance to 6</a> or <a href="?x=4">retreat to 4</a>?
</html>
```

The problem with such a system is that each time the user clicks, the whole page has to be reloaded. Here instead is another way...
of doing it, using script:

```html
<!DOCTYPE HTML>
<!-- this starts off as https://example.com/line?x=5 -->
<html lang="en">
<title>Line Game - 5</title>
<p>You are at coordinate <span id="coord">5</span> on the line.</p>
<a href="?x=6" onclick="go(1); return false;">Advance to 6</a> or
<a href="?x=4" onclick="go(-1); return false;">retreat to 4</a>?

<script>
var currentPage = 5; // prefilled by server
function go(d) {
  setupPage(currentPage + d);
  history.pushState(currentPage, "", '?x=' + currentPage);
}
onpopstate = function(event) {
  setupPage(event.state);
}
function setupPage(page) {
  currentPage = page;
  document.title = 'Line Game - ' + currentPage;
  document.getElementById('coord').textContent = currentPage;
  document.links[0].href = '?x=' + (currentPage+1);
  document.links[0].textContent = 'Advance to ' + (currentPage+1);
  document.links[1].href = '?x=' + (currentPage-1);
  document.links[1].textContent = 'retreat to ' + (currentPage-1);
}
</script>
```

In systems without script, this still works like the previous example. However, users that do have script support can now navigate much faster, since there is no network access for the same experience. Furthermore, contrary to the experience the user would have with just a naïve script-based approach, bookmarking and navigating the session history still work.

In the example above, the `data` argument to the `pushState()` method is the same information as would be sent to the server, but in a more convenient form, so that the script doesn't have to parse the URL each time the user navigates.

**Example**

Most applications want to use the same scroll restoration mode value for all of their history entries. To achieve this they can set the `scrollRestoration` attribute as soon as possible (e.g., in the first `script` element in the document's `head` element) to ensure that any entry added to the history session gets the desired scroll restoration mode.

```html
<head>
<script>
  if ('scrollRestoration' in history)
    history.scrollRestoration = 'manual';
</script>
</head>
```

### 7.2.6 The navigation API

#### 7.2.6.1 Introduction

This section is non-normative.
The navigation API, provided by the global `navigation` property, provides a modern and web application-focused way of managing navigations and history entries. It is a successor to the classic `location` and `history` APIs.

One ability the API provides is inspecting session history entries. For example, the following will display the entries' URLs in an ordered list:

```javascript
const ol = document.createElement("ol");
ol.start = 0; // so that the list items' ordinal values match up with the entry indices

for (const entry of navigation.entries()) {
  const li = document.createElement("li");

  if (entry.index < navigation.currentEntry.index) {
    li.className = "backward";
  } else if (entry.index > navigation.currentEntry.index) {
    li.className = "forward";
  } else {
    li.className = "current";
  }

  li.textContent = entry.url;
  ol.append(li);
}
```

The `navigation.entries()` array contains `NavigationHistoryEntry` instances, which have other useful properties in addition to the `url` and `index` properties shown here. Note that the array only contains `NavigationHistoryEntry` objects that represent the current navigable, and thus its contents are not impacted by navigations inside navigable containers such as `iframe`s, or by navigations of the parent navigable in cases where the navigation API is itself being used inside an `iframe`. Additionally, it only contains `NavigationHistoryEntry` objects representing same-origin session history entries, meaning that if the user has visited other origins before or after the current one, there will not be corresponding `NavigationHistoryEntry`s.

The navigation API can also be used to navigate, reload, or traverse through the history:

```html
<button onclick="navigation.reload()">Reload</button>
<input type="url" id="navigationURL"/>
<button onclick="navigation.navigate(navigationURL.value)">Navigate</button>
<button id="backButton" onclick="navigation.back()">Back</button>
<button id="forwardButton" onclick="navigation.forward()">Forward</button>
<select id="traversalDestinations"></select>
<button id="goButton" onclick="navigation.traverseTo(traversalDestinations.value)">Traverse To</button>
<script>
backButton.disabled = !navigation.canGoBack;
forwardButton.disabled = !navigation.canGoForward;

for (const entry of navigation.entries()) {
  traversalDestinations.append(new Option(entry.url, entry.key));
}
</script>
```

Note that traversals are again limited to same-origin destinations, meaning that, for example, `navigation.canGoBack` will be false if the previous session history entry is for a page from another origin.

The most powerful part of the navigation API is the `navigate` event, which fires whenever almost any navigation or traversal occurs in the current navigable:

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The event will not fire for location bar-initiated navigations, or navigations initiated from other windows, when the destination of the navigation is a new document.

Much of the time, the event's `cancelable` property will be true, meaning this event can be canceled using `preventDefault()`:

```javascript
navigation.onnavigate = event => {
  if (event.cancelable && isDisallowedURL(event.destination.url)) {
    alert(`Please don't go to ${event.destination.url}!`);
    event.preventDefault();
  }
};
```

The `cancelable` property will be false for some "traverse" navigations, such as those taking place inside child navigables, those crossing to new origins, or when the user attempts to traverse again shortly after a previous call to `preventDefault()` prevented them from doing so.

The `NavigateEvent`'s `intercept()` method allows intercepting a navigation and converting it into a same-document navigation:

```javascript
navigation.addEventListener("navigate", e => {
  // Some navigations, e.g. cross-origin navigations, we cannot intercept.
  // Let the browser handle those normally.
  if (!e.canIntercept) {
    return;
  }

  // Similarly, don't intercept fragment navigations or downloads.
  if (e.hashChange || e.downloadRequest !== null) {
    return;
  }

  const url = new URL(event.destination.url);

  if (url.pathname.startsWith("/articles/")) {
    e.intercept({
      async handler() {
        // The URL has already changed, so show a placeholder while
        // fetching the new content, such as a spinner or loading page.
        renderArticlePagePlaceholder();

        // Fetch the new content and display when ready.
        const articleContent = await getArticleContent(url.pathname, { signal: e.signal });
        renderArticlePage(articleContent);
      }
    });
  }
});
```

Note that the `handler` function can return a promise to represent the asynchronous progress, and success or failure, of the navigation. While the promise is still pending, browser UI can treat the navigation as ongoing (e.g., by presenting a loading spinner). Other parts of the navigation API are also sensitive to these promises, such as the return value of `navigation.navigate()`:

```javascript
const { committed, finished } = await navigation.navigate("/articles/the-navigation-api-is-cool");
// The committed promise will fulfill once the URL has changed, which happens
```
// immediately (as long as the NavigateEvent wasn't canceled).
await committed;

// The finished promise will fulfill once the Promise returned by handler() has
// fulfilled, which happens once the article is downloaded and rendered. (Or,
// it will reject, if handler() fails along the way).
await finished;

7.2.6.2 The `Navigation` interface

IDL [Exposed=Window]
interface Navigation : EventTarget {
  sequence<NavigationHistoryEntry> entries();
  readonly attribute NavigationHistoryEntry? currentEntry;
  undefined updateCurrentEntry(NavigationUpdateCurrentEntryOptions options);
  readonly attribute NavigationTransition? transition;
  readonly attribute NavigationActivation? activation;

  readonly attribute boolean canGoBack;
  readonly attribute boolean canGoForward;

  NavigationResult navigate(U8VString url, optional NavigationNavigateOptions options = {});
  NavigationResult reload(optional NavigationReloadOptions options = {});
  NavigationResult traverseTo(U8MString key, optional NavigationOptions options = {});
  NavigationResult back(optional NavigationOptions options = {});
  NavigationResult forward(optional NavigationOptions options = {});

  attribute EventHandler onnavigate;
  attribute EventHandler onnavigatesuccess;
  attribute EventHandler onnavigateerror;
  attribute EventHandler oncurrententrychange;
};

dictionary NavigationUpdateCurrentEntryOptions {
  required any state;
};

dictionary NavigationOptions {
  any info;
};

dictionary NavigationNavigateOptions : NavigationOptions {
  any state;
  NavigationHistoryBehavior history = "auto";
};

dictionary NavigationReloadOptions : NavigationOptions {
  any state;
};

dictionary NavigationResult {
  Promise<NavigationHistoryEntry> committed;
  Promise<NavigationHistoryEntry> finished;
};

dictionary NavigationResult {
  "auto",
  "push",
  "replace",
  "same",  // Can only be used in the initial navigation.
  "error", //NavigatorEvents is fired upon an error.
};

dictionary NavigationUpdateCurrentEntryOptions {
  required any state;
};

dictionary NavigationOptions {
  any info;
};

dictionary NavigationNavigateOptions : NavigationOptions {
  any state;
  NavigationHistoryBehavior history = "auto";
};

dictionary NavigationReloadOptions : NavigationOptions {
  any state;
};

dictionary NavigationResult {
  Promise<NavigationHistoryEntry> committed;
  Promise<NavigationHistoryEntry> finished;
};

dictionary NavigationResult {
  "auto",
  "push",
  "replace",
  "same",  // Can only be used in the initial navigation.
  "error", //NavigatorEvents is fired upon an error.
};
Each Window has an associated navigation API, which is a Navigation object. Upon creation of the Window object, its navigation API must be set to a new Navigation object created in the Window object's relevant realm.

The navigation getter steps are to return this's navigation API.

The following are the event handlers (and their corresponding event handler event types) that must be supported, as event handler IDL attributes, by all objects implementing the Navigation interface:

<table>
<thead>
<tr>
<th>Event handler</th>
<th>Event handler event type</th>
</tr>
</thead>
<tbody>
<tr>
<td>onnavigate</td>
<td>navigate</td>
</tr>
<tr>
<td>onnavigatesuccess</td>
<td>navigatesuccess</td>
</tr>
<tr>
<td>onnavigateerror</td>
<td>navigateerror</td>
</tr>
<tr>
<td>oncurrententrychange</td>
<td>currententrychange</td>
</tr>
</tbody>
</table>

7.2.6.3 Core infrastructure

Each Navigation has an associated entry list, a list of NavigationHistoryEntry objects, initially empty.

Each Navigation has an associated current entry index, an integer, initially −1.

The current entry of a Navigation navigation is the result of running the following steps:

1. If navigation has entries and events disabled, then return null.
2. Assert: navigation's current entry index is not −1.
3. Return navigation's entry list [navigation's current entry index].

A Navigation navigation has entries and events disabled if the following steps return true:

1. Let document be navigation's relevant global object's associated Document.
2. If document is not fully active, then return true.
3. If document's is initial about:blank is true, then return true.
4. If document's origin is opaque, then return true.
5. Return false.

To get the navigation API entry index of a session history entry she within a Navigation navigation:

1. Let index be 0.
2. For each nhe of navigation's entry list:
   1. If nhe's session history entry is equal to she, then return index.
   2. Increment index by 1.

A key type used throughout the navigation API is the NavigationType enumeration:

```
enum NavigationType {
  "push",
  "replace",
  "reload",
  "traverse"
}
```
This captures the main web developer-visible types of "navigations", which (as noted elsewhere) do not exactly correspond to this standard's singular `navigate` algorithm. The meaning of each value is the following:

"push"  
Corresponds to calls to `navigate` where the `history handling behavior` ends up as "push", or to `history.pushState()`.

"replace"  
Corresponds to calls to `navigator` where the `history handling behavior` ends up as "replace", or to `history.replaceState()`.

"reload"  
Corresponds to calls to `reload`.

"traverse"  
Corresponds to calls to `traverse the history by a delta`.

To initialize the navigation API entries for a new document given a `Navigation` navigation, a list of `session history entries` `newSHEs`, and a `session history entry` `initialSHE`:

1. Assert: `navigation`'s entry list is empty.
2. Assert: `navigation`'s current entry index is −1.
3. If `navigation` has entries and events disabled, then return.
4. For each `newSHE` of `newSHEs`:
   1. Let newNHE be a new `NavigationHistoryEntry` created in the relevant realm of navigation.
   2. Set newNHE's `session history entry` to `newSHE`.
   3. Append newNHE to `navigation`'s entry list.
5. Set `navigation`'s current entry index to the result of getting the navigation API entry index of `initialSHE` within navigation.

To update the navigation API entries for reactivation given a `Navigator` navigation, a list of `session history entries` `newSHEs`, and a `session history entry` `reactivatedSHE`:

1. If `navigation` has entries and events disabled, then return.
2. Let newNHEs be a new empty list.
3. Let oldNHEs be a `clone` of `navigation`'s entry list.
4. For each `newSHE` of `newSHEs`:
   1. Let newNHE be null.
   2. If `oldNHEs` contains a `NavigationHistoryEntry` matching `oldNHE` whose `session history entry` is `newSHE`,
then:

1. Set `newNHE` to `matchingOldNHE`.
2. Remove `matchingOldNHE` from `oldNHEs`.

3. Otherwise:

   1. Set `newNHE` to a new NavigationHistoryEntry created in the relevant realm of navigation.
   2. Set `newNHE`'s session history entry to `newSHE`.

4. Append `newNHE` to `newNHEs`.
5. Set navigation's entry list to `newNHEs`.
6. Set navigation's current entry index to the result of getting the navigation API entry index of reactivatedSHE within navigation.
7. Queue a global task on the navigation and traversal task source given navigation's relevant global object to run the following steps:

   1. For each disposedNHE of `oldNHEs`:
      1. Fire an event named dispose at disposedNHE.

   Note: We delay these steps by a task to ensure that dispose events will fire after the pageshow event. This ensures that pageshow is the first event a page receives upon reactivation. (However, the rest of this algorithm runs before the pageshow event fires. This ensures that navigation.entries() and navigation.currentEntry will have correctly-updated values during any pageshow event handlers.)

To update the navigation API entries for a same-document navigation given a Navigation navigation, a session history entry, destinationSHE, and a NavigationType navigationType:

1. If navigation has entries and events disabled, then return.
2. Let oldCurrentNHE be the current entry of navigation.
3. Let disposedNHEs be a new empty list.
4. If navigationType is "traverse", then:
   1. Set navigation's current entry index to the result of getting the navigation API entry index of destinationSHE within navigation.
   2. Assert: navigation's current entry index is not −1.

   Note: This algorithm is only called for same-document traversals. Cross-document traversals will instead call either initialize the navigation API entries for a new document or update the navigation API entries for reactivation.

5. Otherwise, if navigationType is "push", then:
   1. Set navigation's current entry index to navigation's current entry index + 1.
   2. Let i be navigation's current entry index.
3. While $i < \text{navigation's entry list's size}$:
   1. Append navigation's entry list[i] to disposedNHEs.
   2. Set $i$ to $i + 1$.

4. Remove all items in disposedNHEs from navigation's entry list.

6. Otherwise, if $\text{navigationType}$ is "replace", then:
   1. Append oldCurrentNHE to disposedNHEs.

7. If $\text{navigationType}$ is "push" or "replace", then:
   1. Let newNHE be a new NavigationHistoryEntry created in the relevant realm of navigation.
   2. Set newNHE's session history entry to destinationSHE.
   3. Set navigation's entry list[navigation's current entry index] to newNHE.

8. If navigation's ongoing API method tracker is non-null, then notify about the committed-to entry given navigation's ongoing API method tracker and the current entry of navigation.

   **Note**
   It is important to do this before firing the dispose or currententrychange events, since event handlers could start another navigation, or otherwise change the value of navigation's ongoing API method tracker.

9. Prepare to run script given navigation's relevant settings object.

   **Note**
   See the discussion for other navigation API events to understand why we do this.

10. Fire an event named currententrychange at navigation using NavigationCurrentEntryChangeEvent, with its navigationType initialized to navigationType and its from initialized to oldCurrentNHE.

11. For each disposedNHE of disposedNHEs:
    1. Fire an event named dispose at disposedNHE.

12. Clean up after running script given navigation's relevant settings object.

In implementations, same-document navigations can cause session history entries to be disposed by falling off the back of the session history entry list. This is not yet handled by the above algorithm (or by any other part of this standard). See issue #8620 to track progress on defining the correct behavior in such cases.

### 7.2.6.5 The NavigationHistoryEntry interface

```idl
[Exposed=Window]
interface NavigationHistoryEntry : EventTarget {
    readonly attribute USVString? url;
    readonly attribute DOMString key;
    readonly attribute DOMString id;
    readonly attribute long long index;
    readonly attribute boolean sameDocument;

    any getState();

    attribute EventHandler ondispose;
};
```

For web developers (non-normative)
Each NavigationHistoryEntry has an associated session history entry, which is a session history entry.

The key of a NavigationHistoryEntry is given by the return value of the following algorithm:

1. If nhe's relevant global object's associated Document is not fully active, then return the empty string.
2. Return nhe's session history entry's navigation API key.

The ID of a NavigationHistoryEntry is given by the return value of the following algorithm:

1. If nhe's relevant global object's associated Document is not fully active, then return the empty string.
2. Return nhe's session history entry's navigation API ID.

The index of a NavigationHistoryEntry is given by the return value of the following algorithm:

1. If nhe's relevant global object's associated Document is not fully active, then return −1.
2. Return the result of getting the navigation API entry index of this's session history entry within this's relevant global object's navigation API.

The URL of this navigation history entry.

This can return null if the entry corresponds to a different Document than the current one (i.e., if sameDocument is false), and that Document was fetched with a referer policy of "no-referrer" or "origin", since that indicates the Document in question is hiding its URL even from other same-origin pages.

A user agent-generated random UUID string representing this navigation history entry's place in the navigation history list. This value will be reused by other NavigationHistoryEntry instances that replace this one due to "replace" navigations, and will survive reloads and session restores.

This is useful for navigating back to this entry in the navigation history list, using navigation.traverseTo(key).

A user agent-generated random UUID string representing this specific navigation history entry. This value will not be reused by other NavigationHistoryEntry instances. This value will survive reloads and session restores.

This is useful for associating data with this navigation history entry using other storage APIs.

The index of this NavigationHistoryEntry within navigation.entries(), or −1 if the entry is not in the navigation history entry list.

Indicates whether or not this navigation history entry is for the same Document as the current one, or not. This will be true, for example, when the entry represents a fragment navigation or single-page app navigation.

Returns the deserialization of the state stored in this entry, which was added to the entry using navigation.navigate() or navigation.updateCurrentEntry(). This state survives reloads and session restores.

Note that in general, unless the state value is a primitive, entry.getState() !== entry.getState(), since a fresh deserialization is returned each time.

This state is unrelated to the classic history API's history.state.
5. Return she's URL, serialized.

The **key** getter steps are to return this's **key**.

The **id** getter steps are to return this's **ID**.

The **index** getter steps are to return this's **index**.

The **sameDocument** getter steps are:

1. Let *document* be this's relevant global object's associated **Document**.
2. If *document* is not fully active, then return false.
3. Return true if this's session history entry's document equals *document*, and false otherwise.

The **getState()** method steps are:

1. If this's relevant global object's associated **Document** is not fully active, then return undefined.
2. Return StructuredDeserialize((this's session history entry's navigation API state)). Rethrow any exceptions.

Note

*This can in theory throw an exception, if attempting to deserialize a large ArrayBuffer when not enough memory is available.*

The following are the **event handlers** (and their corresponding **event handler event types**) that must be supported, as **event handler IDL attributes**, by all objects implementing the **NavigationHistoryEntry** interface:

<table>
<thead>
<tr>
<th>Event handler</th>
<th>Event handler event type</th>
</tr>
</thead>
<tbody>
<tr>
<td>ondispose</td>
<td>dispose</td>
</tr>
</tbody>
</table>

7.2.6.6 The history entry list

For web developers (non-normative)

```javascript
entries = navigation.entries()  

Returns an array of **NavigationHistoryEntry** instances represent the current navigation history entry list, i.e., all session history entries for this navigable that are same origin and contiguous to the current session history entry.
```

```javascript
navigation.currentEntry  

Returns the **NavigationHistoryEntry** corresponding to the current session history entry.
```

```javascript
navigation.updateCurrentEntry({ state })  

Updates the navigation API state of the current session history entry, without performing a navigation like `navigation.reload()` would do.

This method is best used to capture updates to the page that have already happened, and need to be reflected into the navigation API state. For cases where the state update is meant to drive a page update, instead use `navigation.navigate()` or `navigation.reload()`, which will trigger a navigate event.
```

```javascript
navigation.canGoBack  

Returns true if the current current session history entry (i.e., currentEntry) is not the first one in the navigation history entry list (i.e., in entries()). This means that there is a previous session history entry for this navigable, and its document state's origin is same origin with the current Document's origin.
```

```javascript
navigation.canGoForward  

Returns true if the current current session history entry (i.e., currentEntry) is not the last one in the navigation history entry list (i.e., in entries()). This means that there is a next session history entry for this navigable, and its document state's origin is same origin with the current Document's origin.
```

The **entries()** method steps are:

1. If this has entries and events disabled, then return the empty list.
2. Return this's entry list.

Note

Recall that because of Web IDL's sequence type conversion rules, this will create a new JavaScript array object on each call. That is, navigation.entries() !== navigation.entries().

The currentEntry getter steps are to return the current entry of this.

The updateCurrentEntry(options) method steps are:

1. Let current be the current entry of this.
2. If current is null, then throw an "InvalidStateError" DOMException.
3. Let serializedState be StructuredSerializeForStorage(options["state"]), rethrowing any exceptions.
4. Set current's session history entry's navigation API state to serializedState.
5. Fire an event named currententrychange at this using NavigationCurrentEntryChangeEvent, with its navigationType attribute initialized to null and its from initialized to current.

The canGoBack getter steps are:

1. If this has entries and events disabled, then return false.
2. Assert: this's current entry index is not −1.
3. If this's current entry index is 0, then return false.
4. Return true.

The canGoForward getter steps are:

1. If this has entries and events disabled, then return false.
2. Assert: this's current entry index is not −1.
3. If this's current entry index is equal to this's entry list's size − 1, then return false.
4. Return true.

7.2.6.7 Initiating navigations

For web developers (non-normative)

{ committed, finished } = navigation.navigate(url)
{ committed, finished } = navigation.navigate(url, options)

Navigates the current page to the given url. options can contain the following values:

- history can be set to "replace" to replace the current session history entry, instead of pushing a new one.
- info can be set to any value; it will populate the info property of the corresponding NavigateEvent.
- state can be set to any serializable value; it will populate the state retrieved by navigation.currentEntry.getState() once the navigation completes, for same-document navigations. (It will be ignored for navigations that end up cross-document.)

By default this will perform a full navigation (i.e., a cross-document navigation, unless the given URL differs only in a fragment from the current one). The navigateEvent.intercept() method can be used to convert it into a same-document navigation.

The returned promises will behave as follows:

- For navigations that get aborted, both promises will reject with an "AbortError" DOMException.
- For same-document navigations created by using the navigateEvent.intercept() method, committed will
fulfill immediately, and \texttt{finished} will fulfill or reject according to any promises returned by handlers passed to \texttt{intercept()}.  

- For other same-document navigations (e.g., non-intercepted \texttt{fragment} navigations), both promises will fulfill immediately.

- For cross-document navigations, or navigations that result in 204 or 205 \texttt{statuses} or `Content-Disposition: attachment` header fields from the server (and thus do not actually navigate), both promises will never settle.

In all cases, when the returned promises fulfill, it will be with the \texttt{NavigationHistoryEntry} that was navigated to.

```javascript
{ committed, finished } = navigation.reload(options)
```

Reloads the current page. \texttt{options} can contain \texttt{info} and \texttt{state}, which behave as described above.

The default behavior of performing a from-network-or-cache reload of the current page can be overridden by the \texttt{navigateEvent.intercept()} method. Doing so will mean this call only updates state or passes along the appropriate \texttt{info}, plus performing what actions the \texttt{navigate} event handlers see fit to carry out.

The returned promises will behave as follows:

- If the reload is intercepted by using the \texttt{navigateEvent.intercept()} method, \texttt{committed} will fulfill immediately, and \texttt{finished} will fulfill or reject according to any promises returned by handlers passed to \texttt{intercept()}.

- Otherwise, both promises will never settle.

```javascript
{ committed, finished } = navigation.traverseTo(key)
```

Traverses to the closest previous session history entry that matches the \texttt{NavigationHistoryEntry} with the given key. \texttt{info} can be set to any value; it will populate the \texttt{info} property of the corresponding \texttt{NavigateEvent}. If a traversal to that session history entry is already in progress, then this will return the promises for that original traversal, and \texttt{info} will be ignored.

The returned promises will behave as follows:

- If there is no \texttt{NavigationHistoryEntry} in \texttt{navigation.entries()} whose \texttt{key} matches \texttt{key}, both promises will reject with an `InvalidStateError` \texttt{DOMException}.

- For same-document traversals intercepted by the \texttt{navigateEvent.intercept()} method, \texttt{committed} will fulfill as soon as the traversal is processed and \texttt{navigation.currentEntry} is updated, and \texttt{finished} will fulfill or reject according to any promises returned by the handlers passed to \texttt{intercept()}.  

- For non-intercepted same-document traversals, both promises will fulfill as soon as the traversal is processed and \texttt{navigation.currentEntry} is updated.

- For cross-document traversals, including attempted cross-document traversals that end up resulting in a 204 or 205 \texttt{statuses} or `Content-Disposition: attachment` header fields from the server (and thus do not actually traverse), both promises will never settle.

```javascript
{ committed, finished } = navigation.back(key)
```

Traverses to the closest previous session history entry which results in this \texttt{Navigable} traversing, i.e., which corresponds to a different \texttt{NavigationHistoryEntry} and thus will cause \texttt{navigation.currentEntry} to change. \texttt{info} can be set to any value; it will populate the \texttt{info} property of the corresponding \texttt{NavigateEvent}.

If a traversal to that session history entry is already in progress, then this will return the promises for that original traversal, and \texttt{info} will be ignored.

The returned promises behave equivalently to those returned by \texttt{traverseTo()}.  

```javascript
{ committed, finished } = navigation.forward(key)
```

Traverses to the closest forward session history entry which results in this \texttt{Navigable} traversing, i.e., which corresponds to a different \texttt{NavigationHistoryEntry} and thus will cause \texttt{navigation.currentEntry} to change. \texttt{info} can be set to any value; it will populate the \texttt{info} property of the corresponding \texttt{NavigateEvent}.
The `navigate(options)` method steps are:

1. Let `urlRecord` be the result of encoding-parsing a URL given `url`, relative to this’s relevant settings object.
2. If `urlRecord` is failure, then return an early error result for a "SyntaxError" DOMException.
3. Let `document` be this’s relevant global object’s associated Document.
4. If options["history"] is "push", and the navigation must be a replace given `urlRecord` and `document`, then return an early error result for a "NotSupportedError" DOMException.
5. Let `state` be options["state"], if it exists; otherwise, undefined.
6. Let `serializedState` be `StructuredSerializeForStorage` (state). If this throws an exception, then return an early error result for that exception.
7. If `document` is not fully active, then return an early error result for an "InvalidStateError" DOMException.
8. If `document`’s unload counter is greater than 0, then return an early error result for an "InvalidStateError" DOMException.
9. Let `info` be options["info"], if it exists; otherwise, undefined.
10. Let `apiMethodTracker` be the result of maybe setting the upcoming non-traverse API method tracker for this given `info` and `serializedState`.
11. Navigate document’s node navigable to `urlRecord` using `document`, with historyHandling set to `options["history"]` and navigationAPIState set to `serializedState`.

   **Note**
   
   It is importantly to perform this step early, since serialization can invoke web developer code, which in turn might change various things we check in later steps.

   **Note**
   
   Unlike `location.assign()` and friends, which are exposed across origin-domain boundaries, `navigation.navigate()` can only be accessed by code with direct synchronous access to the `window.navigation` property. Thus, we avoid the complications about attributing the source document of the navigation, and we don’t need to deal with the allowed by sandboxing to navigate check and its accompanying exceptionsEnabled flag. We just treat all navigations as if they come from the `Document` corresponding to this `Navigation` object itself (i.e., document).

12. If this’s upcoming non-traverse API method tracker is `apiMethodTracker`, then:

   **Note**
   
   If the upcoming non-traverse API method tracker is still `apiMethodTracker`, this means that the `navigate` algorithm bailed out before ever getting to the inner navigate event firing algorithm, which would promote that upcoming API method tracker to ongoing.

   1. Set this’s upcoming non-traverse API method tracker to null.
   2. Return an early error result for an "AbortError" DOMException.
13. Return a navigation API method tracker-derived result for `apiMethodTracker`.

The `reload(options)` method steps are:

1. Let `document` be this’s relevant global object’s associated Document.
2. Let `serializedState` be `StructuredSerializeForStorage` (undefined).
3. If `options["state"]` exists, then set `serializedState` to `StructuredSerializeForStorage` (options["state"]). If this throws an exception, then return an `early error result` for that exception.

   **Note**
   It is importantly to perform this step early, since serialization can invoke web developer code, which in turn might change various things we check in later steps.

4. Otherwise:
   1. Let `current` be the `current entry` of this.
   2. If `current` is not null, then set `serializedState` to current's `session history entry`'s navigation API state.

5. If `document` is not `fully active`, then return an `early error result` for an "InvalidStateError" DOMException.

6. If `document`'s unload counter is greater than 0, then return an `early error result` for an "InvalidStateError" DOMException.

7. Let `info` be `options["info"]`, if it exists; otherwise, undefined.

8. Let `apiMethodTracker` be the result of `maybe setting the upcoming non-traverse API method tracker` for this given `info` and `serializedState`.

9. `Reload` document's `node navigable` with `navigationAPIState` set to `serializedState`.

10. Return a `navigation API method tracker-derived result` for `apiMethodTracker`.

The `traverseTo(key, options)` method steps are:

1. If `this's current entry index` is −1, then return an `early error result` for an "InvalidStateError" DOMException.

2. If `this's entry list` does not contain a `NavigationHistoryEntry` whose `session history entry`'s navigation API key equals `key`, then return an `early error result` for an "InvalidStateError" DOMException.

3. Return the result of `performing a navigation API traversal` given this, `key`, and `options`.

The `back(options)` method steps are:

1. If `this's current entry index` is −1 or 0, then return an `early error result` for an "InvalidStateError" DOMException.

2. Let `key` be `this's entry list`'s `session history entry`'s navigation API key.

3. Return the result of `performing a navigation API traversal` given this, `key`, and `options`.

The `forward(options)` method steps are:

1. If `this's current entry index` is −1 or is equal to `this's entry list`'s `size` − 1, then return an `early error result` for an "InvalidStateError" DOMException.

2. Let `key` be `this's entry list`'s `session history entry`'s navigation API key.

3. Return the result of `performing a navigation API traversal` given this, `key`, and `options`.

To perform a navigation API traversal given a `Navigation` navigation, a string `key`, and a `NavigationOptions` options:

1. Let `document` be navigation's `relevant global object`'s associated `Document`.

2. If `document` is not `fully active`, then return an `early error result` for an "InvalidStateError" DOMException.

3. If `document`'s unload counter is greater than 0, then return an `early error result` for an "InvalidStateError" DOMException.

4. Let `current` be the `current entry` of navigation.

5. If `key` equals current's `session history entry`'s navigation API key, then return «["committed"] → a promise resolved with current, "finished" → a promise resolved with current ».

6. If navigation's `upcoming traverse API method trackers` for `navigation's upcoming traverse API method trackers` exists, then return a `navigation API method tracker-derived result` for navigation's `upcoming traverse API method trackers`.
7. Let info be options["info"], if it exists; otherwise, undefined.

8. Let apiMethodTracker be the result of adding an upcoming traverse API method tracker for navigation given key and info.

9. Let navigable be document's node navigable.

10. Let traversable be navigable's traversable navigable.

11. Let sourceSnapshotParams be the result of snapshotting source snapshot params given document.

12. Append the following session history traversal steps to traversable:

   1. Let navigableSHEs be the result of getting session history entries given navigable.

   2. Let targetSHE be the session history entry in navigableSHEs whose navigation API key is key. If no such entry exists, then:

      1. Queue a global task on the navigation and traversal task source given navigation's relevant global object to reject the finished promise for apiMethodTracker with an "InvalidStateError" DOMException.

     2. Abort these steps.

   3. If targetSHE is navigable's active session history entry, then abort these steps.

   4. Let result be the result of applying the traverse history step given by targetSHE's step, given sourceSnapshotParams, navigable, and "none".

   5. If result is "canceled-by-beforeunload", then queue a global task on the navigation and traversal task source given navigation's relevant global object to reject the finished promise for apiMethodTracker with a new "AbortError" DOMException created in navigation's relevant realm.

   6. If result is "initiator-disallowed", then queue a global task on the navigation and traversal task source given navigation's relevant global object to reject the finished promise for apiMethodTracker with a new "SecurityError" DOMException created in navigation's relevant realm.

   7. Return a navigation API method tracker-derived result for apiMethodTracker.

An early error result for an exception e is a NavigationResult dictionary instance given by «[ "committed" → a promise rejected with e, "finished" → a promise rejected with e ]».

A navigation API method-derived result for a navigation API method tracker is a NavigationResult dictionary instance given by «[ "committed" → apiMethodTracker's committed promise, "finished" → apiMethodTracker's finished promise ]».
During any given navigation (in the broad sense of the word), the Navigation object needs to keep track of the following:

<table>
<thead>
<tr>
<th>State</th>
<th>Duration</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The NavigateEvent</td>
<td>For the duration of event firing</td>
<td>So that if the navigation is canceled while the event is firing, we can cancel the event</td>
</tr>
<tr>
<td>The event's abort controller</td>
<td>Until all promises returned from handlers passed to intercept() have settled</td>
<td>So that if the navigation is canceled, we can signal abort</td>
</tr>
<tr>
<td>Whether a new element was focused</td>
<td>Until all promises returned from handlers passed to intercept() have settled</td>
<td>So that if one was, focus is not reset</td>
</tr>
<tr>
<td>The NavigationHistoryEntry being navigated to</td>
<td>From when it is determined, until all promises returned from handlers passed to intercept() have settled</td>
<td>So that we know what to resolve any committed and finished promises with</td>
</tr>
<tr>
<td>Any finished promise that was returned</td>
<td>Until all promises returned from handlers passed to intercept() have settled</td>
<td>So that we can resolve or reject it appropriately</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>State</th>
<th>Duration</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any state</td>
<td>For the duration of event firing</td>
<td>So that we can update the current entry's navigation API state if the event finishes firing without being canceled</td>
</tr>
<tr>
<td>Any info</td>
<td>Until the task is queued to fire the navigation event</td>
<td>So that we can use it to fire the navigate event after the trip through the session history traversal queue.</td>
</tr>
<tr>
<td>Any committed promise that was returned</td>
<td>Until the session history is updated (inside that same task)</td>
<td>So that we can resolve or reject it appropriately</td>
</tr>
<tr>
<td>Whether intercept() was called</td>
<td>Until the session history is updated (inside that same task)</td>
<td>So that we can suppress the normal scroll restoration logic in favor of the behavior given by the scroll option</td>
</tr>
</tbody>
</table>

We also cannot assume there is only a single navigation requested at any given time, due to web developer code such as:

```javascript
const p1 = navigation.navigate(url1).finished;
const p2 = navigation.navigate(url2).finished;
```

That is, in this scenario, we need to ensure that while navigating to url2, we still have the promise p1 around so that we can reject it. We can't just get rid of any ongoing navigation promises the moment the second call to navigate() happens.

We end up accomplishing all this by associating the following with each Navigation:

- **Ongoing navigate event**, a NavigateEvent or null, initially null.
- **Focus changed during ongoing navigation**, a boolean, initially false.
- **Suppress normal scroll restoration during ongoing navigation**, a boolean, initially false.
- **Ongoing API method tracker**, a navigation API method tracker or null, initially null.
- **Upcoming non-traverse API method tracker**, a navigation API method tracker or null, initially null.
- **Upcoming traverse API method trackers**, a map from strings to navigation API method trackers, initially empty.

A navigation API method tracker is a struct with the following items:

- **A navigation object**, a Navigation
- **A key**, a string or null
- **An info**, a JavaScript value
• A serialized state, a serialized state or null
• A committed-to entry, a NavigationHistoryEntry or null
• A committed promise, a promise
• A finished promise, a promise

All this state is then managed via the following algorithms.

To maybe set the upcoming non-traverse API method tracker given a Navigation navigation, a JavaScript value info, and a serialized state-or-null serializedState:

1. Let committedPromise and finishedPromise be new promises created in navigation's relevant realm.
2. Mark as handled finishedPromise.

Note
The web developer doesn’t necessarily care about finishedPromise being rejected:

◦ They might only care about committedPromise.
◦ They could be doing multiple synchronous navigations within the same task, in which case all but the last will be aborted (causing their finishedPromise to reject). This could be an application bug, but also could just be an emergent feature of disparate parts of the application overriding each others' actions.
◦ They might prefer to listen to other transition-failure signals instead of finishedPromise, e.g., the navigateerror event, or the navigation.transition.finished promise.

As such, we mark it as handled to ensure that it never triggers unhandledrejection events.

3. Let apiMethodTracker be a new navigation API method tracker with:

   navigation object
   navigation
   key
   null
   info
   info
   serialized state
   serializedState
   committed-to entry
   null
   committed promise
   committedPromise
   finished promise
   finishedPromise

4. Assert: navigation's upcoming non-traverse API method tracker is null.
5. If navigation does not have entries and events disabled, then set navigation's upcoming non-traverse API method tracker to apiMethodTracker.

Note
If navigation has entries and events disabled, then committedPromise and finishedPromise will never fulfill (since we never create a NavigationHistoryEntry object for such Document's, and so we have nothing to resolve them with); there is no NavigationHistoryEntry to apply serializedState to; and there is no navigate event to include info with. So, we don't need to track this API method call after all.

6. Return apiMethodTracker.

To add an upcoming traverse API method tracker given a Navigation navigation, a string destinationKey, and a JavaScript value info:

1. Let committedPromise and finishedPromise be new promises created in navigation's relevant realm.
2. Mark as handled finishedPromise.
3. Let `apiMethodTracker` be a new navigation API method tracker with:

```
navigation object
  navigation
  key
    destinationKey
  info
    info
  serialized state
    null
  committed-to entry
    null
  committed promise
    committedPromise
  finished promise
    finishedPromise
```


5. Return `apiMethodTracker`.

To promote an upcoming API method tracker to ongoing given a navigation and a string-or-null `destinationKey`:

1. **Assert**: navigation's ongoing API method tracker is null.

2. If `destinationKey` is not null, then:
   1. **Assert**: navigation's upcoming non-traverse API method tracker is null.
   2. If navigation's `upcoming traverse API method trackers`[destinationKey] exists, then:
      1. Set navigation's ongoing API method tracker to navigation's `upcoming traverse API method trackers`[destinationKey].
      2. Remove navigation's `upcoming traverse API method trackers`[destinationKey].
   3. Otherwise:
      1. Set navigation's ongoing API method tracker to navigation's upcoming non-traverse API method tracker.
      2. Set navigation's upcoming non-traverse API method tracker to null.

To clean up a navigation API method tracker `apiMethodTracker`:

1. Let navigation be `apiMethodTracker`'s navigation object.

2. If navigation's ongoing API method tracker is `apiMethodTracker`, then set navigation's ongoing API method tracker to null.

3. Otherwise:
   1. Let `key` be `apiMethodTracker`'s key.
   2. **Assert**: key is not null.
   3. **Assert**: navigation's `upcoming traverse API method trackers`[key] exists.
   4. Remove navigation's `upcoming traverse API method trackers`[key].

To notify about the committed-to entry given a navigation API method tracker `apiMethodTracker` and a NavigationHistoryEntry `nhe`:

1. Set `apiMethodTracker`'s committed-to entry to `nhe`.

2. If `apiMethodTracker`'s serialized state is not null, then set `nhe`'s session history entry's navigation API state to `apiMethodTracker`'s serialized state.
3. Resolve apiMethodTracker's **committed promise**\(^{p956}\) with nhe.

**Note**
At this point, apiMethodTracker's **committed promise**\(^{p956}\) is only needed in cases where it has not yet been returned to author code. Implementations might want to clear it out to avoid keeping it alive for the lifetime of the navigation API method tracker\(^{p955}\).

To **resolve the finished promise** for a navigation API method tracker\(^{p955}\) apiMethodTracker:

1. Resolve apiMethodTracker's **committed promise**\(^{p956}\) with its committed-to entry\(^{p956}\).

**Note**
Usually, notify about the committed-to entry\(^{p957}\) has previously been called on apiMethodTracker, and so this will do nothing. However, in some cases resolve the finished promise\(^{p958}\) is called directly, in which case this step is necessary.

2. Resolve apiMethodTracker's **finished promise**\(^{p956}\) with its committed-to entry\(^{p956}\).

3. **Clean up**\(^{p957}\) apiMethodTracker.

To **reject the finished promise** for a navigation API method tracker\(^{p955}\) apiMethodTracker with a JavaScript value exception:

1. Reject apiMethodTracker's **committed promise**\(^{p956}\) with exception.

**Note**
This will do nothing if apiMethodTracker's **committed promise**\(^{p956}\) was previously resolved via notify about the committed-to entry\(^{p957}\).

2. Reject apiMethodTracker's **finished promise**\(^{p956}\) with exception.

3. **Clean up**\(^{p957}\) apiMethodTracker.

To **abort the ongoing navigation** given a Navigation\(^{p943}\) navigation and an optional DOMException error:

1. Let event be navigation's ongoing navigate event\(^{p955}\).

2. **Assert**: event is not null.

3. Set navigation's focus changed during ongoing navigation\(^{p955}\) to false.

4. Set navigation's suppress normal scroll restoration during ongoing navigation\(^{p955}\) to false.

5. If error was not given, then let error be a new "AbortError" DOMException created in navigation's relevant realm\(^{p1071}\).

6. If event's dispatch flag is set, then set event's canceled flag to true.

7. **Signal abort** on event's abort controller\(^{p963}\) given error.

8. Set navigation's ongoing navigate event\(^{p955}\) to null.

9. Fire an event named navigateerror\(^{p1452}\) at navigation using ErrorEvent\(^{p1086}\), with error\(^{p1087}\) initialized to error, and message\(^{p1087}\), filename\(^{p1087}\), lineno\(^{p1087}\), and colno\(^{p1087}\) initialized to appropriate values that can be extracted from error and the current JavaScript stack in the same underspecified way that the report the exception\(^{p1086}\) algorithm does.

**Note**
Thus, for example, if this algorithm is reached because of a call to window.stop()\(^{p919}\), these properties would probably end up initialized based on the line of script that called window.stop()\(^{p919}\). But if it's because the user clicked the stop button, these properties would probably end up with default values like the empty string or 0.
10. If navigation's ongoing API method tracker is non-null, then reject the finished promise for apiMethodTracker with error.

11. If navigation's transition is not null, then:
   1. Reject navigation's transition's finished promise with error.
   2. Set navigation's transition to null.

To inform the navigation API about aborting navigation in a navigable navigable:

1. If this algorithm is running on navigable's active window's relevant agent's event loop, then continue on to the following steps. Otherwise, queue a global task on the navigation and traversal task source, given navigable's active window to run the following steps.

2. Let navigation be navigable's active window's navigation API.

3. If navigation's ongoing navigate event is null, then return.

4. Abort the ongoing navigation given navigation.

To inform the navigation API about child navigable destruction given a navigable navigable:

1. Inform the navigation API about aborting navigation in navigable.

2. Let navigation be navigable's active window's navigation API.

3. Let traversalAPIMethodTrackers to be clone of navigation's upcoming traverse API method trackers.

4. For each apiMethodTracker of traversalAPIMethodTrackers: reject the finished promise for apiMethodTracker with a new "AbortError" DOMException created in navigation's relevant realm.

The ongoing navigation concept is most-directly exposed to web developers through the navigation.transition property, which is an instance of the NavigationTransition interface:

```idl
[Exposed=Window]
interface NavigationTransition {
    readonly attribute NavigationType navigationType;
    readonly attribute NavigationHistoryEntry from;
    readonly attribute Promise<undefined> finished;
};
```

For web developers (non-normative)

**navigation**.transition A NavigationTransition representing any ongoing navigation that hasn't yet reached the navigatesuccess or navigateerror stage, if one exists; or null, if there is no such transition ongoing.

Since navigation.currentEntry (and other properties like location.href) are updated immediately upon navigation, this navigation.transition property is useful for determining when such navigations are not yet fully settled, according to any handlers passed to navigateEvent.intercept().

**navigation**.transition .navigationType One of "push", "replace", "reload", or "traverse", indicating what type of navigation this transition is for.

**navigation**.transition .from The NavigationHistoryEntry from which the transition is coming. This can be useful to compare against navigation.currentEntry.

**navigation**.transition .finished A promise which fulfills at the same time as the navigatesuccess fires, or rejects at the same time the navigateerror event fires.

Each Navigation has a transition, which is a NavigationTransition or null, initially null.
The `transition` getter steps are to return `this`'s `transition`.

Each `NavigationTransition` has an associated `navigation type`, which is a `NavigationType`.

Each `NavigationTransition` has an associated `from entry`, which is a `NavigationHistoryEntry`.

Each `NavigationTransition` has an associated `finished promise`, which is a promise.

The `navigationType` getter steps are to return `this`'s `navigation type`.

The `from` getter steps are to return `this`'s `from entry`.

The `finished` getter steps are to return `this`'s `finished promise`.

### 7.2.6.9 The `NavigationActivation` interface

```idl
[Exposed=window]
interface NavigationActivation {
    readonly attribute NavigationHistoryEntry? from;
    readonly attribute NavigationHistoryEntry entry;
    readonly attribute NavigationType navigationType;
};
```

#### For web developers (non-normative) navigation

A `NavigationActivation` containing information about the most recent cross-document navigation, the navigation that "activated" this `Document`.

While `navigation.currentEntry` and the `Document`'s URL can be updated regularly due to same-document navigations, `navigation.activation` stays constant, and its properties are only updated if the `Document` is reactivated from history.

**navigation**

A `NavigationHistoryEntry`, equivalent to the value of the `navigation.currentEntry` property at the moment the `Document` was activated.

**navigation**

A `NavigationHistoryEntry`, representing the `Document` that was active right before the current `Document`. This will have a value null in case the previous `Document` was not `same origin` with this one or if it was the `initial about:blank` `Document`.

There are some cases in which either the `from` or `entry` `NavigationHistoryEntry` objects would not be viable targets for the `traverseTo()` method, as they might not be retained in history. For example, the `Document` can be activated using `location.replace()` or its initial entry could be replaced by `history.replaceState()`. However, those entries' `url` property and `getState()` method are still accessible.

**navigation**

One of "push", "replace", "reload", or "traverse", indicating what type of navigation activated this `Document`.

Each `Navigation` has an associated `activation`, which is null or a `NavigationActivation` object, initially null.

Each `NavigationActivation` has:

- `old entry`, null or a `NavigationHistoryEntry`.
- `new entry`, null or a `NavigationHistoryEntry`.
- `navigation type`, a `NavigationType`.

The `activation` getter steps are to return `this`'s `activation`.

The `from` getter steps are to return `this`'s `old entry`. 

960
The entry getter steps are to return this's new entry.

The navigationType getter steps are to return this's navigation type.

7.2.6.10 The navigate event

A major feature of the navigation API is the navigate event. This event is fired on any navigation (in the broad sense of the word), allowing web developers to monitor such outgoing navigations. In many cases, the event is cancelable, which allows preventing the navigation from happening. And in others, the navigation can be intercepted and replaced with a same-document navigation by using the intercept() method of the NavigateEvent class.

7.2.6.10.1 The NavigateEvent interface

IDL

```
[Exposed=Window]
interface NavigateEvent : Event {
    constructor(DOMString type, NavigateEventInit eventInitDict);

    readonly attribute NavigationType navigationType;
    readonly attribute NavigationDestination destination;
    readonly attribute boolean canIntercept;
    readonly attribute boolean userInitiated;
    readonly attribute boolean hashChange;
    readonly attribute AbortSignal signal;
    readonly attribute FormData? formData;
    readonly attribute DOMString? downloadRequest;
    readonly attribute any info;
    readonly attribute boolean hasUAVisualTransition;

    undefined intercept(optional NavigateInterceptOptions options = {});
    undefined scroll();
};
```

dictionary NavigateEventInit : EventInit {
    NavigationType navigationType = "push";
    required NavigationDestination destination;
    boolean canIntercept = false;
    boolean userInitiated = false;
    boolean hashChange = false;
    required AbortSignal signal;
    FormData? formData = null;
    DOMString? downloadRequest = null;
    any info;
    boolean hasUAVisualTransition = false;
};

dictionary NavigateInterceptOptions {
    NavigateInterceptHandler handler;
    NavigationFocusReset focusReset;
    NavigationScrollBehavior scroll;
};

enum NavigationFocusReset {
    "after-transition",
    "manual"
};

denum NavigationScrollBehavior {
    "after-transition",
    "after-animation"
};
For web developers (non-normative)

`event.navigationType`¹⁹⁶³

One of "push"¹⁹⁴⁵, "replace"¹⁹⁴⁵, "reload"¹⁹⁴⁵, or "traverse"¹⁹⁴⁵, indicating what type of navigation this is.

`event.destination`¹⁹⁶³

A `NavigationDestination`¹⁹⁶⁴ representing the destination of the navigation.

`event.canIntercept`¹⁹⁶³

True if `intercept()`¹⁹⁶³ can be called to intercept this navigation and convert it into a same-document navigation, replacing its usual behavior; false otherwise.

Generally speaking, this will be true whenever the current `Document`¹²²⁸ can have its URL rewritten¹⁹³⁸ to the destination URL, except for in the case of cross-document "traverse"¹⁹⁴⁵ navigations, where it will always be false.

`event.userInitiated`¹⁹⁶³

True if this navigation was due to a user clicking on an `a`²⁵⁴ element, submitting a `form`⁵¹⁰ element, or using the browser UI¹⁰⁵⁸ to navigate; false otherwise.

`event.hashChange`¹⁹⁶³

True for a fragment navigation¹⁰¹⁰; false otherwise.

`event.signal`¹⁹⁶³

An `AbortSignal` which will become aborted if the navigation gets canceled, e.g., by the user pressing their browser's "Stop" button, or by another navigation interrupting this one.

The expected pattern is for developers to pass this along to any async operations, such as `fetch()`, which they perform as part of handling this navigation.

`event.formData`¹⁹⁶³

The `FormData` representing the submitted form entries for this navigation, if this navigation is a "push"¹⁹⁴⁵ or "replace"¹⁹⁴⁵ navigation representing a POST `form submission`¹⁶²⁴; null otherwise.

(Notably, this will be null even for "reload"¹⁹⁴⁵ or "traverse"¹⁹⁴⁵ navigations that are revisiting a `session history entry`¹⁰⁹⁴ that was originally created from a form submission.)

`event.downloadRequest`¹⁹⁶³

Represents whether or not this navigation was requested to be a download, by using an `a`²⁵⁴ or `area`⁴⁶⁸ element's `download`²⁹⁹ attribute:

- If a download was not requested, then this property is null.
- If a download was requested, returns the filename that was supplied as the `download`²⁹⁹ attribute's value. (This could be the empty string.)

Note that a download being requested does not always mean that a download will happen: for example, a download might be blocked by browser security policies, or end up being treated as a "push"³¹⁰⁸, a navigation for unspecified reasons.

Similarly, a navigation might end up being a download even if it was not requested to be one, due to the destination server responding with a `Content-Disposition: attachment` header.

Finally, note that the `navigate`³¹⁴⁵ event will not fire at all for downloads initiated using browser UI affordances, e.g., those created by right-clicking and choosing to save the target of a link.

`event.info`¹⁹⁶³

An arbitrary JavaScript value passed via one of the `navigation API methods`⁹⁵⁰ which initiated this navigation, or undefined if the navigation was initiated by the user or by a different API.

`event.hasUAVisualTransition`¹⁹⁶³

Returns true if the user agent performed a visual transition for this navigation before dispatching this event. If true, the best user experience will be given if the author synchronously updates the DOM to the post-navigation state.

`event.intercept`¹⁹⁶³({ `handler`¹⁹⁶¹, `focusReset`¹⁹⁶¹, `scroll`¹⁹⁶¹ })

Intercepts this navigation, preventing its normal handling and instead converting it into a same-document navigation of the
The `handler` option can be a function that returns a promise. The handler function will run after the `navigate` event has finished firing, and the `navigation_currentEntry` property has been synchronously updated. This returned promise is used to signal the duration, and success or failure, of the navigation. After it settles, the browser signals to the user (e.g., via a loading spinner UI, or assistive technology) that the navigation is finished. Additionally, it fires `navigatesuccess` or `navigateerror` events as appropriate, which other parts of the web application can respond to.

By default, using this method will cause focus to reset when any handlers' returned promises settle. Focus will be reset to the first element with the `autofocus` attribute set, or the `body` element if the attribute isn't present. The `focusReset` option can be set to "manual" to avoid this behavior.

By default, using this method will delay the browser's scroll restoration logic for "traverse" or "reload" navigations, or its scroll-reset/scroll-to-a-fragment logic for "push" or "replace" navigations, until any handlers' returned promises settle. The `scroll()` option can be set to "manual" to turn off any browser-driven scroll behavior entirely for this navigation, or `scroll()` can be called before the promise settles to trigger this behavior early.

This method will throw a "SecurityError" DOMException if `canIntercept` is false, or if `isTrusted` is false. It will throw an "InvalidStateError" DOMException if not called synchronously, during event dispatch.

```javascript
event.scroll()
```

For "traverse" or "reload" navigations, restores the scroll position using the browser's usual scroll restoration logic.

For "push" or "replace" navigations, either resets the scroll position to the top of the document or scrolls to the fragment specified by `destination_url` if there is one.

If called more than once, or called after automatic post-transition scroll processing has happened due to the `scroll()` option being left as "after-transition", or called before the navigation has committed, this method will throw an "InvalidStateError" DOMException.

Each `NavigateEvent` has an interception state, which is either "none", "intercepted", "committed", "scrolled", or "finished", initially "none".

Each `NavigateEvent` has a navigation handler list, a list of `NavigationInterceptHandler` callbacks, initially empty.

Each `NavigateEvent` has a focus reset behavior, a `NavigationFocusReset-or-null`, initially null.

Each `NavigateEvent` has a scroll behavior, a `NavigationScrollBehavior-or-null`, initially null.

Each `NavigateEvent` has an abort controller, an `AbortController-or-null`, initially null.

Each `NavigateEvent` has a classic history API state, a `serialized state-or-null`, or null. It is only used in some cases where the event's `navigationType` is "push" or "replace", and is set appropriately when the event is fired.

The `navigationType`, destination, `canIntercept`, `userInitiated`, `hashChange`, `signal`, `formData`, `downloadRequest`, `info`, and `hasUAVisualTransition` attributes must return the values they are initialized to.

The `intercept(options)` method steps are:

1. Perform shared checks given this.
2. If this's `canIntercept` attribute was initialized to false, then throw a "SecurityError" DOMException.
3. If this's `dispatch flag` is unset, then throw an "InvalidStateError" DOMException.
4. Assert: this's `interception state` is either "none" or "intercepted".
5. Set this's `interception state` to "intercepted".
6. If options["handler"] exists, then append it to this's `navigation handler list`.
7. If options["focusReset"] exists, then:
   1. If this's `focus reset behavior` is not null, and it is not equal to options["focusReset"], then the user agent may report a warning to the console indicating that the `focusReset` option for a previous call to `intercept()` was overridden by this new value, and the previous value will be ignored.
   2. Set this's `focus reset behavior` to options["focusReset"].
8. If `options["scroll"]` exists, then:
   1. If this's scroll behavior is not null, and it is not equal to `options["scroll"]`, then the user agent may report a warning to the console indicating that the `scroll` option for a previous call to `intercept()` was overridden by this new value, and the previous value will be ignored.
   2. Set this's scroll behavior to `options["scroll"]`.

The `scroll()` method steps are:

   1. Perform shared checks given this.
   2. If this's interception state is not "committed", then throw an "InvalidStateError" DOMException.
   3. Process scroll behavior given this.

To perform shared checks for a `NavigateEvent` event:

   1. If event's relevant global object's associated Document is not fully active, then throw an "InvalidStateError" DOMException.
   2. If event's isTrusted attribute was initialized to false, then throw a "SecurityError" DOMException.
   3. If event's canceled flag is set, then throw an "InvalidStateError" DOMException.

### 7.2.6.10.2 The `NavigationDestination` interface

```idl
[Exposed=Window]
interface NavigationDestination {
  readonly attribute USVString url;
  readonly attribute DOMString key;
  readonly attribute DOMString id;
  readonly attribute long long index;
  readonly attribute boolean sameDocument;
  any getState();
};
```

For web developers (non-normative)

- `event.destination.url` (readonly attr) The URL being navigated to.
- `event.destination.key` (readonly attr) The value of the `key` property of the destination `NavigationHistoryEntry`, if this is a "traverse" navigation, or the empty string otherwise.
- `event.destination.id` (readonly attr) The value of the `id` property of the destination `NavigationHistoryEntry`, if this is a "traverse" navigation, or the empty string otherwise.
- `event.destination.index` (readonly attr) The value of the `index` property of the destination `NavigationHistoryEntry`, if this is a "traverse" navigation, or −1 otherwise.
- `event.destination.sameDocument` (readonly attr) Indicates whether or not this navigation is to the same `Document` as the current one, or not. This will be true, for example, in the case of fragment navigations or `history.pushState()` navigations.

Note that this property indicates the original nature of the navigation. If a cross-document navigation is converted into a same-document navigation using `navigateEvent.intercept()`, that will not change the value of this property.

- `event.destination.getState()` For "traverse" navigations, returns the deserialization of the state stored in the destination session history entry.
For "push" or "replace" navigations, returns the deserialization of the state passed to `navigation.navigate()` if the navigation was initiated by that method, or undefined if it wasn't.
For "reload" navigations, returns the deserialization of the state passed to `navigation.reload()`, if the reload was initiated by that method, or undefined if it wasn't.

Each `NavigationDestination` has a `URL`, which is a `URL`.

Each `NavigationDestination` has an `entry`, which is a `NavigationHistoryEntry` or null.

**Note**

It will be non-null if and only if the `NavigationDestination` corresponds to a "traverse" navigation.

Each `NavigationDestination` has a `state`, which is a `serialized state`.

Each `NavigationDestination` has an `is same document`, which is a boolean.

The `url` getter steps are to return this's `URL`, serialized.

The `key` getter steps are:

1. If this's `entry` is null, then return the empty string.
2. Return this's `entry`'s `key`.

The `id` getter steps are:

1. If this's `entry` is null, then return the empty string.
2. Return this's `entry`'s `ID`.

The `index` getter steps are:

1. If this's `entry` is null, then return −1.
2. Return this's `entry`'s `index`.

The `sameDocument` getter steps are to return this's `is same document`.

The `getState()` method steps are to return `StructuredDeserialize(this's `state`).

7.2.6.10.3 Firing the event

Other parts of the standard fire the `navigate` event, through a series of wrapper algorithms given in this section.

To fire a traverse `navigate` event at a `Navigation` navigation given a `session history entry` `destinationSHE` and an optional `user navigation involvement` `userInvolvement` (default "none"):

1. Let event be the result of creating an event given `NavigateEvent`, in navigation's `relevant realm`.
2. Set event's `classic history API state` to null.
3. Let `destination` be a `new NavigationDestination` created in navigation's `relevant realm`.
4. Set destination's `URL` to `destinationSHE`'s `URL`.
5. Let `destinationNHE` be the `NavigationHistoryEntry` in navigation's `entry list` whose `session history entry` is `destinationSHE`, or null if no such `NavigationHistoryEntry` exists.
6. If `destinationNHE` is non-null, then:
   1. Set `destination`'s `entry` to `destinationNHE`.
2. Set destination's state to destinationSHE's navigation API state.

7. Otherwise,
   1. Set destination's entry to null.
   2. Set destination's state to StructuredSerializeForStorage(null).

8. Set destination's is same document to false if destinationSHE's document is equal to navigation's relevant global object's associated Document; otherwise true.

9. Return the result of performing the inner navigate event firing algorithm given navigation, "traverse", event, destination, userInvolvement, null, and null.

To fire a push/replace/reload navigate event at a Navigation navigation given a NavigationType, a URL destinationURL, a boolean isSameDocument, an optional user navigation involvement, userInvolvement (default "none"), an optional entry list-or-null formDataEntryList (default null), an optional serialized state navigationAPIState (default StructuredSerializeForStorage(null)), and an optional serialized state classicHistoryAPIState (default null):

1. Let event be the result of creating an event given NavigateEvent, in navigation's relevant realm.

2. Set event's classic history API state to classicHistoryAPIState.

3. Let destination be a new NavigationDestination created in navigation's relevant realm.

4. Set destination's URI to destinationURL.

5. Set destination's entry to null.

6. Set destination's state to navigationAPIState.

7. Set destination's is same document to isSameDocument.

8. Return the result of performing the inner navigate event firing algorithm given navigation, navigationType, event, destination, userInvolvement, formDataEntryList, and null.

To fire a download request navigate event at a Navigation navigation given a URL destinationURL, a user navigation involvement userInvolvement, and a string filename:

1. Let event be the result of creating an event given NavigateEvent, in navigation's relevant realm.

2. Set event's classic history API state to null.

3. Let destination be a new NavigationDestination created in navigation's relevant realm.

4. Set destination's URI to destinationURL.

5. Set destination's entry to null.

6. Set destination's state to StructuredSerializeForStorage(null).

7. Set destination's is same document to false.

8. Return the result of performing the inner navigate event firing algorithm given navigation, "push", event, destination, userInvolvement, null, and filename.

The inner navigate event firing algorithm consists of the following steps, given a Navigation navigation, a NavigationType navigationType, a NavigateEvent event, a NavigationDestination destination, a user navigation involvement userInvolvement, an entry list-or-null formDataEntryList, and a string-or-null downloadRequestFilename:

1. If navigation has entries and events disabled, then:
   1. Assert: navigation's ongoing API method tracker is null.
   2. Assert: navigation's upcoming non-traverse API method tracker is null.
   3. Assert: navigation's upcoming traverse API method trackers is empty.
   4. Return true.
2. Let destinationKey be null.

3. If destination's entry is non-null, then set destinationKey to destination's entry's key.

4. Assert: destinationKey is not the empty string.

5. Promote an upcoming API method tracker to ongoing given navigation and destinationKey.


7. Let navigable be navigation's relevant global object's navigable.

8. Let document be navigation's relevant global object's associated Document.

9. If document can have its URL rewritten to destination's URL, and either destination's is same document is true or navigationType is not \texttt{traverse}, then initialize event's canIntercept to true. Otherwise, initialize it to false.

10. Let traverseCanBeCanceled be true if all of the following are true:
\begin{itemize}
\item navigable is a top-level traversable;
\item destination's is same document is true; and
\item either userInvolvement is not \texttt{browser UI}, or navigation's relevant global object's history-action activation.
\end{itemize}
Otherwise, let it be false.

11. If either:
\begin{itemize}
\item navigationType is not \texttt{traverse} or
\item traverseCanBeCanceled is true
\end{itemize}
the initialize event's cancelable to true. Otherwise, initialize it to false.

12. Initialize event's type to \texttt{navigate}.

13. Initialize event's navigationType to navigationType.

14. Initialize event's destination to destination.

15. Initialize event's downloadRequest to downloadRequestFilename.

16. If apiMethodTracker is not null, then initialize event's info to apiMethodTracker's info. Otherwise, initialize it to undefined.

17. Initialize event's hasUAVisualTransition to true if a visual transition, to display a cached rendered state of the document's latest entry, was done by the user agent. Otherwise, initialize it to false.

18. Set event's abort controller to a new AbortController created in navigation's relevant realm.

19. Initialize event's signal to event's abort controller's signal.

20. Let currentURL be document's URL.

21. If all of the following are true:
\begin{itemize}
\item destination's is same document is true;
\item destination's URL equals currentURL with exclude fragments set to true; and
\end{itemize}
"destination"'s URL's fragment is not identical to currentURL's fragment, then initialize event's hashChange to true. Otherwise, initialize it to false.

22. If userInvolvement is not "none", then initialize event's userInitiated to true. Otherwise, initialize it to false.

23. If formDataEntryList is not null, then initialize event's formData to a new FormData created in navigation's relevant realm, associated to formDataEntryList. Otherwise, initialize it to null.

24. Assert: navigation's ongoing navigate event is null.

25. Set navigation's ongoing navigate event to event.

26. Set navigation's focus changed during ongoing navigation to false.

27. Set navigation's suppress normal scroll restoration during ongoing navigation to false.

28. Let dispatchResult be the result of dispatching event at navigation.

29. If dispatchResult is false:
   1. If navigationType is "traverse", then consume history-action user activation given navigation's relevant global object.
   2. If event's abort controller's signal is not aborted, then abort the ongoing navigation given navigation.
   3. Return false.

30. Let endResultIsSameDocument be true if event's interception state is not "none" or event's destination's is same document is true.

31. Prepare to run script given navigation's relevant settings object.

32. If event's interception state is not "none":
   1. Set event's interception state to "committed".
   2. Let fromNHE be the current entry of navigation.
   3. Assert: fromNHE is not null.
   4. Set navigation's transition to a new NavigationTransition created in navigation's relevant realm, whose navigation type is navigationType, from entry is fromNHE, and whose finished promise is a new promise created in navigation's relevant realm.
   5. Mark as handled navigation's transition's finished promise.

   See the discussion about other finished promises to understand why this is done.

   6. If navigationType is "traverse", then set navigation's suppress normal scroll restoration during ongoing navigation to true.
7. If `navigationType` is "push" or "replace", then run the URL and history update steps given document and event's destination's URL, with `serialiedData` set to event's classic history API state and `historyHandling` set to `navigationType`.

**Note**

If `navigationType` is "reload", then we are converting a reload into a "same-document reload", for which the URL and history update steps, are not appropriate. Navigation API-related stuff still happens, such as updating the active session history entry if this was caused by a call to `navigation.reload()` and all the ongoing navigation tracking.

If `navigationType` is "traverse", then this event firing is happening as part of the traversal process, and that process will take care of performing the appropriate session history entry updates.

33. If `endResultIsSameDocument` is true:

1. Let `promisesList` be an empty list.
2. **For each** handler of event's navigation handler list:
   1. Append the result of invoking handler with an empty arguments list to `promisesList`.
3. If `promisesList`'s size is 0, then set `promisesList` to « a promise resolved with undefined ».
4. **Wait for all** of `promisesList`, with the following success steps:
   1. If event's relevant global object is not fully active, then abort these steps.
2. If event's abort controller's signal is aborted, then abort these steps.
3. Assert: event equals navigation's ongoing navigate event.
4. Set navigation's ongoing navigate event to null.
5. Finish event given true.
6. Fire an event named navigatesuccess at navigation.
7. If navigation's transition is not null, then resolve navigation's transition's finished promise with undefined.
8. Set navigation's transition to null.
9. If `apiMethodTracker` is non-null, then resolve the finished promise for `apiMethodTracker`.

and the following failure steps given reason `rejectionReason`:

1. If event's relevant global object is not fully active, then abort these steps.
2. If event's abort controller's signal is aborted, then abort these steps.
3. Assert: event equals navigation's ongoing navigate event.
4. Set navigation's ongoing navigate event to null.

There is a subtle timing difference between how waiting for all schedules its success and failure steps when given zero promises versus ≥1 promises. For most uses of waiting for all, this does not matter. However, with this API, there are so many events and promise handlers which could fire around the same time that the difference is pretty easily observable: it can cause the event/promise handler sequence to vary. (Some of the events and promises involved include: navigatesuccess, navigateerror, currententrychange, dispose, apiMethodTracker's promises, and the navigation.transition.finished promise.)
5. **Finish** event given false.

6. **Fire an event** named `navigateerror` at navigation using `ErrorEvent`, with `error` initialized to `rejectionReason`, and `message`, `filename`, `lineno`, and `colno` initialized to appropriate values that can be extracted from `rejectionReason` in the same underspecified way that the report the exception algorithm does.

7. If navigation's `transition` is not null, then reject navigation's `transition`'s `finished promise` with `rejectionReason`.

8. Set navigation's `transition` to null.

9. If `apiMethodTracker` is non-null, then reject the finished promise for `apiMethodTracker` with `rejectionReason`.

34. Otherwise, if `apiMethodTracker` is non-null, then clean up `apiMethodTracker`.

35. **Clean up after running script** given navigation's relevant settings object.

Note

Per the previous note, this stops suppressing any potential promise handler microtasks, causing them to run at this point or later.

36. If event's interception state is "none", then return true.

37. Return false.

### 7.2.6.10.4 Scroll and focus behavior

By calling `navigateEvent.intercept()`, web developers can suppress the normal scroll and focus behavior for same-document navigations, instead invoking cross-document navigation-like behavior at a later time. The algorithms in this section are called at those appropriate later points.

To **finish** a `NavigateEvent` event, given a boolean `didFulfill`:

1. **Assert**: event's interception state is not "intercepted" or "finished".
2. If event's interception state is "none", then return.
3. **Potentially reset the focus** given event.
4. If `didFulfill` is true, then potentially process scroll behavior, given event.
5. Set event's interception state to "finished".

To **potentially reset the focus** given a `NavigateEvent` event:

1. **Assert**: event's interception state is "committed" or "scrolled".
2. Let navigation be event's relevant global object's navigation API.
3. Let `focusChanged` be navigation's focus changed during ongoing navigation.
4. Set navigation's focus changed during ongoing navigation to false.
5. If `focusChanged` is true, then return.
6. If event's focus reset behavior is "manual", then return.

Note

If it was left as null, then we treat that as "after-transition", and continue onward.

7. Let document be event's relevant global object's associated `Document`.
8. Let `focusTarget` be the autofocus delegate for document.
9. If focusTarget is null, then set focusTarget to document's body element.

10. If focusTarget is null, then set focusTarget to document's document element.

11. Run the focusing steps for focusTarget, with document's viewport as the fallback target.

12. Move the sequential focus navigation starting point to focusTarget.

To potentially process scroll behavior given a NavigateEvent event:

1. Assert: event's interception state is "committed" or "scrolled".

2. If event's interception state is "scrolled", then return.

3. If event's scroll behavior is "manual", then return.

4. Process scroll behavior given event.

To process scroll behavior given a NavigateEvent event:

1. Assert: event's interception state is "committed".

2. Set event's interception state to "scrolled".

3. If event's navigationType was initialized to "traverse" or "reload", then restore scroll position data given event's relevant global object's navigable's active session history entry.

4. Otherwise:

   1. Let document be event's relevant global object's associated Document.

   2. If document's indicated part is null, then scroll to the beginning of the document given document.

   3. Otherwise, scroll to the fragment given document.

### 7.2.7 Event interfaces

The NavigateEvent interface has its own dedicated section, due to its complexity.

#### 7.2.7.1 The NavigationCurrentEntryChangeEvent interface

```idl
[Exposed=Window]
interface NavigationCurrentEntryChangeEvent : Event {
    constructor(BOMString type, NavigationCurrentEntryChangeEventInit eventInitDict);

    readonly attribute NavigationType? navigationType;
    readonly attribute NavigationHistoryEntry from;
};

dictionary NavigationCurrentEntryChangeEventInit : EventInit {
    NavigationType? navigationType = null;
    required NavigationHistoryEntry from;
};
```

For web developers (non-normative)
The `navigationType` and `from` attributes must return the values they were initialized to.

### 7.2.7.2 The PopStateEvent interface

```idl
[Exposed=Window]
interface PopStateEvent : Event {
  constructor(DOMString type, optional PopStateEventInit eventInitDict = {});

  readonly attribute any state;
  readonly attribute boolean hasUAVisualTransition;
};

dictionary PopStateEventInit : EventInit {
  any state = null;
  boolean hasUAVisualTransition = false;
};
```

For web developers (non-normative)

**event.state**

Returns a copy of the information that was provided to `pushState()` or `replaceState()`.  

**event.hasUAVisualTransition**

Returns true if the user agent performed a visual transition for this navigation before dispatching this event. If true, the best user experience will be given if the author synchronously updates the DOM to the post-navigation state.

The `state` attribute must return the value it was initialized to. It represents the context information for the event, or null, if the state represented is the initial state of the `Document`.  

The `hasUAVisualTransition` attribute must return the value it was initialized to.

### 7.2.7.3 The HashChangeEvent interface

```idl
[Exposed=Window]
interface HashChangeEvent : Event {
  constructor(DOMString type, optional HashChangeEventInit eventInitDict = {});

  readonly attribute USVString oldURL;
  readonly attribute USVString newURL;
};

dictionary HashChangeEventInit : EventInit {
  USVString oldURL = "";
  USVString newURL = "";
};
```

For web developers (non-normative)

...
The **oldURL** attribute must return the value it was initialized to. It represents context information for the event, specifically the URL of the session history entry that was traversed from.

The **newURL** attribute must return the value it was initialized to. It represents context information for the event, specifically the URL of the session history entry that was traversed to.

### 7.2.7.4 The **PageSwapEvent** interface

```
[Exposed=Window]
interface PageSwapEvent : Event {
    constructor(DOMString type, optional PageSwapEventInit eventInitDict = {});
    readonly attribute NavigationActivation? activation;
    readonly attribute ViewTransition? viewTransition;
};

dictionary PageSwapEventInit : EventInit {
    NavigationActivation? activation = null;
    ViewTransition? viewTransition = null;
};
```

**For web developers (non-normative)**

**event.**activation

A **NavigationActivation** object representing the destination and type of the cross-document navigation. This would be null for cross-origin navigations.

**event.**activation.**entry**

A **NavigationHistoryEntry**, representing the **Document** that is about to become active.

**event.**activation.**from**

A **NavigationHistoryEntry**, equivalent to the value of the **navigation.currentEntry** property at the moment the event is fired.

**event.**activation.**navigationType**

One of "push", "replace", "reload", or "traverse", indicating what type of navigation that is about to result in a page swap.

**event.**viewTransition

Returns the **ViewTransition** object that represents an outbound cross-document view transition, if such transition is active when the event is fired. Otherwise, returns null.

The **activation** attribute and **viewTransition** attributes must return the values they were initialized to.

### 7.2.7.5 The **PageRevealEvent** interface

```
[Exposed=Window]
interface PageRevealEvent : Event {
    constructor(DOMString type, optional PageRevealEventInit eventInitDict = {});
    readonly attribute ViewTransition? viewTransition;
};

dictionary PageRevealEventInit : EventInit {
    ViewTransition? viewTransition = null;
};
```
```javascript
ViewTransition? viewTransition = null;
```

**For web developers (non-normative)**

```javascript
event.viewTransition
```

Returns the `ViewTransition` object that represents an inbound cross-document view transition, if such transition is active when the event is fired. Otherwise, returns null.

The `viewTransition` attribute must return the value it was initialized to.

### 7.2.7.6 The `PageTransitionEvent` interface

```javascript
IDL
interface PageTransitionEvent : Event {
    constructor(DOMString type, optional PageTransitionEventInit eventInitDict = {});

    readonly attribute boolean persisted;
};
```

**For web developers (non-normative)**

```javascript
event.persisted
```

For the `pageshow` event, returns false if the page is newly being loaded (and the `load` event will fire). Otherwise, returns true.

For the `pagehide` event, returns false if the page is going away for the last time. Otherwise, returns true, meaning that the page might be reused if the user navigates back to this page (if the `Document`'s `salvageable` state stays true).

Things that can cause the page to be unsalvageable include:

- The user agent decided to not keep the `Document` alive in a session history entry after `unload`
- Having `iframe`s that are not `salvageable`
- Active `WebSocket` objects
- Aborting a `Document`

The `persisted` attribute must return the value it was initialized to. It represents the context information for the event.

To fire a page transition event named `eventName` at a `Window` window with a boolean `persisted`, fire an event named `eventName` at `window`, using `PageTransitionEvent`, with the `persisted` attribute initialized to `persisted`, the `cancelable` attribute initialized to true, the `bubbles` attribute initialized to true, and `legacy target override flag` set.

**Note**

The values for `cancelable` and `bubbles` don't make any sense, since canceling the event does nothing and it's not possible to bubble past the `Window` object. They are set to true for historical reasons.

### 7.2.7.7 The `BeforeUnloadEvent` interface

```javascript
IDL
interface BeforeUnloadEvent : Event {
    attribute DOMString returnValue;
};
```
The `BeforeUnloadEvent` interface is a legacy interface which allows checking if unloading is canceled to be controlled not only by canceling the event, but by setting the `returnValue` attribute to a value besides the empty string. Authors should use the `preventDefault()` method, or other means of canceling events, instead of using `returnValue`.

The `returnValue` attribute controls the process of checking if unloading is canceled. When the event is created, the attribute must be set to the empty string. On getting, it must return the last value it was set to. On setting, the attribute must be set to the new value.

There are no `BeforeUnloadEvent`-specific initialization methods.

Note

This attribute is a DOMString only for historical reasons. Any value besides the empty string will be treated as a request to ask the user for confirmation.

### 7.2.8 The `NotRestoredReasons` interface

```idl
[Exposed=Window]
interface NotRestoredReasonDetails {
    [Default] object toJSON();
};

[Exposed=Window]
interface NotRestoredReasons {
    readonly attribute DOMString? src;
    readonly attribute DOMString? id;
    readonly attribute DOMString? name;
    readonly attribute DOMString? url;
    readonly attribute FrozenArray<NotRestoredReasonDetails>? reasons;
    readonly attribute FrozenArray<NotRestoredReasons>? children;
    [Default] object toJSON();
};
```

For web developers (non-normative)

**notRestoredReasonDetails.reason**

Returns a string that explains the reason that prevented the document from being served from back/forward cache. See the definition of bfcache blocking details for the possible string values.

**notRestoredReasons.src**

Returns the `src` attribute of the document's `node navigable`'s `container` if it is an `iframe` element. This can be null if not set or if it is not an `iframe` element.

**notRestoredReasons.id**

Returns the `id` attribute of the document's `node navigable`'s `container` if it is an `iframe` element. This can be null if not set or if it is not an `iframe` element.

**notRestoredReasons.name**

Returns the `name` attribute of the document's `node navigable`'s `container` if it is an `iframe` element. This can be null if not set or if it is not an `iframe` element.

**notRestoredReasons.url**

Returns the document's URL, or null if the document is in a cross-origin `iframe` navigated since the original `src` was set.
A `NotRestoredReasonDetails` object has a **backing struct**, a **not restored reason details** or null, initially null.

The **reason** getter steps are to return this's **backing struct**'s **reason**.

To **create a `NotRestoredReasonDetails` object** given a **not restored reason details** backingStruct and a **realm** realm:

1. Let `notRestoredReasonDetails` be a new `NotRestoredReasonDetails` object created in realm.
2. Set `notRestoredReasonDetails`'s **backing struct** to `backingStruct`.
3. Return `notRestoredReasonDetails`.

A **not restored reason details** is a **struct** with the following **items**:

- **reason**, a string, initially empty.

The **reason** is a string that represents the reason that prevented the page from being restored from **back/forward cache**. The string is one of the following:

**"fetch"**
While unloading, a fetch initiated by this `Document` was still ongoing and was canceled, so the page was not in a stable state that could be stored in **back/forward cache**.

**"navigation-failure"**
The original navigation that created this `Document` errored, so storing the resulting error document in the **back/forward cache** was prevented.

**"parser-aborted"**
The `Document` never finished its initial HTML parsing, so storing the unfinished document in the **back/forward cache** was prevented.

**"websocket"**
While unloading, an open `WebSocket` connect was shut down, so the page was not in a stable state that could be stored in the **back/forward cache**. [WEBSOCKETS]

**"lock"**
While unloading, held `locks` and `lock requests` were terminated, so the page was not in a stable state that could be stored in the **back/forward cache**. [WEBLOCKS]

**"masked"**
This `Document` has children that are in a cross-origin `iframe`, and they prevented **back/forward cache**; or this `Document` could not be **back/forward cached** for user agent-specific reasons.

A `NotRestoredReasons` object has a **backing struct**, a **not restored reasons** or null, initially null.

A `NotRestoredReasons` object has a **reasons array**, a `FrozenArray<NotRestoredReasonDetails>` or null, initially null.

A `NotRestoredReasons` object has a **children array**, a `FrozenArray<NotRestoredReasons>` or null, initially null.

The **src** getter steps are to return this's **backing struct**'s **src**.

The **id** getter steps are to return this's **backing struct**'s **id**.

The **name** getter steps are to return this's **backing struct**'s **name**.

The **url** getter steps are:
1. If this's backing struct's URL is null, then return null.
2. Return this's backing struct's URL, serialized.

The reasons getter steps are to return this's reasons array.

The children getter steps are to return this's children array.

To create a NotRestoredReasons object given a not restored reasons backingStruct and a realm:

1. Let notRestoredReasons be a new NotRestoredReasons object created in realm.
2. Set notRestoredReasons's backing struct to backingStruct.
3. If backingStruct's reasons is null, set notRestoredReasons's reasons array to null.
4. Otherwise:
   1. Let reasonsArray be an empty list.
   2. For each reason of backingStruct's reasons:
      1. Create a NotRestoredReasonDetails object given reason and realm, and append it to reasonsArray.
   3. Set notRestoredReasons's reasons array to the result of creating a frozen array given reasonsArray.
5. If backingStruct's children is null, set notRestoredReasons's children array to null.
6. Otherwise:
   1. Let childrenArray be an empty list.
   2. For each child of backingStruct's children:
      1. Create a NotRestoredReasons object given child and realm and append it to childrenArray.
   3. Set notRestoredReasons's children array to the result of creating a frozen array given childrenArray.
7. Return notRestoredReasons.

A not restored reasons is a struct with the following items:

- src, a string or null, initially null.
- id, a string or null, initially null.
- name, a string or null, initially null.
- url, a URL or null, initially null.
- reasons, null or a list of not restored reason details, initially null.
- children, null or a list of not restored reasons, initially null.

A Document's not restored reasons is its node navigable's active session history entry's document state's not restored reasons, if Document's node navigable is a top-level traversable; otherwise null.

7.3 Infrastructure for sequences of documents

This standard contains several related concepts for grouping sequences of documents. As a brief, non-normative summary:

- Navigables are a user-facing representation of a sequence of documents, i.e., they represent something that can be navigated between documents. Typical examples are tabs or windows in a web browser, or iframe s, or frame s in a frameset.
- Traversable navigables are a special type of navigable which control the session history of themselves and of their descendant navigables. That is, in addition to their own series of documents, they represent a tree of further series of
documents, plus the ability to linearly traverse back and forward through a flattened view of this tree.

- **Browsing contexts** are a developer-facing representation of a series of documents. They correspond 1:1 with `WindowProxy` objects. Each navigable can present a series of browsing contexts, with switches between those browsing contexts occurring under certain well-defined circumstances.

Most of this standard works in the language of navigables, but certain APIs expose the existence of browsing context switches, and so some parts of the standard need to work in terms of browsing contexts.

### 7.3.1 Navigables

A navigable presents a `Document` to the user via its **active session history entry**. Each navigable has:

- An `id`, a new unique internal value.
- A `parent`, a navigable or null.
- A **current session history entry**, a session history entry. This can only be modified within the session history traversal queue of the parent `traversable navigable`.
- An **active session history entry**, a session history entry. This can only be modified from the event loop of the active session history entry's `document`.
- An `is closing` boolean, initially false.
- An `is delaying load events` boolean, initially false.

**Note**

This is only ever set to true for top-level traversable navigables.

**Note**

This is only ever set to true in cases where the navigable's parent is non-null.

The **current session history entry** and the **active session history entry** are usually the same, but they get out of sync when:

- Synchronous navigations are performed. This causes the active session history entry to temporarily step ahead of the current session history entry.
- A non-displayable, non-error response is received when applying the history step. This updates the current session history entry but leaves the active session history entry as-is.

A navigable's **active document** is its active session history entry's `document`.

**Note**

This can be safely read from within the session history traversal queue of the navigable's top-level traversable. Although a navigable's active history entry can change synchronously, the new entry will always have the same `Document`.

A navigable's **active browsing context** is its active document's `browsing context`. If this navigable is a `traversable navigable`, then its active browsing context will be a top-level browsing context.

A navigable's **active WindowProxy** is its active browsing context's associated `WindowProxy`.

A navigable's **active window** is its active WindowProxy's `Window`.

**Note**

This will always equal the navigable's active document's `relevant global object`; this is kept in sync by the `make active` algorithm.
A navigable's target name is its active session history entry's document state's navigable target name.

To get the node navigable of a node node, return the navigable whose active document is node's node document, or null if there is no such navigable.

To initialize the navigable navigable, given a document state and an optional navigable-or-null parent (default null):

1. Assert: documentState's document is non-null.
2. Let entry be a new session history entry, with
   - URL documentState's document's URL
   - document state
   - documentState

   Note
   
   The caller of this algorithm is responsible for initializing entry's step; it will be left as "pending" until that is complete.

3. Set navigable's current session history entry to entry.
4. Set navigable's active session history entry to entry.
5. Set navigable's parent to parent.

7.3.1.1 Traversable navigables

A traversable navigable is a navigable that also controls which session history entry should be the current session history entry for itself and its descendant navigables.

In addition to the properties of a navigable, a traversable navigable has:

- A current session history step, a number, initially 0.
- Session history entries, a list of session history entries, initially a new list.
- A session history traversal queue, a session history traversal parallel queue, the result of starting a new session history traversal parallel queue.
- A running nested apply history step boolean, initially false.
- A system visibility state, which is either "hidden" or "visible".

See the page visibility section for the requirements on this item.

To get the traversable navigable of a navigable InputNavigable:

1. Let navigable be inputNavigable.
2. While navigable is not a traversable navigable, set navigable to navigable's parent.
3. Return navigable.

7.3.1.2 Top-level traversables

A top-level traversable is a traversable navigable with a null parent.

Note

Currently, all traversable navigables are top-level traversables. Future proposals envision introducing non-top-level
A user agent holds a **top-level traversable set** (a set of top-level traversables). These are typically presented to the user in the form of browser windows or browser tabs.

To get the **top-level traversable** of a navigable inputNavigable:

1. Let navigable be inputNavigable.
2. While navigable's parent is not null, set navigable to navigable's parent.
3. Return navigable.

To **create a new top-level traversable** given a browsing context-or-null opener and a string targetName:

1. Let document be null.
2. If opener is null, then set document to the second return value of creating a new top-level browsing context and document.
3. Otherwise, set document to the second return value of creating a new auxiliary browsing context and document given opener.
4. Let documentState be a new document state, with document
   - initiator origin
   - document's origin
   - navigable target name
   - targetName
   - about base URL
5. Let traversable be a new traversable navigable.
6. Initialize the navigable given documentState.
7. Let initialHistoryEntry be traversable's active session history entry.
8. Set initialHistoryEntry's step to 0.
9. Append initialHistoryEntry to traversable's session history entries.
10. If opener is non-null, then legacy-clone a traversable storage shed given opener's top-level traversable and traversable. [STORAGE]
11. Append traversable to the user agent's top-level traversable set.
12. Return traversable.

To **create a fresh top-level traversable** given a URL initialNavigationURL and an optional POST resource-or-null initialNavigationPostResource (default null):

1. Let traversable be the result of creating a new top-level traversable given null and the empty string.

**Note**: We treat these initial navigations as traversable navigating itself, which will ensure all relevant security checks pass.
7.3.1.3 Child navigables

Certain elements (for example, *iframe* elements) can present a navigable to the user. These elements are called navigable containers.

Each navigable container has a content navigable, which is either a navigable or null. It is initially null.

The container of a navigable navigable is the navigable container whose content navigable is navigable, or null if there is no such element.

The container document of a navigable navigable is the result of running these steps:

1. If navigable's container is null, then return null.
2. Return navigable's container's node document.

    Note
    This is equal to navigable's container's shadow-including root as navigable's container has to be connected.

The container document of a Document document is the result of running these steps:

1. If document's node navigable is null, then return null.
2. Return document's node navigable's container document.

A navigable navigable is a child navigable of another navigable potentialParent when navigable's parent is potentialParent. We can also just say that a navigable is a child navigable, which means that its parent is non-null.

    Note
    All child navigables are the content navigable of their container.

The content document of a navigable container container is the result of running these steps:

1. If container's content navigable is null, then return null.
2. Let document be container's content navigable's active document.
3. If document's origin and container's node document's origin are not same origin-domain, then return null.

The content window of a navigable container container is the result of running these steps:

1. If container's content navigable is null, then return null.
2. Return container's content navigable's active WindowProxy's object.

To create a new child navigable, given an element element:

1. Let parentNavigable be element's node navigable.
2. Let group be element's node document's browsing context's top-level browsing context's group.
3. Let browsingContext and document be the result of creating a new browsing context and document given element's node document, element, and group.
4. Let targetName be null.
5. If element has a name content attribute, then set targetName to the value of that attribute.
6. Let documentState be a new document state, with

   document
   initiator origin
   document's origin
Let navigable be a new navigable.

Initialize the navigable navigable given documentState and parentNavigable.

Set element's content navigable to navigable.

Let historyEntry be navigable's active session history entry.

Let traversable be parentNavigable's traversable navigable.

Append the following session history traversal steps to traversable:

1. Let parentDocState be parentNavigable's active session history entry's document state.
2. Let parentNavigableEntries be the result of getting session history entries for parentNavigable.
3. Let targetStepSHE be the first session history entry in parentNavigableEntries whose document state equals parentDocState.
4. Set historyEntry's step to targetStepSHE's step.
5. Let nestedHistory be a new nested history whose id is navigable's id and entries list is « historyEntry ».
6. Append nestedHistory to parentDocState's nested histories.
7. Update for navigable creation/destruction given traversable.

A useful method for visualizing sequences of documents, and in particular navigables and their session history entries, is the Jake diagram. A typical Jake diagram is the following:

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>top</td>
<td>/t-a</td>
<td>/t-a#foo</td>
<td>/t-b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>frames[0]</td>
<td>/i-0-a</td>
<td>/i-0-b</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>frames[1]</td>
<td>/i-1-a</td>
<td>/i-1-b</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Here, each numbered column denotes a possible value for the traversable's session history step. Each labeled row depicts a navigable, as it transitions between different URLs and documents. The first, labeled top, being the top-level traversable, and the others being child navigables. The documents are given by the background color of each cell, with a new background color indicating a new document in that navigable. The URLs are given by the text content of the cells; usually they are given as relative URLs for brevity, unless a cross-origin case is specifically under investigation. A given navigable might not exist at a given step, in which case the corresponding cells are empty. The bold-italic step number depicts the current session history step of the traversable, and all cells with bold-italic URLs represent the current session history entry for that row's navigable.

Thus, the above Jake diagram depicts the following sequence of events:

0. A top-level traversable is created, starting a the URL /t-a, with two child navigables starting at /i-0-a and /i-1-a respectively.
1. The first child navigable is navigated to another document, with URL /i-0-b.
2. The second child navigable is navigated to another document, with URL /i-1-b.
3. The top-level traversable is navigated to the same document, updating its URL to /t-a#foo.
4. The top-level traversable is navigated to another document, with URL /t-b. (Notice how this document, of course, does not carry over the old document's child navigables.)
5. The traversable was traversed by a delta of \(-3\), back to step 1.

Jake diagrams are a powerful tool for visualizing the interactions of multiple navigables, navigations, and traversals. They cannot capture every possible interaction — for example, they only work with a single level of nesting — but we will have occasion to use them to illustrate several complex situations throughout this standard.

**Note**

Jake diagrams are named after their creator, the inimitable Jake Archibald.

### 7.3.1.5 Related navigable collections

It is often helpful in this standard’s algorithms to look at collections of navigables starting at a given Document. This section contains a curated set of algorithms for collecting those navigables.

**Note**

The return values of these algorithms are ordered so that parents appears before their children. Callers rely on this ordering.

**Note**

Starting with a Document, rather than a navigable, is generally better because it makes the caller cognizant of whether they are starting with a fully active Document or not. Although non-fully active Document’s do have ancestor and descendant navigables, they often behave as if they don’t (e.g., in the window.parent getter).

The **ancestor navigables** of a Document document are given by these steps:

1. Let navigable be document’s node navigable’s parent.
2. Let ancestors be an empty list.
3. While navigable is not null:
   1. Prepend navigable to ancestors.
   2. Set navigable to navigable’s parent.
4. Return ancestors.

The **inclusive ancestor navigables** of a Document document are given by these steps:

1. Let navigables be document’s ancestor navigables.
2. Append document’s node navigable to navigables.
3. Return navigables.

The **descendant navigables** of a Document document are given by these steps:

1. Let navigables be new list.
2. Let navigableContainers be a list of all shadow-including descendants of document that are navigable containers, in shadow-including tree order.
3. For each navigableContainer of navigableContainers:
   1. If navigableContainer’s content navigable is null, then continue.
   2. Extend navigables with navigableContainer’s content navigable’s active document’s inclusive descendant navigables.
4. Return navigables.

The **inclusive descendant navigables** of a Document document are given by these steps:

1. Let navigables be « document’s node navigable ».
2. Extend navigables with document's descendant navigables.

3. Return navigables.

**Note**

These descendant-collecting algorithms are described as looking at the DOM tree of descendant Document objects. In reality, this is often not feasible since the DOM tree can be in another process from the caller of the algorithm. Instead, implementations generally replicate the appropriate trees across processes.

The document-tree child navigables of a Document document are given by these steps:

1. If document's node navigable is null, then return the empty list.
2. Let navigables be new list.
3. Let navigableContainers be a list of all descendants of document that are navigable containers, in tree order.
4. For each navigableContainer of navigableContainers:
   1. If navigableContainer's content navigable is null, then continue.
   2. Append navigableContainer's content navigable to navigables.
5. Return navigables.

### 7.3.1.6 Navigable destruction

To destroy a child navigable given a navigable container container:

1. Let navigable be container's content navigable.
2. If navigable is null, then return.
3. Set container's content navigable to null.
4. Inform the navigation API about child navigable destruction given navigable.
6. Let parentDocState be container's node navigable's active session history entry's document state.
7. Remove the nested history from parentDocState's nested histories whose id equals navigable's id.
8. Let traversable be container's node navigable's traversable navigable.
9. Append the following session history traversal steps to traversable:
   1. Update for navigable creation/destruction given traversable.

To destroy a top-level traversable given a top-level traversable traversable:

1. Let browsingContext be traversable's active browsing context.
2. For each historyEntry in traversable's session history entries in what order?
   1. Let document be historyEntry's document.
   2. If document is not null, then destroy a document and its descendants given document.
3. Remove browsingContext.
4. Remove traversable from the user interface (e.g., close or hide its tab in a tabbed browser).
5. Remove traversable from the user agent's top-level traversable set.

User agents may destroy a top-level traversable at any time (typically, in response to user requests).
To close a top-level traversable `traversable`:

1. If `traversable`'s `is closing` is true, then return.
2. Let `toUnload` be `traversable`'s `active document`'s inclusive descendant navigables.
3. If the result of checking if unloading is canceled for `toUnload` is true, then return.
4. Append the following session history traversal steps to `traversable`:
   1. Let `afterAllUnloads` be an algorithm step which destroys `traversable`.
   2. Unload a document and its descendants given `traversable`'s `active document`, null, and `afterAllUnloads`.

7.3.1.7 Navigable target names

Navigables can be given target names, which are strings allowing certain APIs (such as `window.open()` or the `a` element's `target` attribute) to target `navigations` at that navigable.

A valid navigable target name is any string with at least one character that does not contain both an ASCII tab or newline and a U+003C (<), and it does not start with a U+005F (_). (Names starting with a U+005F (_) are reserved for special keywords.)

A valid navigable target name or keyword is any string that is either a valid navigable target name or that is an ASCII case-insensitive match for one of: `_blank`, `_self`, `_parent`, or `_top`.

These values have different meanings based on whether the page is sandboxed or not, as summarized in the following (non-normative) table. In this table, "current" means the navigable that the link or script is in, "parent" means the parent of the navigable that the link or script is in, "top" means the top-level traversable of the navigable that the link or script is in, "new" means a new traversable navigable with a null parent (which may use an auxiliary browsing context, subject to various user preferences and user agent policies), "none" means that nothing will happen, and "maybe new" means the same as "new" if the "allow-popups" keyword is also specified on the sandbox attribute (or if the user overrode the sandboxing), and the same as "none" otherwise.

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Ordinary effect</th>
<th>Effect in an iframe with...</th>
</tr>
</thead>
<tbody>
<tr>
<td>none specified, for links and form submissions</td>
<td>current</td>
<td>current</td>
</tr>
<tr>
<td>empty string</td>
<td>current</td>
<td>current</td>
</tr>
<tr>
<td><code>_blank</code></td>
<td>new</td>
<td>maybe new</td>
</tr>
<tr>
<td><code>_self</code></td>
<td>current</td>
<td>current</td>
</tr>
<tr>
<td><code>_parent if there isn’t a parent</code></td>
<td>current</td>
<td>current</td>
</tr>
<tr>
<td><code>_parent if parent is also top</code></td>
<td>parent/top</td>
<td>none</td>
</tr>
<tr>
<td><code>_parent if there is one and it’s not top</code></td>
<td>parent</td>
<td>none</td>
</tr>
<tr>
<td><code>top if top is current</code></td>
<td>current</td>
<td>current</td>
</tr>
<tr>
<td><code>top if top is not current</code></td>
<td>top</td>
<td>none</td>
</tr>
<tr>
<td>name that doesn’t exist</td>
<td>new</td>
<td>maybe new</td>
</tr>
<tr>
<td>name that exists and is a descendant</td>
<td>specified descendant</td>
<td>specified descendant</td>
</tr>
<tr>
<td>name that exists and is current</td>
<td>current</td>
<td>current</td>
</tr>
<tr>
<td>name that exists and is an ancestor that is top</td>
<td>specified ancestor</td>
<td>none</td>
</tr>
<tr>
<td>name that exists and is an ancestor that is not top</td>
<td>specified ancestor</td>
<td>none</td>
</tr>
<tr>
<td>other name that exists with common top</td>
<td>specified</td>
<td>none</td>
</tr>
<tr>
<td>name that exists with different top, if familiar and one permitted sandboxed navigator</td>
<td>specified</td>
<td>specified</td>
</tr>
<tr>
<td>name that exists with different top, if familiar but not one permitted sandboxed navigator</td>
<td>specified</td>
<td>none</td>
</tr>
<tr>
<td>name that exists with different top, not familiar</td>
<td>new</td>
<td>maybe new</td>
</tr>
</tbody>
</table>

Most of the restrictions on sandboxed browsing contexts are applied by other algorithms, e.g. the navigation algorithm, not the rules for choosing a navigable given below.
The rules for choosing a navigable, given a string \textit{name}, a \texttt{currentNavigable}, and a boolean \texttt{noopener} are as follows:

1. Let \textit{chosen} be null.
2. Let \textit{windowType} be "existing or none".
3. Let \textit{sandboxingFlagSet} be \texttt{currentNavigable}'s \texttt{active document}'s active sandboxing flag set.
4. If \textit{name} is the empty string or an ASCII case-insensitive match for "\_self", then set \textit{chosen} to \texttt{currentNavigable}.
5. Otherwise, if \textit{name} is an ASCII case-insensitive match for "\_parent", set \textit{chosen} to \texttt{currentNavigable}'s parent, if any, and \texttt{currentNavigable} otherwise.
6. Otherwise, if \textit{name} is an ASCII case-insensitive match for "\_top", set \textit{chosen} to \texttt{currentNavigable}'s traversable navigable.
7. Otherwise, if \textit{name} is not an ASCII case-insensitive match for "\_blank", there exists a \texttt{navigable} whose target name is the same as \textit{name}, \texttt{currentNavigable}'s active browsing context is familiar with that \texttt{navigable}'s active browsing context, and the user agent determines that the two browsing contexts are related enough that it is ok if they reach each other, set \textit{chosen} to that navigable. If there are multiple matching \texttt{navigables}, the user agent should pick one in some arbitrary consistent manner, such as the most recently opened, most recently focused, or more closely related, and set \textit{chosen} to it.

This will be made more precise in issue #313.

8. Otherwise, a new top-level traversable is being requested, and what happens depends on the user agent's configuration and abilities — it is determined by the rules given for the first applicable option from the following list:

\begin{itemize}
\item \textbf{If} \textit{currentNavigable}'s \texttt{active window} does not have transient activation and the user agent has been configured to not show popups (i.e., the user agent has a "popup blocker" enabled)
\textit{The user agent may inform the user that a popup has been blocked.}

\item \textbf{If} \textit{sandboxingFlagSet} has the sandboxed auxiliary navigation browsing context flag set
\textit{The user agent may report to a developer console that a popup has been blocked.}

\item \textbf{If} the user agent has been configured such that in this instance it will create a new top-level traversable
\begin{itemize}
\item 1. Set \textit{windowType} to "new and unrestricted".
\item 2. Let \textit{currentDocument} be \texttt{currentNavigable}'s \texttt{active document}.
\item 3. If \textit{currentDocument}'s cross-origin opener policy's value is "same-origin" or "same-origin-plus-COEP", and \textit{currentDocument}'s origin is not same origin with \textit{currentDocument}'s relevant settings object's top-level origin, then:
\begin{itemize}
\item 1. Set \textit{noopener} to true.
\item 2. Set \textit{name} to "\_blank".
\item 3. Set \textit{windowType} to "new with no opener".
\end{itemize}
\end{itemize}

\textbf{Note}
\begin{itemize}
\item In the presence of a cross-origin opener policy, nested documents that are cross-origin with their top-level browsing context's active document always set \textit{noopener} to true.
\end{itemize}

\item 4. Let \textit{chosen} be null.
\item 5. Let \textit{targetName} be the empty string.
\item 6. If \textit{name} is not an ASCII case-insensitive match for "\_blank", then set \textit{targetName} to \textit{name}.
\item 7. If \textit{noopener} is true, then set \textit{chosen} to the result of \textbf{creating a new top-level traversable} given null and \textit{targetName}.
\item 8. Otherwise:
\begin{itemize}
\item 1. Set \textit{chosen} to the result of \textbf{creating a new top-level traversable} given \texttt{currentNavigable}'s active browsing context and \textit{targetName}.
\end{itemize}
\end{itemize}
2. If `sandboxingFlagSet`'s `sandboxed navigation browsing context flag` is set, then set `chosen`'s `active browsing context`'s one permitted sandboxed navigator to `currentNavigable`'s `active browsing context`.

9. If `sandboxingFlagSet`'s `sandbox propagates to auxiliary browsing contexts flag` is set, then all the flags that are set in `sandboxingFlagSet` must be set in `chosen`'s `active browsing context`'s popup sandboxing flag set.

If the user agent has been configured such that in this instance it will choose `currentNavigable`:

- Set `chosen` to `currentNavigable`.

- If the user agent has been configured such that in this instance it will not find a navigable:
  
  Do nothing.

Note

If the newly created `navigable` chosen is immediately `navigated`, then the navigation will be done as a "replace" navigation.

7.3.2 Browsing contexts

A browsing context is a programmatic representation of a series of documents, multiple of which can live within a single navigable. Each browsing context has a corresponding WindowProxy object, as well as the following:

- An opener browsing context, a browsing context or null, initially null.

- An opener origin at creation, an origin or null, initially null.

- An is popup boolean, initially false.

Note

The only mandatory impact in this specification of is popup is on the visible getter of the relevant BarProp objects. However, user agents might also use it for user interface considerations.

- An is auxiliary boolean, initially false.

- An initial URL, a URL or null, initially null.

- A virtual browsing context group ID integer, initially 0. This is used by cross-origin opener policy reporting, to keep track of the browsing context group switches that would have happened if the report-only policy had been enforced.

A browsing context's active window is its WindowProxy object's [[Window]] internal slot value. A browsing context's active document is its active window's associated Document.

A browsing context's top-level traversable is its active document's node navigable's top-level traversable.

A browsing context whose is auxiliary is true is known as an auxiliary browsing context. Auxiliary browsing contexts are always top-level browsing contexts.

It's unclear whether a separate is auxiliary concept is necessary. In issue #5680, it is indicated that we may be able to simplify this by using whether or not the opener browsing context is null.

⚠ Warning!

Modern specifications should avoid using the browsing context concept in most cases, unless they are dealing with the subtleties of browsing context group switches and agent cluster allocation. Instead, the Document concept...
A Document's browsing context is a browsing context or null, initially null.

A Document does not necessarily have a non-null browsing context. In particular, data mining tools are likely to never instantiate browsing contexts. A Document created using an API such as createDocument() never has a non-null browsing context. And the Document originally created for an iframe element, which has since been removed from the document, has no associated browsing context, since that browsing context was nulled out.

In general, there is a 1-to-1 mapping from the Window object to the Document object, as long as the Document object has a non-null browsing context. There is one exception. A Window can be reused for the presentation of a second Document in the same browsing context, such that the mapping is then 1-to-2. This occurs when a browsing context is navigated to another, which will be done with replacement.

### 7.3.2.1 Creating browsing contexts

To create a new browsing context and document, given null or a Document object creator, null or an element embedder, and a browsing context group group:

1. Let `browsingContext` be a new browsing context.
2. Let `unsafeContextCreationTime` be the unsafe shared current time.
3. Let `creatorOrigin` be null.
4. Let `creatorBaseURL` be null.
5. If `creator` is non-null, then:
   1. Set `creatorOrigin` to `creator`'s origin.
   2. Set `creatorBaseURL` to `creator`'s document base URL.
   3. Set `browsingContext`'s virtual browsing context group ID to `creator`'s browsing context's top-level browsing context group ID.
6. Let `sandboxFlags` be the result of determining the creation sandboxing flags given `browsingContext` and `embedder`.
7. Let `origin` be the result of determining the origin given about:blank, `sandboxFlags`, and `creatorOrigin`.
8. Let `permissionsPolicy` be the result of creating a permissions policy given `embedder` and `origin`.
9. Let `agent` be the result of obtaining a similar-origin window agent given `origin`, `group`, and false.
10. Let `realm execution context` be the result of creating a new realm given `agent` and the following customizations:
    - For the global object, create a new Window object.
    - For the global this binding, use `browsingContext`'s WindowProxy object.
11. Let `topLevelCreationURL` be about:blank if `embedder` is null; otherwise `embedder`'s relevant settings object's top-level creation URL.
12. Let `topLevelOrigin` be origin if `embedder` is null; otherwise `embedder`'s relevant settings object's top-level origin.
13. Set up a window environment settings object with about:blank, `document`'s realm execution context, null, `topLevelCreationURL`, and `topLevelOrigin`.
14. Let `loadTimingInfo` be a new document load timing info, with its navigation start time, set to the result of calling coarsen time with `unsafeContextCreationTime` and the new environment settings object's cross-origin isolated.
15. Let `document` be a new `Document`, with:
   
   - **type**: "html"
   - **content type**: "text/html"
   - **mode**: "quirks"
   - **origin**: origin
   - **browsing context**: browsingContext
   - **permissions policy**: permissionsPolicy
   - **active sandboxing flag set**: sandboxFlags
   - **load timing info**: loadTimingInfo
   - **is initial**: `about:blank`
   - **about base URL**: creatorBaseURL
   - **allow declarative shadow roots**: true

16. If `creator` is non-null, then:
   1. Set `document`'s `referrer` to the serialization of creator's `URL`.
   2. Set `document`'s `policy container` to a clone of creator's `policy container`.
   3. If creator's `origin` is same origin with creator's `relevant settings object`'s `top-level origin`, then set `document`'s `cross-origin opener policy` to creator's `browsing context`'s `top-level browsing context`'s `active document`'s `cross-origin opener policy`.

17. Assert: `document`'s `URL` and `document`'s `relevant settings object`'s `creation URL` are `about:blank`.


**To create a new top-level browsing context and document:**

1. Let `group` and `document` be the result of creating a new browsing context group and document.

2. Return `group`'s `browsing context set`[0] and `document`.

**To create a new auxiliary browsing context and document,** given a `browsing context` opener:

1. Let `openerTopLevelBrowsingContext` be opener's `top-level traversable`'s `active browsing context`.

2. Let `group` be `openerTopLevelBrowsingContext`'s `group`.

3. Assert: `group` is non-null, as navigating invokes this directly.

4. Set `browsingContext` and `document` be the result of creating a new browsing context and document with opener's `active document` null, and `group`.

5. Set `browsingContext`'s `is auxiliary` to true.

6. Append `browsingContext` to `group`. 

---

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7. Set `browsingContext`'s opener browsing context to opener.

8. Set `browsingContext`'s virtual browsing context group ID to openerTopLevelBrowsingContext's virtual browsing context group ID.

9. Set `browsingContext`'s opener origin at creation to opener's active document's origin.


To determine the origin, given a URL, a sandboxing flag set sandboxFlags, and an origin-or-null sourceOrigin:

1. If sandboxFlags has its sandboxed origin browsing context flag set, then return a new opaque origin.
2. If url is null, then return a new opaque origin.
3. If url is `about:srcdoc`, then:
   1. Assert: sourceOrigin is non-null.
   2. Return sourceOrigin.
4. If url matches `about:blank` and sourceOrigin is non-null, then return sourceOrigin.
5. Return url's origin.

Note: The cases that return sourceOrigin result in two Documents that end up with the same underlying origin, meaning that `document.domain` affects both.

### 7.3.2.2 Related browsing contexts

A browsing context potentialDescendant is said to be an ancestor of a browsing context potentialAncestor if the following algorithm returns true:

1. Let potentialDescendantDocument be potentialDescendant's active document.
2. If potentialDescendantDocument is not fully active, then return false.
3. Let ancestorBCs be the list obtained by taking the browsing context of the active document of each member of potentialDescendantDocument's ancestor navigables.
4. If ancestorBCs contains potentialAncestor, then return true.
5. Return false.

A top-level browsing context is a browsing context whose active document's node navigable is a traversable navigable.

Note: It is not required to be a top-level traversable.

The top-level browsing context of a browsing context start is the result of the following algorithm:

1. If start's active document is not fully active, then return null.
2. Let navigable be start's active document's node navigable.
3. While navigable's parent is not null, set navigable to navigable's parent.
4. Return navigable's active browsing context.

⚠ Warning! The terms ancestor browsing context and top-level browsing context are rarely useful, since browsing...
A browsing context\(^{987}\) is familiar with a second browsing context\(^{987}\) if the following algorithm returns true:

1. If A’s active document\(^{987}\)’s origin is same origin\(^{981}\) with B’s active document\(^{987}\)’s origin, then return true.
2. If A’s top-level browsing context\(^{990}\) is B, then return true.
3. If B is an auxiliary browsing context\(^{987}\) and A is familiar with\(^{991}\) B’s opener browsing context\(^{987}\), then return true.
4. If there exists an ancestor browsing context\(^{990}\) of B whose active document\(^{987}\) has the same\(^{981}\) origin as the active document\(^{987}\) of A, then return true.
5. Return false.

### 7.3.2.3 Groupings of browsing contexts\(^ {999}\)

A top-level browsing context\(^{990}\) has an associated group (null or a browsing context group\(^{991}\)). It is initially null.

A user agent holds a browsing context group set (a set of browsing context groups\(^{991}\)).

A browsing context group holds a browsing context set (a set of top-level browsing contexts\(^{990}\)).

#### Note

A top-level browsing context\(^{990}\) is added to the group\(^{991}\) when the group is created\(^{992}\). All subsequent top-level browsing contexts\(^{990}\) added to the group\(^{991}\) will be auxiliary browsing contexts\(^{987}\).

A browsing context group\(^{991}\) has an associated agent cluster map (a weak map of agent cluster keys\(^{1061}\) to agent clusters). User agents are responsible for collecting agent clusters when it is deemed that nothing can access them anymore.

A browsing context group\(^{991}\) has an associated historical agent cluster key map, which is a map of origins\(^{980}\) to agent cluster keys\(^{1061}\). This map is used to ensure the consistency of the origin-keyed agent clusters\(^{894}\) feature by recording what agent cluster keys were previously used for a given origin.

#### Note

The historical agent cluster key map\(^{991}\) only ever gains entries over the lifetime of the browsing context group.

A browsing context group\(^{991}\) has a cross-origin isolation mode, which is a cross-origin isolation mode\(^{991}\). It is initially “none\(^{991}\)”.

A cross-origin isolation mode is one of three possible values: “none”, “logical”, or “concrete”.

#### Note

“logical\(^{991}\)” and “concrete\(^{991}\)” are similar. They are both used for browsing context groups\(^{992}\) where:

- every top-level Document\(^{128}\) has `Cross-Origin-Opener-Policy`\(^{986}\): same-origin\(^{985}\), and
- every Document\(^{128}\) has a `Cross-Origin-Embedder-Policy`\(^{984}\) header whose value is compatible with cross-origin isolation\(^{984}\).

On some platforms, it is difficult to provide the security properties required to grant safe access to the APIs gated by the cross-
To create a new browsing context group and document:

1. Let group be a new browsing context group.
2. Append group to the user agent's browsing context group set.
3. Let browsingContext and document be the result of creating a new browsing context and document with null, null, and group.
4. Append browsingContext to group.
5. Return group and document.

To append a top-level browsing context browsingContext to a browsing context group group:

1. Append browsingContext to group's browsing context set.
2. Set browsingContext's group to group.

To remove a top-level browsing context browsingContext:

1. Assert: browsingContext's group is non-null.
2. Let group be browsingContext's group.
3. Set browsingContext's group to null.
4. Remove browsingContext from group's browsing context set.
5. If group's browsing context set is empty, then remove group from the user agent's browsing context group set.

A Document d is said to be fully active when d is the active document of a navigable, and either navigable is a top-level traversable or navigable's container document is fully active.

Because they are associated with an element, child navigables are always tied to a specific Document, their container document, in their parent navigable. User agents must not allow the user to interact with child navigables whose container documents are not themselves fully active.

Example

The following example illustrates how a Document can be the active document of its node navigable, while not being fully active. Here a.html is loaded into a browser window, b-1.html starts out loaded into an iframe as shown, and b-2.html and c.html are omitted (they can simply be an empty document).

<!DOCTYPE html>
<html>
<head></head>
<body>

<!-- a.html -->
<!DOCTYPE html>
<html>
<head></head>
<body>

</body>
</html>

<!DOCTYPE html>
<html>
<head></head>
<body>

</body>
</html>

</body>
</html>
Welcome to the dragon's maw. Navigation, session history, and the traversal through that session history are some of the most complex parts of this standard.

The basic concept may not seem so difficult:

- The user is looking at a navigable that is presenting its active document. They navigate it to another URL.
- The browser fetches the given URL from the network, using it to populate a new session history entry with a newly-created Document.
- The browser updates the navigable's active session history entry to the newly-populated one, and thus updates the active document that it is showing to the user.
- At some point later, the user presses the browser back button to go back to the previous session history entry.
- The browser looks at the URL stored in that session history entry, and uses it to re-fetch and populate that entry's document.
- The browser again updates the navigable's active session history entry.

You can see some of the intertwined complexity peeking through here, in how traversal can cause a navigation (i.e., a network fetch to a stored URL), and how a navigation necessarily needs to interface with the session history list to ensure that when it finishes the user is looking at the right thing. But the real problems come in with the various edge cases and interacting web platform features:

- Child navigables (e.g., those contained in iframes) can also navigate and traverse, but those navigations need to be linearized into a single session history list since the user only has a single back/forward interface for the entire traversable navigable (e.g., browser tab).
- Since the user can traverse back more than a single step in the session history (e.g., by holding down their back button), they can end up traversing multiple navigables at the same time when child navigables are involved. This needs to be

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7.4 Navigation and session history

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- At some point later, the user presses the browser back button to go back to the previous session history entry.
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- Child navigables (e.g., those contained in iframes) can also navigate and traverse, but those navigations need to be linearized into a single session history list since the user only has a single back/forward interface for the entire traversable navigable (e.g., browser tab).
- Since the user can traverse back more than a single step in the session history (e.g., by holding down their back button), they can end up traversing multiple navigables at the same time when child navigables are involved. This needs to be
synchronized across all of the involved navigables, which might involve multiple event loops or even agent clusters.

- During navigation, servers can respond with 204 or 205 status codes or with `Content-Disposition: attachment` headers, which cause navigation to abort and the navigable to stay on its original active document. (This is much worse if it happens during a traversal-initiated navigation!)

- Various other HTTP headers, such as `Location`, `Refresh`, `X-Frame-Options`, and those for Content Security Policy, contribute to either the fetching process, or the Document-creation process, or both. The `Cross-Origin-Opener-Policy` header even contributes to the browsing context selection and creation process!

- Some navigations (namely fragment navigations and single-page app navigations) are synchronous, meaning that JavaScript code expects to observe the navigation's results instantly. This then needs to be synchronized with the view of the session history that all other navigables in the tree see, which can be subject to race conditions and necessitate resolving conflicting views of the session history.

- The platform has accumulated various exciting navigation-related features that need special-casing, such as javascript URLs, srcdoc iframe s, and the beforeunload event.

In what follows, we have attempted to guide the reader through these complexities by appropriately cordoning them off into labeled sections and algorithms, and giving appropriate words of introduction where possible. Nevertheless, if you wish to truly understand navigation and session history, the usual advice will be invaluable.

### 7.4.1 Session history

#### 7.4.1.1 Session history entries

A session history entry is a struct with the following items:

- **step**, a non-negative integer or "pending", initially "pending".
- **URL**, a URL
- **document state**, a document state.
- **classic history API state**, which is serialized state, initially StructuredSerializeForStorage(null).
- **navigation API state**, which is a serialized state, initially StructuredSerializeForStorage(undefined).
- **navigation API key**, which is a string, initially set to the result of generating a random UUID.
- **navigation API ID**, which is a string, initially set to the result of generating a random UUID.
- **scroll restoration mode**, a scroll restoration mode, initially "auto".
- **scroll position data**, which is scroll position data for the document's restorable scrollable regions.
- **persisted user state**, which is implementation-defined, initially null

Example

For example, some user agents might want to persist the values of form controls.

Note

User agents that persist the value of form controls are encouraged to also persist their directionality (the value of the element’s `dir` attribute). This prevents values from being displayed incorrectly after a history traversal when the user had originally entered the values with an explicit, non-default directionality.

To get a session history entry’s document, return its document state’s document.

**Serialized state** is a serialization (via StructuredSerializeForStorage) of an object representing a user interface state. We sometimes informally refer to “state objects”, which are the objects representing user interface state supplied by the author, or alternately the objects created by deserializing (via StructuredDeserialize) serialized state.

Pages can add serialized state to the session history. These are then deserialized and returned to the script when the

994
user (or script) goes back in the history, thus enabling authors to use the "navigation" metaphor even in one-page applications.

**Note**

Serialized state\textsuperscript{5994} is intended to be used for two main purposes: first, storing a preparsed description of the state in the URL so that in the simple case an author doesn't have to do the parsing (though one would still need the parsing for handling URLs passed around by users, so it's only a minor optimization). Second, so that the author can store state that one wouldn't store in the URL because it only applies to the current Document\textsuperscript{5128} instance and it would have to be reconstructed if a new Document\textsuperscript{5128} were opened.

An example of the latter would be something like keeping track of the precise coordinate from which a popup div\textsuperscript{253} was made to animate, so that if the user goes back, it can be made to animate to the same location. Or alternatively, it could be used to keep a pointer into a cache of data that would be fetched from the server based on the information in the URL, so that when going back and forward, the information doesn't have to be fetched again.

A scroll restoration mode indicates whether the user agent should restore the persisted scroll position (if any) when traversing to an entry\textsuperscript{5994}. A scroll restoration mode is one of the following:

"auto"

The user agent is responsible for restoring the scroll position upon navigation.

"manual"

The page is responsible for restoring the scroll position and the user agent does not attempt to do so automatically

### 7.4.1.2 Document state

Document state holds state inside a session history entry\textsuperscript{5994} regarding how to present and, if necessary, recreate, a Document\textsuperscript{5128}. It has:

- A document, a Document\textsuperscript{5128} or null, initially null.

- A history policy container, a policy container\textsuperscript{5009} or null, initially null.

- A request referrer, which is "no-referrer", "client", or a URL, initially "client".

- A request referrer policy, which is a referrer policy, initially the default referrer policy.

- An initiator origin, which is an origin\textsuperscript{5990} or null, initially null.

- An origin, which is an origin\textsuperscript{5990} or null, initially null.

**Note**

When a history entry is active\textsuperscript{5978}, it has a Document\textsuperscript{5128} in its document state\textsuperscript{5994}. However, when a Document\textsuperscript{5128} is not fully active\textsuperscript{5992}, it's possible for it to be destroyed\textsuperscript{51054} to free resources. In such cases, this document\textsuperscript{5995} item will be nulled out. The URL\textsuperscript{5994} and other data in the session history entry\textsuperscript{5994} and document state\textsuperscript{5994} is then used to bring a new Document\textsuperscript{5128} into being to take the place of the original, in the case where the user agent finds itself having to traverse to the entry.

If the Document\textsuperscript{5128} is not destroyed\textsuperscript{51054}, then during history traversal\textsuperscript{51016}, it can be reactivated\textsuperscript{51040}. The cache in which browsers store such Document\textsuperscript{5128} s is often called a back-forward cache, or bfcache (or perhaps “blazingly fast” cache).

**Note**

The request referrer policy\textsuperscript{5995} is distinct from the history policy container\textsuperscript{5995}’s referrer policy\textsuperscript{5009}. The former is used for fetches of this document, whereas the latter controls fetches by this document.

This is the origin that we set "about:"-schemed Document\textsuperscript{5128} s origin to. We store it here because it is also used when restoring these Document\textsuperscript{5128} s during traversal, since they are reconstructed locally without visiting the network. It is also used to compare the origin before and after the session history entry\textsuperscript{5994} is repopulated\textsuperscript{51018}. If the origins change, the navigable target name\textsuperscript{5996} is cleared.
• An **about base URL**, which is a [URL](#) or null, initially null.

  **Note**
  This will be populated only for "about:"-schemed Document[s] and will be the fallback base URL for those Document[s]. It is a snapshot of the initiator Document's document base URL.

• **Nested histories**, a list of nested histories, initially an empty list.

• A **resource**, a string, POST resource or null, initially null.

  **Note**
  A string is treated as HTML. It’s used to store the source of an iframe srcdoc document.

• A **reload pending** boolean, initially false.

• An **ever populated** boolean, initially false.

• A **navigable target name** string, initially the empty string.

• A **not restored reasons**, a not restored reasons or null, initially null.

User agents may destroy a document and its descendants given the documents of document states with non-null documents, as long as the Document is not fully active.

Apart from that restriction, this standard does not specify when user agents should destroy the document stored in a document state, versus keeping it cached.

A **POST resource** has:

• A **request body**, a byte sequence or failure.

  This is only ever accessed in parallel, so it doesn’t need to be stored in memory. However, it must return the same byte sequence each time. If this isn’t possible due to resources changing on disk, or if resources can no longer be accessed, then this must be set to failure.

• A **request content-type**, which is `application/x-www-form-urlencoded`, `multipart/form-data`, or `text/plain`.

A **nested history** has:

• An **id**, a unique internal value.

  **Note**
  This is used to associate the nested history with a navigable.

• **Entries**, a list of session history entries.

  This will later contain ways to identify a child navigable across reloads.

Several contiguous entries in a session history can share the same document state. This can occur when the initial entry is reached via normal navigation, and the following entry is added via `history.pushState()` . Or it can occur via navigation to a fragment.

**Note**
All entries that share the same document state (and that are therefore merely different states of one particular document) are contiguous by construction.

A **Document** has a latest entry, a session history entry or null.
To maintain a single source of truth, all modifications to a traversable navigable's session history entries need to be synchronized. This is especially important due to how session history is influenced by all of the descendant navigables, and thus by multiple event loops. To accomplish this, we use the session history traversal parallel queue structure.

A session history traversal parallel queue is very similar to a parallel queue. It has an algorithm set, an ordered set. The items in a session history traversal parallel queue's algorithm set are either algorithm steps, or synchronous navigation steps, which are a particular brand of algorithm steps involving a target navigable (a navigable).

To append session history traversal steps to a traversable navigable's traversable given algorithm steps steps, append steps to traversable's session history traversal queue's algorithm set.

To append session history synchronous navigation steps involving a navigable targetNavigable to a traversable navigable traversable given algorithm steps steps, append steps as synchronous navigation steps targeting targetNavigable to traversable's session history traversal queue's algorithm set.

To start a new session history traversal parallel queue:

1. Let sessionHistoryTraversalQueue be a new session history traversal parallel queue.
2. Run the following steps in parallel:
   1. While true:
      1. If sessionHistoryTraversalQueue's algorithm set is empty, then continue.
      2. Let steps be the result of dequeuing from sessionHistoryTraversalQueue's algorithm set.
      3. Run steps.
   3. Return sessionHistoryTraversalQueue.

Synchronous navigation steps are tagged in the algorithm set to allow them to conditionally "jump the queue". This is handled within apply the history step.

Example

Imagine the joint session history depicted by this Jake diagram:

```
0 1 2
```

And the following code runs at the top level:

```javascript
history.back();
location.href = '#foo';
```

The desired result is:

```
0 1 2
```

This isn't straightforward, as the sync navigation wins the race in terms of being observable, whereas the traversal wins the race in terms of queuing steps on the session history traversal parallel queue. To achieve this result, the following happens:
1. `history.back()` appends steps intended to traverse by a delta of −1.

2. `location.href = '#foo'` synchronously changes the active session history entry to a newly-created one, with the URL `/b#foo`, and appends synchronous steps to notify the central source of truth about that new entry. Note that this does not yet update the current session history entry, current session history step, or the session history entries list; those updates cannot be done synchronously, and instead must be done as part of the queued steps.

3. On the session history traversal parallel queue, the steps queued by `history.back()` run:
   1. The target history step is determined to be 0: the current session history step (i.e., 1) plus the intended delta of −1.
   2. We enter the main apply the history step algorithm.
      
      The entry at step 0, for the `/a` URL, has its document populated.
      
      Meanwhile, the queue is checked for synchronous navigation steps. The steps queued by the `location.href` setter now run, and block the traversal from performing effects beyond document population (such as, unloading documents and switching active history entries) until they are finished. Those steps cause the following to happen:
      1. The entry with URL `/b#foo` is added, with its step determined to be 2: the current session history step (i.e., 1) plus 1.
      2. We fully switch to that newly added entry, including a nested call to apply the history step. This ultimately results in updating the document by dispatching events like hashchange.
      
      Only once that is all complete, and the `/a` history entry has been fully populated with a document, do we move on with applying the history step given the target step of 0.
      
      At this point, the Document with URL `/b#foo` unloads, and we finish moving to our target history step 0, which makes the entry with URL `/a` become the active session history entry and 0 become the current session history step.

Example

Here is another more complex example, involving races between populating two different `iframe`s, and a synchronous navigation once one of those iframes loads. We start with this setup:

```
0 1 2  

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>top</td>
<td>/t</td>
<td></td>
</tr>
<tr>
<td>frames[0]</td>
<td>/i-0-a</td>
<td>/i-0-b</td>
</tr>
<tr>
<td>frames[1]</td>
<td>/i-1-a</td>
<td>/i-1-b</td>
</tr>
</tbody>
</table>
```

and then call `history.go(-2)`. The following then occurs:

1. `history.go(-2)` appends steps intended to traverse by a delta of −2. Once those steps run:
   1. The target step is determined to be 2 + (−2) = 0.
   2. In parallel, the fetches are made to populate the two iframes, fetching `/i-0-a` and `/i-1-a` respectively.
      
      Meanwhile, the queue is checked for synchronous navigation steps. There aren’t any right now.
   3. In the fetch race, the fetch for `/i-0-a` wins. We proceed onward to finish all of apply the history step’s work for how the traversal impacts the frames navigable, including updating its active session history entry to the entry with URL `/i-0-a`.
   4. Before the fetch for `/i-1-a` finishes, we reach the point where scripts may run for the newly-created document in the frames navigable’s active document. Some such script does run:

```
location.href = '#foo'
```
This synchronously changes the frames[0] navigable’s active session history entry entry to a newly-created one, with the URL /i-0-a#foo, and appends synchronous steps to notify the central source of truth about that new entry.

Unlike in the previous example, these synchronous steps do not “jump the queue” and update the traversable before we finish the fetch for /i-1-a. This is because the navigable in question, frames[0], has already been altered as part of the traversal, so we know that with the current session history step being 2, adding the new entry as a step 3 doesn’t make sense.

5. Once the fetch for /i-1-a finally finishes, we proceed to finish updating the frames[1] navigable for the traversal, including updating its active session history entry to the entry with URL /i-1-a.

6. Now that both navigables have finished processing the traversal, we update the current session history step to the target step of 0.

2. Now we can process the steps that were queued for the synchronous navigation:

1. The /i-0-a#foo entry is added, with its step determined to be 1: the current session history step (i.e., 0) plus 1. This also clears existing forward history.

2. We fully switch to that newly added entry, including calling apply the history step. This ultimately results in updating the document by dispatching events like hashchange, as well as updating the current session history step to the target step of 1.

The end result is:

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>top</td>
<td>/t</td>
<td></td>
</tr>
<tr>
<td>frames[0]</td>
<td>/i-0-a; /i-0-a#foo</td>
<td></td>
</tr>
<tr>
<td>frames[1]</td>
<td>/i-1-a</td>
<td></td>
</tr>
</tbody>
</table>

7.4.1.4 Low-level operations on session history

This section contains a miscellaneous grab-bag of operations that we perform throughout the standard when manipulating session history. The best way to get a sense of what they do is to look at their call sites.

To get session history entries of a navigable navigable:

1. Let traversable be navigable's traversable navigable.

2. Assert: this is running within traversable's session history traversal queue.

3. If navigable is traversable, return traversable's session history entries.

4. Let docStates be an empty ordered set of document states.

5. For each entry of traversable's session history entries, append entry's document state to docStates.

6. For each docState of docStates:

   1. For each nestedHistory of docState's nested histories:

      1. If nestedHistory's id equals navigable's id, return nestedHistory's entries.

      2. For each entry of nestedHistory's entries, append entry's document state to docStates.

7. Assert: this step is not reached.

To get session history entries for the navigation API of a navigable navigable given an integer targetStep:

1. Let rawEntries be the result of getting session history entries for navigable.

2. Let entriesForNavigationAPI be a new empty list.
3. Let startingIndex be the index of the session history entry\(^{\text{p994}}\) in rawEntries who has the greatest step\(^{\text{p994}}\) less than or equal to targetStep.

**Note**

See this example\(^{\text{1037}}\) to understand why it's the greatest step less than or equal to targetStep.

4. Append rawEntries[startingIndex] to entriesForNavigationAPI.

5. Let startingOrigin be rawEntries[startingIndex]'s document state\(^{\text{p994}}\)'s origin\(^{\text{p995}}\).

6. Let i be startingIndex − 1.

7. While i > 0:
   1. If rawEntries[i]'s document state\(^{\text{p994}}\)'s origin\(^{\text{p995}}\) is not same origin\(^{\text{p991}}\) with startingOrigin, then break.
   2. Prepend rawEntries[i] to entriesForNavigationAPI.
   3. Set i to i − 1.

8. Set i to startingIndex + 1.

9. While i < rawEntries's size:
   1. If rawEntries[i]'s document state\(^{\text{p994}}\)'s origin\(^{\text{p995}}\) is not same origin\(^{\text{p991}}\) with startingOrigin, then break.
   2. Append rawEntries[i] to entriesForNavigationAPI.
   3. Set i to i + 1.

10. Return entriesForNavigationAPI.

**To clear the forward session history** of a traversable navigable\(^{\text{p979}}\) navigable:

1. Assert: this is running within navigable's session history traversal queue\(^{\text{p979}}\).

2. Let step be the navigable's current session history step\(^{\text{p979}}\).

3. Let entryLists be the ordered set « navigable's session history entries\(^{\text{p979}}\) ».

4. For each entryList of entryLists:
   1. Remove every session history entry\(^{\text{p994}}\) from entryList that has a step\(^{\text{p994}}\) greater than step.
   2. For each entry of entryList:
      1. For each nestedHistory of entry's document state\(^{\text{p994}}\)'s nested histories\(^{\text{p996}}\), append nestedHistory's entries list\(^{\text{p996}}\) to entryLists.

**To get all used history steps** that are part of traversable navigable\(^{\text{p979}}\) traversable:

1. Assert: this is running within traversable's session history traversal queue\(^{\text{p979}}\).

2. Let steps be an empty ordered set of non-negative integers.

3. Let entryLists be the ordered set « traversable's session history entries\(^{\text{p979}}\) ».

4. For each entryList of entryLists:
   1. For each entry of entryList:
      1. Append entry's step\(^{\text{p994}}\) to steps.
      2. For each nestedHistory of entry's document state\(^{\text{p994}}\)'s nested histories\(^{\text{p996}}\), append nestedHistory's entries list\(^{\text{p996}}\) to entryLists.

5. Return steps, sorted.
7.4.2 Navigation

Certain actions cause a navigable to navigate to a new resource.

**Example**

For example, following a hyperlink, form submission, and the `window.open()` and `location.assign()` methods can all cause navigation.

**Note**

Although in this standard the word "navigation" refers specifically to the navigate algorithm, this doesn't always line up with web developer or user perceptions. For example:

- The URL and history update steps are often used during so-called "single-page app navigations" or "same-document navigations", but they do not trigger the navigate algorithm.
- Reloads and traversals are sometimes talked about as a type of navigation, since all three will often attempt to populate the history entry's document and thus could perform navigational fetches. See, e.g., the APIs exposed in Navigation Timing. But they have their own entry point algorithms, separate from the navigate algorithm. [NAVIGATIONTIMING]
- Although fragment navigations are always done through the navigate algorithm, a user might perceive them as more like jumping around a single page, than as a true navigation.

7.4.2.1 Supporting concepts

Before we can jump into the navigation algorithm itself, we need to establish several important structures that it uses.

The source snapshot params struct is used to capture data from a Document initiating a navigation. It is snapshotted at the beginning of a navigation and used throughout the navigation's lifetime. It has the following items:

- **has transient activation**
  - a boolean
- **sandboxing flags**
  - a sandboxing flag set
- **allows downloading**
  - a boolean
- **fetch client**
  - an environment settings object, only to be used as a request client
- **source policy container**
  - a policy container

To snapshot source snapshot params given a Document sourceDocument, return a new source snapshot params with has transient activation, true if sourceDocument's relevant global object has transient activation; otherwise false

sandboxing flags
  - sourceDocument's active sandboxing flag set

allows downloading
  - false if sourceDocument's active sandboxing flag set has the sandboxed downloads browsing context flag set; otherwise true

fetch client
  - sourceDocument's relevant settings object

source policy container
  - sourceDocument's policy container

The target snapshot params struct is used to capture data from a navigable being navigated. Like source snapshot params, it is snapshotted at the beginning of a navigation and used throughout the navigation's lifetime. It has the following items:
**sandboxing flags**

- a sandboxing flag set

To snapshot target snapshot params given a navigable targetNavigable, return a new target snapshot params with sandboxing flags set to the result of determining the creation sandboxing flags given targetNavigable's active browsing context and targetNavigable's container.

Much of the navigation process is concerned with determining how to create a new Document, which ultimately happens in the create and initialize a Document object algorithm. The parameters to that algorithm are tracked via a navigation params struct, which has the following items:

- **id**
  - null or a navigation ID

- **navigable**
  - the navigable to be navigated

- **request**
  - null or a request that started the navigation

- **response**
  - a response that ultimately was navigated to (potentially a network error)

- **fetch controller**
  - null or a fetch controller

- **commit early hints**
  - null or an algorithm accepting a Document, once it has been created

- **COOP enforcement result**
  - a cross-origin opener policy enforcement result, used for reporting and potentially for causing a browsing context group switch

- **reserved environment**
  - null or an environment reserved for the new Document

- **origin**
  - an origin to use for the new Document

- **policy container**
  - a policy container to use for the new Document

- **final sandboxing flag set**
  - a sandboxing flag set to impose on the new Document

- **cross-origin opener policy**
  - a cross-origin opener policy to use for the new Document

- **navigation timing type**
  - a NavigationTimingType used for creating the navigation timing entry for the new Document

- **about base URL**
  - a URL or null used to populate the new Document's about base URL

**Note**

> Once a navigation params struct is created, this standard does not mutate any of its items. They are only passed onward to other algorithms.

A navigation ID is a UUID string generated during navigation. It is used to interface with the WebDriver BiDi specification as well as to track the ongoing navigation. [WEBDRIVERBIDI] After Document creation, the relevant traversable navigable's session history gets updated. The
NavigationHistoryBehavior enumeration is used to indicate the desired type of session history update to the `navigate` algorithm. It is one of the following:

"push"

A regular navigation which adds a new session history entry, and will clear the forward session history.

"replace"

A navigation that will replace the active session history entry.

"auto"

The default value, which will be converted very early in the `navigate` algorithm into "push" or "replace". Usually it becomes "push", but under certain circumstances it becomes "replace" instead.

A history handling behavior is a NavigationHistoryBehavior that is either "push" or "replace", i.e., that has been resolved away from any initial "auto" value.

The navigation must be a replace, given a URL and a Document document, if any of the following are true:

- url's scheme is "javascript"; or
- document's is initial about:blank is true.

Other cases that often, but not always, force a "replace" navigation are:

- if the Document is not completely loaded; or
- if the target URL equals the Document's URL.

Various parts of the platform track whether a user is involved in a navigation. A user navigation involvement is one of the following:

"browser UI"

The navigation was initiated by the user via browser UI mechanisms.

"activation"

The navigation was initiated by the user via the activation behavior of an element.

"none"

The navigation was not initiated by the user.

For convenience at certain call sites, the user navigation involvement for an Event event is defined as follows:

1. Assert: this algorithm is being called as part of an activation behavior definition.
2. Assert: event's type is "click".
3. If event's isTrusted is initialized to true, then return "activation".
4. Return "none".

### 7.4.2.2 Beginning navigation

To navigate a navigable to a URL url using a Document sourceDocument, with an optional POST resource, string, or null documentResource (default null), an optional response-or-null response (default null), an optional boolean exceptionsEnabled (default false), an optional NavigationHistoryBehavior historyHandling (default "auto"), an optional serialized state-or-null navigationAPISate (default null), an optional entry list or null formDataEntryList (default null), an optional referer policy refererPolicy (default the empty string), and an optional user navigation involvement (default "none"):

1. Let cspNavigationType be "form-submission" if formDataEntryList is non-null; otherwise "other".
2. Let sourceSnapshotParams be the result of snapshotting source snapshot params given sourceDocument.

4. Let initiatorBaseURLSnapshot be sourceDocument's document base URL.

5. If sourceDocument's node navigable is not allowed by sandboxing to navigate navigable given and sourceSnapshotParams, then:
   1. If exceptionsEnabled is true, then throw a "SecurityError" DOMException.
   2. Return.

6. Let navigationId be the result of generating a random UUID. [WEBCRYPTO]

7. If the surrounding agent is equal to navigable's active document's relevant agent, then continue these steps. Otherwise, queue a global task on the navigation and traversal task source given navigable's active window to continue these steps.

8. If navigable's active document's unload counter is greater than 0, then invoke WebDriver BiDi navigation failed with a WebDriver BiDi navigation status whose id is navigationId, status is "canceled", and url is url, and return.

9. If historyHandling is "auto", then:
   1. If url equals navigable's active document's URL, and initiatorOriginSnapshot is same origin with targetNavigable's active document's origin, then set historyHandling to "replace".
   2. Otherwise, set historyHandling to "push".

10. If the navigation must be a replace given url and navigable's active document, then set historyHandling to "replace".

11. If all of the following are true:
   - documentResource is null;
   - response is null;
   - url equals navigable's active session history entry's URL with exclude fragments set to true; and
   - url's fragment is non-null,
   then:
   1. Navigate to a fragment given navigable, url, historyHandling, userInvolvement, navigationAPIState, and navigationId.
   2. Return.

12. If navigable's parent is non-null, then set navigable's is delaying load events to true.

13. Let targetBrowsingContext be navigable's active browsing context.

14. Let targetSnapshotParams be the result of snapshotting target snapshot params given navigable.

15. Invoke WebDriver BiDi navigation started with targetBrowsingContext, and a new WebDriver BiDi navigation status whose id is navigationId, status is "pending", and url is url.

16. If navigable's ongoing navigation is "traversal", then:
   1. Invoke WebDriver BiDi navigation failed with targetBrowsingContext and a new WebDriver BiDi navigation status.
whose id is navigationId, status is "canceled", and url is url.

2. Return.

**Note**

Any attempts to navigate a navigable that is currently traversing are ignored.

17. Set the ongoing navigation for navigable to navigationId.

**Note**

This will have the effect of aborting other ongoing navigations of navigable, since at certain points during navigation changes to the ongoing navigation will cause further work to be abandoned.

18. If url's scheme is "javascript", then:

1. Queue a global task on the navigation and traversal task source given navigable's active window to navigate to a javascript: URL given navigable, url, historyHandling, initiatorOriginSnapshot, and cspNavigationType.

2. Return.

19. If all of the following are true:

- userInvolvement is not "browser UI";
- navigable's active document's origin is same origin-domain with sourceDocument's origin;
- navigable's active document's is initial about:blank is false; and
- url's scheme is a fetch scheme,

then:

1. Let navigation be navigable's active window's navigation API.

2. Let entryListForFiring be formDataEntryList if documentResource is a POST resource; otherwise, null.

3. Let navigationAPIStateForFiring be navigationAPIState if navigationAPIState is not null; otherwise, StructuredSerializeForStorage (undefined).

4. Let continue be the result of firing a push/replace/reload navigate event at navigation with navigationType set to historyHandling, isSameDocument set to false, userInvolvement set to userInvolvement, formDataEntryList set to entryListForFiring, destinationURL set to url, and navigationAPIState set to navigationAPIStateForFiring.

5. If continue is false, then return.

**Note**

It is possible for navigations with userInvolvement of "browser UI" or initiated by a cross origin-domain sourceDocument to fire navigate events, if they go through the earlier navigate to a fragment path.

20. In parallel, run these steps:

1. Let unloadPromptCanceled be the result of checking if unloading is canceled for navigable's active document's inclusive descendant navigables.

2. If unloadPromptCanceled is true, or navigable's ongoing navigation is no longer navigationId, then:

   1. Invoke WebDriver BiDi navigation failed with targetBrowsingContext and a new WebDriver BiDi navigation status whose id is navigationId, status is "canceled", and url is url.

   2. Abort these steps.

3. Queue a global task on the navigation and traversal task source given navigable's active window to abort a document and its descendants given navigable's active document.

4. Let documentState be a new document state with
5. If url matches about:blank or is about:srcdoc, then:
   1. Set documentState's origin to initiatorOriginSnapshot.
   2. Set documentState's about base URL to initiatorBaseURLSnapshot.

6. Let historyEntry be a new session history entry, with its URL set to url and its document state set to documentState.

7. Let navigationParams be null.

8. If response is non-null:

   1. Let policyContainer be the result of determining navigation params policy container given response's URL, null, a clone of the sourceDocument's policy container, navigable's container document's policy container, and null.
   2. Let finalSandboxFlags be the union of targetSnapshotParams's sandboxing flags and policyContainer's CSP list's CSP-derived sandboxing flags.
   3. Let responseOrigin be the result of determining the origin given response's URL, finalSandboxFlags, and documentState's initiator origin.
   4. Let coop be a new cross-origin opener policy.
   5. Let coopEnforcementResult be a new cross-origin opener policy enforcement result with url, response's URL, responseOrigin, cross-origin opener policy, and coop.
   6. Set navigationParams to a new navigation params, with id, navigable's target name, request, null, response, fetch controller, null, and commit early hints.
9. Attempt to populate the history entry's document for historyEntry, given navigable, "navigate", sourceSnapshotParams, targetSnapshotParams, navigationId, navigationParams, cspNavigationType, with allowPOST set to true and completionSteps set to the following step:

1. Append session history traversal steps to navigable's traversable to finalize a cross-document navigation given navigable, historyHandling, and historyEntry.

7.4.2.3 Ending navigation

Although the usual cross-document navigation case will first foray into populating a session history entry with a Document, all navigations that don't get aborted will ultimately end up calling into one of the below algorithms.

7.4.2.3.1 The usual cross-document navigation case

To finalize a cross-document navigation given a navigable navigable, history handling behavior historyHandling, and session history entry historyEntry:

1. Assert: this is running on navigable's traversable navigable's session history traversal queue.

2. Set navigable's is delaying load events to false.

3. If historyEntry's document is null, then return.

Note
This means that attempting to populate the history entry's document ended up not creating a document, as a result of e.g., the navigation being canceled by a subsequent navigation, a 204 No Content response, etc.

4. If all of the following are true:
   - navigable's parent is null;
   - historyEntry's document's browsing context is not an auxiliary browsing context whose opener browsing context is non-null; and
   - historyEntry's document's origin is not navigable's active document's origin,

   then set historyEntry's document's navigable target name to the empty string.

5. Let entryToReplace be navigable's active session history entry if historyHandling is "replace", otherwise null.

6. Let traversable be navigable's traversable.

7. Let targetStep be null.

8. Let targetEntries be the result of getting session history entries for navigable.
If entryToReplace is null, then:

1. Clear the forward session history\(^{[1000]}\) of traversable.
2. Set targetStep to traversable's \texttt{current session history step}\(^{[979]}\) + 1.
3. Set historyEntry's \texttt{step}\(^{[994]}\) to targetStep.
4. Append historyEntry to targetEntries.

Otherwise:

1. Replace entryToReplace with historyEntry in targetEntries.
2. Set historyEntry's \texttt{step}\(^{[994]}\) to entryToReplace's \texttt{step}\(^{[994]}\).
3. If historyEntry's \texttt{document state}\(^{[994]}\)'s \texttt{origin}\(^{[995]}\) is same origin\(^{[891]}\) with entryToReplace's \texttt{document state}\(^{[994]}\)'s \texttt{origin}\(^{[995]}\), then set historyEntry's \texttt{navigation API key}\(^{[994]}\) to entryToReplace's \texttt{navigation API key}\(^{[994]}\).
4. Set targetStep to traversable's \texttt{current session history step}\(^{[979]}\).

Apply the push/replace history step\(^{[1029]}\) targetStep to traversable given historyHandling.

\subsection*{7.4.2.3.2 The \texttt{javascript: URL} special case\(^{[10]}\)\(^{[10]}\)}

\texttt{javascript: URLs} have a dedicated label on the issue tracker documenting various problems with their specification.

To navigate to a \texttt{javascript: URL}, given a \texttt{Navigable}\(^{[978]}\) targetNavigable, a \texttt{URL} url, a \texttt{history handling behavior}\(^{[1003]}\) historyHandling, an \texttt{origin}\(^{[890]}\) initiatorOrigin, and a string cspNavigationType:

1. Assert: historyHandling is "replace\(^{[1003]}\)."
2. Set the ongoing navigation\(^{[1016]}\) for targetNavigable to null.
3. If initiatorOrigin is not same origin-domain\(^{[891]}\) with targetNavigable's \texttt{active document}\(^{[978]}\)'s \texttt{origin}, then return.
4. Let request be a new request whose \texttt{URL} is url.

\begin{note}
This is a synthetic request solely for plumbing into the next step. It will never hit the network.
\end{note}

5. If the result of should navigation request of type be blocked by Content Security Policy? given request and cspNavigationType is "Blocked", then return. [CSP]\(^{[10456]}\)
6. Let newDocument be the result of evaluating a \texttt{javascript: URL}\(^{[1006]}\) given targetNavigable, url, and initiatorOrigin.
7. If newDocument is null, then return.

\begin{note}
In this case, some JavaScript code was executed, but no new Document\(^{[912]}\) was created, so we will not perform a navigation.
\end{note}

8. Assert: initiatorOrigin is newDocument's \texttt{origin}.
9. Let entryToReplace be targetNavigable's \texttt{active session history entry}\(^{[978]}\).
10. Let oldDocState be entryToReplace's \texttt{document state}\(^{[994]}\).
11. Let documentState be a new \texttt{document state}\(^{[995]}\) with \texttt{document}\(^{[995]}\) newDocument

\begin{center}
\texttt{history policy container}\(^{[995]}\)
\end{center}

\begin{center}
a \texttt{clone}\(^{[909]}\) of the \texttt{oldDocState's history policy container}\(^{[995]}\) if it is non-null; null otherwise
**request referrer**

oldDocState's **request referrer**

**request referrer policy**

oldDocState's **request referrer policy**

**initiator origin**

initiatorOrigin

**origin**

initiatorOrigin

**about base URL**

oldDocState's **about base URL**

**resource**

null

**ever populated**

true

**navigable target name**

oldDocState's **navigable target name**

12. Let **historyEntry** be a new **session history entry**, with

**URL**

entryToReplace's **URL**

**document state**

documentState

**Note**

For the **URL**, we do not use url, i.e. the actual *javascript:* URL that the **navigate** algorithm was called with. This means *javascript:* URLs are never stored in session history, and so can never be traversed to.

13. **Append session history traversal steps** to targetNavigable's **traversable** to **finalize a cross-document navigation** with targetNavigable, **historyHandling**, and **historyEntry**.

To **evaluate a javascript:** **URL** given a **navigable**, targetNavigable, a **URL** url, and an **origin** newDocumentOrigin:

1. Let **urlString** be the result of running the **URL serializer** on url.
2. Let **encodedScriptSource** be the result of removing the leading "javascript:" from **urlString**.
3. Let **scriptSource** be the **UTF-8 decoding** of the **percent-decoding** of **encodedScriptSource**.
4. Let **settings** be targetNavigable's **active document**'s **relevant settings object**.
5. Let **baseUrl** be **settings**'s **API base URL**.
6. Let **script** be the result of **creating a classic script** given **scriptSource**, **settings**, **baseUrl**, and the **default classic script fetch options**.
7. Let **evaluationStatus** be the result of **running the classic script** **script**.
8. Let **result** be null.
9. If **evaluationStatus** is a normal completion, and **evaluationStatus**.[[Value]] is a String, then set **result** to **evaluationStatus**.[[Value]].
10. Otherwise, return null.

11. Let **response** be a new **response** with

**URL**

targetNavigable's **active document**'s **URL**

**header list**

« ("Content-Type", "text/html;charset=utf-8") »

**body**

the **UTF-8 encoding** of **result**, **as a body**

**Note**

The encoding to UTF-8 means that unpaired surrogates will not roundtrip, once the HTML parser decodes the response body.
12. Let policyContainer be targetNavigable's active document's policy container.
13. Let finalSandboxFlags be policyContainer's CSP list's CSP-derived sandboxing flags.
14. Let coop be targetNavigable's active document's cross-origin opener policy.
15. Let coopEnforcementResult be a new cross-origin opener policy enforcement result with:
   - url
   - origin newDocumentOrigin
   - cross-origin opener policy coop

16. Let navigationParams be a new navigation params with:
   - id
   - navigable targetNavigable
   - request null [this will cause the referrer of the resulting Document to be null; is that correct?]
   - response
   - fetch controller null
   - commit early hints null
   - COOP enforcement result coopEnforcementResult
   - reserved environment null
   - origin newDocumentOrigin
   - policy container policyContainer
   - final sandboxing flag set finalSandboxFlags
   - cross-origin opener policy coop
   - navigation timing type "navigate"
   - about base URL targetNavigable's active document's about base URI

17. Return the result of loading an HTML document given navigationParams.

7.4.2.3.3 Fragment navigations

To navigate to a fragment given a navigable, a URL, a history handling behavior, a user navigation involvement, a serialized state, or-null navigationAPIState, and a navigation ID:

1. Let navigation be navigable's active window's navigation API.
2. Let destinationNavigationAPIState be navigable's active session history entry's navigation API state.
3. If navigationAPIState is not null, then set destinationNavigationAPIState to navigationAPIState.
4. Let continue be the result of firing a push/replace/reload navigate event at navigation with navigationType set to historyHandling, isSameDocument set to true, userInvolvement set to userInvolvement, and destinationURL set to url, and navigationAPIState set to destinationNavigationAPIState.
5. If continue is false, then return.
6. Let `historyEntry` be a new session history entry, with

- **URL**: `url`
- **document state**: `url` document state
- **navigation API state**: `url` navigation API state
- **scroll restoration mode**: `url` scroll restoration mode

**Note**

For navigations performed with `navigation.navigate()`, the value provided by the `state` option is used for the new navigation API state. (This will set it to the serialization of undefined, if no value is provided for that option.) For other fragment navigations, including user-initiated ones, the navigation API state is carried over from the previous entry.

The *classic history API state* is never carried over.

7. Let `entryToReplace` be navigable's active session history entry if `historyHandling` is "replace", otherwise null.

8. Let `history` be navigable's active document's history object.

9. Let `scriptHistoryIndex` be `history`'s index.

10. Let `scriptHistoryLength` be `history`'s length.

11. If `historyHandling` is "push", then:

   1. Set `history`'s `state` to null.
   2. Increment `scriptHistoryIndex`.
   3. Set `scriptHistoryLength` to `scriptHistoryIndex` + 1.

12. Set navigable's active document's URL to `url`.

13. Set navigable's active session history entry to `historyEntry`.

14. Update document for history step application given navigable's active document, `historyEntry`, true, `scriptHistoryIndex`, `scriptHistoryLength`, and `historyHandling`.

**Note**

This algorithm will be called twice as a result of a single fragment navigation: once synchronously, where best-guess values `scriptHistoryIndex` and `scriptHistoryLength` are set, `history.state` is nulled out, and various events are fired; and once asynchronously, where the final values for index and length are set, `history.state` remains untouched, and no events are fired.

15. Scroll to the fragment given navigable's active document.

**Note**

If the scrolling fails because the Document is new and the relevant ID has not yet been parsed, then the second asynchronous call to update document for history step application will take care of scrolling.

16. Let `traversable` be navigable's traversable navigable.

17. Append the following session history synchronous navigation steps involving navigable to traversable:

   1. Finalize a same-document navigation given traversable, navigable, historyEntry, `entryToReplace`, and `historyHandling`.
   2. Invoke WebDriver BiDi fragment navigated with navigable's active browsing context and a new WebDriver BiDi navigation status whose `id` is navigationId, `url` is `url`, and `status` is "complete".

To finalize a same-document navigation given a traversable, a navigable, a targetNavigable, a session history entry, targetEntry, a session history entry-or-null `entryToReplace`, and a history handling behavior
This is used by both fragment navigations and by the URL and history update steps, which are the only synchronous updates to session history. By virtue of being synchronous, those algorithms are performed outside of the top-level traversable’s session history traversal queue. This puts them out of sync with the top-level traversable’s current session history step, so this algorithm is used to resolve conflicts due to race conditions.

1. **Assert**: this is running on traversable's session history traversal queue.

2. If targetNavigable's active session history entry is not targetEntry, then return.

3. Let targetStep be null.

4. Let targetEntries be the result of getting session history entries for targetNavigable.

5. If entryToReplace is null, then:
   1. Clear the forward session history of traversable.
   2. Set targetStep to traversable's current session history step + 1.
   3. Set targetEntry's step to targetStep.
   4. Append targetEntry to targetEntries.

Otherwise:
   1. Replace entryToReplace with targetEntry in targetEntries.
   2. Set targetEntry's step to entryToReplace's step.
   3. Set targetStep to traversable's current session history step.

6. Apply the push/replace history step targetStep to traversable given historyHandling.

Note

This is done even for "replace" navigations, as it resolves race conditions across multiple synchronous navigations.

### 7.4.2.3.4 Non-fetch schemes and external software

The input to attempt to create a non-fetch scheme document is the non-fetch scheme navigation params struct. It is a lightweight version of navigation params, which only carries parameters relevant to the non-fetch scheme navigation case. It has the following items:

- **id**: null or a navigation ID
- **navigable**: the navigable experiencing the navigation
- **URL**: a URL
- **target snapshot sandboxing flags**: the target snapshot params's sandboxing flags present during navigation
- **source snapshot has transient activation**: a copy of the source snapshot params's has transient activation boolean present during activation
- **initiator origin**: an origin, possibly for use in a user-facing prompt to confirm the invocation of an external software package

Note

This differs slightly from a document state's initiator origin in that a non-fetch scheme navigation params's initiator origin follows redirects up to the last fetch scheme URL in a redirect chain that ends in a non-fetch scheme URL.
To attempt to create a non-fetch scheme document, given a non-fetch scheme navigation params\textsuperscript{1012} navigationParams:

1. Let url be navigationParams's URL\textsuperscript{1012}.
2. Let navigable be navigationParams's navigable\textsuperscript{1013}.
3. If url is to be handled using a mechanism that does not affect navigable, e.g., because url's scheme\textsuperscript{1016} is handled externally, then:
   1. Hand-off to external software\textsuperscript{1013} given url, navigable, navigationParams's target snapshot sandboxing flags\textsuperscript{1012}, navigationParams's source snapshot has transient activation\textsuperscript{1012}, and navigationParams's initiator origin\textsuperscript{1012}.
   2. Return null.
4. Handle url by displaying some sort of inline content, e.g., an error message because the specified scheme is not one of the supported protocols, or an inline prompt to allow the user to select a registered handler\textsuperscript{1155} for the given scheme. Return the result of displaying the inline content\textsuperscript{1051} given navigable, navigationParams's id\textsuperscript{1012}, and navigationParams's navigation timing type\textsuperscript{1013}.

**Note**
In the case of a registered handler being used, navigate\textsuperscript{1003} will be invoked with a new URL.

To hand-off to external software given a URL or response resource, a navigable\textsuperscript{978} navigable, a sandbox flag set\textsuperscript{996} sandboxFlags, a boolean hasTransientActivation, and an origin\textsuperscript{980} initiatorOrigin user agents should:

1. If all of the following are true:
   
   ◦ navigable is not a top-level traversable\textsuperscript{997}:
   
   ◦ sandboxFlags has its sandboxed custom protocols navigation browsing context flag\textsuperscript{907} set; and
   
   ◦ sandboxFlags has its sandboxed top-level navigation with user activation browsing context flag\textsuperscript{906} set, or hasTransientActivation is false

   then return without invoking the external software package.

**Note**
Navigation inside an iframe toward external software can be seen by users as a new popup or a new top-level navigation. That's why its is allowed in sandboxed iframe\textsuperscript{387} only when one of allow-popups\textsuperscript{907}, allow-top-navigation\textsuperscript{997}, allow-top-navigation-by-user-activation\textsuperscript{997}, or allow-top-navigation-to-custom-protocols\textsuperscript{998} is specified.

2. Perform the appropriate handoff of resource while attempting to mitigate the risk that this is an attempt to exploit the target software. For example, user agents could prompt the user to confirm that initiatorOrigin is to be allowed to invoke the external software in question. In particular, if hasTransientActivation is false, then the user agent should not invoke the external software package without prior user confirmation.

**Example**
For example, there could be a vulnerability in the target software's URL handler which a hostile page would attempt to exploit by tricking a user into clicking a link.

### 7.4.2.4 Preventing navigation

A couple of scenarios can intervene early in the navigation process and put the whole thing to a halt. This can be especially exciting when multiple navigables\textsuperscript{978} are navigating at the same time, due to a session history traversal.

A navigable\textsuperscript{978} source is allowed by sandboxing to navigate a second navigable\textsuperscript{978} target, given a source snapshot params\textsuperscript{1001} sourceSnapshotParams, if the following steps return true:

1. If source is target, then return true.
2. If source is an ancestor of target, then return true.

3. If target is an ancestor of source, then:
   1. If target is not a top-level traversable, then return true.
   2. If sourceSnapshotParams's has transient activation is true, and sourceSnapshotParams's sandboxing flags's sandboxed top-level navigation with user activation browsing context flag is set, then return false.
   3. If sourceSnapshotParams's has transient activation is false, and sourceSnapshotParams's sandboxing flags's sandboxed top-level navigation without user activation browsing context flag is set, then return false.
   4. Return true.

4. If target is a top-level traversable:
   1. If source is the one permitted sandboxed navigator of target, then return true.
   2. If sourceSnapshotParams's sandboxing flags's sandboxed navigation browsing context flag is set, then return false.
   3. Return true.

5. If sourceSnapshotParams's sandboxing flags's sandboxed navigation browsing context flag is set, then return false.

6. Return true.

To check if unloading is canceled for a list of navigables navigablesThatNeedBeforeUnload, given an optional traversable navigable traversable, an optional integer targetStep, and an optional user navigation involvement userInvolvementForNavigateEvent, run these steps. They return "canceled-by-beforeunload", "canceled-by-navigate", or "continue".

1. Let documentsToFireBeforeunload be the active document of each item in navigablesThatNeedBeforeUnload.
2. Let unloadPromptShown be false.
3. Let finalStatus be "continue".
4. If traversable was given, then:
   1. Assert: targetStep and userInvolvementForNavigateEvent were given.
   2. Let targetEntry be the result of getting the target history entry given traversable and targetStep.
   3. If targetEntry is not traversable's current session history entry's document state's origin is the same as traversable's current session history entry's document state's origin, then:
      1. Assert: userInvolvementForNavigateEvent is not null.
      2. Let eventsFired be false.
      3. Let needsBeforeunload be true if navigablesThatNeedBeforeUnload contains traversable; otherwise false.
      4. If needsBeforeunload is true, then remove traversable's active document from documentsToFireBeforeunload.
      5. Queue a global task on the navigation and traversal task source, given traversable's active window to perform the following steps:
1. If \textit{needsBeforeunload} is true, then:
   \begin{enumerate}
   \item Let \((\text{unloadPromptShownForThisDocument}, \text{unloadPromptCanceledByThisDocument})\) be the result of running the \textit{steps to fire beforeunload} given \textit{traversable}'s \textit{active document} and false.
   \item If \text{unloadPromptShownForThisDocument} is true, then set \text{unloadPromptShown} to true.
   \item If \text{unloadPromptCanceledByThisDocument} is true, then set \textit{finalStatus} to "canceled-by-beforeunload".
   \end{enumerate}

2. If \textit{finalStatus} is "canceled-by-beforeunload", then abort these steps.

3. Let \textit{navigation} be \textit{traversable}'s \textit{active window}'s navigation API.

4. Let \textit{navigateEventResult} be the result of firing \textit{a traverse navigate event} at \textit{navigation} given \textit{targetEntry} and \textit{userInvolvementForNavigateEvent}.

5. If \textit{navigateEventResult} is false, then set \textit{finalStatus} to "canceled-by-navigate".

6. Set \textit{eventsFired} to true.

7. Wait until \textit{eventsFired} is true.

8. If \textit{finalStatus} is not "continue", then return \textit{finalStatus}.

5. Let \textit{totalTasks} be the size of \textit{documentsThatNeedBeforeunload}.

6. Let \textit{completedTasks} be 0.

7. For each document of documents, \textit{queue a global task} on the \textit{navigation and traversal task source} given document's \textit{relevant global object} to run the steps:
   \begin{enumerate}
   \item Let \((\text{unloadPromptShownForThisDocument}, \text{unloadPromptCanceledByThisDocument})\) be the result of running the \textit{steps to fire beforeunload} given document and \textit{unloadPromptShown}.
   \item If \text{unloadPromptShownForThisDocument} is true, then set \text{unloadPromptShown} to true.
   \item If \text{unloadPromptCanceledByThisDocument} is true, then set \textit{finalStatus} to "canceled-by-beforeunload".
   \item Increment \textit{completedTasks}.
   \end{enumerate}

8. Wait for \textit{completedTasks} to be \textit{totalTasks}.

9. Return \textit{finalStatus}.

The \textit{steps to fire beforeunload} given a Document document and a boolean \textit{unloadPromptShown} are:

1. Let \textit{unloadPromptCanceled} be false.

2. Increase the document's \textit{unload counter} by 1.

3. Increase document's \textit{relevant agent}'s \textit{event loop}'s termination nesting level by 1.

4. Let \textit{eventFiringResult} be the result of firing an event named \textit{beforeunload} at document's \textit{relevant global object}, using \textit{BeforeUnloadEvent}, with the \textit{Cancelable} attribute initialized to true.

5. Decrease document's \textit{relevant agent}'s \textit{event loop}'s termination nesting level by 1.

6. If all of the following are true:
   \begin{itemize}
   \item \textit{unloadPromptShown} is false;
   \item document's \textit{active sandboxing flag set} does not have its \textit{sandboxed modals flag} set;
   \item document's \textit{relevant global object} has \textit{sticky activation};
   \item \textit{eventFiringResult} is false, or the \textit{returnValue} attribute of event is not the empty string; and
   \item showing an unload prompt is unlikely to be annoying, deceptive, or pointless,
   \end{itemize}
   then:
1. Set `unloadPromptShown` to true.

2. Invoke `WebDriver BiDi user prompt opened` with document's `relevant global object` "beforeunload", and "".

3. Ask the user to confirm that they wish to unload the document, and `pause` while waiting for the user's response.

   **Note**
   
   The message shown to the user is not customizable, but instead determined by the user agent. In particular, the actual value of the `returnValue` attribute is ignored.

4. If the user did not confirm the page navigation, set `unloadPromptCanceled` to true.

5. Invoke `WebDriver BiDi user prompt closed` with document's `relevant global object` and true if `unloadPromptCanceled` is false or false otherwise.


8. Return `(unloadPromptShown, unloadPromptCanceled)`.

7.4.2.5 Aborting navigation

Each navigable has an ongoing navigation, which is a navigation ID, "traversal", or null, initially null. It is used to track navigation aborting and to prevent any navigations from taking place during traversal.

To set the ongoing navigation for a navigable navigable to newValue:

1. If navigable's ongoing navigation is equal to newValue, then return.
2. Inform the navigation API about aborting navigation given navigable.
3. Set navigable's ongoing navigation to newValue.

7.4.3 Reloading and traversing

To reload a navigable navigable given an optional serialized state-or-null navigationAPIState (default null) and an optional user navigation involvement userInvolvement (default "none"):

1. If userInvolvement is not "browser UI", then:
   1. Let navigation be navigable's active window's navigation API.
   2. Let destinationNavigationAPIState be navigable's active session history entry's navigation API state.
   3. If navigationAPIState is not null, then set destinationNavigationAPIState to navigationAPIState.
   4. Let continue be the result of firing a push/replace/reload navigate event at navigation with navigationType set to "reload", isSameDocument set to false, userInvolvement set to userInvolvement, and destinationURL set to navigable's active session history entry's URL, and navigationAPIState set to destinationNavigationAPIState.
   5. If continue is false, then return.
2. Set navigable's active session history entry's document state's `reload pending` to true.
3. Let traversable be navigable's traversable navigable.
4. Append the following session history traversal steps to traversable:
   1. Apply the `reload history step` to traversable.

To traverse the history by a delta given a traversable traversable, an integer delta, and an optional Document sourceDocument:
1. Let `sourceSnapshotParams` and `initiatorToCheck` be null.

2. Let `userInvolvement` be "browser UI".

3. If `sourceDocument` is given, then:
   1. Set `sourceSnapshotParams` to the result of `snapshotting source snapshot params` given `sourceDocument`.
   2. Set `initiatorToCheck` to `sourceDocument`'s `node navigable`.
   3. Set `userInvolvement` to "none".

4. Append the following session history traversal steps to `traversable`:
   1. Let `allSteps` be the result of `getting all used history steps` for `traversable`.
   2. Let `currentStepIndex` be the index of `traversable`'s `current session history step` within `allSteps`.
   3. Let `targetStepIndex` be `currentStepIndex` plus `delta`.
   4. If `allSteps[targetStepIndex]` does not exist, then abort these steps.
   5. Apply the `traverse history step` allSteps[targetStepIndex] to `traversable`, given `sourceSnapshotParams`, `initiatorToCheck`, and `userInvolvement`.

7.4.4 Non-fragment synchronous "navigations"  

Apart from the `navigate` algorithm, session history entries can be pushed or replaced via one more mechanism, the `URL and history update steps`. The most well-known callers of these steps are the `history.replaceState()` and `history.pushState()` APIs, but various other parts of the standard also need to perform updates to the `active history entry`, and they use these steps to do so.

The `URL and history update steps`, given a `Document`, a `URL` `newURL`, an optional `serialized state`-or-null `serializedData` (default null), and an optional `history handling behavior` historyHandling (default "replace"), are:

1. Let `navigable` be `document`'s `node navigable`.
2. Let `activeEntry` be `navigable`'s `active session history entry`.
3. Let `newEntry` be a new `session history entry`, with
   1. `URL` `newURL` 
   2. `serialized state` if `serializedData` is not null, `serializedData`; otherwise `activeEntry`'s `classic history API state` 
   3. `document state` `activeEntry`'s `document state` 
   4. `scroll restoration mode` `activeEntry`'s `scroll restoration mode` 
   5. `persisted user state` `activeEntry`'s `persisted user state` 
4. If `document`'s `is initial about:blank` is true, then set `historyHandling` to "replace".

Note

This means that `pushState()` on an `initial about:blank` `Document` behaves as a `replaceState()` call.

5. Let `entryToReplace` be `activeEntry` if `historyHandling` is "replace", otherwise null.
6. If `historyHandling` is "push", then:
   1. Increment `document`'s `history object`'s `index`.
   2. Set `document`'s `history object`'s `length` to its `index` + 1.
If serializedData is not null, then restore the history object state\(^{1040}\) given document and newEntry.

Set document’s URL to newURL.

Since this is neither a navigation\(^{1003}\) nor a history traversal\(^{1016}\), it does not cause a hashchange\(^{1452}\) event to be fired.

Set document’s latest entry\(^{996}\) to newEntry.

Set navigable’s active session history entry\(^{978}\) to newEntry.

Update the navigation API entries for a same-document navigation\(^{946}\) given document’s relevant global object\(^{1071}\)’s navigation API\(^{944}\), newEntry, and historyHandling.

Let traversable be navigable’s traversable navigable\(^{979}\).

Append the following session history synchronous navigation steps\(^{997}\) involving navigable to traversable:

1. Finalize a same-document navigation\(^{1011}\) given traversable, navigable, newEntry, entryToReplace, and historyHandling.

Although both fragment navigation\(^{1018}\) and the URL and history update steps\(^{8107}\) perform synchronous history updates, only fragment navigation contains a synchronous call to update document for history step application\(^{1008}\). The URL and history update steps\(^{1021}\) instead perform a few select updates inside the above algorithm, omitting others. This is somewhat of an unfortunate historical accident, and generally leads to web-developer sadness about the inconsistency. For example, this means that popstate\(^{1452}\) events fire for fragment navigations, but not for history.pushState()\(^{938}\) calls.

7.4.5 Populating a session history entry \(^{5\text{p}110}\)\(^{18}\)

As explained in the overview\(^{993}\), both navigation\(^{1001}\) and traversal\(^{1016}\) involve creating a session history entry\(^{994}\) and then attempting to populate its document\(^{994}\) member, so that it can be presented inside the navigable\(^{978}\).

This involves either: using an already-given response\(^{1006}\); using the srcdoc resource\(^{996}\) stored in the session history entry\(^{994}\); or fetching\(^{1022}\). The process has several failure modes, which can either result in doing nothing (leaving the navigable\(^{978}\) on its currently-active\(^{978}\) Document\(^{128}\)) or can result in populating the session history entry\(^{994}\) with an error document\(^{1051}\).

To attempt to populate the history entry’s document for a session history entry\(^{994}\) entry, given a navigable\(^{978}\) navigable, a NavigationTimingType navTimingType, a source snapshot params\(^{1001}\) sourceSnapshotParams, a target snapshot params\(^{1001}\) targetSnapshotParams, an optional navigation ID\(^{1002}\)-or-null navigationId (default null), an optional navigationParams (default null), an optional string cspNavigationType (default “other”), an optional boolean allowPOST (default false), and optional algorithm steps completionSteps (default an empty algorithm):

1. Assert: this is running in parallel\(^{993}\).
2. Assert: if navigationParams is non-null, then navigationParams’s response\(^{1002}\) is non-null.
3. Let currentBrowsingContext be navigable’s active browsing context\(^{978}\).
4. Let documentResource be entry’s document state\(^{994}\)’s resource\(^{996}\).
5. If navigationParams is null, then:

   1. If documentResource is a string, then set navigationParams to the result of creating navigation params from a srcdoc resource\(^{1001}\) given entry, navigable, targetSnapshotParams, navigationId, and navTimingType.

   2. Otherwise, if all of the following are true:

      - entry’s URL\(^{994}\)’s scheme is a fetch scheme; and
      - documentResource is null, or allowPOST is true and documentResource’s request body\(^{996}\) is not failure,
then set navigationParams to the result of creating navigation params by fetching given entry, navigable, sourceSnapshotParams, targetSnapshotParams, cspNavigationType, navigableId, and navTimingType.

3. Otherwise, if entry’s URL’s scheme is not a fetch scheme, then set navigationParams to a new non-fetch scheme navigation params, with

   id
   navigable navigationId
   navigable
   URL

   target snapshot sandboxing flags
   targetSnapshotParams’s sandboxing flags
   source snapshot has transient activation
   sourceSnapshotParams’s has transient activation
   initiator origin
   entry's document state’s initiator origin
   navigation timing type

6. Queue a global task on the navigation and traversal task source, given navigable’s active window, to run these steps:

1. If navigable’s ongoing navigation no longer equals navigationId, then run completionSteps and abort these steps.

2. Let saveExtraDocumentState be true.

   Note
   Usually, in the cases where we end up populating entry's document's document, we then want to save some of the state from that Document into entry. This ensures that if there are future traversals to entry where its document has been destroyed, we can use that state when creating a new Document.

   However, in some specific cases, saving the state would be unhelpful. For those, we set saveExtraDocumentState to false later in this algorithm.

3. If navigationParams is a non-fetch scheme navigation params, then:

   1. Set entry’s document state’s document to the result of running attempt to create a non-fetch scheme document given navigationParams.

      Note
      This can result in setting entry's document state's document to null, e.g., when handing-off to external software.

   2. Set saveExtraDocumentState to false.

4. Otherwise, if any of the following are true:

   - navigationParams is null;

   - the result of should navigation response to navigation request of type in target be blocked by Content Security Policy? given navigationParams's request, navigationParams's response, navigationParams's policy container's CSP list, cspNavigationType, and navigable is "Blocked";

   - navigationParams's reserved environment is non-null and the result of checking a navigation response's adherence to its embedder policy given navigationParams’s response, navigable, and navigationParams’s policy container’s embedder policy is false; or

   - the result of checking a navigation response's adherence to `X-Frame-Options` given navigationParams’s response, navigable, navigationParams's policy container's CSP list, and navigationParams's origin is false,

then:  

1019
1. Set entry’s document state’s document to the result of creating a document for inline content that doesn’t have a DOM, given navigable, null, and navTimingType. The inline content should indicate to the user the sort of error that occurred.

2. Make document unsalvageable, given entry’s document state’s document and *navigation-failure*.


4. If navigationParams is not null, then:
   1. Run the environment discarding steps for navigationParams’s reserved environment.
   2. Invoke WebDriver BiDi navigation failed with currentBrowsingContext and a new WebDriver BiDi navigation status whose id is navigationId, status is "canceled", and url is navigationParams’s response’s URL.

5. Otherwise, if navigationParams’s response has a `Content-Disposition` header specifying the attachment disposition type, then:
   1. Let sourceAllowsDownloading be sourceSnapshotParams’s allows downloading.
   2. Let targetAllowsDownloading be false if navigationParams’s final sandboxing flag set has the sandboxed downloads browsing context flag set; otherwise true.
   3. Let uaAllowsDownloading be true.
   4. Optionally, the user agent may set uaAllowsDownloading to false, if it believes doing so would safeguard the user from a potentially hostile download.
   5. If sourceAllowsDownloading, targetAllowsDownloading, and uaAllowsDownloading are true, then:
      1. Handle navigationParams’s response as a download.
      2. Invoke WebDriver BiDi download started with currentBrowsingContext and a new WebDriver BiDi navigation status whose id is navigationId, status is "complete", and url is navigationParams’s response’s URL.

6. Otherwise, if navigationParams’s response’s status is not 204 and is not 205, then set entry’s document state’s document to the result of loading a document given navigationParams, sourceSnapshotParams, and entry’s document state’s initiator origin.

7. If entry’s document state’s document is not null, then:
   1. Set entry’s document state’s ever populated to true.
   2. If saveExtraDocumentState is true:
      1. Let document be entry's document state's document.
      2. Set entry's document state's origin to document's origin.
      3. If document's URL requires storing the policy container in history, then:
         1. Assert: navigationParams is a navigation params (i.e., neither null nor a non-fetch scheme navigation params).
         2. Set entry’s document state’s history policy container to navigationParams's policy container.
         3. If entry’s document state’s request referrer is "client", and navigationParams is a navigation
params (i.e., neither null nor a non-fetch scheme navigation params), then:

1. **Assert**: navigationParams's request is not null.

2. Set entry's document state's request referrer to navigationParams's request's referrer.

8. Run completionSteps.

To create navigation params from a srcdoc resource given a session history entry, a navigable navigable, a target snapshot params targetSnapshotParams, a navigation ID-or-null navigationId, and a NavigationTimingType navTimingType:

1. Let documentResource be entry's document state's resource.

2. Let response be a new response with
   
   - **URL** about:srcco
   
   - **header list**
     
     - `"Content-Type", "text/html"
   
   - **body**
     
     - the UTF-8 encoding of documentResource, as a body

3. Let responseOrigin be the result of determining the origin given response's URL, targetSnapshotParams's sandboxing flags, and entry's document state's origin.

4. Let coop be a new cross-origin opener policy.

5. Let coopEnforcementResult be a new cross-origin opener policy enforcement result with
   
   - **url** response's URL
   
   - **origin** responseOrigin
   
   - **cross-origin opener policy** coop

6. Let policyContainer be the result of determining navigation params policy container given response's URL, entry's document state's history policy container, null, navigable's container document's policy container, and null.

7. Return a new navigation params, with
   
   - **id** navigationId
   
   - navigable navigable
   
   - navigable request null
   
   - response response
   
   - fetch controller null
   
   - commit early hints null
   
   - **COOP enforcement result** coopEnforcementResult
   
   - **reserved environment** null
   
   - **origin** responseOrigin
   
   - **policy container** policyContainer
   
   - **final sandboxing flag set** targetSnapshotParams's sandboxing flags
   
   - **cross-origin opener policy** coop
To create navigation params by fetching

1. **Assert**: this is running in parallel.
2. Let `documentResource` be `entry`'s `document state`'s `resource`.
3. Let request be a new `request`, with
   - `url` `entry`'s `URL`
   - `client` `sourceSnapshotParams`'s `fetch client`
   - `destination` "document"
   - `credentials_mode` "include"
   - `use-URL-credentials flag` set
   - `redirect_mode` "manual"
   - `replaces_client_id` `navigable`'s `active document`'s `relevant settings object`'s `id`
   - `mode` "navigate"
   - `referrer` `entry`'s `document state`'s `request referrer`
   - `referrer_policy` `entry`'s `document state`'s `request referrer policy`
4. If `documentResource` is a `POST resource`, then:
   1. Set request's `method` to `POST`.
   2. Set request's `body` to `documentResource`'s `request body`.
   3. Set `Content-Type` to `documentResource`'s `request content-type` in request's `header list`.
5. If `entry`'s `document state`'s `reload pending` is true, then set request's `reload-navigation flag`.
6. Otherwise, if `entry`'s `document state`'s `ever populated` is true, then set request's `history-navigation flag`.
7. If `sourceSnapshotParams`'s `has transient activation` is true, then set request's `user-activation` to true.
8. If `navigable`'s `container` is non-null:
   1. If the `navigable`'s `container` has a `browsing context scope origin`, then set request's `origin` to that `browsing context scope origin`.
   2. Set request's `destination` to `navigable`'s `container`'s `local name`.
   3. If `sourceSnapshotParams`'s `fetch client` is `navigable`'s `container document`'s `relevant settings object`, then set request's `initiator type` to `navigable`'s `container`'s `local name`.

**Note**: This algorithm mutates `entry`.

**Note**: This ensure that only container-initiated navigations are reported to resource timing.
9. Let response be null.

10. Let responseOrigin be null.

11. Let fetchController be null.

12. Let coopEnforcementResult be a new cross-origin opener policy enforcement result, with
    - `url` navigable’s active document’s URL
    - `origin` navigable’s active document’s origin
    - `cross-origin opener policy` navigable’s active document’s cross-origin opener policy
    - `current context is navigation source` true if navigable’s active document’s origin is same as entry’s document state’s initiator origin
    - otherwise false

13. Let finalSandboxFlags be an empty sandboxing flag set.

14. Let responsePolicyContainer be null.

15. Let responseCOOP be a new cross-origin opener policy.

16. Let locationURL be null.

17. Let currentURL be request’s current URL.

18. Let commitEarlyHints be null.

19. While true:

   1. If request’s reserved client is not null and currentURL’s origin is not the same as request’s reserved client’s creation URL’s origin, then:
      1. Run the environment discarding steps for request’s reserved client.
      2. Set request’s reserved client to null.
      3. Set commitEarlyHints to null.

   2. If request’s reserved client is null, then:
      1. Let topLevelCreationURL be currentURL.
      2. Let topLevelOrigin be null.
      3. If navigable is not a top-level traversable, then:
         1. Let parentEnvironment be navigable’s parent’s active document’s relevant settings object.
         2. Set topLevelCreationURL to parentEnvironment’s top-level creation URL.
         3. Set topLevelOrigin to parentEnvironment’s top-level origin.
      4. Set request’s reserved client to a new environment whose id is a unique opaque string, target browsing context is navigable’s active browsing context, creation URL is currentURL, top-level creation URL is topLevelCreationURL, and top-level origin is topLevelOrigin.

         **Note**
         The created environment’s active service worker is set in the Handle Fetch algorithm during the fetch if the request URL matches a service worker registration. [SW]

   3. If the result of should navigation request of type be blocked by Content Security Policy? given request and...
cspNavigationType is “Blocked”, then set response to a network error and break. [CSP][1456]

4. Set response to null.

5. If fetchController is null, then set fetchController to the result of fetching request, with processEarlyHintsResponse set to processEarlyHintsResponse as defined below, processResponse set to processResponse as defined below, and useParallelQueue set to true.

Let processEarlyHintsResponse be the following algorithm given a response earlyResponse:

1. If commitEarlyHints is null, then set commitEarlyHints to the result of processing early hint headers given earlyResponse and request’s reserved client.

Let processResponse be the following algorithm given a response fetchedResponse:

1. Set response to fetchedResponse.

6. Otherwise, process the next manual redirect for fetchController.

\[
\text{Note}
\]

This will result in calling the processResponse we supplied above, during our first iteration through the loop, and thus setting response.

\[
\text{Note}
\]

Navigation handles redirects manually as navigation is the only place in the web platform that cares for redirects to mailto: URLs and such.

7. Wait until either response is non-null, or navigable’s ongoing navigation changes to no longer equal navigationId.

If the latter condition occurs, then abort fetchController, and return.

Otherwise, proceed onward.

8. If request’s body is null, then set entry’s document state’s resource to null.

\[
\text{Note}
\]

Fetch unset the body for particular redirects.

9. Set responsePolicyContainer to the result of creating a policy container from a fetch response given response and request’s reserved client.

10. Set finalSandboxFlags to the union of targetSnapshotParams’s sandboxing flags and responsePolicyContainer’s CSP list’s CSP-derived sandboxing flags.

11. Set responseOrigin to the result of determining the origin given response’s URL, finalSandboxFlags, and entry’s document state’s initiator origin.

\[
\text{Note}
\]

If response is a redirect, then response’s URL will be the URL that led to the redirect to response’s location URL; it will not be the location URL itself.

12. If navigable is a top-level traversable, then:

1. Set responseCOOP to the result of obtaining a cross-origin opener policy given response and request’s reserved client.

2. Set coopEnforcementResult to the result of enforcing the response’s cross-origin opener policy given navigable’s active browsing context, response’s URL, responseOrigin, responseCOOP, coopEnforcementResult and request’s referrer.

3. If finalSandboxFlags is not empty and responseCOOP’s value is not “unsafe-none”, then set response to an appropriate network error and break.

\[
\text{Note}
\]

This results in a network error as one cannot simultaneously provide a clean slate to a response.
13. If response is not a network error, navigable is a child navigable, and the result of performing a cross-origin resource policy check with navigable's container document's origin, navigable's container document's relevant settings object, request's destination, response, and true is blocked, then set response to a network error and break.

**Note**
Here we're running the cross-origin resource policy check against the parent navigable rather than navigable itself. This is because we care about the same-originness of the embedded content against the parent context, not the navigation source.

14. Set locationURL to response's location URL given currentURL's fragment.

15. If locationURL is failure or null, then break.

16. Assert: locationURL is a URL.

17. Set entry's classic history API state to StructuredSerializeForStorage(null).

18. Let oldDocState be entry's document state.

19. Set entry's document state to a new document state, with history policy container's clone of the oldDocState's history policy container if it is non-null; null otherwise request referrer of oldDocState's request referrer.

**request referrer policy**
oldDocState's request referrer policy

**initiator origin**
oldDocState's initiator origin

**origin**
oldDocState's origin

**about base URL**
oldDocState's about base URL

**resource**
oldDocState's resource

**ever populated**
oldDocState's ever populated

**navigable target name**
oldDocState's navigable target name

**Note**
For the navigation case, only entry referenced oldDocState, which was created early in the navigate algorithm. So for navigations, this is functionally just an update to entry's document state. For the traversal case, it's possible adjacent session history entries also reference oldDocState, in which case they will continue doing so even after we've updated entry's document state.

**Note**
oldDocState's history policy container is only ever non-null here in the traversal case, after we've populated it during a navigation to a URL that requires storing the policy container in history.

**Example**
The setup is given by the following lake diagram:

```
   0  1  2  3
 top /a/a#foo/a#bar/b
```

Also assume that the document state shared by the entries in steps 0, 1, and 2 has a null document, i.e., bfcache is not in play.
20. If `locationURL`'s `scheme` is not an `HTTP(S)` scheme, then:
   1. Set entry's `document state`'s `resource` to null.
   2. `Break`.

21. Set `currentURL` to `locationURL`.

22. Set entry's `URL` to `currentURL`.

### Note

*By the end of this loop we will be in one of these scenarios:*

- `locationURL` is failure, because of an unparsable `Location` header.
- `locationURL` is null, either because response is a network error or because we successfully fetched a non-network error HTTP(S) response with no `Location` header.
- `locationURL` is a URL with a non-HTTP(S) scheme.

20. If `locationURL` is a URL whose `scheme` is not a fetch scheme, then return a new non-fetch scheme navigation params, with
   - `id`
   - `navigationId`
   - `navigable`
   - `navigable`
   - `URL` `locationURL`
   - `target snapshot sandboxing flags`
   - `targetSnapshotParams`'s `sandboxing flags`
   - `source snapshot has transient activation`
   - `sourceSnapshotParams`'s `has transient activation`
   - `initiator origin`
   - `responseOrigin`
   - `navigation timing type`

### Note

At this point, request's `current URL` is the last URL in the redirect chain with a fetch scheme before redirecting to a non-fetch scheme URL. It is this URL's `origin` that will be used as the initiator origin for navigations to non-fetch scheme URLs.

21. If any of the following are true:
   - `response` is a network error.
22. Assert: locationURL is null and response is not a network error.

23. Let resultPolicyContainer be the result of determining navigation params policy container given response's URL, entry's document state's history policy container, sourceSnapshotParams's source policy container, null, and responsePolicyContainer.

24. If navigable's container is an iframe, and response's timing allow passed flag is set, then set container's pending resource-timing start time to null.

Note

If the iframe is allowed to report to resource timing, we don't need to run its fallback steps as the normal reporting would happen.

25. Return a new navigation params, with

An element has a browsing context scope origin if its Document's node navigable is a top-level traversable or if all of its Document's ancestor navigables all have active documents whose origins are the same origin, as the element's node document's origin. If an element has a browsing context scope origin, then its value is the origin of the element's node document.

This definition is broken and needs investigation to see what it was intended to express: see issue #4703.

To load a document given navigation params navigationParams, source snapshot params sourceSnapshotParams, and origin initiatorOrigin, perform the following steps. They return a Document or null.
1. Let type be the computed type of navigationParams's response.

2. If the user agent has been configured to process resources of the given type using some mechanism other than rendering the content in a navigable, then skip this step. Otherwise, if the type is one of the following types:

   - an HTML MIME type
     Return the result of loading an HTML document, given navigationParams.
   - an XML MIME type that is not an explicitly supported XML MIME type
     Return the result of loading an XML document, given navigationParams and type.
   - a JavaScript MIME type
   - a JSON MIME type that is not an explicitly supported JSON MIME type
     Return the result of loading a text document given navigationParams and type.
   - "text/css"
     Return the result of loading a text document given navigationParams and type.
   - "text/plain"
     Return the result of loading a text document given navigationParams and type.
   - "text/vtt"
     Return the result of loading a multipart/x-mixed-replace document, given navigationParams, sourceSnapshotParams, and initiatorOrigin.
   - A supported image, video, or audio type
     Return the result of loading a media document given navigationParams and type.
   - "application/pdf"
   - "text/pdf"
     If the user agent's PDF viewer supported is true, return the result of creating a document for inline content that doesn't have a DOM given navigationParams's navigable.

 Otherwise, proceed onward.

An explicitly supported XML MIME type is an XML MIME type for which the user agent is configured to use an external application to render the content, or for which the user agent has dedicated processing rules. For example, a web browser with a built-in Atom feed viewer would be said to explicitly support the application/atom+xml MIME type.

An explicitly supported JSON MIME type is a JSON MIME type for which the user agent is configured to use an external application to render the content, or for which the user agent has dedicated processing rules.

3. If, given type, the new resource is to be handled by displaying some sort of inline content, e.g., a native rendering of the content or an error message because the specified type is not supported, then return the result of creating a document for inline content that doesn't have a DOM given navigationParams's navigable, navigationParams's id, and navigationParams's navigation timing type. Both happen in the steps below.

4. Otherwise, the document's type is such that the resource will not affect navigationParams's navigable, e.g., because the resource is to be handed to an external application or because it is an unknown type that will be processed as a download. Hand-off to external software given navigationParams's response, navigationParams's navigable, navigationParams's final sandboxing flag set, sourceSnapshotParams's has transient activation, and initiatorOrigin.

5. Return null.

7.4.6 Applying the history step

For both navigation and traversal, once we have an idea of where we want to head to in the session history, much of the work comes about in applying that notion to the traversable navigable and the relevant Document. For navigations, this work generally occurs toward the end of the process; for traversals, it is the beginning.
Ensuring a traversable ends up at the right session history step is particularly complex, as it can involve coordinating across multiple navigables descendants of the traversable, populating them in parallel, and then synchronizing back up to ensure everyone has the same view of the result. This is further complicated by the existence of synchronous same-document navigations being mixed together with cross-document navigations, and how web pages have come to have certain relative timing expectations.

A changing navigable continuation state is used to store information during the apply the history step algorithm, allowing parts of the algorithm to continue only after other parts have finished. It is a struct with:

displayed document
A Document

target entry
A session history entry

navigable
A navigable

update only
A boolean

Although all updates to the traversable navigable end up in the same apply the history step algorithm, each possible entry point comes along with some minor customizations:

To update for navigable creation/destruction given a traversable navigable traversable:

1. Let step be traversable's current session history step.
2. Return the result of applying the history step step to traversable given false, null, null, and null.

To apply the push/replace history step given a non-negative integer step and a history handling behavior historyHandling to a traversable navigable traversable:

1. Return the result of applying the history step step to traversable given false, null, null, and historyHandling.

Note
Apply the push/replace history step never passes source snapshot params or an initiator navigable to apply the history step. This is because those checks are done earlier in the navigation algorithm.

To apply the reload history step to a traversable navigable traversable:

1. Let step be traversable's current session history step.
2. Return the result of applying the history step step to traversable given true, null, null, and "reload".

Note
Apply the reload history step never passes source snapshot params or an initiator navigable to apply the history step. This is because reloading is always treated as if it were done by the navigable itself, even in cases like parent.location.reload().

To apply the traverse history step given a non-negative integer step to a traversable navigable traversable, with source snapshot params sourceSnapshotParams, navigable initiatorToCheck, and user navigation involvement userInvolvement:

1. Return the result of applying the history step step to traversable given true, sourceSnapshotParams, initiatorToCheck, userInvolvement, and "traverse".

Now for the algorithm itself.

To apply the history step given a non-negative integer step to a traversable navigable traversable, with boolean checkForCancellation, source snapshot params, or-null sourceSnapshotParams, navigable, or-null initiatorToCheck, user
navigation involvement\(^{1003}\)-or-null userInvolvementForNavigateEvents, and NavigationType\(^{944}\)-or-null navigationType, perform the following steps. They return "initiator-disallowed", "canceled-by-beforeunload", "canceled-by-navigate", or "applied".

1. **Assert**: This is running within traversable's session history traversal queue\(^{979}\).
2. Let targetStep be the result of getting the used step\(^{1016}\) given traversable and step.
3. If initiatorToCheck is not null, then:
   1. **Assert**: sourceSnapshotParams is not null.
   2. For each navigable of get all navigables whose current session history entry will change or reload\(^{1036}\) : if initiatorToCheck is not allowed by sandboxing to navigate\(^{1013}\) navigable given sourceSnapshotParams, then return "initiator-disallowed".
4. Let navigablesCrossingDocuments be the result of getting all navigables that might experience a cross-document traversal\(^{1038}\) given traversable and targetStep.
5. If checkForCancellation is true, and the result of checking if unloading is canceled\(^{1014}\) given navigablesCrossingDocuments, traversable, targetStep, and userInvolvementForNavigateEvents is not "continue", then return that result.
6. Let changingNavigables be the result of getting all navigables whose current session history entry will change or reload\(^{1036}\) given traversable and targetStep.
7. Let nonchangingNavigablesThatStillNeedUpdates be the result of getting all navigables that only need history object length/index update\(^{1037}\) given traversable and targetStep.
8. For each navigable of changingNavigables:
   1. Let targetEntry be the result of getting the target history entry\(^{1037}\) given navigable and targetStep.
   2. Set navigable's current session history entry\(^{978}\) to targetEntry.
   3. Set the ongoing navigation\(^{1016}\) for navigable to "traversal".
9. Let totalChangeJobs be the size of changingNavigables.
10. Let completedChangeJobs be 0.
11. Let changingNavigableContinuations be an empty queue of changing navigable continuation states\(^{1029}\).

   **Note**
   This queue is used to split the operations on changingNavigables into two parts. Specifically, changingNavigableContinuations holds data for the second part\(^{1033}\).

12. For each navigable of changingNavigables, queue a global task\(^{1106}\) on the navigation and traversal task source\(^{1115}\) of navigable's active window\(^{978}\) to run the steps:

   **Note**
   This set of steps are split into two parts to allow synchronous navigations to be processed before documents unload. State is stored in changingNavigableContinuations for the second part\(^{1033}\).

   1. Let displayedEntry be navigable's active session history entry\(^{978}\).
   2. Let targetEntry be navigable's current session history entry\(^{978}\).
   3. Let changingNavigableContinuation be a changing navigable continuation state\(^{1029}\) with:
      
      displayed document\(^{1029}\)
      displayedEntry's document\(^{994}\)
      target entry\(^{1029}\)
      targetEntry
      navigable\(^{1029}\)
      navigable
      update-only\(^{1029}\)
      false

   4. If displayedEntry is targetEntry and targetEntry's document state\(^{994}\)s reload pending\(^{996}\) is false, then:
1. Set `changingNavigableContinuation`'s `update-only` to true.
2. Enqueue `changingNavigableContinuation` on `changingNavigableContinuations`.
3. Abort these steps.

Note

This case occurs due to a synchronous navigation which already updated the active session history entry.

5. Switch on `navigationType`:
   
   - **reload**
     
     Assert: targetEntry's `document state`'s `reload pending` is true.
   
   - **traverse**
     
     Assert: targetEntry's `document state`'s `ever populated` is true.
   
   - **replace**
     
     Assert: targetEntry's `step` is displayedEntry's `step` and targetEntry's `document state`'s `ever populated` is false.
   
   - **push**
     
     Assert: targetEntry's `step` is displayedEntry's `step` + 1 and targetEntry's `document state`'s `ever populated` is false.


7. If all of the following are true:
   
   - `navigable` is not traversable;
   
   - targetEntry is not `navigable`'s `current session history entry`;
   
   - `oldOrigin` is the same as `navigable`'s `current session history entry`'s `document state`'s `origin`,

   then:
   
   1. Assert: `userInvolvementForNavigateEvents` is not null.
   2. Let `navigation` be `navigable`'s `active window`'s `navigation API`.
   3. Fire a traverse navigate event at `navigation` given targetEntry and `userInvolvementForNavigateEvents`.

8. If targetEntry's `document` is null, or targetEntry's `document state`'s `reload pending` is true, then:
   
   1. Let `navTimingType` be "back-forward" if targetEntry's `document` is null; otherwise "reload".
   2. Let `targetSnapshotParams` be the result of snapshotting target snapshot params given `navigable`.
   3. Let `potentiallyTargetSpecificSourceSnapshotParams` be `sourceSnapshotParams`.
   4. If `potentiallyTargetSpecificSourceSnapshotParams` is null, then set it to the result of snapshotting source snapshot params given `navigable`'s `active document`.

Note

In this case there is no clear source of the traversal/reload. We treat this situation as if `navigable` navigated itself, but note that some properties of targetEntry's original initiator are preserved in `targetEntry`'s `document state`, such as the `initiator origin` and `referrer`, which will appropriately influence the navigation.

5. Set targetEntry's `document state`'s `reload pending` to false.
6. Let `allowPOST` be targetEntry's `document state`'s `reload pending`.
7. In parallel, attempt to populate the history entry's `document` for targetEntry, given `navigable`,
potentiallyTargetSpecificSourceSnapshotParams, targetSnapshotParams, with allowPOST set to allowPOST and completionSteps set to queue a global task on the navigation and traversal task source given navigable's active window to run afterDocumentPopulated.

Otherwise, run afterDocumentPopulated immediately.

In both cases, let afterDocumentPopulated be the following steps:

1. If targetEntry's document is null, then set changingNavigableContinuation's update-only to true.

   **Note**
   This means we tried to populate the document, but were unable to do so, e.g. because of the server returning a 204.

2. If targetEntry's document's origin is not oldOrigin, then set targetEntry's classic history API state to StructuredSerializeForStorage(null).

   **Note**
   This clears history state when the origin changed vs a previous load of targetEntry without a redirect occurring. This can happen due to a change in CSP sandbox headers.

3. If all of the following are true:
   
   - navigable's parent is null;
   - targetEntry's document's browsing context is not an auxiliary browsing context whose opener browsing context is non-null; and
   - targetEntry's document's origin is not oldOrigin,

   then set targetEntry's document state's navigable target name to the empty string.

4. Enqueue changingNavigableContinuation on changingNavigableContinuations.

   **Note**
   The rest of this job runs later in this algorithm.


14. While completedChangeJobs does not equal totalChangeJobs:

   1. If traversable's running nested apply history step is false, then:

      1. While traversable's session history traversal queue's algorithm set contains one or more synchronous navigation steps, with a target navigable, not contained in navigablesThatMustWaitBeforeHandlingSyncNavigation:

         1. Let steps be the first Item in traversable's session history traversal queue's algorithm set that is synchronous navigation steps with a target navigable, not contained in navigablesThatMustWaitBeforeHandlingSyncNavigation.

         2. Remove steps from traversable's session history traversal queue's algorithm set.
3. Set traversable's running nested apply history step\(^{979}\) to true.
4. Run steps.
5. Set traversable's running nested apply history step\(^{979}\) to false.

### Note

Synchronous navigations that are intended to take place before this traversal jump the queue at this point, so they can be added to the correct place in traversable's session history entries\(^{979}\) before this traversal potentially unloads their document. More details can be found here\(^{997}\).

2. Let changingNavigableContinuation be the result of dequeuing from changingNavigableContinuations.
3. If changingNavigableContinuation is nothing, then continue.
4. Let displayedDocument be changingNavigableContinuation's displayed document\(^{1029}\).
5. Let targetEntry be changingNavigableContinuation's target entry\(^{1029}\).
6. Let navigable be changingNavigableContinuation's navigable\(^{1029}\).
7. Let (scriptHistoryLength, scriptHistoryIndex) be the result of getting the history object length and index\(^{1036}\) given traversable and targetStep.

### Note

These values might have changed since they were last calculated.


### Note

Once a navigable has reached this point in traversal, additionally queued synchronous navigation steps are likely to be intended to occur after this traversal rather than before it, so they no longer jump the queue. More details can be found here\(^{997}\).

9. Let entriesForNavigationAPI be the result of getting session history entries for the navigation API\(^{999}\) given navigable and targetStep.
10. If changingNavigableContinuation's update-only\(^{1029}\) is true, or targetEntry's document\(^{994}\) is displayedDocument, then:

#### Note

This is a same-document navigation: we proceed without unloading.

1. Set the ongoing navigation\(^{1016}\) for navigable to null.

### Note

This allows new navigations\(^{1003}\) of navigable to start, whereas during the traversal they were blocked.

2. Queue a global task\(^{1106}\) on the navigation and traversal task source\(^{1115}\) given navigable's active window\(^{978}\) to perform afterPotentialUnloads.

11. Otherwise:

1. Assert: navigationType is not null.
2. Deactivate\(^{1014}\) displayedDocument, given userNavigationInvolvement, targetEntry, navigationType, and afterPotentialUnloads.

12. In both cases, let afterPotentialUnloads be the following steps:

1. If changingNavigableContinuation's update-only\(^{1029}\) is false, then activate history entry\(^{1036}\) targetEntry for navigable.
2. Let updateDocument be an algorithm step which performs update document for history step application\(^{1038}\) given targetEntry's document\(^{994}\), targetEntry, changingNavigableContinuation's update-
3. If `targetEntry`'s `document` is equal to `displayedDocument`, then perform `updateDocument`.

4. Otherwise, queue a global task on the navigation and traversal task source given `targetEntry`'s `document`'s relevant global object to perform `updateDocument`.

5. Increment `completedChangeJobs`.

15. Let `totalNonchangingJobs` be the size of `nonchangingNavigablesThatStillNeedUpdates`.

16. Let `completedNonchangingJobs` be 0.

17. Let `(scriptHistoryLength, scriptHistoryIndex)` be the result of getting the history object length and index given `traversable` and `targetStep`.

18. For each navigable of `nonchangingNavigablesThatStillNeedUpdates`, queue a global task on the navigation and traversal task source given navigable's active window to run the steps:
   1. Let `document` be navigable's active document.
   2. Set `document`'s history object's index to `scriptHistoryIndex`.
   3. Set `document`'s history object's length to `scriptHistoryLength`.
   4. Increment `completedNonchangingJobs`.


20. Set `traversable`'s current session history step to `targetStep`.

21. Return "applied".

To deactivate a document for a cross-document navigation given a `Document`, `displayedDocument`, a `user navigation involvement` userNavigationInvolvement, a session history entry targetEntry, a `NavigationType` navigationType, and `afterPotentialUnloads`, which is an algorithm that receives no arguments:

1. Let `navigable` be `displayedDocument`'s node navigable.

2. Let `potentiallyTriggerViewTransition` be false.

3. Let `isBrowserUINavigation` be true if `userNavigationInvolvement` is "browser UI"; otherwise false.

4. Set `potentiallyTriggerViewTransition` to the result of calling `can navigation trigger a cross-document view-transition?` given `displayedDocument`, `targetEntry`'s `document`, `navigationType`, and `isBrowserUINavigation`.

5. If `potentiallyTriggerViewTransition` is false, then:
   1. Let `firePageSwapBeforeUnload` be the following step:
      1. Fire the pageswap event given `displayedDocument`, `targetEntry`, `navigationType`, and null.
   2. Set the ongoing navigation for `navigable` to null.
      
      This allows new navigations of `navigable` to start, whereas during the traversal they were blocked.


6. Otherwise, queue a global task on the navigation and traversal task source given `navigable`'s active window to run the steps:
   1. Let `proceedWithNavigationAfterViewTransitionCapture` be the following step:
1. Append the following session history traversal steps\textsuperscript{997} to navigable's traversable navigable\textsuperscript{979}:

   1. Set the ongoing navigation\textsuperscript{9101} for navigable to null.

   \textbf{Note}\textsuperscript{1033}
   \begin{itemize}
   \item This allows new navigations\textsuperscript{1083} of navigable to start, whereas during the traversal they were blocked.
   \end{itemize}

   2. Unload a document and its descendants\textsuperscript{91053} given displayedDocument, targetEntry's document\textsuperscript{994}, and afterPotentialUnloads.

   2. Let viewTransition be the result of setting up a cross-document view-transition given displayedDocument, targetEntry's document\textsuperscript{994}, navigationType, and proceedWithNavigationAfterViewTransitionCapture.

   3. Fire the pageswap event\textsuperscript{1035} given displayedDocument, targetEntry, navigationType, and viewTransition.

   4. If viewTransition is null, then run proceedWithNavigationAfterViewTransitionCapture.

\textbf{Note}\textsuperscript{1032}
\begin{itemize}
\item In the case where a view transition started, the view transitions algorithms are responsible for calling proceedWithNavigationAfterViewTransitionCapture.
\end{itemize}

\textit{To fire the pageswap event} given a Document\textsuperscript{1118} displayedDocument, a session history entry\textsuperscript{994} targetEntry, a NavigationType\textsuperscript{944} navigationType, and a ViewTransition-or-null viewTransition:

1. \textbf{Assert}: this is running as part of a task\textsuperscript{9110} queued on displayedDocument's relevant agent\textsuperscript{91061}'s event loop\textsuperscript{9114}.

2. Let navigation be displayedDocument's relevant global object\textsuperscript{1071}'s navigation API\textsuperscript{944}.

3. Let activation be null.

4. If all of the following are true:
   \begin{itemize}
   \item targetEntry's document\textsuperscript{994}'s origin is same origin\textsuperscript{991} with displayedDocument's origin; and
   \item targetEntry's document\textsuperscript{994}'s was created via cross-origin redirects\textsuperscript{9132} is false, or targetEntry's document\textsuperscript{994}'s latest entry\textsuperscript{996} is not null,
   \end{itemize}

   then:

   1. Let destinationEntry be determined by switching on navigationType:
      \begin{itemize}
      \item \textit{reload}\textsuperscript{945}:
         \begin{itemize}
         \item The current entry\textsuperscript{944} of navigation
         \end{itemize}
      \item \textit{traverse}\textsuperscript{945}:
         \begin{itemize}
         \item The NavigationHistoryEntry\textsuperscript{947} in navigation's entry list\textsuperscript{944} whose session history entry\textsuperscript{948} is targetEntry
         \end{itemize}
      \item \textit{push}\textsuperscript{945}:
      \item \textit{replace}\textsuperscript{945}:
         \begin{itemize}
         \item A new NavigationHistoryEntry\textsuperscript{941} in displayedDocument's relevant realm\textsuperscript{1071} with its session history entry\textsuperscript{948} set to targetEntry.
         \end{itemize}
      \end{itemize}

   2. Set activation to a new NavigationActivation\textsuperscript{968} created in displayedDocument's relevant realm\textsuperscript{1071}, with old entry\textsuperscript{966} the current entry\textsuperscript{944} of navigation
      \begin{itemize}
      \item new entry\textsuperscript{966} destinationEntry
      \item navigation type\textsuperscript{966}
      \end{itemize}

   \textbf{Note}\textsuperscript{973}
   \begin{itemize}
   \item This means that a cross-origin redirect during a navigation would result in a null activation\textsuperscript{973} in the old document's PageSwapEvent\textsuperscript{973}, unless the new document is being restored from bfcache\textsuperscript{995}.
   \end{itemize}
To activate history entry session history entry entry\(^{994}\) entry for navigable navigable:\(^{979}\)

1. Save persisted state\(^{1043}\) to the navigable's active session history entry\(^{978}\).
2. Let newDocument be entry's document\(^{994}\).
3. Assert: newDocument's is initial about:blank\(^{129}\) is false, i.e., we never traverse back to the initial about:blank Document\(^{129}\) because it always gets replaced\(^{1004}\) when we navigate away from it.
4. Set navigable's active session history entry\(^{978}\) to entry.

To get the used step given a traversable navigable traversable, and a non-negative integer step, perform the following steps. They return a non-negative integer.

1. Let steps be the result of getting all used history steps\(^{1000}\) within traversable.
2. Return the greatest item in steps that is less than or equal to step.

**Note**

This caters for situations where there's no session history entry entry\(^{994}\) with step step\(^{994}\) step, due to the removal of a navigable\(^{978}\).

To get the history object length and index given a traversable navigable traversable, and a non-negative integer step, perform the following steps. They return a tuple of two non-negative integers.

1. Let steps be the result of getting all used history steps\(^{1000}\) within traversable.
2. Let scriptHistoryLength be the size of steps.

**Note**

It is assumed that step has been adjusted by getting the used step\(^{1036}\).

4. Let scriptHistoryIndex be the index of step in steps.
5. Return (scriptHistoryLength, scriptHistoryIndex).

To get all navigables whose current session history entry will change or reload given a traversable navigable traversable, and a non-negative integer targetStep, perform the following steps. They return a list of navigables.

1. Let results be an empty list.
2. Let navigablesToCheck be « traversable ».
3. For each navigable of navigablesToCheck:
   1. Let targetEntry be the result of getting the target history entry\(^{1037}\) given navigable and targetStep.
   2. If targetEntry is not navigable's current session history entry\(^{978}\) or targetEntry's document state\(^{994}\)'s reload pending\(^{996}\) is true, then append navigable to results.
   3. If targetEntry's document\(^{994}\) is navigable's document\(^{978}\), and targetEntry's document state\(^{994}\)'s reload pending\(^{996}\) is false, then extend navigablesToCheck with the child navigables\(^{981}\) of navigable.

**Note**

Adding child navigables\(^{981}\) to navigablesToCheck means those navigables will also be checked by this loop. Child navigables\(^{982}\) are only checked if the navigable's active document\(^{978}\) will not change as part of this...
4. Return results.

To get all navigables that only need history object length/index update given a traversable navigable traversable, and a non-negative integer targetStep, perform the following steps. They return a list of navigables.

Note
Other navigables might not be impacted by the traversal. For example, if the response is a 204, the currently active document will remain. Additionally, going 'back' after a 204 will change the current session history entry, but the active session history entry will already be correct.

1. Let results be an empty list.
2. Let navigablesToCheck be « traversable ».

Note
This list is extended in the loop below.

3. For each navigable of navigablesToCheck:
   1. Let targetEntry be the result of getting the target history entry given navigable and targetStep.
   2. If targetEntry is navigable's current session history entry and targetEntry's document state's reload pending is false, then:
      1. Append navigable to results.
      2. Extend navigablesToCheck with navigable's child navigables.

Note
Adding child navigables to navigablesToCheck means those navigables will also be checked by this loop. child navigables are only checked if the navigable's active document will not change as part of this traversal.

4. Return results.

To get the target history entry given a navigable navigable, and a non-negative integer step, perform the following steps. They return a session history entry.

1. Let entries be the result of getting session history entries for navigable.
2. Return the item in entries that has the greatest step less than or equal to step.

Example
To see why getting the target history entry returns the entry with the greatest step less than or equal to the input step, consider the following Jake diagram:

```
  | 0 | 1 | 2 | 3 |
top /t /t#foo
frames[0] /i-0-a /i-0-b
```

For the input step 1, the target history entry for the top navigable is the /t entry, whose step is 0, while the target history entry for the frames[0] navigable is the /i-0-b entry, whose step is 1:

```
  | 0 | 1 | 2 | 3 |
top /t /t#foo
frames[0] /i-0-a /i-0-b
```

Similarly, given the input step 3 we get the top entry whose step is 3, and the frames[0] entry whose step is 1:
To **get all navigables that might experience a cross-document traversal** given a traversable navigable traversable, and a non-negative integer targetStep, perform the following steps. They return a list of navigables.

1. Let results be an empty list.
2. Let navigablesToCheck be « traversable ».
3. For each navigable of navigablesToCheck:
   1. Let targetEntry be the result of getting the target history entry given navigable and targetStep.
   2. If targetEntry’s document is not navigable’s document or targetEntry’s document state’s reload pending is true, then append navigable to results.
   3. Otherwise, extend navigablesToCheck with navigable’s child navigables.
4. Return results.

### 7.4.6.2 Updating the document

To **update document for history step application** given a Document document, a session history entry entry, a boolean doNotReactivate, integers scriptHistoryLength and scriptHistoryIndex, NavigationType or-null navigationType, an optional list of session history entries entriesForNavigationAPI, and an optional session history entry previousEntryForActivation:

1. Let documentisNew be true if document’s latest entry is null; otherwise false.
2. Let documentsEntryChanged be true if document’s latest entry is not entry; otherwise false.
3. Set document’s history object’s index to scriptHistoryIndex.
4. Set document’s history object’s length to scriptHistoryLength.
5. Let navigation be history’s relevant global object’s navigation API.
6. If documentsEntryChanged is true, then:
1. Let oldURL be document's latest entry's URL.
2. Set document's latest entry to entry.
3. Restore the history object state given document and entry.
4. If documentIsNew is false, then:
   1. Assert: navigationType is not null.
   2. Update the navigation API entries for a same-document navigation given navigation, entry, and navigationType.
   3. Fire an event named popstate at document's relevant global object, using PopStateEvent, with the state attribute initialized to document's history object's state and hasAVisibleTransition initialized to true if a visual transition, to display a cached rendered state of the latest entry, was done by the user agent.
   4. Restore persisted state given entry.
   5. If oldURL's fragment is not equal to entry's URL's fragment, then queue a global task on the DOM manipulation task source given document's relevant global object, to fire an event named hashchange at document's relevant global object, using HashChangeEvent, with the oldURL attribute initialized to the serialization of oldURL and the newURL attribute initialized to the serialization of entry's URL.
5. Otherwise:
   1. Assert: entriesForNavigationAPI is given.
   2. Restore persisted state given entry.
   3. Initialize the navigation API entries for a new document given navigation, entriesForNavigationAPI, and entry.
7. If all the following are true:
   - previousEntryForActivation is given;
   - navigationType is non-null; and
   - navigationType is "reload" or previousEntryForActivation's document is not document
then:
   1. If navigation's activation is null, then set navigation's activation to a new NavigationActivation object in navigation's relevant realm.
   2. Let previousEntryIndex be the result of getting the navigation API entry index of previousEntryForActivation within navigation.
   3. If previousEntryIndex is non-negative, then set activation's old entry to navigation's entry list[previousEntryIndex].
4. Otherwise, if all the following are true:
   - navigationType is "replace";
   - previousEntryForActivation's document state's origin's same origin with document's origin; and
   - previousEntryForActivation's document's initial about:blank is false,
then set activation's old entry to a new NavigationHistoryEntry in navigation's relevant realm, whose session history entry is previousEntryForActivation.
5. Set activation's new entry to navigation's current entry.
6. Set activation's navigation type to navigationType.
8. If documentIsNew is true, then:
1. Try to scroll to the fragment for document.

2. At this point scripts may run for the newly-created document document.

9. Otherwise, if documentsEntryChanged is false and doNotReactivate is false, then:

   1. Assert: entriesForNavigationAPI is given.

   2. Reactivate document given entry and entriesForNavigationAPI.

   Note

documentsEntryChanged can be false for one of two reasons: either we are restoring from bfcache, or we are asynchronously finishing up a synchronous navigation which already synchronously set document’s latest entry. The doNotReactivate argument distinguishes between these two cases.

To restore the history object state given Document document and session history entry entry:

1. Let targetRealm be document’s relevant realm.

2. Let state be StructuredDeserializ (entry’s classic history API state, targetRealm). If this throws an exception, catch it and let state be null.

3. Set document’s history object’s state to state.

To make active a Document document:

1. Let window be document’s relevant global object.

2. Set document’s browsing context’s WindowProxy’s [[Window]] internal slot value to window.

3. Set document’s visibility state to document’s node navigable’s traversable navigable’s system visibility state.

4. Queue a new VisibilityStateEntry whose visibility state is document’s visibility state and whose timestamp is zero.

5. Set window’s relevant settings object’s execution ready flag.

To reactivate a Document document given a session history entry reactivatedEntry and a list of session history entries entriesForNavigationAPI:

Note

This algorithm updates document after it has come out of bfcache, i.e., after it has been made fully active again. Other specifications that want to watch for this change to the fully active state are encouraged to add steps into this algorithm, so that the ordering of events that happen in effect of the change is clear.

1. For each formControl of form controls in document with an autofill field name of "off", invoke the reset algorithm for formControl.

2. If document’s suspended timer handles is not empty:

   1. Assert: document’s suspension time is not zero.

   2. Let suspendDuration be the current high resolution time minus document’s suspension time.

   3. Let activeTimers be document’s relevant global object’s map of active timers.

   4. For each handle in document’s suspended timer handles, if activeTimers[handle] exists, then increase activeTimers[handle] by suspendDuration.

3. Update the navigation API entries for reactivation given document’s relevant global object’s navigation API, entriesForNavigationAPI, and reactivatedEntry.

4. If document’s current document readiness is "complete", and document’s page showing flag is false, then:

   1. Set document’s page showing flag to true.

   2. Set document’s has been revealed to false.
3. Update the visibility state\(^{820}\) of document to "visible".

4. Fire a page transition event\(^{874}\) named \texttt{pageshow}\(^{1452}\) at document's relevant global object\(^{6107}\) with true.

To try to scroll to the fragment for a Document\(^{128}\) document, perform the following steps in parallel\(^{443}\):

1. Wait for an implementation-defined amount of time. (This is intended to allow the user agent to optimize the user experience in the face of performance concerns.)

2. Queue a global task\(^{1106}\) on the navigation and traversal task source\(^{1115}\) given document's relevant global object\(^{6107}\) to run these steps:
   
   1. If document has no parser, or its parser has stopped parsing\(^{1339}\), or the user agent has reason to believe the user is no longer interested in scrolling to the fragment, then abort these steps.
   
   2. Scroll to the fragment\(^{1042}\) given document.
   
   3. If document's indicated part\(^{1043}\) is still null, then try to scroll to the fragment\(^{1041}\) for document.

To make document unsalvageable, given a Document\(^{128}\) document and a string reason:

1. Let details be a new not restored reason details\(^{976}\) whose reason\(^{976}\) is reason.

2. Append details to document's bfcache blocking details\(^{510}\).

3. Set document's salvageable\(^{1052}\) state to false.

To build not restored reasons for document state given Document\(^{128}\) document:

1. Let notRestoredReasonsForDocument be a new not restored reasons\(^{977}\).

2. Set notRestoredReasonsForDocument's URL\(^{977}\) to document's URL.

3. If document's node navigable\(^{979}\)'s container\(^{981}\) is an iframe\(^{387}\) element, then:
   
   1. Set notRestoredReasonsForDocument's src\(^{977}\) to the value of document's node navigable\(^{979}\)'s container\(^{981}\)'s src\(^{388}\) attribute.
   
   2. Set notRestoredReasonsForDocument's id\(^{977}\) to the value of document's node navigable\(^{979}\)'s container\(^{981}\)'s id\(^{152}\) attribute.
   
   3. Set notRestoredReasonsForDocument's name\(^{977}\) to the value of document's node navigable\(^{979}\)'s container\(^{981}\)'s name\(^{392}\) attribute.

4. Set notRestoredReasonsForDocument's reasons\(^{977}\) to a clone of document's bfcache blocking details\(^{510}\).

5. For each navigable of document's document-tree child navigables\(^{984}\):
   
   1. Let childDocument be navigable's active document\(^{979}\).
   
   2. Build not restored reasons for document state\(^{1041}\) given childDocument.

   3. Append childDocument's not restored reasons\(^{977}\) to notRestoredReasonsForDocument's children\(^{977}\).

6. Set document's node navigable\(^{979}\)'s active session history entry\(^{978}\)'s document state\(^{984}\)'s not restored reasons\(^{996}\) to notRestoredReasonsForDocument.

To build not restored reasons for a top-level traversable and its descendants given top-level traversable\(^{979}\) topLevelTraversable:

1. Build not restored reasons for document state\(^{1041}\) given topLevelTraversable's active document\(^{978}\).

2. Let crossOriginDescendants be an empty list.

3. For each childNavigable of topLevelTraversable's active document\(^{978}\)'s descendant navigables\(^{983}\):
   
   1. If childNavigable's active document\(^{978}\)'s origin is not same origin\(^{601}\) with topLevelTraversable's active document\(^{978}\)'s origin, then append childNavigable to crossOriginDescendants.

4. Let crossOriginDescendantsPreventsBfcache be false.
5. **For each** `crossOriginNavigable` of `crossOriginDescendants`:
   2. If `reasonsForCrossOriginChild`'s `reasons` is not empty, set `crossOriginDescendantsPreventsBfcache` to true.
   3. Set `reasonsForCrossOriginChild`'s `URL` to null.
   4. Set `reasonsForCrossOriginChild`'s `reasons` to null.
   5. Set `reasonsForCrossOriginChild`'s `children` to null.

6. If `crossOriginDescendantsPreventsBfcache` is true, `make document unsalvageable` given `topLevelTraversable`'s `active document` and "masked".

### 7.4.6.3 Revealing the document

A Document has a boolean **has been revealed**, initially false. It is used to ensure that the `pagereveal` event is fired once for each activation of the Document (once when it's rendered initially, and once for each reactivation).

To reveal a Document document:

1. If document's `has been revealed` is true, then return.
2. Set document's `has been revealed` to true.
3. Let transition be the result of resolving inbound cross-document view-transition for document.
4. Fire an event named `pagereveal` at document's relevant global object, using `PageRevealEvent` with its `viewTransition` set to transition.
5. If transition is not null, then activate transition.

---

**Note**

Though `pagereveal` is guaranteed to be fired during the first update the rendering step that displays an up-to-date version of the page, user agents are free to display a cached frame of the page before firing it. This prevents the presence of a `pagereveal` handler from delaying the presentation of such cached frame.

### 7.4.6.4 Scrolling to a fragment

To scroll to the fragment given a Document document:

1. If document's `indicated part` is null, then set document's `target element` to null.
2. Otherwise, if document's `indicated part` is top of the document, then:
   1. Set document's `target element` to null.
   2. Scroll to the beginning of the document for document. [CSSOMVIEW]
   3. Return.
3. Otherwise:
   1. Assert: document's `indicated part` is an element.
   2. Let target be document's `indicated part`.
   4. Run the `ancestor details revealing algorithm` on target.
   5. Run the `ancestor hidden-until-found revealing algorithm` on target.
6. Scroll target into view, with behavior set to "auto", block set to "start", and inline set to "nearest". [CSSOMVIEW]

7. Run the focusing steps for target, with the Document's viewport as the fallback target.

8. Move the sequential focus navigation starting point to target.

A Document's indicated part is the one that its URL's fragment identifies, or null if the fragment does not identify anything. The semantics of the fragment in terms of mapping it to a node is defined by the specification that defines the MIME type used by the Document (for example, the processing of fragments for XML MIME types is the responsibility of RFC7303). [RFC7303]

There is also a target element for each Document, which is used in defining the :target pseudo-class and is updated by the above algorithm. It is initially null.

For an HTML document document, its indicated part is the result of selecting the indicated part given document and document's URL.

To select the indicated part given a Document document and a URL url:

1. If document's URL does not equal url with exclude fragments set to true, then return null.
2. Let fragment be url's fragment.
3. If fragment is the empty string, then return the special value top of the document.
4. Let potentialIndicatedElement be the result of finding a potential indicated element given document and fragment.
5. If potentialIndicatedElement is not null, then return potentialIndicatedElement.
6. Let fragmentBytes be the result of percent-decoding fragment.
7. Let decodedFragment be the result of running UTF-8 decode without BOM on fragmentBytes.
8. Set potentialIndicatedElement to the result of finding a potential indicated element given document and decodedFragment.
9. If potentialIndicatedElement is not null, then return potentialIndicatedElement.
10. If decodedFragment is an ASCII case-insensitive match for the string top, then return the top of the document.
11. Return null.

To find a potential indicated element given a Document document and a string fragment, run these steps:

1. If there is an element in the document tree whose root is document and that has an ID equal to fragment, then return the first such element in tree order.
2. If there is an a element in the document tree whose root is document that has a name attribute whose value is equal to fragment, then return the first such element in tree order.
3. Return null.

7.4.6.5 Persisted history entry state

To save persisted state to a session history entry entry:

1. Set the scroll position data of entry to contain the scroll positions for all of entry's document's restorable scrollable regions.
2. Optionally, update entry's persisted user state to reflect any state that the user agent wishes to persist, such as the values of form fields.

To restore persisted state from a session history entry entry:

1. If entry's scroll restoration mode is "auto", and entry's document's relevant global object's navigation API's suppress normal scroll restoration during ongoing navigation is false, then restore scroll position data given entry.
2. Optionally, update other aspects of entry's document and its rendering, for instance values of form fields, that the user agent had previously recorded in entry's persisted user state.

Each Document has a boolean has been scrolled by the user, initially false. If the user scrolls the document, the user agent must set that document's has been scrolled by the user to true.

The restorable scrollable regions of a Document document are document's viewport, and all of document's scrollable regions excepting any navigable containers.

To restore scroll position data given a session history entry entry:

1. Let document be entry's document.
2. If document's has been scrolled by the user is true, then the user agent should return.
3. The user agent should attempt to use entry's scroll position data to restore the scroll positions of entry's document's restorable scrollable regions. The user agent may continue to attempt to do so periodically, until document's has been scrolled by the user becomes true.

Note: This is formulated as an attempt, which is potentially repeated until success or until the user scrolls, due to the fact that relevant content indicated by the scroll position data might take some time to load from the network.

Note: Scroll restoration might be affected by scroll anchoring.

7.5 Document lifecycle

7.5.1 Shared document creation infrastructure

When loading a document using one of the below algorithms, we use the following steps to create and initialize a Document object, given a type, content type, and navigation params navigationParams.
1. Let `browsingContext` be `navigationParams`'s `navigable`'s active `browsing context`.

2. Set `browsingContext` to the result of the obtaining a browsing context to use for a navigation response, given `browsingContext`, `navigationParams`'s final sandboxing flag set, `navigationParams`'s cross-origin opener policy, and `navigationParams`'s COOP enforcement result.

3. Let `permissionsPolicy` be the result of creating a permissions policy from a response given `navigationParams`'s `navigable`'s container, `navigationParams`'s `origin`, and `navigationParams`'s `response`. If `permissionsPolicy` is non-null, then set `creationURL` to `navigationParams`'s `response`'s URL.

4. If `navigationParams`'s `request` is non-null, then set `creationURL` to `navigationParams`'s `request`'s current URL.

5. Let `window` be null.

6. If `browsingContext`'s active `document`'s `is initial about:blank` is true, and `browsingContext`'s active `document`'s `origin` is same-origin-domain with `navigationParams`'s `origin`, then set `window` to `browsingContext`'s active window.

7. Otherwise:
   1. Let `oacHeader` be the result of getting a structured field value given `Origin-Agent-Cluster` and "item" from `navigationParams`'s `response`'s header list.
   2. Let `requestsOAC` be true if `oacHeader` is not null and `oacHeader[0]` is the boolean true; otherwise false.
   3. If `navigationParams`'s `reserved environment` is a non-secure context, then set `requestsOAC` to false.
   4. Let `agent` be the result of obtaining a similar-origin window agent given `navigationParams`'s `origin`, `browsingContext`'s group, and `requestsOAC`.
   5. Let `realmExecutionContext` be the result of creating a new realm given `agent` and the following customizations:
      - For the global object, create a new `Window` object.
      - For the global this binding, use `browsingContext`'s `WindowProxy` object.
   6. Set `window` to the global object of `realmExecutionContext`'s Realm component.
   7. Let `topLevelCreationURL` be `creationURL`.

---

**Note**

- Document objects are also created when creating a new browsing context and document; such initial about:blank are never created by this algorithm. Also, browsing context-less Document objects can be created via various APIs, such as `document.implementation.createHTMLDocument()`.

- This can result in a browsing context group switch, in which case case `browsingContext` will be a newly-created browsing context instead of being `navigationParams`'s navigable's active `browsing context`. In such a case, the created `Window`, `Document`, and agent will not end up being used; because the created `Document`'s `origin` is opaque, we will end up creating a new agent and `Window` later in this algorithm to go along with the new `Document`.

- This means that both the initial about:blank Document, and the new Document that is about to be created, will share the same `Window` object.

---

**Note**

- The creating a permissions policy from a response algorithm makes use of the passed `origin`. If `document.domain` has been used for `navigationParams`'s `navigable`'s container document, then its `origin` cannot be same-origin-domain with the passed origin, because these steps run before the document is created, so it cannot itself yet have used `document.domain`. Note that this means that Permissions Policy checks are less permissive compared to doing a same-origin check instead.

See below for some examples of this in action.
8. Let `topLevelOrigin` be `navigationParams`'s `origin`.

9. If `navigable`'s `container` is not null, then:
   
   1. Let `parentEnvironment` be `navigable`'s `container`'s `relevant settings object`.
   2. Set `topLevelCreationURL` to `parentEnvironment`'s `top-level creation URL`.
   3. Set `topLevelOrigin` to `parentEnvironment`'s `top-level origin`.

10. Set up a `window environment settings object` with `creationURL`, `realmExecutionContext`, `navigationParams`'s `reserved environment`, `topLevelCreationURL`, and `topLevelOrigin`.

Note

This is the usual case, where the new `Document` we're about to create gets a new `Window` to go along with it.

9. Let `loadTimingInfo` be a new `document load timing info` with its `navigation start time` set to `navigationParams`'s `response`'s `timing info`'s `start time`.

10. Let `document` be a new `Document`, with

    type
    type
    content type
    contentType
    origin
    navigationParams's `origin`
    browsing context
    browsingContext
    policy container
    navigationParams's `policy container`
    permissions policy
    permissionsPolicy
    active sandboxing flag set
    navigationParams's `final sandboxing flag set`
    cross-origin opener policy
    navigationParams's `cross-origin opener policy`
    load timing info
    `loadTimingInfo`
    was created via cross-origin redirects
    navigationParams's `response`'s `has cross-origin redirects`
    during-loading navigation ID for WebDriver BiDi
    navigationParams's `id`
    URL
    `creationURL`
    current document readiness
    "loading"
    about base URL
    navigationParams's `about base URL`
    allow declarative shadow roots
    true


12. Run CSP initialization for a `Document` given `document`.

13. If `navigationParams`'s `request` is non-null, then:

   1. Set `document`'s `referrer` to the empty string.
   2. Let `referrer` be `navigationParams`'s `request`'s `referrer`.
   3. If `referrer` is a `URL record`, then set `document`'s `referrer` to the serialization of `referrer`.

Note

Per Fetch, `referrer` will be either a `URL record` or "no-referrer" at this point.
14. If `navigationParams`'s `fetch controller` is not null, then:
   1. Let `fullTimingInfo` be the result of extracting the full timing info from `navigationParams`'s `fetch controller`.
   2. Let `redirectCount` be 0 if `navigationParams`'s `response`'s has cross-origin redirects is true; otherwise `navigationParams`'s `request`'s `redirect count`.
   3. Create the navigation timing entry for document, given `fullTimingInfo`, `redirectCount`, `navigationTimingType`, `navigationParams`'s `response`'s `service worker timing info`, and `navigationParams`'s `response`'s `body info`.

15. Create the navigation timing entry for document, with `navigationParams`'s `response`'s `timing info`, `redirectCount`, `navigationParams`'s `navigation timing type`, and `navigationParams`'s `response`'s `service worker timing info`.

16. If `navigationParams`'s `response` has a `Refresh` header, then:
   1. Let `value` be the isomorphic decoding of the value of the header.
   2. Run the shared declarative refresh steps with `document` and `value`.

   We do not currently have a spec for how to handle multiple `Refresh` headers. This is tracked as issue #2900.

17. If `navigationParams`'s `commit early hints` is not null, then call `navigationParams`'s `commit early hints` with `document`.

18. Process link headers given `document`, `navigationParams`'s `response`, and "pre-media".


Example

In this example, the child document is not allowed to use `PaymentRequest`, despite being `same origin-domain` at the time the child document tries to use it. At the time the child document is initialized, only the parent document has set `document.domain`, and the child document has not.

```html
<!-- https://foo.example.com/a.html -->
<!doctype html>
<script>
    document.domain = 'example.com';
</script>
<iframe src='b.html'></iframe>
```

```html
<!-- https://bar.example.com/b.html -->
<!doctype html>
<script>
    document.domain = 'example.com'; // This happens after the document is initialized
    new PaymentRequest(); // Not allowed to use
</script>
```

Example

In this example, the child document is allowed to use `PaymentRequest`, despite not being `same origin-domain` at the time the child document tries to use it. At the time the child document is initialized, none of the documents have set `document.domain`, yet so `same origin-domain` falls back to a normal `same origin` check.

```html
<!-- https://example.com/a.html -->
<!doctype html>
<iframe src='b.html'></iframe>
```

```html
<!-- The child document is now initialized, before the script below is run. -->
<script>
    document.domain = 'example.com';
</script>
```

```html
<!-- https://example.com/b.html -->
<!doctype html>
<script>
</script>
```
To populate with html/head/body given a Document document:

1. Let html be the result of creating an element given document, html, and the HTML namespace.
2. Let head be the result of creating an element given document, head, and the HTML namespace.
3. Let body be the result of creating an element given document, body, and the HTML namespace.
4. Append html to document.
5. Append head to html.
6. Append body to html.

7.5.2 Loading HTML documents

To load an HTML document, given navigation params navigationParams:

1. Let document be the result of creating and initializing a Document object given "html", "text/html", and navigationParams.
2. If document's URL is about:blank, then populate with html/head/body given document.
3. Otherwise, create an HTML parser and associate it with the document. Each task that the networking task source places on the task queue while fetching runs must then fill the parser's input byte stream with the fetched bytes and cause the HTML parser to perform the appropriate processing of the input stream.

The first task that the networking task source places on the task queue while fetching runs must process link headers given document, navigationParams's response, and "media", after the task has been processed by the HTML parser.

Before any script execution occurs, the user agent must wait for scripts may run for the newly-created document to be true for document.


7.5.3 Loading XML documents

When faced with displaying an XML file inline, provided navigation params navigationParams and a string type, user agents must follow the requirements defined in XML and Namespaces in XML, XML Media Types, DOM, and other relevant specifications to create and initialize a Document object document, given "xml", type, and navigationParams, and return that Document. They must also
create a corresponding XML parser.

The first task that the networking task source places on the task queue while fetching runs must process link headers given document, navigationParams's response, and "media", after the task has been processed by the XML parser.

The actual HTTP headers and other metadata, not the headers as mutated or implied by the algorithms given in this specification, are the ones that must be used when determining the character encoding according to the rules given in the above specifications. Once the character encoding is established, the document's character encoding must be set to that character encoding.

Before any script execution occurs, the user agent must wait for scripts may run for the newly-created document to be true for the newly-created Document.

Once parsing is complete, the user agent must set document's during-loading navigation ID for WebDriver BiDi to null.

**Note**

For HTML documents this is reset when parsing is complete, after firing the load event.

Error messages from the parse process (e.g., XML namespace well-formedness errors) may be reported inline by mutating the Document.

### 7.5.4 Loading text documents

To load a text document, given a navigation params navigationParams and a string type:

1. Let document be the result of creating and initializing a Document object given "html", type, and navigationParams.
2. Set document's parser cannot change the mode flag to true.
3. Set document's mode to "no-quirks".
4. Create an HTML parser and associate it with the document. Act as if the tokenizer had emitted a start tag token with the tag name "pre" followed by a single U+000A LINE FEED (LF) character, and switch the HTML parser's tokenizer to the PLAINTEXT state. Each task that the networking task source places on the task queue while fetching runs must then fill the parser's input byte stream with the fetched bytes and cause the HTML parser to perform the appropriate processing of the input stream.

document's encoding must be set to the character encoding used to decode the document during parsing.

The first task that the networking task source places on the task queue while fetching runs must process link headers given document, navigationParams's response, and "media", after the task has been processed by the HTML parser.

Before any script execution occurs, the user agent must wait for scripts may run for the newly-created document to be true for document.

When no more bytes are available, the user agent must queue a global task on the networking task source given document's relevant global object to have the parser to process the implied EOF character, which eventually causes a load event to be fired.

5. User agents may add content to the head element of document, e.g., linking to a style sheet, providing script, or giving the document a title.

**Note**

In particular, if the user agent supports the Format=Flowed feature of RFC 3676 then the user agent would need to apply extra styling to cause the text to wrap correctly and to handle the quoting feature. This could be performed using, e.g., a CSS extension.

The rules for how to convert the bytes of the plain text document into actual characters, and the rules for actually rendering the text to the user, are defined by the specifications for the computed MIME type of the resource (i.e., type).

7.5.5 Loading multipart/x-mixed-replace documents

To load a multipart/x-mixed-replace document, given navigation params, source snapshot params, and origin initiatorOrigin:

1. Parse navigationParams's response's body using the rules for multipart types. [RFC2046]
2. Let firstPartNavigationParams be a copy of navigationParams.

For each additional body part obtained from navigationParams's response, the user agent must navigate document's node navigable to navigationParams's request's URL, using document, with response set to navigationParams's response and historyHandling set to "replace".

5. Return document.

For the purposes of algorithms processing these body parts as if they were complete stand-alone resources, the user agent must act as if there were no more bytes for those resources whenever the boundary following the body part is reached.

Note

Thus, load events (and for that matter unload events) do fire for each body part loaded.

7.5.6 Loading media documents

To load a media document, given navigationParams and a string type:

1. Let document be the result of creating and initializing a Document object given "html", type, and navigationParams.
2. Set document's mode to "no-quirks".
4. Append an element host element for the media, as described below, to the body element.
5. Set the appropriate attribute of the element host element, as described below, to the address of the image, video, or audio resource.
6. User agents may add content to the head element of document, or attributes to host element, e.g., to link to a style sheet, to provide a script, to give the document a title, or to make the media autoplay.
7. Process link headers given document, navigationParams's response, and "media".
8. Act as if the user agent had stopped parsing document.

The element host element to create for the media is the element given in the table below in the second cell of the row whose first cell describes the media. The appropriate attribute to set is the one given by the third cell in that same row.

<table>
<thead>
<tr>
<th>Type of media</th>
<th>Element for the media</th>
<th>Appropriate attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image</td>
<td>img</td>
<td>src</td>
</tr>
<tr>
<td>Video</td>
<td>video</td>
<td>src</td>
</tr>
<tr>
<td>Audio</td>
<td>audio</td>
<td>src</td>
</tr>
</tbody>
</table>
Before any script execution occurs, the user agent must wait for scripts may run for the newly-created document to be true for the Document.

### 7.5.7 Loading a document for inline content that doesn't have a DOM

When the user agent is to create a document to display a user agent page or PDF viewer inline, provided a navigable, a navigation ID, a NavigationTimingType navTimingType, the user agent should:

1. Let origin be a new opaque origin.
2. Let coop be a new cross-origin opener policy.
3. Let coopEnforcementResult be a new cross-origin opener policy enforcement result with
   - url's URL
   - origin
   - cross-origin opener policy coop
4. Let navigationParams be a new navigation params with
   - id
   - navigationId
   - navigable navigable request
   - null
   - a new response
   - origin
   - fetch controller
   - null
   - COOP enforcement result coopEnforcementResult
   - reserved environment
   - null
   - policy container
   - a new policy container final sandboxing flag set
   - an empty set
   - cross-origin opener policy coop
   - navigation timing type navTimingType
   - about base URL
5. Let document be the result of creating and initializing a Document object given "html", "text/html", and navigationParams.
6. Either associate document with a custom rendering that is not rendered using the normal Document rendering rules, or mutate document until it represents the content the user agent wants to render.

**Note**

Because we ensure the resulting Document's origin is opaque, and the resulting Document cannot run script with access to the DOM, the existence and properties of this Document are not observable to web developer code. This means that most of...
Once the page has been set up, the user agent must act as if it had stopped parsing.

7.5.8 Finishing the loading process

A Document has a completely loaded time (a time or null), which is initially null.

A Document is considered completely loaded if its completely loaded time is non-null.

To completely finish loading a Document document:

1. Assert: document's browsing context is non-null.
2. Set document's completely loaded time to the current time.
3. Let container be document's node navigable's container.
   
   Note: This will be null in the case where document is the initial about:blank Document in a frame or iframe, since at the point of browsing context creation which calls this algorithm, the container relationship has not yet been established. (That happens in a subsequent step of create a new child navigable.)

   The consequence of this is that the following steps do nothing, i.e., we do not fire an asynchronous load event on the container element for such cases. Instead, a synchronous load event is fired in a special initial-insertion case when processing the iframe attributes.

4. If container is an iframe element, then queue an element task on the DOM manipulation task source given container to run the iframe load event steps given container.
5. Otherwise, if container is non-null, then queue an element task on the DOM manipulation task source given container to fire an event named load at container.

7.5.9 Unloading documents

A Document has a salvageable state, which must initially be true, and a page showing flag, which must initially be false. The page showing flag is used to ensure that scripts receive pageshow and pagehide events in a consistent manner (e.g. that they never receive two pagehide events in a row without an intervening pageshow, or vice versa).

A Document has a DOMHighResTimeStamp suspension time, initially 0.

A Document has a list of suspended timer handles, initially empty.

Event loops have a termination nesting level counter, which must initially be 0.

Document objects have an unload counter, which is used to ignore certain operations while the below algorithms run. Initially, the counter must be set to zero.

To unload a Document oldDocument, given an optional Document newDocument:

1. Assert: this is running as part of a task queued on oldDocument's relevant agent's event loop.
2. Let unloadTimingInfo be a new document unload timing info.
3. If newDocument is not given, then set unloadTimingInfo to null.

Note: In this case there is no new document that needs to know about how long it took oldDocument to unload.
4. Otherwise, if `newDocument`'s `event loop`\(^{1104}\) is not `oldDocument`'s `event loop`\(^{1104}\), then the user agent may be **unloading**\(^{1052}\) `oldDocument` in parallel\(^{1103}\). In that case, the user agent should set `unloadTimingInfo` to null.

**Note**

_in this case newDocument's loading is not impacted by how long it takes to unload oldDocument, so it would be meaningless to communicate that timing info._

5. Let `intendToKeepInBfcache` be true if the user agent intends to keep `oldDocument` alive in a **session history entry**\(^{994}\), such that it can later be **used for history traversal**\(^{999}\).

This must be false if `oldDocument` is not **salvageable**\(^{1052}\), or if there are any descendants of `oldDocument` which the user agent does not intend to keep alive in the same way (including due to their lack of **salvageability**\(^{1052}\)).

6. Let `eventLoop` be `oldDocument`'s **relevant agent**\(^{1061}\)'s `event loop`\(^{1104}\).

7. Increase `eventLoop`'s **termination nesting level**\(^{1052}\) by 1.

8. Increase `oldDocument`'s **unload counter**\(^{1052}\) by 1.

9. If `intendToKeepInBfcache` is false, then set `oldDocument`'s **salvageable**\(^{1052}\) state to false.

10. If `oldDocument`'s **page showing**\(^{1052}\) is true:

    1. Set `oldDocument`'s **page showing**\(^{1052}\) to false.

    2. **Fire a page transition event**\(^{974}\) named `pagehide`\(^{1452}\) at `oldDocument`'s **relevant global object**\(^{1071}\) with `oldDocument`'s **salvageable**\(^{1052}\) state.

    3. **Update the visibility state**\(^{820}\) of `oldDocument` to "hidden".

11. If `unloadTimingInfo` is not null, then set `unloadTimingInfo`'s **unload event start time**\(^{1132}\) to the **current high resolution time** given `newDocument`'s **relevant global object**\(^{1071}\), **coarsened** given `oldDocument`'s **relevant settings object**\(^{1071}\)'s **cross-origin isolated capability**\(^{1064}\).

12. If `oldDocument`'s **salvageable**\(^{1052}\) state is false, then **fire an event** named `unload`\(^{1452}\) at `oldDocument`'s **relevant global object**\(^{1071}\), with legacy target override flag set.

13. If `unloadTimingInfo` is not null, then set `unloadTimingInfo`'s **unload event end time**\(^{1132}\) to the **current high resolution time** given `newDocument`'s **relevant global object**\(^{1071}\), **coarsened** given `oldDocument`'s **relevant settings object**\(^{1071}\)'s **cross-origin isolated capability**\(^{1064}\).

14. Decrease `eventLoop`'s **termination nesting level**\(^{1052}\) by 1.

15. Set `oldDocument`'s **suspension time**\(^{1052}\) to the **current high resolution time** given `document`'s **relevant global object**\(^{1071}\).

16. Set `oldDocument`'s **suspended timer handles**\(^{1052}\) to the result of **getting the keys** for the **map of active timers**\(^{1143}\).

17. Set `oldDocument`'s **has been scrolled by the user**\(^{1044}\) to false.

18. Run any **unloading document cleanup steps**\(^{1052}\) for `oldDocument` that are defined by this specification and other applicable specifications\(^{971}\).

19. If `oldDocument`'s **node navigable**\(^{979}\) is a **top-level traversable**\(^{979}\), **build not restored reasons for a top-level traversable and its descendants**\(^{1041}\) given `oldDocument`'s **node navigable**\(^{979}\).

20. If `oldDocument`'s **salvageable**\(^{1052}\) state is false, then **destroy**\(^{1054}\) `oldDocument`.


22. If `newDocument` is given, `newDocument`'s **was created via cross-origin redirects**\(^{1132}\) is false, and `newDocument`'s **origin** is the **same**\(^{981}\) as `oldDocument`'s **origin**, then set `newDocument`'s **previous document unload timing**\(^{1132}\) to `unloadTimingInfo`.

To **unload a document and its descendants**, given a `Document`\(^{1128}\) `document`, an optional `Document`\(^{1128}\)-or-null `newDocument` (default null), an optional set of steps **afterAllUnloads**, and an optional set of steps **firePageSwapSteps**:

1. **Assert**: this is running within `document`'s **node navigable**\(^{979}\) is **traversable navigable**\(^{979}\) and **session history traversal queue**\(^{979}\).

2. Let `childNavigables` be `document`'s **child navigables**\(^{981}\).
3. Let $numberUnloaded$ be 0.

4. For each $childNavigable$ of $childNavigable$'s children, queue a global task on the navigation and traversal task source given $childNavigable$'s active window to perform the following steps:
   1. Let $incrementUnloaded$ be an algorithm step which increments $numberUnloaded$.

5. Wait until $numberUnloaded$ equals $childNavigable$'s size.

6. Queue a global task on the navigation and traversal task source given $childNavigable$'s active window to perform the following steps:
   1. Let $incrementUnloaded$ be an algorithm step which increments $numberUnloaded$.

This specification defines the following unloading document cleanup steps. Other specifications can define more. Given a Document document:

1. Let $window$ be document's relevant global object.
2. For each WebSocket object $webSocket$ whose relevant global object is $window$, make disappear $webSocket$.
   If this affected any WebSocket objects, then make document unsalvageable given document and "websocket".
3. For each WebTransport object $transport$ whose relevant global object is $window$, run the context cleanup steps given $transport$.
4. If document's salvageable state is false, then:
   1. For each EventSource object $eventSource$ whose relevant global object is equal to $window$, forcibly close $eventSource$.
   2. Clear $window$'s map of active timers.

It would be better if specification authors sent a pull request to add calls from here into their specifications directly, instead of using the unloading document cleanup steps hook, to ensure well-defined cross-specification call order. As of the time of this writing the following specifications are known to have unloading document cleanup steps, which will be run in an unspecified order: Fullscreen API, Web NFC, WebDriver BiDi, Compute Pressure, File API, Media Capture and Streams, Picture-in-Picture, Screen Orientation, Service Workers, WebLocks API, WebAudio API, WebRTC, [FULLSCREEN], [WEBNFC], [WEBDRIVERBIDI], [COMPUTEPRESSURE], [FILEAPI], [MEDIASTREAM], [PICTUREINPICTURE], [SCREENORIENTATION], [SW], [WEBLOCKS], [WEBAUDIO], [WEBRTC].

Issue #8906 tracks the work to make the order of these steps clear.

7.5.10 Destroying documents

To destroy a Document document:

1. Assert: this is running as part of a task queued on document's relevant agent's event loop.
3. Set document's salvageable state to false.
4. Let ports be the list of MessagePort objects whose relevant global object's associated Document is document.
5. For each port in ports, disentangle port.
6. Run any unloading document cleanup steps for document that are defined by this specification and other applicable
7. Remove any tasks whose document is document from any task queue (without running those tasks).

8. Set document’s browsing context to null.

9. Set document’s node navigable’s active session history entry’s document state’s document to null.

10. Remove document from the owner set of each WorkerGlobalScope object whose set contains document.

11. For each workletGlobalScope in document’s worklet global scopes, terminate workletGlobalScope.

To destroy a document and its descendants given a Document document and an optional set of steps afterAllDestruction, perform the following steps in parallel:

1. If document is not fully active, then:
   1. Make document unsalvageable given document and "masked".
   2. If document’s node navigable is a top-level traversable, build not restored reasons for a top-level traversable and its descendants given document’s node navigable.

2. Let childNavigables be document’s child navigables.

3. Let numberDestroyed be 0.

4. For each childNavigable of childNavigable’s in what order?, queue a global task on the navigation and traversal task source given childNavigable’s active window to perform the following steps:
   1. Let incrementDestroyed be an algorithm step which increments numberDestroyed.

5. Wait until numberDestroyed equals childNavigable’s size.

6. Queue a global task on the navigation and traversal task source given document’s relevant global object to perform the following steps:
   1. Destroy document.
   2. If afterAllDestruction was given, then run it.

7.5.11 Aborting a document load

To abort a Document document:

1. Assert: this is running as part of a task queued on document’s relevant agent’s event loop.

2. Cancel any instances of the fetch algorithm in the context of document, discarding any tasks, queued for them, and discarding any further data received from the network for them. If this resulted in any instances of the fetch algorithm being canceled or any queued or any tasks or any network data getting discarded, then make document unsalvageable given document and "fetch".

3. If document’s during-loading navigation ID for WebDriver BiDi is non-null, then:
   1. Invoke WebDriver BiDi navigation aborted with document’s browsing context, and new WebDriver BiDi navigation status whose whose id is document’s during-loading navigation ID for WebDriver BiDi, status is "canceled", and url is document’s URL.
   2. Set document’s during-loading navigation ID for WebDriver BiDi to null.

4. If document has an active parser, then:
1. Set document's active parser was aborted\(^{1}\) to true.
2. Abort that parser\(^{2}\).
3. Set document's salvageable\(^{3}\) to false.
4. Make document unsalvageable\(^{4}\) given document and "parser-aborted"\(^{5}\).

To abort a document and its descendants given a Document\(^{1}\) document:

1. Assert: this is running as part of a task\(^{1}\) queued on document's relevant agent\(^{1}\)'s event loop\(^{1}\).
2. Let descendantNavigables be document's descendant navigables\(^{6}\).
3. For each descendantNavigable of descendantNavigables in what order? queue a global task\(^{7}\) on the navigation and traversal task source\(^{8}\) given descendantNavigable's active window\(^{9}\) to perform the following steps:
   1. Abort\(^{1}\) descendantNavigable's active document\(^{9}\).
   2. If descendantNavigable's active document\(^{9}\)'s salvageable\(^{3}\) is false, then set document's salvageable\(^{3}\) to false.
4. Abort\(^{1}\) document.

To stop loading a navigable\(^{9}\) navigable:

1. Let document be navigable's active document\(^{9}\).
2. If document's unload counter\(^{3}\) is 0, and navigable's ongoing navigation\(^{10}\) is a navigation ID\(^{10}\), then set the ongoing navigation\(^{10}\) for navigable to null.

   Note

   This will have the effect of aborting any ongoing navigations of navigable, since at certain points during navigation, changes to the ongoing navigation\(^{10}\) will cause further work to be abandoned.

3. Abort a document and its descendants\(^{1}\) given document.

Through their user interface\(^{1}\), user agents also allow stopping traversals, i.e. cases where the ongoing navigation\(^{10}\) is "traversal". The above algorithm does not account for this. (On the other hand, user agents do not allow window.stop()\(^{11}\) to stop traversals, so the above algorithm is correct for that caller.) See issue #6905.

7.6 The `X-Frame-Options`\(^{1}\) header\(^{1}\)

The `X-Frame-Options` HTTP response header is a legacy way of controlling whether and how a Document\(^{1}\) may be loaded inside of a child navigable\(^{9}\). It is obsoleted by the frame-ancestors CSP directive, which provides more granular control over the same situations. It was originally defined in HTTP Header Field X-Frame-Options, but the definition and processing model here supersedes that document. [CSP]\(^{1}\) [RFC7034]\(^{1}\)

Note

In particular, HTTP Header Field X-Frame-Options specified an `ALLOW-FROM` variant of the header, but that is not to be implemented.

Note

Per the below processing model, if both a CSP frame-ancestors directive and a `X-Frame-Options`\(^{1}\) header are used in the same response, then `X-Frame-Options`\(^{1}\) is ignored.

For web developers and conformance checkers, its value ABNF is:

\[
X\text{-Frame-Options} = "\text{DENY}" / "\text{SAMEORIGIN}" \]

---

\(^{1}\) Document

\(^{2}\) Abort

\(^{3}\) Salvageable

\(^{4}\) Make document unsalvageable

\(^{5}\) "parser-aborted"

\(^{6}\) DescendantNavigables

\(^{7}\) Global task

\(^{8}\) Navigation and traversal task source

\(^{9}\) Active window

\(^{10}\) Ongoing navigation

\(^{11}\) Window.stop()
To check a navigation response's adherence to `X-Frame-Options`, given a response, a navigable, a CSP list, and an origin:

1. If navigable is not a child navigable, then return true.
2. For each policy of cspList:
   1. If policy's disposition is not "enforce", then continue.
   2. If policy's directive set contains a frame-ancestors directive, then return true.
3. Let rawXFrameOptions be the result of getting, decoding, and splitting `X-Frame-Options` from response's header list.
4. Let xFrameOptions be a new set.
5. For each value of rawXFrameOptions, append value, converted to ASCII lowercase, to xFrameOptions.
6. If xFrameOptions's size is greater than 1, and xFrameOptions contains any of "deny", "allowall", or "sameorigin", then return false.

Note
The intention here is to block any attempts at applying `X-Frame-Options` which were trying to do something valid, but appear confused.

Note
This is the only impact of the legacy `ALLOWALL` value on the processing model.

7. If xFrameOptions's size is greater than 1, then return true.

Note
This means it contains multiple invalid values, which we treat the same way as if the header was omitted entirely.

8. If xFrameOptions[0] is "deny", then return false.
9. If xFrameOptions[0] is "sameorigin", then:
   1. Let containerDocument be navigable's container document.
   2. While containerDocument is not null:
      1. If containerDocument's origin is not same origin with destinationOrigin, then return false.
10. Return true.

Note
If we've reached this point then we have a lone invalid value (which could potentially be one the legacy `ALLOWALL` or `ALLOW-FROM` forms). These are treated as if the header were omitted entirely.

Example
The following table illustrates the processing of various values for the header, including non-conformant ones:

<table>
<thead>
<tr>
<th><code>X-Frame-Options</code></th>
<th>Valid</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;DENY&quot;</td>
<td>✓</td>
<td>embedding disallowed</td>
</tr>
<tr>
<td>&quot;SAMEORIGIN&quot;</td>
<td>✓</td>
<td>same-origin embedding allowed</td>
</tr>
<tr>
<td>&quot;INVALID&quot;</td>
<td>✗</td>
<td>embedding allowed</td>
</tr>
<tr>
<td>&quot;ALLOWALL&quot;</td>
<td>✗</td>
<td>embedding allowed</td>
</tr>
<tr>
<td>&quot;ALLOW-FROM=<a href="https://example.com/">https://example.com/</a>&quot;</td>
<td>✗</td>
<td>embedding allowed (from anywhere)</td>
</tr>
</tbody>
</table>

Example
The following table illustrates how various non-conformant cases involving multiple values are processed:
<table>
<thead>
<tr>
<th><code>X-Frame-Options</code></th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>SAMEORIGIN, SAMEORIGIN</code></td>
<td>same-origin embedding allowed</td>
</tr>
<tr>
<td><code>SAMEORIGIN, DENY</code></td>
<td>embedding disallowed</td>
</tr>
<tr>
<td><code>SAMEORIGIN,</code></td>
<td>embedding disallowed</td>
</tr>
<tr>
<td><code>SAMEORIGIN, ALLOWALL</code></td>
<td>embedding disallowed</td>
</tr>
<tr>
<td><code>SAMEORIGIN, INVALID</code></td>
<td>embedding disallowed</td>
</tr>
<tr>
<td><code>ALLOWALL, INVALID</code></td>
<td>embedding disallowed</td>
</tr>
<tr>
<td><code>ALLOWALL,</code></td>
<td>embedding disallowed</td>
</tr>
<tr>
<td><code>INVALID, INVALID</code></td>
<td>embedding allowed</td>
</tr>
</tbody>
</table>

The same results are obtained whether the values are delivered in a single header whose value is comma-delimited, or in multiple headers.

7.7 The `Refresh` header

The `Refresh` HTTP response header is the HTTP-equivalent to a meta element with an `http-equiv` attribute in the Refresh state. It takes the same value and works largely the same. Its processing model is detailed in create and initialize a Document object.

7.8 Browser user interface considerations

Browser user agents should provide the ability to navigate, reload, and stop loading any top-level traversable in their top-level traversable set.

Example

For example, via a location bar and reload/stop button UI.

Browser user agents should provide the ability to traverse by a delta any top-level traversable in their top-level traversable set.

Example

For example, via back and forward buttons, possibly including long-press abilities to change the delta.

It is suggested that such user agents allow traversal by deltas greater than one, to avoid letting a page "trap" the user by stuffing the session history with spurious entries. (For example, via repeated calls to `history.pushState()` or fragment navigations.)

Note

Some user agents have heuristics for translating a single "back" or "forward" button press into a larger delta, specifically to overcome such abuses. We are contemplating specifying these heuristics in issue #7832.

Browser user agents should offer users the ability to create a fresh top-level traversable, given a user-provided or user agent-detected initial URL.

Example

For example, via a "new tab" or "new window" button.

Browser user agents should offer users the ability to arbitrarily close any top-level traversable in their top-level traversable set.
Browser user agents may provide ways for the user to explicitly cause any navigable (not just a top-level traversable) to navigate, reload, or stop loading.

Browser user agents may provide the ability for users to destroy a top-level traversable.

When a user requests a reload of a navigable whose active session history entry's document state's resource is a POST resource, the user agent should prompt the user to confirm the operation first, since otherwise transactions (e.g., purchases or database modifications) could be repeated.

When a user requests a reload of a navigable, user agents may provide a mechanism for ignoring any caches when reloading.

All calls to navigate initiated by the mechanisms mentioned above must have the userInvolvement argument set to "browser UI".

All calls to reload initiated by the mechanisms mentioned above must have the userInvolvement argument set to "browser UI".

All calls to traverse the history by a delta initiated by the mechanisms mentioned above must not pass a value for the sourceDocument argument.

The above recommendations, and the data structures in this specification, are not meant to place restrictions on how user agents represent the session history to the user.

For example, although a top-level traversable's session history entries are stored and maintained as a list, and the user agent is recommended to give an interface for traversing that list by a delta, a novel user agent could instead or in addition present a tree-like view, with each page having multiple “forward” pages that the user can choose between.

Similarly, although session history for all descendant navigables is stored in their traversable navigable, user agents could present the user with a more nuanced per-navigable view of the session history.

Browser user agents may use a top-level browsing context’s is popup boolean for the following purposes:

- Deciding whether or not to provide a minimal web browser user interface for the corresponding top-level traversable.
- Performing the optional steps in set up browsing context features.

In both cases user agents might additionally incorporate user preferences, or present a choice as to whether to go down the popup route.

User agents that provides a minimal user interface for such popups are encouraged to not hide the browser's location bar.
Various mechanisms can cause author-provided executable code to run in the context of a document. These mechanisms include, but are probably not limited to:

- Processing of `script` elements.
- Navigating to `javascript:` URLs.
- Event handlers, whether registered through the DOM using `addEventListener()`, by explicit `event handler content attributes`, by `event handler IDL attributes`, or otherwise.
- Processing of technologies like SVG that have their own scripting features.

JavaScript defines the concept of an `agent`. This section gives the mapping of that language-level concept on to the web platform.

The following types of agents exist on the web platform:

**Similar-origin window agent**
Contains various `Window` objects which can potentially reach each other, either directly or by using `document.domain`.

If the encompassing `agent cluster` is `is origin-keyed` is true, then all the `Window` objects will be `same origin`, can reach each other directly, and `document.domain` will no-op.

**Dedicated worker agent**
Contains a single `DedicatedWorkerGlobalScope`.

**Shared worker agent**
Contains a single `SharedWorkerGlobalScope`.

**Service worker agent**
Contains a single `ServiceWorkerGlobalScope`.

**Worklet agent**
Contains a single `WorkletGlobalScope` object.
Only shared and dedicated worker agents allow the use of JavaScript Atomics APIs to potentially block.

To create an agent, given a boolean `canBlock`:

1. Let `signifier` be a new unique internal value.
2. Let `candidateExecution` be a new candidate execution.
3. Let `agent` be a new agent whose `[[CanBlock]]` is `canBlock`, `[[Signifier]]` is `signifier`, `[[CandidateExecution]]` is `candidateExecution`, and `[[IsLockFree1]]`, `[[IsLockFree2]]`, and `[[LittleEndian]]` are set at the implementation's discretion.
4. Set `agent`'s `event loop` to a new `event loop`.
5. Return `agent`.

For a `realm` `realm`, the agent whose `[[Signifier]]` is `realm.[[AgentSignifier]]` is the realm's agent.

The relevant agent for a platform object `platformObject` is `platformObject`'s relevant `realm`'s agent.

8.1.2.2 Integration with the JavaScript agent cluster formalism

JavaScript also defines the concept of an agent cluster, which this standard maps to the web platform by placing agents appropriately when they are created using the obtain a similar-origin window agent or obtain a worker/worklet agent algorithms.

The agent cluster concept is crucial for defining the JavaScript memory model, and in particular among which agents the backing data of `SharedArrayBuffer` objects can be shared.

An agent cluster has an associated cross-origin isolation mode, which is a cross-origin isolation mode. It is initially "none".

An agent cluster has an associated is origin-keyed (a boolean), which is initially false.

The following defines the allocation of the agent clusters of similar-origin window agents.

An agent cluster key is a site or tuple origin. Without web developer action to achieve origin-keyed agent clusters, it will be a site.

Note

An equivalent formulation is that an agent cluster key can be a scheme-and-host or an origin.

To obtain a similar-origin window agent, given an origin origin, a browsing context group group, and a boolean requestsOAC, run these steps:

1. Let `site` be the result of obtaining a site with origin.
2. Let `key` be `site`.

Note

Although a given worklet can have multiple realms, each such realm needs its own agent, as each realm can be executing code independently and at the same time as the others.
3. If group's cross-origin isolation mode is not "none", then set key to origin.

4. Otherwise, if group's historical agent cluster key map [origin] exists, then set key to group's historical agent cluster key map [origin].

5. Otherwise:
   1. If requestsOAC is true, then set key to origin.
   2. Set group's historical agent cluster key map [origin] to key.

6. If group's agent cluster map [key] does not exist, then:
   1. Let agentCluster be a new agent cluster.
   2. Set agentCluster's cross-origin isolation mode to group's cross-origin isolation mode.
   3. Set agentCluster's is origin-keyed to true if key equals origin; otherwise false.
   4. Add the result of creating an agent, given false, to agentCluster.
   5. Set group's agent cluster map [key] to agentCluster.

7. Return the single similar-origin window agent contained in group's agent cluster map [key].

Note: This means that there is only one similar-origin window agent per browsing context agent cluster. (However, dedicated worker and worklet agents might be in the same cluster.)

The following defines the allocation of the agent clusters of all other types of agents.

To obtain a worker/worklet agent, given an environment settings object or null outside settings, a boolean isTopLevel, and a boolean canBlock, run these steps:

1. Let agentCluster be null.
2. If isTopLevel is true, then:
   1. Set agentCluster to a new agent cluster.
   2. Set agentCluster's is origin-keyed to true.
3. Otherwise:
   1. Assert: outside settings is not null.
   2. Let ownerAgent be outside settings's realm's agent.
   3. Set agentCluster to the agent cluster which contains ownerAgent.
4. Let agent be the result of creating an agent, given canBlock.
5. Add agent to agentCluster.
6. Return agent.

To obtain a dedicated/shared worker agent, given an environment settings object outside settings and a boolean isShared, return the result of obtaining a worker/worklet agent given outside settings, isShared, and true.

To obtain a worklet agent, given an environment settings object outside settings, return the result of obtaining a worker/worklet agent given outside settings, false, and false.

To obtain a service worker agent, return the result of obtaining a worker/worklet agent given null, true, and false.
The following pairs of global objects are each within the same agent cluster, and thus can use `SharedArrayBuffer` instances to share memory with each other:

- A `Window` object and a dedicated worker that it created.
- A worker (of any type) and a dedicated worker it created.
- A `Window` object A and the `Window` object of an `iframe` element that A created that could be same origin-domain with A.
- A `Window` object and a same origin-domain `Window` object that opened it.
- A `Window` object and a worklet that it created.

The following pairs of global objects are not within the same agent cluster, and thus cannot share memory:

- A `Window` object and a shared worker it created.
- A worker (of any type) and a shared worker it created.
- A `Window` object and a service worker it created.
- A `Window` object A and the `Window` object of an `iframe` element that A created that cannot be same origin-domain with A.
- Any two `Window` objects with no opener or ancestor relationship. This holds even if the two `Window` objects are same origin.

### 8.1.3 Realms and their counterparts

The JavaScript specification introduces the realm concept, representing a global environment in which script is run. Each realm comes with an implementation-defined global object; much of this specification is devoted to defining that global object and its properties.

For web specifications, it is often useful to associate values or algorithms with a realm/global object pair. When the values are specific to a particular type of realm, they are associated directly with the global object in question, e.g., in the definition of the `Window` or `WorkerGlobalScope` interfaces. When the values have utility across multiple realms, we use the environment settings object concept.

Finally, in some cases it is necessary to track associated values before a realm/global object/environment settings object even comes into existence (for example, during `navigation`). These values are tracked in the environment concept.

#### 8.1.3.1 Environments

An environment is an object that identifies the settings of a current or potential execution environment (i.e., a `navigation params`'s reserved environment or a `request`'s reserved client). An environment has the following fields:

**An id**

An opaque string that uniquely identifies this environment.

**A creation URL**

A URL that represents the location of the resource with which this environment is associated.

**Note**

In the case of a `Window` environment settings object, this URL might be distinct from its global object's associated Document's URL due to mechanisms such as `history.pushState()` which modify the latter.

**A top-level creation URL**

Null or a URL that represents the creation of the "top-level" environment. It is null for workers and worklets.
A **top-level origin** is an implementation-defined value, null, or an origin. For a "top-level" potential execution environment it is null (i.e., when there is no response yet); otherwise it is the "top-level" environment’s origin. For a dedicated worker or worklet it is the top-level origin of its creator. For a shared or service worker it is an implementation-defined value.

**Note**
This is distinct from the top-level creation URL’s origin when sandboxing, workers, and worklets are involved.

A **target browsing context** is null or a target browsing context for a navigation request.

An **active service worker** is null or a service worker that controls the environment.

An **execution ready flag** is a flag that indicates whether the environment setup is done. It is initially unset.

Specifications may define environment discarding steps for environments. The steps take an environment as input.

**Note**
The environment discarding steps are run for only a select few environments: the ones that will never become execution ready because, for example, they failed to load.

### 8.1.3.2 Environment settings objects

An **environment settings object** is an environment that additionally specifies algorithms for:

#### A realm execution context

A JavaScript execution context shared by all scripts that use this settings object, i.e., all scripts in a given realm. When we run a classic script or run a module script, this execution context becomes the top of the JavaScript execution context stack, on top of which another execution context specific to the script in question is pushed. (This setup ensures Source Text Module Record’s `Evaluate` knows which realm to use.)

#### A module map

A module map that is used when importing JavaScript modules.

#### An API base URL

A URL used by APIs called by scripts that use this environment settings object to parse URLs.

#### An origin

An origin used in security checks.

#### A policy container

A policy container containing policies used for security checks.

#### A cross-origin isolated capability

A boolean representing whether scripts that use this environment settings object are allowed to use APIs that require cross-origin isolation.

#### A time origin

A number used as the baseline for performance-related timestamps.

An environment settings object also has an outstanding rejected promises weak set and an about-to-be-notified rejected promises list, used to track unhandled promise rejections. The outstanding rejected promises weak set must not create strong references to any of its members, and implementations are free to limit its size, e.g. by removing old entries from it when new ones are added.

An environment settings object’s responsible event loop is its global object’s relevant agent’s event loop.
8.1.3.3 Realms, settings objects, and global objects

A **global object** is a JavaScript object that is the `[[GlobalObject]]` field of a **realm**.

**Note**
In this specification, all **realms** are created with **global objects** that are either `Window`, `WorkerGlobalScope`, or `WorkletGlobalScope` objects.

There is always a 1-to-1-to-1 mapping between **realms**, **global objects**, and **environment settings objects**:

- A **realm** has a `[[HostDefined]]` field, which contains the realm's **settings object**.
- A **realm** has a `[[GlobalObject]]` field, which contains the realm's **global object**.
- Each **global object** in this specification is created during the *creation* of a corresponding **realm**, known as the global object's realm.
- Each **global object** in this specification is created alongside a corresponding **environment settings object**, known as its relevant settings object.
- An **environment settings object**'s realm execution context's Realm component is the environment settings object's realm.
- An **environment settings object**'s realm then has a `[[GlobalObject]]` field, which contains the environment settings object's global object.

To **create a new realm** in an **agent**, optionally with instructions to create a global object or a global `this` binding (or both), the following steps are taken:

1. Perform `InitializeHostDefinedRealm()` with the provided customizations for creating the global object and the global `this` binding.
2. Let realm execution context be the running JavaScript execution context.

**Note**
*This is the JavaScript execution context created in the previous step.*

3. Remove realm execution context from the JavaScript execution context stack.
4. Let realm be realm execution context's Realm component.
5. If agent's agent cluster's cross-origin isolation mode is "none", then:
   1. Let global be realm's global object.
   2. Let status be ! global.[[Delete]]("SharedArrayBuffer").
   3. **Assert**: status is true.

**Note**
*This is done for compatibility with web content and there is some hope that this can be removed in the future. Web developers can still get at the constructor through `new WebAssembly.Memory({ shared: true, initial: 0, maximum: 0 }).buffer.constructor`.*

6. Return realm execution context.

When defining algorithm steps throughout this specification, it is often important to indicate what **realm** is to be used—or, equivalently, what **global object** or **environment settings object** is to be used. In general, there are at least four possibilities:

**Entry**
This corresponds to the script that initiated the currently running script action: i.e., the function or script that the user agent called into when it called into author code.

**Incumbent**
This corresponds to the most-recently-entered author function or script on the stack, or the author function or script that originally
scheduled the currently-running callback.

**Current**

This corresponds to the currently-running function object, including built-in user-agent functions which might not be implemented as JavaScript. (It is derived from the current realm.)

**Relevant**

Every platform object has a relevant realm, which is roughly the realm in which it was created. When writing algorithms, the most prominent platform object whose relevant realm might be important is the this value of the currently-running function object. In some cases, there can be other important relevant realms, such as those of any arguments.

Note how the entry, incumbent, and current concepts are usable without qualification, whereas the relevant concept must be applied to a particular platform object.

⚠️ Warning!

The incumbent and entry concepts should not be used by new specifications, as they are excessively complicated and unintuitive to work with. We are working to remove almost all existing uses from the platform: see issue #1430 for incumbent, and issue #1431 for entry.

In general, web platform specifications should use the relevant concept, applied to the object being operated on (usually the this value of the current method). This mismatches the JavaScript specification, where current is generally used as the default (e.g., in determining the realm whose Array constructor should be used to construct the result in Array.prototype.map). But this inconsistency is so embedded in the platform that we have to accept it going forward.

**Example**

Consider the following pages, with a.html being loaded in a browser window, b.html being loaded in an iframe as shown, and c.html and d.html omitted (they can simply be empty documents):

```html
<!-- a.html -->
<!DOCTYPE html>
<html lang="en">
<title>Entry page</title>

<iframe src="b.html"></iframe>
<button onclick="frames[0].hello()">Hello</button>

<!-- b.html -->
<!DOCTYPE html>
<html lang="en">
<title>Incumbent page</title>

<iframe src="c.html" id="c"></iframe>
<iframe src="d.html" id="d"></iframe>

<script>
    const c = document.querySelector("#c").contentWindow;
    const d = document.querySelector("#d").contentWindow;

    window.hello = () => {
        c.print.call(d);
    }
</script>
```

Each page has its own browsing context, and thus its own realm, global object, and environment settings object.

When the print method is called in response to pressing the button in a.html, then:

- The entry realm is that of a.html.
- The incumbent realm is that of b.html.
- The current realm is that of c.html (since it is the print method from c.html whose code is running).
The relevant realm\textsuperscript{1071} of the object on which the \texttt{print()}\textsuperscript{1149} method is being called is that of \texttt{d.html}.

**Example**

One reason why the relevant\textsuperscript{1066} concept is generally a better default choice than the current\textsuperscript{1066} concept is that it is more suitable for creating an object that is to be persisted and returned multiple times. For example, the \texttt{navigator.getBattery()} method creates promises in the relevant realm\textsuperscript{1071} for the \texttt{Navigator}\textsuperscript{1151} object on which it is invoked. This has the following impact: [BATTERY]\textsuperscript{1455}

```html
<!-- outer.html -->
<!DOCTYPE html>
<html lang="en">
<title>Relevant realm demo: outer page</title>
<script>
  function doTest() {
    const promise = navigator.getBattery().call(frames[0].navigator);
    console.log(promise instanceof Promise); // logs false
    console.log(promise instanceof frames[0].Promise); // logs true
    frames[0].hello();
  }
</script>
<iframe src="inner.html" onload="doTest()"></iframe>

<!-- inner.html -->
<!DOCTYPE html>
<html lang="en">
<title>Relevant realm demo: inner page</title>
<script>
  function hello() {
    const promise = navigator.getBattery();
    console.log(promise instanceof Promise); // logs true
    console.log(promise instanceof parent.Promise); // logs false
  }
</script>
```

If the algorithm for the \texttt{getBattery()} method had instead used the current realm, all the results would be reversed. That is, after the first call to \texttt{getBattery()} in \texttt{outer.html}, the \texttt{Navigator}\textsuperscript{1151} object in \texttt{inner.html} would be permanently storing a Promise object created in \texttt{outer.html}'s realm, and calls like that inside the \texttt{hello()} function would thus return a promise from the "wrong" realm. Since this is undesirable, the algorithm instead uses the relevant realm\textsuperscript{1071}, giving the sensible results indicated in the comments above.

The rest of this section deals with formally defining the entry\textsuperscript{1067}, incumbent\textsuperscript{1065}, current\textsuperscript{1066}, and relevant\textsuperscript{1066} concepts.

### 8.1.3.3 Entry\textsuperscript{6410}

The process of calling scripts\textsuperscript{1083} will push or pop realm execution contexts\textsuperscript{1064} onto the JavaScript execution context stack, interspersed with other execution contexts.

With this in hand, we define the entry execution context to be the most recently pushed item in the JavaScript execution context stack that is a realm execution context\textsuperscript{1064}. The entry realm is the entry execution context\textsuperscript{1067}’s Realm component.

Then, the entry settings object is the environment settings object\textsuperscript{1065} of the entry realm\textsuperscript{1067}.

Similarly, the entry global object is the global object\textsuperscript{1065} of the entry realm\textsuperscript{1067}.
All JavaScript execution contexts must contain, as part of their code evaluation state, a skip-when-determining-incumbent counter value, which is initially zero. In the process of preparing to run a callback and cleaning up after running a callback, this value will be incremented and decremented.

Every event loop has an associated backup incumbent settings object stack, initially empty. Roughly speaking, it is used to determine the incumbent settings object when no author code is on the stack, but author code is responsible for the current algorithm having been run in some way. The process of preparing to run a callback and cleaning up after running a callback manipulate this stack. [WEBIDL]

When Web IDL is used to invoke author code, or when HostEnqueuePromiseJob invokes a promise job, they use the following algorithms to track relevant data for determining the incumbent settings object:

To prepare to run a callback with an environment settings object settings:

1. Push settings onto the backup incumbent settings object stack.
2. Let context be the topmost script-having execution context.
3. If context is not null, increment context’s skip-when-determining-incumbent counter.

To clean up after running a callback with an environment settings object settings:

1. Let context be the topmost script-having execution context.
2. If context is not null, decrement context’s skip-when-determining-incumbent counter.
3. Assert: the topmost entry of the backup incumbent settings object stack is settings.
4. Remove settings from the backup incumbent settings object stack.

Here, the topmost script-having execution context is the topmost entry of the JavaScript execution context stack that has a non-null ScriptOrModule component, or null if there is no such entry in the JavaScript execution context stack.

With all this in place, the incumbent settings object is determined as follows:

1. Let context be the topmost script-having execution context.
2. If context is null, or if context’s skip-when-determining-incumbent counter is greater than zero, then:
   1. Assert: the backup incumbent settings object stack is not empty.
      
      This assert would fail if you try to obtain the incumbent settings object from inside an algorithm that was triggered neither by calling scripts, nor by Web IDL invoking a callback. For example, it would trigger if you tried to obtain the incumbent settings object inside an algorithm that ran periodically as part of the event loop, with no involvement of author code. In such cases the incumbent concept cannot be used.
   2. Return the topmost entry of the backup incumbent settings object stack.
3. Return context’s Realm component’s settings object.

Then, the incumbent realm is the realm of the incumbent settings object.

Similarly, the incumbent global object is the global object of the incumbent settings object.

The following series of examples is intended to make it clear how all of the different mechanisms contribute to the definition of the incumbent concept:
Example Consider the following starter example:

```html
<!DOCTYPE html>
<script>
frames[0].postMessage("some data", ";");
</script>
```

There are two interesting environment settings objects here: that of window, and that of frames[0]. Our concern is: what is the incumbent settings object at the time that the algorithm for postMessage executes?

It should be that of window, to capture the intuitive notion that the author script responsible for causing the algorithm to happen is executing in window, not frames[0]. This makes sense: the window post message steps use the incumbent settings object to determine the source property of the resulting MessageEvent, and in this case window is definitely the source of the message.

Let us now explain how the steps given above give us our intuitively-desired result of window's relevant settings object.

When the window post message steps look up the incumbent settings object, the topmost script-having execution context will be that corresponding to the script element: it was pushed onto the JavaScript execution context stack as part of ScriptEvaluation during the run a classic script algorithm. Since there are no Web IDL callback invocations involved, the context's skip-when-determining-incumbent counter is zero, so it is used to determine the incumbent settings object, the result is the environment settings object of window.

(Note how the environment settings object of frames[0] is the relevant settings object of this at the time the postMessage method is called, and thus is involved in determining the target of the message. Whereas the incumbent is used to determine the source.)

Example Consider the following more complicated example:

```html
<!DOCTYPE html>
<script>
const bound = frames[0].postMessage.bind(frames[0], "some data", ";");
window.setTimeout(bound);
</script>
```

This example is very similar to the previous one, but with an extra indirection through Function.prototype.bind as well as setTimeout(). But, the answer should be the same: invoking algorithms asynchronously should not change the incumbent concept.

This time, the result involves more complicated mechanisms:

When bound is converted to a Web IDL callback type, the incumbent settings object is that corresponding to window (in the same manner as in our starter example above). Web IDL stores this as the resulting callback value's callback context.

When the task posted by setTimeout executes, the algorithm for that task uses Web IDL to invoke the stored callback value. Web IDL in turn calls the above prepare to run a callback algorithm. This pushes the stored callback context onto the backup incumbent settings object stack. At this time (inside the timer task) there is no author code on the stack, so the topmost script-having execution context is null, and nothing gets its skip-when-determining-incumbent counter incremented.

Invoking the callback then calls bound, which in turn calls the postMessage method of frames[0]. When the postMessage algorithm looks up the incumbent settings object, there is still no author code on the stack, since the bound function just directly calls the built-in method. So the topmost script-having execution context will be null: the JavaScript execution context stack only contains an execution context corresponding to postMessage, with no ScriptEvaluation context or similar below it.

This is where we fall back to the backup incumbent settings object stack. As noted above, it will contain as its topmost entry the relevant settings object of window. So that is what is used as the incumbent settings object while executing the
The JavaScript specification defines the current realm, also known as the "current Realm Record". [JAVASCRIPT]

Then, the current settings object is the environment settings object of the current realm.

Similarly, the current global object is the global object of the current realm.

Example

Consider this final, even more convoluted example:

```html
<!-- a.html -->
<!DOCTYPE html>
<button>click me</button>
<iframe></iframe>
<script>
const bound = frames[0].location.assign.bind(frames[0].location, "https://example.com");
document.querySelector("button").addEventListener("click", bound);
</script>

<!-- b.html -->
<!DOCTYPE html>
<iframe src="a.html"></iframe>
<script>
const iframe = document.querySelector("iframe");
iframe.onload = function onLoad()
    { iframe.contentWindow.document.querySelector("button").click();
    }
</script>
```

Again there are two interesting environment settings objects in play: that of a.html, and that of b.html. When the location.assign() method triggers the Location-object navigate algorithm, what will be the incumbent settings object? As before, it should intuitively be that of a.html: the click listener was originally scheduled by a.html, so even if something involving b.html causes the listener to fire, the incumbent responsible is that of a.html.

The callback setup is similar to the previous example: when bound is converted to a Web IDL callback type, the incumbent settings object is that corresponding to a.html, which is stored as the callback’s callback context.

When the click() method is called inside b.html, it dispatches a click event on the button that is inside a.html. This time, when the prepare to run a callback algorithm executes as part of event dispatch, there is author code on the stack; the toplevel script-having execution context is that of the onLoad function, whose skip-when-determining-incumbent counter gets incremented. Additionally, a.html’s environment settings object (stored as the EventHandler’s callback context) is pushed onto the backup incumbent settings object stack. This gives us the environment settings object of a.html, as expected.

Note that this means that even though it is the iframe inside a.html that navigates, it is a.html itself that is used as the source Document, which determines among other things the request client. This is perhaps the only justifiable use of the incumbent concept on the web platform; in all other cases the consequences of using it are simply confusing and we hope to one day switch them to use current or relevant as appropriate.

8.1.3.3 Current

The JavaScript specification defines the current realm, also known as the "current Realm Record". [JAVASCRIPT]
8.1.3.3.4 Relevant

The relevant realm for a platform object is the value of its [[Realm]] field.

Then, the relevant settings object for a platform object o is the environment settings object of the relevant realm for o.

Similarly, the relevant global object for a platform object o is the global object of the relevant realm for o.

8.1.3.4 Enabling and disabling scripting

Scripting is enabled for an environment settings object settings when all of the following conditions are true:

- The user agent supports scripting.
- The user has not disabled scripting for settings at this time. (User agents may provide users with the option to disable scripting globally, or in a finer-grained manner, e.g., on a per-origin basis, down to the level of individual environment settings objects.)
- Either settings's global object is not a Window object, or settings's global object's associated Document's active sandboxing flag does not have its sandboxed scripts browsing context flag set.

Scripting is disabled for an environment settings object settings when scripting is not enabled for it, i.e., when any of the above conditions are false.

Scripting is enabled for a node node if node's node document's browsing context is non-null, and scripting is enabled for node's relevant settings object.

Scripting is disabled for a node when scripting is not enabled, i.e., when its node document's browsing context is null or when scripting is disabled for its relevant settings object.

8.1.3.5 Secure contexts

An environment environment is a secure context if the following algorithm returns true:

1. If environment is an environment settings object, then:
   1. Let global be environment's global object.
   2. If global is a WorkerGlobalScope, then:
      1. If global's owner set's relevant settings object is a secure context, then return true.
      2. Return false.
   3. If global is a WorkletGlobalScope, then return true.

   **Note**
   We only need to check the 0th item since they will necessarily all be consistent.

   **Note**
   Worklets can only be created in secure contexts.

   2. If the result of Is url potentially trustworthy? given environment's top-level creation URL is "Potentially Trustworthy", then return true.
   3. Return false.

An environment is a non-secure context if it is not a secure context.
A script is one of two possible structs (namely, a classic script or a module script). All scripts have:

A settings object
An environment settings object, containing various settings that are shared with other scripts in the same context.

A record
One of the following:
• a script record, for classic scripts;
• a Source Text Module Record, for JavaScript module scripts;
• a Synthetic Module Record, for CSS module scripts and JSON module scripts;
• null, representing a parsing failure.

A parse error
A JavaScript value, which has meaning only if the record is null, indicating that the corresponding script source text could not be parsed.

Note
This value is used for internal tracking of immediate parse errors when creating scripts, and is not to be used directly. Instead, consult the error to rethrow when determining “what went wrong” for this script.

An error to rethrow
A JavaScript value representing an error that will prevent evaluation from succeeding. It will be re-thrown by any attempts to run the script.

Note
This could be the script’s parse error, but in the case of a module script it could instead be the parse error from one of its dependencies, or an error from resolve a module specifier.

Note
Since this exception value is provided by the JavaScript specification, we know that it is never null, so we use null to signal that no error has occurred.

Fetch options
Null or a script fetch options, containing various options related to fetching this script or module scripts that it imports.

A base URL
Null or a base URL used for resolving module specifiers. When non-null, this will either be the URL from which the script was obtained, for external scripts, or the document base URL of the containing document, for inline scripts.

A classic script is a type of script that has the following additional item:

A muted errors boolean
A boolean which, if true, means that error information will not be provided for errors in this script. This is used to mute errors for cross-origin scripts, since that can leak private information.

A module script is another type of script. It has no additional items.

Module scripts can be classified into three types:
• A module script is a JavaScript module script if its record is a Source Text Module Record.
• A module script is a CSS module script if its record is a Synthetic Module Record, and it was created via the create a CSS module script algorithm. CSS module scripts represent a parsed CSS stylesheet.
• A module script is a JSON module script if its record is a Synthetic Module Record, and it was created via the
create a JSON module script algorithm. JSON module scripts represent a parsed JSON document.

The **active script** is determined by the following algorithm:

1. Let record be `GetActiveScriptOrModule()`.
2. If record is null, return null.
3. Return `record.[[HostDefined]]`.

---

### Note

As CSS stylesheets and JSON documents do not import dependent modules, and do not throw exceptions on evaluation, the **fetch options** and **base URL** of CSS module scripts and JSON module scripts and are always null.

The **active script** concept is so far only used by the `import()` feature, to determine the **base URL** to use for resolving relative module specifiers.

---

#### 8.1.4.2 Fetching scripts

This section introduces a number of algorithms for fetching scripts, taking various necessary inputs and resulting in **classic** or **module scripts**.

**Script fetch options** is a **struct** with the following **items**:

- **cryptographic nonce**
  The **cryptographic nonce metadata** used for the initial fetch and for fetching any imported modules

- **integrity metadata**
  The **integrity metadata** used for the initial fetch

- **parser metadata**
  The **parser metadata** used for the initial fetch and for fetching any imported modules

- **credentials mode**
  The **credentials mode** used for the initial fetch (for **module scripts**) and for fetching any imported modules (for both **module scripts** and **classic scripts**)

- **referrer policy**
  The **referrer policy** used for the initial fetch and for fetching any imported modules

#### Note

This policy can mutate after a **module script**'s **response** is received, to be the **referrer policy** parsed from the **response**, and used when fetching any module dependencies.

- **render-blocking**
  The boolean value of **render-blocking** used for the initial fetch and for fetching any imported modules. Unless otherwise stated, its value is false.

- **fetch priority**
  The **priority** used for the initial fetch

#### Note

Recall that via the `import()` feature, **classic** can import **module scripts**.

The **default classic script fetch options** are a **script fetch options** whose **cryptographic nonce** is the empty string, **integrity metadata** is the empty string, **parser metadata** is "not-parser-inserted", **credentials mode** is "same-origin", **referrer**
policy[^1073] is the empty string, and fetch priority[^1073] is "auto".

Given a request request and a script fetch options[^1073] options, we define:

set up the classic script request

Set request's cryptographic nonce metadata to options's cryptographic nonce[^1073], its integrity metadata to options's integrity metadata[^1073], its parser metadata to options's parser metadata[^1073], its referrer policy to options's referrer policy[^1073], its render-blocking to options's render-blocking[^1073], and its priority to options's fetch priority[^1073].

set up the module script request

Set request's cryptographic nonce metadata to options's cryptographic nonce[^1073], its integrity metadata to options's integrity metadata[^1073], its parser metadata to options's parser metadata[^1073], its credentials mode to options's credentials mode[^1073], its referrer policy to options's referrer policy[^1073], its render-blocking to options's render-blocking[^1073], and its priority to options's fetch priority[^1073].

To get the descendant script fetch options given a script fetch options[^1073] originalOptions, a URL url, and an environment settings object[^1064] settingsObject:

1. Let newOptions be a copy of originalOptions.
2. Let integrity be the empty string.
3. If settingsObject's global object[^1065] is a Window[^913] object, then set integrity to the result of resolving a module integrity metadata[^1074] with url and settingsObject.
4. Set newOptions's integrity[^1073] to integrity.
5. Set newOptions's fetch priority[^1073] to "auto".
6. Return newOptions.

To resolve a module integrity metadata, given a URL url and an environment settings object[^1064] settingsObject:

2. Let map be settingsObject's global object[^1065]'s import map[^1094].
3. If map's integrity[^1064][url] does not exist, then return the empty string.
4. Return map's integrity[^1064][url].

Several of the below algorithms can be customized with a perform the fetch hook algorithm, which takes a request, a boolean isTopLevel[^1074], and a processCustomFetchResponse algorithm. It runs processCustomFetchResponse[^1074] with a response and either null (on failure) or a byte sequence containing the response body. isTopLevel will be true for all classic script[^1072] fetches, and for the initial fetch when fetching an external module script graph[^1077] or fetching a module worker script graph[^1077], but false for the fetches resulting from import statements encountered throughout the graph or from import() expressions.

By default, not supplying a perform the fetch hook[^1074] will cause the below algorithms to simply fetch the given request, with algorithm-specific customizations to the request and validations of the resulting response.

To layer your own customizations on top of these algorithm-specific ones, supply a perform the fetch hook[^1074] that modifies the given request, fetches it, and then performs specific validations of the resulting response (completing with a network error if the validations fail).

The hook can also be used to perform more subtle customizations, such as keeping a cache of responses and avoiding performing a fetch at all.

Note

Service Workers is an example of a specification that runs these algorithms with its own options for the hook. [SW][^1462]

Now for the algorithms themselves.

To fetch a classic script given a URL url, an environment settings object[^1064] settingsObject, a script fetch options[^1073] options, a
CORS settings attribute state corsSetting, an encoding, and an algorithm onComplete, run these steps. onComplete must be an algorithm accepting null (on failure) or a classic script (on success).

1. Let request be the result of creating a potential-CORS request given url, "script", and corsSetting.
2. Set request's client to settingsObject.
3. Set request's initiator type to "script".
4. Set up the classic script request given request and options.
5. Fetch request with the following processResponseConsumeBody steps given response response and null, failure, or a byte sequence bodyBytes:

Note
response can be either CORS-same-origin or CORS-cross-origin. This only affects how error reporting happens.

1. Set response to response's unsafe response.
2. If any of the following are true:
   - bodyBytes is null or failure; or
   - response's status is not an ok status,

then run onComplete given null, and abort these steps.

Note
For historical reasons, this algorithm does not include MIME type checking, unlike the other script-fetching algorithms in this section.

3. Let potentialMIMETypeForEncoding be the result of extracting a MIME type given response's header list.
4. Set encoding to the result of legacy extracting an encoding given potentialMIMETypeForEncoding and encoding.

Note
This intentionally ignores the MIME type essence.

5. Let sourceText be the result of decoding bodyBytes to Unicode, using encoding as the fallback encoding.

Note
The decode algorithm overrides encoding if the file contains a BOM.

6. Let mutedErrors be true if response was CORS-cross-origin, and false otherwise.
7. Let script be the result of creating a classic script given sourceText, settingsObject, response's URL, options, mutedErrors, and url.
8. Run onComplete given script.

To fetch a classic worker script given a URL url, an environment settings object fetchClient, a destination destination, an environment settings object settingsObject, an algorithm onComplete, and an optional perform the fetch hook performFetch, run these steps. onComplete must be an algorithm accepting null (on failure) or a classic script (on success).

1. Let request be a new request whose URL is url, client is fetchClient, destination is destination, initiator type is "other", mode is "same-origin", credentials mode is "same-origin", parser metadata is "not parser-inserted", and whose use-URL-credentials flag is set.
2. If performFetch was given, run performFetch with request, true, and with processResponseConsumeBody as defined below. Otherwise, fetch request with processResponseConsumeBody set to processResponseConsumeBody as defined below.

In both cases, let processResponseConsumeBody given response response and null, failure, or a byte sequence bodyBytes be the following algorithm:

1. Set response to response's unsafe response.
2. If any of the following are true:
- bodyBytes is null or failure; or
- response's status is not an ok status.

then run onComplete given null, and abort these steps.

3. If all of the following are true:
   - response's URL's scheme is an HTTP(S) scheme; and
   - the result of extracting a MIME type from response's header list is not a JavaScript MIME type.

then run onComplete given null, and abort these steps.

Note

Other fetch schemes are exempted from MIME type checking for historical web-compatibility reasons. We might be able to tighten this in the future; see issue #3255.

4. Let sourceText be the result of UTF-8 decoding bodyBytes.

5. Let script be the result of creating a classic script using sourceText, settingsObject, response's URL, and the default classic script fetch options.

6. Run onComplete given script.

To fetch a classic worker-imported script given a URL url, an environment settings object settingsObject, and an optional perform the fetch hook performFetch, run these steps. The algorithm will return a classic script on success, or throw an exception on failure.

1. Let response be null.

2. Let bodyBytes be null.

3. Let request be a new request whose URL is url, client is settingsObject, destination is "script", initiator type is "other", parser metadata is "not parser-inserted", and whose use-URL-credentials flag is set.

4. If performFetch was given, run performFetch with request, isTopLevel, and with processResponseConsumeBody as defined below.

Otherwise, fetch request with processResponseConsumeBody set to processResponseConsumeBody as defined below.

In both cases, let processResponseConsumeBody given response res and null, failure, or a byte sequence bb be the following algorithm:

1. Set bodyBytes to bb.

2. Set response to res.

5. Pause until response is not null.

Note

Unlike other algorithms in this section, the fetching process is synchronous here.


7. If any of the following are true:
   - bodyBytes is null or failure;
   - response's status is not an ok status; or
   - the result of extracting a MIME type from response's header list is not a JavaScript MIME type.

then throw a "NetworkError" DOMException.

8. Let sourceText be the result of UTF-8 decoding bodyBytes.

9. Let mutedErrors be true if response was CORS-cross-origin, and false otherwise.

10. Let script be the result of creating a classic script given sourceText, settingsObject, response's URL, the default classic Other fetch schemes are exempted from MIME type checking for historical web-compatibility reasons. We might be able to tighten this in the future; see issue #3255.
To fetch an external module script graph given a URL url, an environment settings object\(^1\) settingsObject, a script fetch options\(^1\) options, and an algorithm onComplete, run these steps. onComplete must be an algorithm accepting null (on failure) or a module script\(^1\) (on success).

1. Disallow further import maps\(^1\) given settingsObject.
2. Fetch a single module script\(^1\) given url, settingsObject, "script", options, settingsObject, "client", true, and with the following steps given result:
   1. If result is null, run onComplete given null, and abort these steps.
   2. Fetch the descendants of and link\(^1\) result given settingsObject, "script", and onComplete.

To fetch a modulepreload module script graph given a URL url, a destination destination, an environment settings object\(^1\) settingsObject, a script fetch options\(^1\) options, and an algorithm onComplete, run these steps. onComplete must be an algorithm accepting null (on failure) or a module script\(^1\) (on success).

1. Disallow further import maps\(^1\) given settingsObject.
2. Fetch a single module script\(^1\) given url, settingsObject, destination, options, settingsObject, "client", true, and with the following steps given result:
   1. Run onComplete given result.
   2. If result is not null, optionally fetch the descendants of and link\(^1\) result given settingsObject, destination, and an empty algorithm.

---

**Note**

Generally, performing this step will be beneficial for performance, as it allows pre-loading the modules that will invariably be requested later, via algorithms such as fetch an external module script graph\(^1\) that fetch the entire graph. However, user agents might wish to skip them in bandwidth-constrained situations, or situations where the relevant fetches are already in flight.

To fetch an inline module script graph given a string sourceText, a URL baseURL, an environment settings object\(^1\) settingsObject, a script fetch options\(^1\) options, and an algorithm onComplete, run these steps. onComplete must be an algorithm accepting null (on failure) or a module script\(^1\) (on success).

1. Disallow further import maps\(^1\) given settingsObject.
2. Let script be the result of creating a JavaScript module script\(^1\) using sourceText, settingsObject, baseURL, and options.
3. Fetch the descendants of and link\(^1\) script, given settingsObject, "script", and onComplete.

To fetch a module worker script graph given a URL url, an environment settings object\(^1\) fetchClient, a destination destination, a credentials mode\(^1\) credentialsMode, an environment settings object\(^1\) settingsObject, and an algorithm onComplete, fetch a worklet/module worker script graph\(^1\) given url, fetchClient, destination, credentialsMode, settingsObject, and onComplete.

To fetch a worklet script graph given a URL url, an environment settings object\(^1\) fetchClient, a destination destination, a credentials mode\(^1\) credentialsMode, an environment settings object\(^1\) settingsObject, a module responses map\(^1\) moduleResponsesMap, and an algorithm onComplete, fetch a worklet/module worker script graph\(^1\) given url, fetchClient, destination, credentialsMode, settingsObject, onComplete, and the following perform the fetch hook\(^1\) given request and processCustomFetchResponse\(^1\).

1. Let requestURL be request's URL.
2. If moduleResponsesMap[requestURL] is "fetching", wait in parallel\(^1\) until that entry's value changes, then queue a task\(^1\) on the networking task source\(^1\) to proceed with running the following steps.
3. If moduleResponsesMap[requestURL] exists, then:
   1. Let cached be moduleResponsesMap[requestURL].
   2. Run processCustomFetchResponse with cached[0] and cached[1].
3. Return.

4. Set `moduleResponsesMap[requestURL]` to "fetching".

5. Fetch request, with `processResponseConsumeBody` set to the following steps given `response` response and null, failure, or a byte sequence `bodyBytes`:
   1. Set `moduleResponsesMap[requestURL]` to `(response, bodyBytes)`.  
   2. Run `processCustomFetchResponse` with `response` and `bodyBytes`.

The following algorithms are meant for internal use by this specification only as part of fetching an external module script graph or other similar concepts above, and should not be used directly by other specifications.

This diagram illustrates how these algorithms relate to the ones above, as well as to each other:

To fetch a worklet/module worker script graph given a URL `url`, an environment settings object `fetchClient`, a destination `destination`, a credentials mode `credentialsMode`, an environment settings object `settingsObject`, an algorithm `onComplete`, and an optional perform the fetch hook `performFetch`, run these steps. `onComplete` must be an algorithm accepting null (on failure) or a module script (on success).

1. Let `options` be a script fetch options whose cryptographic nonce is the empty string, integrity metadata is the empty string, parser metadata is "not-parser-inserted", credentials mode is `credentialsMode`, referrer policy is the empty string, and fetch priority is "auto".

2. Fetch a single module script given `url`, `fetchClient`, `destination`, `options`, `settingsObject`, "client", true, and `onSingleFetchComplete` as defined below. If `performFetch` was given, pass it along as well.

   `onSingleFetchComplete` given `result` is the following algorithm:
   1. If `result` is null, run `onComplete` given null, and abort these steps.
   2. Fetch the descendants of and link result given `fetchClient`, `destination`, and `onComplete`. If `performFetch` was given, pass it along as well.

To fetch the descendants of and link a module script `moduleScript` given an environment settings object `fetchClient`, a destination `destination`, an algorithm `onComplete`, and an optional perform the fetch hook `performFetch`, run these steps. `onComplete` must be an algorithm accepting null (on failure) or a module script (on success).

1. Let `record` be `moduleScript`'s record.

2. If `record` is null, then:
   1. Set `moduleScript`'s error to rethrow to `moduleScript`'s parse error.
   2. Run `onComplete` given `moduleScript`.
   3. Return.

3. Let state be `Record` `{ [[ParseError]]: null, [[Destination]]: destination, [[PerformFetch]]: null, [[FetchClient]]: fetchClient }.

4. If `performFetch` was given, set state.[[PerformFetch]] to `performFetch`.

5. Let `loadingPromise` be record `LoadRequestedModules` state.

**Note** This step will recursively load all the module transitive dependencies.
6. Upon fulfillment of loadingPromise, run the following steps:
   1. Perform record.Link().

   **Note**
   This step will recursively call Link on all of the module's unlinked dependencies.

   If this throws an exception, catch it, and set moduleScript's error to rethrow to that exception.

   2. Run onComplete given moduleScript.

7. Upon rejection of loadingPromise, run the following steps:
   1. If state.[[ParseError]] is not null, set moduleScript's error to rethrow to state.[[ParseError]] and run onComplete given moduleScript.
   2. Otherwise, run onComplete given null.

   **Note**
   state.[[ParseError]] is null when loadingPromise is rejected due to a loading error.

To fetch a single module script, given a URL url, an environment settings object fetchClient, a destination destination, a script fetch options options, an environment settings object settingsObject, a referrer referrer, an optional ModuleRequest moduleRequest, a boolean isTopLevel, an algorithm onComplete, and an optional perform the fetch hook performFetch, run these steps. onComplete must be an algorithm accepting null (on failure) or a module script (on success).

1. Let moduleType be "javascript".
2. If moduleRequest was given, then set moduleType to the result of running the module type from module request steps given moduleRequest.
3. **Assert**: the result of running the module type allowed steps given moduleType and settingsObject is true. Otherwise we would not have reached this point because a failure would have been raised when inspecting moduleRequest.[Attributes] in create a JavaScript module script or fetch a single imported module script.
4. Let moduleMap be settingsObject's module map.
5. If moduleMap[url, moduleType] is "fetching", wait in parallel until that entry's value changes, then queue a task on the networking task source to proceed with running the following steps.
6. If moduleMap[url, moduleType] exists, run onComplete given moduleMap[url, moduleType], and return.
7. Set moduleMap[url, moduleType] to "fetching".
8. Let request be a new request whose URL is url, mode is "cors", referrer is referrer, and client is fetchClient.
9. Set request's destination to the result of running the fetch destination from module type steps given destination and moduleType.
10. If destination is "worker", "sharedworker", or "serviceworker", and isTopLevel is true, then set request's mode to "same-origin".
11. Set request's initiator type to "script".
12. Set up the module script request given request and options.
13. If performFetch was given, run performFetch with request, isTopLevel, and with processResponseConsumeBody as defined below.
   
   Otherwise, fetch request with processResponseConsumeBody set to processResponseConsumeBody as defined below.
   
   In both cases, let processResponseConsumeBody given response response and null, failure, or a byte sequence bodyBytes be the following algorithm:

   **Note**
   response is always CORS-same-origin.

   1. If any of the following are true:
Let $bodyBytes$ is null or failure; or

- response's status is not an ok status.

then set $moduleMap[url, moduleType]$ to null, run onComplete given null, and abort these steps.

2. Let $sourceText$ be the result of UTF-8 decoding $bodyBytes$.
3. Let $mimeType$ be the result of extracting a MIME type from response's header list.
4. Let $moduleScript$ be null.
5. Let $referrerPolicy$ be the result of parsing the `Referrer-Policy` header given response. [REFERRERPOLICY]⁸¹⁴³
6. If $referrerPolicy$ is not the empty string, set options's $referrerPolicy$ to $referrerPolicy$.
7. If $mimeType$ is a JavaScript MIME type and $moduleType$ is "javascript", then set $moduleScript$ to the result of creating a JavaScript module script given $sourceText$, $settingsObject$, response's $URL$, and options.
8. If the MIME type essence of $mimeType$ is "text/css" and $moduleType$ is "css", then set $moduleScript$ to the result of creating a CSS module script given $sourceText$ and $settingsObject$.
9. If $mimeType$ is a JSON MIME type and $moduleType$ is "json", then set $moduleScript$ to the result of creating a JSON module script given $sourceText$ and $settingsObject$.
10. Set $moduleMap[url, moduleType]$ to $moduleScript$, and run onComplete given $moduleScript$.

Note

It is intentional that the $module map$ is keyed by the request URL, whereas the base URL for the module script is set to the response URL. The former is used to deduplicate fetches, while the latter is used for URL resolution.

To fetch a single imported module script, given a URL $url$, an environment settings object fetchClient, a destination destination, a script fetch options options, environment settings object $settingsObject$, a referrer referrer, a ModuleRequest Record $moduleRequest$, an algorithm onComplete, and an optional perform the fetch hook performFetch, run these steps.
onComplete must be an algorithm accepting null (on failure) or a module script (on success).

1. Assert: $moduleRequest.[[Attributes]]$ does not contain any Record entry such that entry.[[Key]] is not "type", because we only asked for "type" attributes in HostGetSupportedImportAttributes.
2. Let $moduleType$ be the result of running the module type from module request steps given $moduleRequest$.
3. If the result of running the module type allowed steps given $moduleType$ and $settingsObject$ is false, then run onComplete given null, and return.
4. Fetch a single module script given $url$, fetchClient, destination, options, $settingsObject$, referrer, $moduleRequest$, false, and onComplete. If performFetch was given, pass it along as well.

8.1.4.3 Creating scripts

To create a classic script, given a string source, an environment settings object settings, a URL baseURL, a script fetch options options, an optional boolean mutedErrors (default false), and an optional URL-or-null sourceURLForWindowScripts (default null):

1. If mutedErrors is true, then set baseURL to about:blank.

Note

When mutedErrors is true, baseURL is the script's CORS-cross-origin response's $url$, which shouldn't be exposed to JavaScript. Therefore, baseURL is sanitized here.

2. If scripting is disabled for settings, then set source to the empty string.
3. Let script be a new classic script that this algorithm will subsequently initialize.
4. Set script's settings object to settings.
5. Set script's base URL to baseURL.
6. Set script's fetch options to options.
7. Set script's muted errors to mutedErrors.
8. Set script's parse error and error to rethrow to null.
9. Record classic script creation time given script and sourceURLForWindowScripts.
10. Let result be ParseScript(source, settings's realm, script).

**Note**
Passing script as the last parameter here ensures result.[[HostDefined]] will be script.

11. If result is a list of errors, then:
   1. Set script's parse error and its error to rethrow to result[0].
   2. Return script.
12. Set script's record to result.
13. Return script.

To create a JavaScript module script, given a string source, an environment settings object settings, a URL baseURL, and a script fetch options options:

1. If scripting is disabled for settings, then set source to the empty string.
2. Let script be a new module script that this algorithm will subsequently initialize.
3. Set script's settings object to settings.
4. Set script's base URL to baseURL.
5. Set script's fetch options to options.
6. Set script's parse error and error to rethrow to null.
7. Let result be ParseModule(source, settings's realm, script).

**Note**
Passing script as the last parameter here ensures result.[[HostDefined]] will be script.

8. If result is a list of errors, then:
   1. Set script's parse error and its error to rethrow to result[0].
   2. Return script.
9. For each ModuleRequest record requested of result.[[RequestedModules]]:
   1. If requested.[[Attributes]] contains a Record entry such that entry.[[Key]] is not "type", then:
      1. Let error be a new SyntaxError exception.
      2. Set script's parse error to error.
      3. Return script.

**Note**
The JavaScript specification re-performs this validation when loading script's dependencies. It is duplicated here to skip unnecessary work given that, in case of an invalid attribute key, loading the module graph would fail anyway. Additionally, this makes the errors reported for invalid static imports consistent with dynamic imports, for which invalid attributes are reported before calling into HTML and thus before validating the imported specifier.

2. Resolve a module specifier given script and requested.[[Specifier]], catching any exceptions.
3. If the previous step threw an exception, then:
   1. Set script's parse error to that exception.
   2. Return script.

4. Let moduleType be the result of running the module type from module request steps given requested.

5. If the result of running the module type allowed steps given moduleType and settings is false, then:
   1. Let error be a new TypeError exception.
   2. Set script's parse error to error.
   3. Return script.

Note

This step is essentially validating all of the requested module specifiers and type attributes. We treat a module with unresolvable module specifiers or unsupported type attributes the same as one that cannot be parsed; in both cases, a syntactic issue makes it impossible to ever contemplate linking the module later.

10. Set script's record to result.

11. Return script.

To create a CSS module script, given a string source and an environment settings object settings:

1. Let script be a new module script that this algorithm will subsequently initialize.

2. Set script's settings object to settings.

3. Set script's base URI and fetch options to null.

4. Set script's parse error and error to rethrow to null.

5. Let sheet be the result of running the steps to create a constructed CSSStyleSheet with an empty dictionary as the argument.

6. Run the steps to synchronously replace the rules of a CSSStyleSheet on sheet given source.

   If this throws an exception, catch it, and set script's parse error to that exception, and return script.

Note

The steps to synchronously replace the rules of a CSSStyleSheet will throw if source contains any @import rules. This is by-design for now because there is not yet an agreement on how to handle these for CSS module scripts; therefore they are blocked altogether until a consensus is reached.

7. Set script's record to the result of CreateDefaultExportSyntheticModule(sheet).

8. Return script.

To create a JSON module script, given a string source and an environment settings object settings:

1. Let script be a new module script that this algorithm will subsequently initialize.

2. Set script's settings object to settings.

3. Set script's base URI and fetch options to null.

4. Set script's parse error and error to rethrow to null.

5. Let result be ParseJSONModule(source).

   If this throws an exception, catch it, and set script's parse error to that exception, and return script.

6. Set script's record to result.

7. Return script.

The module type from module request steps, given a ModuleRequest Record moduleRequest, are as follows:
1. Let \texttt{moduleType} be "javascript".

2. If \texttt{moduleRequest.[[Attributes]].[Record entry such that entry.[[Key]] is "type", then:

   1. If \texttt{entry.[Value]} is "javascript", then set \texttt{moduleType} to null.

   \textbf{Note} This specification uses the "javascript" module type internally for JavaScript module scripts\textsuperscript{1072}, so this step is needed to prevent modules from being imported using a "javascript" type attribute (a null \texttt{moduleType} will cause the \texttt{module type allowed}\textsuperscript{1083} check to fail).

   2. Otherwise, set \texttt{moduleType} to \texttt{entry.[Value]}.

3. Return \texttt{moduleType}.

   \textbf{The module type allowed} steps, given a \texttt{string} \texttt{moduleType} and an \texttt{environment settings object}\textsuperscript{1004} \texttt{settings}, are as follows:

   1. If \texttt{moduleType} is not "javascript", "css", or "json", then return false.

   2. If \texttt{moduleType} is "css" and the \texttt{CSSStyleSheet} interface is not exposed in \texttt{settings}'s \texttt{realm}\textsuperscript{1065}, then return false.

   3. Return true.

   \textbf{The fetch destination from module type} steps, given a \texttt{destination defaultDestination} and a \texttt{string} \texttt{moduleType}, are as follows:

   1. If \texttt{moduleType} is "json", then return "json".

   2. If \texttt{moduleType} is "css", then return "style".

   3. Return \texttt{defaultDestination}.

8.1.4.4 Calling scripts\textsuperscript{1010}

To \textbf{run a classic script} given a \texttt{classic script}\textsuperscript{1072} \texttt{script} and an optional boolean \texttt{rethrow errors} (default false):

1. Let \texttt{settings} be the \texttt{settings object}\textsuperscript{1007} of \texttt{script}.

2. \textbf{Check if we can run script}\textsuperscript{1004} with \texttt{settings}. If this returns "do not run" then return \texttt{NormalCompletion(}\texttt{empty}).

3. \textbf{Record classic script execution start time} given \texttt{script}.

4. \textbf{Prepare to run script}\textsuperscript{1004} given \texttt{settings}.

5. Let \texttt{evaluationStatus} be null.

6. If \texttt{script's error to rethrow}\textsuperscript{1072} is not null, then set \texttt{evaluationStatus} to Completion { [[Type]]: throw, [[Value]]: \texttt{script's error to rethrow}\textsuperscript{1072}, [[Target]]: empty }.

7. Otherwise, set \texttt{evaluationStatus} to \texttt{ScriptEvaluation(script's record}\textsuperscript{1007} \texttt{).}

   If \texttt{ScriptEvaluation} does not complete because the user agent has \texttt{aborted the running script}\textsuperscript{1085}, leave \texttt{evaluationStatus} as null.

8. If \texttt{evaluationStatus} is an \textbf{abrupt completion}, then:

   1. If \texttt{rethrow errors} is true and \texttt{script's muted errors}\textsuperscript{1072} is false, then:

      1. \textbf{Clean up after running script}\textsuperscript{1004} with \texttt{settings}.

      2. Rethrow \texttt{evaluationStatus.[[Value]]}.

   2. If \texttt{rethrow errors} is true and \texttt{script's muted errors}\textsuperscript{1072} is true, then:

      1. \textbf{Clean up after running script}\textsuperscript{1004} with \texttt{settings}.

      2. Throw a "NetworkError" \texttt{DOMException}.

   3. Otherwise, \texttt{rethrow errors} is false. Perform the following steps:
1. Report the exception\textsuperscript{1086} given by evaluationStatus.\\textsuperscript{[Value]} for script.

2. Clean up after running script\textsuperscript{1084} with settings.

3. Return evaluationStatus.

9. Clean up after running script\textsuperscript{1084} with settings.

10. If evaluationStatus is a normal completion, then return evaluationStatus.

11. If we've reached this point, evaluationStatus was left as null because the script was aborted prematurely\textsuperscript{1085} during evaluation. Return Completion { [[Type]]: throw, [[Value]]: a new "QuotaExceededError", DOMException, [[Target]]: empty }.

To run a module script given a module script\textsuperscript{1072} script and an optional boolean preventErrorReporting (default false):

1. Let settings be the settings object\textsuperscript{1072} of script.

2. Check if we can run script\textsuperscript{1084} with settings. If this returns “do not run”, then return a promise resolved with with undefined.

3. Record module script execution start time given script.

4. Prepare to run script\textsuperscript{1084} given settings.

5. Let evaluationPromise be null.

6. If script's error to rethrow\textsuperscript{1072} is not null, then set evaluationPromise to a promise rejected with script's error to rethrow\textsuperscript{1072}.

7. Otherwise:

   1. Let record be script's record\textsuperscript{1072}.

   2. Set evaluationPromise to record.Evaluate().

   \textbf{Note}

   This step will recursively evaluate all of the module's dependencies.

   If Evaluate fails to complete as a result of the user agent aborting the running script\textsuperscript{1085}, then set evaluationPromise to a promise rejected with a new "QuotaExceededError", DOMException.

8. If preventErrorReporting is false, then upon rejection of evaluationPromise with reason, report the exception\textsuperscript{1086} given by reason for script.

9. Clean up after running script\textsuperscript{1084} with settings.

10. Return evaluationPromise.

The steps to check if we can run script with an environment settings object\textsuperscript{1064} settings are as follows. They return either "run" or "do not run".

1. If the global object\textsuperscript{1065} specified by settings is a Window\textsuperscript{913} object whose Document\textsuperscript{128} object is not fully active\textsuperscript{992}, then return "do not run".

2. If scripting is disabled\textsuperscript{1071} for settings, then return "do not run".

3. Return "run".

The steps to prepare to run script with an environment settings object\textsuperscript{1064} settings are as follows:

1. Push settings's realm execution context\textsuperscript{1064} onto the JavaScript execution context stack; it is now the running JavaScript execution context.

2. Add settings to the surrounding agent's event loop\textsuperscript{1010}’s currently running task\textsuperscript{1106}’s script evaluation environment settings object set\textsuperscript{1105}.

The steps to clean up after running script with an environment settings object\textsuperscript{1064} settings are as follows:

1. Assert: settings's realm execution context\textsuperscript{1064} is the running JavaScript execution context.

2. Remove settings's realm execution context\textsuperscript{1064} from the JavaScript execution context stack.
3. If the JavaScript execution context stack is now empty, perform a microtask checkpoint. (If this runs scripts, these algorithms will be invoked reentrantly.)

**Note**

*These algorithms are not invoked by one script directly calling another, but they can be invoked reentrantly in an indirect manner, e.g. if a script dispatches an event which has event listeners registered.*

The running script is the script in the [[HostDefined]] field in the ScriptOrModule component of the running JavaScript execution context.

### 8.1.4.5 Killing scripts

Although the JavaScript specification does not account for this possibility, it's sometimes necessary to **abort a running script**. This causes any `ScriptEvaluation` or `Source Text Module Record Evaluate` invocations to cease immediately, emptying the JavaScript execution context stack without triggering any of the normal mechanisms like finally blocks. ([JAVASCRIPT])

User agents may impose resource limitations on scripts, for example CPU quotas, memory limits, total execution time limits, or bandwidth limitations. When a script exceeds a limit, the user agent may either throw a "QuotaExceededError" `DOMException`, abort the script without an exception, prompt the user, or throttle script execution.

**Example**

For example, the following script never terminates. A user agent could, after waiting for a few seconds, prompt the user to either terminate the script or let it continue.

```html
<script>
  while (true) { /* loop */ }
</script>
```

User agents are encouraged to allow users to disable scripting whenever the user is prompted either by a script (e.g. using the `window.alert()` API) or because of a script's actions (e.g. because it has exceeded a time limit).

If scripting is disabled while a script is executing, the script should be terminated immediately.

User agents may allow users to specifically disable scripts just for the purposes of closing a browsing context.

**Example**

For example, the prompt mentioned in the example above could also offer the user with a mechanism to just close the page entirely, without running any `unload` event handlers.

### 8.1.4.6 Runtime script errors

For web developers (non-normative)

```javascript
self.reportError(e)
```

Dispatches an `error` event at the global object for the given value `e`, in the same fashion as an unhandled exception.

When the user agent is required to **report an error** for a particular script script with a particular position `line:col`, using a particular target target, it must run these steps, after which the error is either **handled** or **not handled**:

1. If target is in error reporting mode, then return; the error is not handled.
2. Let target be in error reporting mode.
3. Let `message` be an `implementation-defined` string describing the error in a helpful manner.
4. Let `errorMessage` be the value that represents the error: in the case of an uncaught exception, that would be the value that was thrown; in the case of a JavaScript error that would be an `Error` object. If there is no corresponding value, then the null value must be used instead.
Let \( \text{urlString} \) be the result of applying the URL serializer to the URL record that corresponds to the resource from which \( \text{script} \) was obtained.

**Note**

The resource containing the script will typically be the file from which the \( \text{Document} \) was parsed, e.g. for inline \( \text{script} \) elements or \( \text{event handler content attributes} \), or the JavaScript file that the script was in, for external scripts. Even for dynamically-generated scripts, user agents are strongly encouraged to attempt to keep track of the original source of a script. For example, if an external script uses the \( \text{document.write()} \) API to insert an inline \( \text{script} \) element during parsing, the URL of the resource containing the script would ideally be reported as being the external script, and the line number might ideally be reported as the line with the \( \text{document.write()} \) call or where the string passed to that call was first constructed. Naturally, implementing this can be somewhat non-trivial.

If \( \text{script} \) is a classic script and \( \text{script}'s \) muted errors is true, then set \( \text{message} \) to "Script error.", \( \text{urlString} \) to the empty string, \( \text{line} \) and \( \text{col} \) to 0, and \( \text{errorValue} \) to null.

Let \( \text{notHandled} \) be true.

If \( \text{target} \) implements \( \text{EventTarget} \), then set \( \text{notHandled} \) to the result of firing an event named \( \text{error} \) at \( \text{target} \), using \( \text{ErrorEvent} \), with the \( \text{cancelable} \) attribute initialized to true, the \( \text{message} \) attribute initialized to \( \text{message} \), the \( \text{filename} \) attribute initialized to \( \text{urlString} \), the \( \text{lineno} \) attribute initialized to \( \text{line} \), the \( \text{colno} \) attribute initialized to \( \text{col} \), and the \( \text{error} \) attribute initialized to \( \text{errorValue} \).

Let \( \text{target} \) no longer be in error reporting mode.

If \( \text{notHandled} \) is false, then the error is handled. Otherwise, the error is not handled.

**Note**

Returning true in an event handler cancels the event per the event handler processing algorithm.

When the user agent is to report an exception \( E \), the user agent must report the error for the relevant script, with the problematic position (line number and column number) in the resource containing the script, using the global object specified by the script's settings object as the target. If the error is still not handled after this, then the error may be reported to a developer console.

The existence of both report an error and report an exception is confusing, and both algorithms have known problems. You can track future cleanup in this area in issue #958.

The \( \text{reportError(e)} \) method steps are to report the exception \( \text{e} \).

The \( \text{ErrorEvent} \) interface is defined as follows:

```idl
[Exposed=*]
interface ErrorEvent : Event {
    constructor(DOMString type, optional ErrorEventInit eventInitDict = {});
}
```

```idl
dictionary ErrorEventInit : EventInit {
    DOMString message = "";
    USVString filename = "";
    unsigned long lineno = 0;
}
```
The `message` attribute must return the value it was initialized to. It represents the error message.

The `filename` attribute must return the value it was initialized to. It represents the URL of the script in which the error originally occurred.

The `lineno` attribute must return the value it was initialized to. It represents the line number where the error occurred in the script.

The `colno` attribute must return the value it was initialized to. It represents the column number where the error occurred in the script.

The `error` attribute must return the value it was initialized to. It must initially be initialized to undefined. Where appropriate, it is set to the object representing the error (e.g., the exception object in the case of an uncaught exception).

### 8.1.4.7 Unhandled promise rejections

In addition to synchronous runtime script errors, scripts may experience asynchronous promise rejections, tracked via the `unhandledrejection` and `rejectionhandled` events. Tracking these rejections is done via the `HostPromiseRejectionTracker` abstract operation, but reporting them is defined here.

To **notify about rejected promises** on a given `environment settings object` settings object:

1. Let `list` be a copy of settings object's `about-to-be-notified rejected promises list`.
2. If `list` is empty, return.
4. Let `global` be settings object's `global object`.
5. Queue a global task on the DOM manipulation task source given `global` to run the following substep:
   1. For each promise `p` in `list`:
      1. If `p`'s [[PromisesHandled]] internal slot is true, continue to the next iteration of the loop.
      2. Let `notHandled` be the result of firing an event named `unhandledrejection` at `global`, using `PromiseRejectionEvent`, with the `cancelable` attribute initialized to true, the `promise` attribute initialized to `p`, and the `reason` attribute initialized to the value of `p`'s [[PromiseResult]] internal slot.
      3. If `notHandled` is false, then the promise rejection is `handled`. Otherwise, the promise rejection is `not handled`.
      4. If `p`'s [[PromisesHandled]] internal slot is false, add `p` to settings object's `outstanding rejected promises weak set`.

This algorithm results in promise rejections being marked as `handled` or `not handled`. These concepts parallel `handled` and `not handled` script errors. If a rejection is still `not handled` after this, then the rejection may be reported to a developer console.

The `PromiseRejectionEvent` interface is defined as follows:

```idl
[Exposed=*]
interface PromiseRejectionEvent : Event {
  constructor(DOMString type, PromiseRejectionEventInit eventInitDict);

  readonly attribute object promise;
  readonly attribute any reason;
};
```

```
dictionary PromiseRejectionEventInit : EventInit {
  required object promise;
}```
The `promise` attribute must return the value it was initialized to. It represents the promise which this notification is about.

The `reason` attribute must return the value it was initialized to. It represents the rejection reason for the promise.

### 8.1.4.8 Import map parse results

An import map parse result is a struct that is similar to a `script`, and also can be stored in a `script` element's `result`, but is not counted as a `script` for other purposes. It has the following items:

- An import map
- An import map or null.
- An error to rethrow

A JavaScript value representing an error that will prevent using this import map, when non-null.

To create an import map parse result given a string input and a URL baseURL:

1. Let result be an import map parse result whose import map is null and whose error to rethrow is null.
2. Parse an import map string given input and baseURL, catching any exceptions. If this threw an exception, then set result's error to rethrow to that exception. Otherwise, set result's import map to the return value.
3. Return result.

To register an import map given a Window global and an import map parse result result:

1. If result's error to rethrow is not null, then report the exception given by result's error to rethrow and return.
2. Assert: global's import map is an empty import map.
3. Set global's import map to result's import map.

### 8.1.5 Module specifier resolution

#### 8.1.5.1 The resolution algorithm

The resolve a module specifier algorithm is the primary entry point for converting module specifier strings into URLs. When no import maps are involved, it is relatively straightforward, and reduces to resolving a URL-like module specifier.

When there is a non-empty import map present, the behavior is more complex. It checks candidate entries from all applicable module specifier maps, from most-specific to least-specific scopes (falling back to the top-level unscope imports), and from most-specific to least-specific prefixes. For each candidate, the resolve an imports match algorithm will give on the following results:

- Successful resolution of the specifier to a URL. Then the resolve a module specifier algorithm will return that URL.
- Throwing an exception. Then the resolve a module specifier algorithm will rethrow that exception, without any further fallbacks.
- Failing to resolve, without an error. In this case the outer resolve a module specifier algorithm will move on to the next candidate.

In the end, if no successful resolution is found via any of the candidate module specifier maps, resolve a module specifier will throw an exception. Thus the result is always either a URL or a thrown exception.
To resolve a module specifier given a `script`-or-null referringScript and a `string` specifier:

1. Let `settingsObject` and `baseURL` be null.
2. If `referringScript` is not null, then:
   1. Set `settingsObject` to `referringScript`'s settings object\textsuperscript{1072}.
   2. Set `baseURL` to `referringScript`'s base URL\textsuperscript{1072}.
3. Otherwise:
   1. Assert: there is a current settings object\textsuperscript{1070}.
   2. Set `settingsObject` to the current settings object\textsuperscript{1070}.
   3. Set `baseURL` to `settingsObject`'s API base URL\textsuperscript{1064}.
4. Let `importMap` be an empty import map\textsuperscript{1094}.
5. If `settingsObject`'s global object\textsuperscript{1065} implements `Window`\textsuperscript{913}, then set `importMap` to `settingsObject`'s global object\textsuperscript{1065}'s import map\textsuperscript{1094}.
7. Let `asURL` be the result of resolving a URL-like module specifier\textsuperscript{1090} given specifier and `baseURL`.
8. Let `normalizedSpecifier` be the serialization of `asURL`, if `asURL` is non-null; otherwise, specifier.
9. For each `scopePrefix` → `scopeImports` of `importMap`'s scopes\textsuperscript{1094}:
   1. If `scopePrefix` is `baseURLString`, or if `scopePrefix` ends with U+002F (/) and `scopePrefix` is a code unit prefix of `baseURLString`, then:
      1. Let `scopelImportsMatch` be the result of resolving an imports match\textsuperscript{1089} given `normalizedSpecifier`, `asURL`, and `scopeImports`.
      2. If `scopelImportsMatch` is not null, then return `scopelImportsMatch`.
10. Let `topLevelImportsMatch` be the result of resolving an imports match\textsuperscript{1089} given `normalizedSpecifier`, `asURL`, and `importMap`'s imports\textsuperscript{1094}.
11. If `topLevelImportsMatch` is not null, then return `topLevelImportsMatch`.

**Note**

At this point, specifier wasn't remapped to anything by importMap, but it might have been able to be turned into a URL.

If `asURL` is not null, then return `asURL`.

13. Throw a `TypeError` indicating that `specifier` was a bare specifier, but was not remapped to anything by importMap.

To resolve an imports match, given a `string` `normalizedSpecifier`, a `URL`-or-null `asURL`, and a module specifier map\textsuperscript{1094} `specifierMap`:

1. For each `specifierKey` → `resolutionResult` of `specifierMap`:
   1. If `specifierKey` is `normalizedSpecifier`, then:
      1. If `resolutionResult` is null, then throw a `TypeError` indicating that resolution of `specifierKey` was blocked by a null entry.
      
     **Note**

This will terminate the entire resolve a module specifier\textsuperscript{1089} algorithm, without any further fallbacks.

   2. Assert: `resolutionResult` is a `URL`.
   3. Return `resolutionResult`.
2. If all of the following are true:
   - `specifierKey` ends with U+002F (/)
specifierKey is a code unit prefix of normalizedSpecifier; and

either asURL is null, or asURL is special.

then:

1. If resolutionResult is null, then throw a TypeError indicating that the resolution of specifierKey was blocked by a null entry.

   Note
   This will terminate the entire resolve a module specifier\textsuperscript{(1089)} algorithm, without any further fallbacks.

2. Assert: resolutionResult is a URL.

3. Let afterPrefix be the portion of normalizedSpecifier after the initial specifierKey prefix.

4. Assert: resolutionResult, serialized, ends with U+002F (/), as enforced during parsing\textsuperscript{(1094)}.

5. Let url be the result of URL parsing afterPrefix with resolutionResult.

6. If url is failure, then throw a TypeError indicating that resolution of normalizedSpecifier was blocked since the afterPrefix portion could not be URL-parsed relative to the resolutionResult mapped to by the specifierKey prefix.

   Note
   This will terminate the entire resolve a module specifier\textsuperscript{(1089)} algorithm, without any further fallbacks.

7. Assert: url is a URL.

8. If the serialization of resolutionResult is not a code unit prefix of the serialization of url, then throw a TypeError indicating that the resolution of normalizedSpecifier was blocked due to it backtracking above its prefix specifierKey.

   Note
   This will terminate the entire resolve a module specifier\textsuperscript{(1089)} algorithm, without any further fallbacks.


2. Return null.

   Note
   The resolve a module specifier\textsuperscript{(1089)} algorithm will fall back to a less-specific scope, or to "imports", if possible.

To resolve a URL-like module specifier, given a string specifier and a URL baseURL:

1. If specifier starts with "/", "./", or ".../", then:

   1. Let url be the result of URL parsing specifier with baseURL.

   2. If url is failure, then return null.

   Example
   One way this could happen is if specifier is ".../foo" and baseURL is a data URL.

   Note
   This includes cases where specifier starts with "/", i.e., scheme-relative URLs. Thus, url might end up with a different host than baseURL.

2. Let url be the result of URL parsing specifier (with no base URL).

3. If url is failure, then return null.

4. Return url.
8.1.5.2 Import maps

An import map allows control over module specifier resolution. Import maps are delivered via inline script elements with their type attribute set to "importmap", and with their child text content containing a JSON representation of the import map.

Only one import map is processed per Document. After the first import map is seen, others will be ignored, with their corresponding script elements generating error events. Similarly, once any modules have been imported, e.g., via import() expressions or script elements with their type attribute set to "module", further import maps will be ignored.

Note

These restrictions, as well as the lack of support for external import maps, are in place to keep the initial version of the feature simple. They might be lifted over time as implementer bandwidth allows.

Example

The simplest use of import maps is to globally remap a bare module specifier:

```json
{  "imports": {  "moment": "/node_modules/moment/src/moment.js" }}
```

This enables statements like import moment from "moment"; to work, fetching and evaluating the JavaScript module at the /node_modules/moment/src/moment.js URL.

Example

An import map can remap a class of module specifiers into a class of URLs by using trailing slashes, like so:

```json
{  "imports": {  "moment/": "/node_modules/moment/src/" }}
```

This enables statements like import localeData from "moment/locale/zh-cn.js"; to work, fetching and evaluating the JavaScript module at the /node_modules/moment/src/locale/zh-cn.js URL. Such trailing-slash mappings are often combined with bare-specifier mappings, e.g.

```json
{  "imports": {  "moment": "/node_modules/moment/src/moment.js",  "moment/": "/node_modules/moment/src/" }}
```

so that both the "main module" specified by "moment" and the "submodules" specified by paths such as "moment/locale/zh-cn.js" are available.

Example

Bare specifiers are not the only type of module specifiers which import maps can remap. "URL-like" specifiers, i.e., those that are either parseable as absolute URLs or start with "/", "./", or "./.", can be remapped as well:

```json
{  "imports": {  "https://cdn.example.com/vue/dist/vue.runtime.esm.js": "/node_modules/vue/dist/vue.runtime.esm.js",  "/js/app.mjs": "/js/app-8e0d62a03.mjs",  "./.helpers": "https://cdn.example/helpers/" }}
```

These restrictions, as well as the lack of support for external import maps, are in place to keep the initial version of the feature simple. They might be lifted over time as implementer bandwidth allows.
Note how the URL to be remapped, as well as the URL being mapped to, can be specified either as absolute URLs, or as relative URLs starting with "/", "./", or ".../". (They cannot be specified as relative URLs without those starting sigils, as those help distinguish from bare module specifiers.) Also note how the trailing slash mapping works in this context as well.

Such remappings operate on the post-canonicalization URL, and do not require a match between the literal strings supplied in the import map key and the imported module specifier. So for example, if this import map was included on https://example.com/app.html, then not only would import "/js/app.mjs" be remapped, but so would import "./js/app.mjs" and import "./foo/../js/app.mjs".

Example

All previous examples have globally remapped module specifiers, by using the top-level "imports" key in the import map. The top-level "scopes" key can be used to provide localized remappings, which only apply when the referring module matches a specific URL prefix. For example:

```json
{
  "scopes": {
    "/a/": {
      "moment": "/node_modules/moment/src/moment.js"
    },
    "/b/": {
      "moment": 
      "https://cdn.example.com/moment/src/moment.js"
    }
  }
}
```

With this import map, the statement `import "moment"` will have different meanings depending on which referrer script contains the statement:

- Inside scripts located under "/a/", this will import "/node_modules/moment/src/moment.js".
- Inside scripts located under "/b/", this will import "https://cdn.example.com/moment/src/moment.js".
- Inside scripts located under "/c/", this will fail to resolve and thus throw an exception.

A typical usage of scopes is to allow multiple versions of the "same" module to exist in a web application, with some parts of the module graph importing one version, and other parts importing another version.

Example

Scopes can overlap each other, and overlap the global "imports" specifier map. At resolution time, scopes are consulted in order of most- to least-specific, where specificity is measured by sorting the scopes using the code unit less than operation. So, for example, "/scope2/scope3/" is treated as more specific than "/scope2/", which is treated as more specific than the top-level (unscoped) mappings.

The following import map illustrates this:

```json
{
  "imports": {
    "a": "/a-1.mjs",
    "b": "/b-1.mjs",
    "c": "/c-1.mjs"
  },
  "scopes": {
    "/scope2/": {
      "a": "/a-2.mjs"
    },
    "/scope2/scope3/": {
    
```
The child text content of a script element representing an import map must match the following import map authoring requirements:

- It must be valid JSON.
- The JSON must represent a JSON object, with at most the three keys "imports", "scopes", and "integrity".
- The values corresponding to the "imports", "scopes", and "integrity" keys, if present, must themselves be JSON objects.
- The value corresponding to the "imports" key, if present, must be a valid module specifier map.
- The value corresponding to the "scopes" key, if present, must be a JSON object, whose keys are valid URL strings and whose values are valid module specifier maps.
- The value corresponding to the "integrity" key, if present, must be a JSON object, whose keys are valid URL strings and whose values fit the requirements of the integrity attribute.

A valid module specifier map is a JSON object that meets the following requirements:

- All of its keys must be nonempty.
- All of its values must be strings.
- Each value must be either a valid absolute URL or a valid URL string that starts with "/", "."," or ". ./".
- If a given key ends with "/", then the corresponding value must also.

This results in the following resolutions (using relative URLs for brevity):

<table>
<thead>
<tr>
<th>Specifier</th>
<th>&quot;a&quot;</th>
<th>&quot;b&quot;</th>
<th>&quot;c&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Referrer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/scope1/r.mjs</td>
<td>/a-1.mjs</td>
<td>/b-1.mjs</td>
<td>/c-1.mjs</td>
</tr>
<tr>
<td>/scope2/r.mjs</td>
<td>/a-2.mjs</td>
<td>/b-1.mjs</td>
<td>/c-1.mjs</td>
</tr>
<tr>
<td>/scope2/scope3/r.mjs</td>
<td>/a-2.mjs</td>
<td>/b-3.mjs</td>
<td>/c-1.mjs</td>
</tr>
</tbody>
</table>

Example

Import maps can also be used to provide modules with integrity metadata to be used in Subresource Integrity checks. [SRI]

The following import map illustrates this:

```json
{
  "imports": {
    "a": "/a-1.mjs",
    "b": "/b-1.mjs",
    "c": "/c-1.mjs"
  },
  "integrity": {
    "/a-1.mjs": "sha384-Li9vy3DqF8tnTXuiaAjuML3ky+er10rcgNR/VqsVpcw+ThHmYcwiB1pb0xEBzJr7",
    "/d-1.mjs": "sha384-MBO5IDfYaE6c6Aao940Zri0iC6G1SN2n4QUbHNPzhk5Xhm0djZLQqTLP0HzTUxk"
  }
}
```

The above example provides integrity metadata to be enforced on the modules /a-1.mjs and /d-1.mjs, even if the latter is not defined as an import in the map.
Formally, an import map is a struct with three items:

- imports, a module specifier map;
- scopes, an ordered map of URLs to module specifier maps; and
- integrity, a module integrity map.

A module specifier map is an ordered map whose keys are strings and whose values are either URLs or nulls.

A module integrity map is an ordered map whose keys are URLs and whose values are strings that will be used as integrity metadata.

An empty import map is an import map with its imports and scopes both being empty maps.

Each Window has an import map, initially an empty import map.

Each Window has an import maps allowed boolean, initially true.

To disallow further import maps given an environment settings object:

1. Let global be settingsObject's global object.
2. If global does not implement Window, then return.
3. Set global's import maps allowed to false.

Import maps are currently disallowed once any module loading has started, or once a single import map is loaded. These restrictions might be lifted in future specification revisions.

To parse an import map string, given a string input and a URL baseURL:

1. Let parsed be the result of parsing a JSON string to an Infra value given input.
2. If parsed is not an ordered map, then throw a TypeError indicating that the top-level value needs to be a JSON object.
3. Let sortedAndNormalizedImports be an empty ordered map.
4. If parsed["imports"] exists, then:
   1. If parsed["imports"] is not an ordered map, then throw a TypeError indicating that the value for the "imports" top-level key needs to be a JSON object.
   2. Set sortedAndNormalizedImports to the result of sorting and normalizing a module specifier map given parsed["imports"] and baseURL.
5. Let sortedAndNormalizedScopes be an empty ordered map.
6. If parsed["scopes"] exists, then:
   1. If parsed["scopes"] is not an ordered map, then throw a TypeError indicating that the value for the "scopes" top-level key needs to be a JSON object.
   2. Set sortedAndNormalizedScopes to the result of sorting and normalizing scopes given parsed["scopes"] and baseURL.
7. Let normalizedIntegrity be an empty ordered map.
8. If parsed["integrity"] exists, then:
   1. If parsed["integrity"] is not an ordered map, then throw a TypeError indicating that the value for the "integrity" top-level key needs to be a JSON object.
2. Set `normalizedIntegrity` to the result of normalizing a module integrity map given `parsed["integrity"]` and `baseURL`.

9. If `parsed`'s `keys contains` any items besides "imports", "scopes", or "integrity", then the user agent should report a warning to the console indicating that an invalid top-level key was present in the import map.

   **Note**
   ```plaintext```
   This can help detect typos. It is not an error, because that would prevent any future extensions from being added backward-compatible.
   ```plaintext```

10. Return an import map whose `imports` are `sortedAndNormalizedImports`, whose `scopes` are `sortedAndNormalizedScopes`, and whose `integrity` are `normalizedIntegrity`.

**Example**

The import map that results from this parsing algorithm is highly normalized. For example, given a base URL of https://example.com/base/page.html, the input

```javascript
{
  "imports": {
    "/app/helper": "node_modules/helper/index.mjs",
    "lodash": "/node_modules/lodash-es/lodash.js"
  }
}
```

will generate an import map with `imports` of

```json```
«[
  "https://example.com/app/helper" → https://example.com/base/node_modules/helper/index.mjs
  "lodash" → https://example.com/node_modules/lodash-es/lodash.js
]»
```

and (despite nothing being present in the input string) an empty `ordered map` for its `scopes`.

To sort and normalize a module specifier map, given an ordered map `originalMap` and a URL `baseURL`:

1. Let `normalized` be an empty `ordered map`.

2. For each `specifierKey` → `value` of `originalMap`:

   1. Let `normalizedSpecifierKey` be the result of normalizing a specifier key given `specifierKey` and `baseURL`.

   2. If `normalizedSpecifierKey` is null, then continue.

   3. If `value` is not a `string`, then:

      1. The user agent may report a warning to the console indicating that addresses need to be strings.

      2. Set `normalized[normalizedSpecifierKey]` to null.

      3. Continue.

   4. Let `addressURL` be the result of resolving a URL-like module specifier given `value` and `baseURL`.

   5. If `addressURL` is null, then:

      1. The user agent may report a warning to the console indicating that the address was invalid.

      2. Set `normalized[normalizedSpecifierKey]` to null.

      3. Continue.

   6. If `specifierKey` ends with U+002F (/), and the serialization of `addressURL` does not end with U+002F (/), then:

      1. The user agent may report a warning to the console indicating that an invalid address was given for the specifier key `specifierKey`; since `specifierKey` ends with a slash, the address needs to as well.
2. Set `normalized[normalizedSpecifierKey]` to null.

3. Continue.

7. Set `normalized[normalizedSpecifierKey]` to `addressURL`.

3. Return the result of sorting in descending order `normalized`, with an entry `a` being less than an entry `b` if `a`'s `key` is code unit less than `b`'s `key`.

To sort and normalize scopes, given an `ordered map` `originalMap` and a `URL` `baseURL`:

1. Let `normalized` be an empty `ordered map`.

2. For each `scopePrefix → potentialSpecifierMap` of `originalMap`:
   1. If `potentialSpecifierMap` is not an `ordered map`, then throw a `TypeError` indicating that the value of the scope with prefix `scopePrefix` needs to be a JSON object.
   2. Let `scopePrefixURL` be the result of `URL parsing` `scopePrefix` with `baseURL`.
   3. If `scopePrefixURL` is failure, then:
      1. The user agent may `report a warning to the console` that the scope prefix URL was not parseable.
      2. Continue.
   4. Let `normalizedScopePrefix` be the serialization of `scopePrefixURL`.
   5. Set `normalized[normalizedScopePrefix]` to the result of sorting and normalizing a module specifier map given `potentialSpecifierMap` and `baseURL`.

3. Return the result of sorting in descending order `normalized`, with an entry `a` being less than an entry `b` if `a`'s `key` is code unit less than `b`'s `key`.

To sort and normalize scopes, given an `ordered map` `originalMap` and a `URL` `baseURL`:

1. Let `normalized` be an empty `ordered map`.

2. For each `scopePrefix → potentialSpecifierMap` of `originalMap`:
   1. If `potentialSpecifierMap` is not an `ordered map`, then throw a `TypeError` indicating that the value of the scope with prefix `scopePrefix` needs to be a JSON object.
   2. Let `scopePrefixURL` be the result of `URL parsing` `scopePrefix` with `baseURL`.
   3. If `scopePrefixURL` is failure, then:
      1. The user agent may `report a warning to the console` that the scope prefix URL was not parseable.
      2. Continue.
   4. Let `normalizedScopePrefix` be the serialization of `scopePrefixURL`.
   5. Set `normalized[normalizedScopePrefix]` to the result of sorting and normalizing a module specifier map given `potentialSpecifierMap` and `baseURL`.

3. Return the result of sorting in descending order `normalized`, with an entry `a` being less than an entry `b` if `a`'s `key` is code unit less than `b`'s `key`.

To normalize a module integrity map, given an `ordered map` `originalMap`:

1. Let `normalized` be an empty `ordered map`.

2. For each `key → value` of `originalMap`:
   1. Let `resolvedURL` be the result of resolving a URL-like module specifier given `key` and `baseURL`.
   2. If `resolvedURL` is null, then:
      1. The user agent may `report a warning to the console` indicating that the key failed to resolve.
      2. Continue.
   3. If `value` is not a `string`, then:
      1. The user agent may `report a warning to the console` indicating that `integrity metadata` values need to be strings.
      2. Continue.
   4. Set `normalized[resolvedURL]` to `value`.

3. Return `normalized`.

To normalize a specifier key, given a `string` `specifierKey` and a `URL` `baseURL`:
1. If `specifierKey` is the empty string, then:
   1. The user agent may report a warning to the console indicating that specifier keys may not be the empty string.
   2. Return null.
2. Let `url` be the result of resolving a URL-like module specifier, given `specifierKey` and `baseURL`.
3. If `url` is not null, then return the serialization of `url`.
4. Return `specifierKey`.

### 8.1.6 JavaScript specification host hooks

The JavaScript specification contains a number of implementation-defined abstract operations, that vary depending on the host environment. This section defines them for user agent hosts.

#### 8.1.6.1 HostEnsureCanAddPrivateElement(O)

JavaScript contains an implementation-defined `HostEnsureCanAddPrivateElement(O)` abstract operation. User agents must use the following implementation: [JAVASCRIPT]

1. If `O` is a `WindowProxy` object, or implements `Location`, then return Completion { [[Type]]: throw, [[Value]]: a new `TypeError` }.
2. Return `NormalCompletion` (unused).

Note: JavaScript private fields can be applied to arbitrary objects. Since this can dramatically complicate implementation for particularly-exotic host objects, the JavaScript language specification provides this hook to allow hosts to reject private fields on objects meeting a host-defined criteria. In the case of HTML, `WindowProxy` and `Location` have complicated semantics — particularly around navigation and security — that make implementation of private field semantics challenging, so our implementation simply rejects those objects.

#### 8.1.6.2 HostEnsureCanCompileStrings(realm)

JavaScript contains an implementation-defined `HostEnsureCanCompileStrings(realm)` abstract operation. User agents must use the following implementation: [JAVASCRIPT]

1. Perform ? `EnsureCSPDoesNotBlockStringCompilation(realm)`. [CSP]

#### 8.1.6.3 HostPromiseRejectionTracker(promise, operation)

JavaScript contains an implementation-defined `HostPromiseRejectionTracker(promise, operation)` abstract operation. User agents must use the following implementation: [JAVASCRIPT]

1. Let `script` be the running script.
2. If `script` is a classic script and `script`'s muted errors is true, then return.
3. Let `settings object` be the current settings object.
4. If `script` is not null, then set `settings object` to `script`'s settings object.
5. If `operation` is "reject", then:
   1. Append `promise` to `settings object`'s about-to-be-notified rejected promises list.
6. If `operation` is "handle", then:
1. If settings object's about-to-be-notified rejected promises list contains promise, then remove promise from that list and return.

2. If settings object's outstanding rejected promises weak set does not contain promise, then return.

3. Remove promise from settings object's outstanding rejected promises weak set.

4. Let global be settings object's global object.

5. Queue a global task on the DOM manipulation task source given global to fire an event named rejectionhandled at global, using PromiseRejectionEvent, with the promise attribute initialized to promise, and the reason attribute initialized to promise.[[PromiseResult]].

### 8.1.6.4 Job-related host hooks

The JavaScript specification defines jobs to be scheduled and run later by the host, as well as JobCallback Records which encapsulate JavaScript functions that are called as part of jobs. The JavaScript specification contains a number of implementation-defined abstract operations that lets the host define how jobs are scheduled and how JobCallbacks are handled. HTML uses these abstract operations to track the incumbent settings object in promises and FinalizationRegistry callbacks by saving and restoring the incumbent settings object and a JavaScript execution context for the active script in JobCallbacks. This section defines them for user agent hosts.

#### 8.1.6.4.1 HostCallJobCallback(callback, V, argumentsList)

JavaScript contains an implementation-defined HostCallJobCallback(callback, V, argumentsList) abstract operation to let hosts restore state when invoking JavaScript callbacks from inside tasks. User agents must use the following implementation:

1. Let incumbent settings be callback.[[HostDefined]].[[IncumbentSettings]].

2. Let script execution context be callback.[[HostDefined]].[[ActiveScriptContext]].

3. Prepare to run a callback with incumbent settings.

   **Note**
   
   *This affects the incumbent concept while the callback runs.*

4. If script execution context is not null, then push script execution context onto the JavaScript execution context stack.

   **Note**
   
   *This affects the active script while the callback runs.*

5. Let result be Call(callback.[[Callback]], V, argumentsList).

6. If script execution context is not null, then pop script execution context from the JavaScript execution context stack.

7. Clean up after running a callback with incumbent settings.

8. Return result.

#### 8.1.6.4.2 HostEnqueueFinalizationRegistryCleanupJob(finalizationRegistry)

JavaScript has the ability to register objects with FinalizationRegistry objects, in order to schedule a cleanup action if they are found to be garbage collected. The JavaScript specification contains an implementation-defined HostEnqueueFinalizationRegistryCleanupJob(finalizationRegistry) abstract operation to schedule the cleanup action.

**Note**

*The timing and occurrence of cleanup work is implementation-defined in the JavaScript specification. User agents might differ in when and whether an object is garbage collected, affecting both whether the return value of the WeakRef.prototype.deref() method is undefined, and whether FinalizationRegistry cleanup callbacks occur. There are well-known cases in popular web*
Cleanup actions do not take place interspersed with synchronous JavaScript execution, but rather happen in queued tasks. User agents must use the following implementation:

```javascript
1. Let global be finalizationRegistry.[[Realm]]'s global object.
2. Queue a global task on the JavaScript engine task source given global to perform the following steps:
   1. Let entry be finalizationRegistry.[[CleanupCallback]].[[Callback]].[[Realm]]'s environment settings object.
   2. Check if we can run script with entry. If this returns "do not run", then return.
   3. Prepare to run script with entry.
   4. Let result be the result of performing CleanupFinalizationRegistry(finalizationRegistry).
   5. Clean up after running script with entry.
   6. If result is an abrupt completion, then report the exception given by result.[[Value]].
```

HTML clears kept-alive WeakRef objects in the perform a microtask checkpoint algorithm. Authors would be best off not depending on the timing details of garbage collection implementations.

8.1.6.4.3 HostEnqueueGenericJob(job, realm)

JavaScript contains an implementation-defined HostEnqueueGenericJob(job, realm) abstract operation to perform generic jobs in a particular realm (e.g., resolve promises resulting from Atomics.waitAsync). User agents must use the following implementation:

```javascript
1. Let global be realm's global object.
2. Queue a global task on the JavaScript engine task source given global to perform job().
```

8.1.6.4.4 HostEnqueuePromiseJob(job, realm)

JavaScript contains an implementation-defined HostEnqueuePromiseJob(job, realm) abstract operation to schedule Promise-related operations. HTML schedules these operations in the microtask queue. User agents must use the following implementation:

```javascript
1. If realm is not null, then let job settings be the settings object for realm. Otherwise, let job settings be null.
   Note
   If realm is not null, it is the realm of the author code that will run. When job is returned by NewPromiseReactionJob, it is the realm of the promise's handler function. When job is returned by NewPromiseResolveThenableJob, it is the realm of the then function.

   If realm is null, either no author code will run or author code is guaranteed to throw. For the former, the author may not have passed in code to run, such as in promise.then(null, null). For the latter, it is because a revoked Proxy was passed. In both cases, all the steps below that would otherwise use job settings get skipped.

2. Queue a microtask to perform the following steps:
   1. If job settings is not null, then check if we can run script with job settings. If this returns "do not run" then return.
   2. If job settings is not null, then prepare to run script with job settings.
```
Let result be job().

job is an abstract closure returned by `NewPromiseReactionJob` or `NewPromiseResolveThenableJob`. The promise's handler function when job is returned by `NewPromiseReactionJob` and the then function when job is returned by `NewPromiseResolveThenableJob` are wrapped in `JobCallback` Records. HTML saves the incumbent settings object and a JavaScript execution context for to the active script in `HostMakeJobCallback` and restores them in `HostCallJobCallback`.

If job settings is not null, then clean up after running script with job settings.

If result is an abrupt completion, then report the exception given by result.[[Value]].

8.1.6.4.5 `HostEnqueueTimeoutJob(job, realm, milliseconds)`

JavaScript contains an implementation-defined `HostEnqueueTimeoutJob(job, milliseconds)` abstract operation to schedule an operation to be performed after a timeout. HTML schedules these operations using `run steps after a timeout`. User agents must use the following implementation:

1. Let global be realm's global object.
2. Let timeoutStep be an algorithm step which queues a global task on the JavaScript engine task source given global to perform job().
3. Run steps after a timeout given global, "JavaScript", milliseconds, and timeoutStep.

8.1.6.4.6 `HostMakeJobCallback(callable)`

JavaScript contains an implementation-defined `HostMakeJobCallback(callable)` abstract operation to let hosts attach state to JavaScript callbacks that are called from inside task s. User agents must use the following implementation:

1. Let incumbent settings be the incumbent settings object.
2. Let active script be the active script.
3. Let script execution context be null.
4. If active script is not null, set script execution context to a new JavaScript execution context, with its Function field set to null, its Realm field set to active script's settings object's realm, and its ScriptOrModule set to active script's record.

As seen below, this is used in order to propagate the current active script forward to the time when the job callback is invoked.

A case where active script is non-null, and saving it in this way is useful, is the following:

```javascript
Promise.resolve('import('./example.mjs')).then(eval);
```

Without this step (and the steps that use it in `HostCallJobCallback`), there would be no active script when the import expression is evaluated, since eval() is a built-in function that does not originate from any particular script.

With this step in place, the active script is propagated from the above code into the job, allowing import() to use the original script's base URL appropriately.
5. Return the JobCallback Record `{ [[Callback]]: callable, [[HostDefined]]: { [[IncumbentSettings]]: incumbent settings, [[ActiveScriptContext]]: script execution context } }.

8.1.6.5 Module-related host hooks

The JavaScript specification defines a syntax for modules, as well as some host-agnostic parts of their processing model. This specification defines the rest of their processing model: how the module system is bootstrapped, via the script element with type attribute set to "module", and how modules are fetched, resolved, and executed. [JAVASCRIPT]

A module map is a map keyed by tuples consisting of a URL record and a string. The URL record is the request URL at which the module was fetched, and the string indicates the type of the module (e.g. "javascript"). The module map's values are either a module script, null (used to represent failed fetches), or a placeholder value "fetching". Module maps are used to ensure that imported module scripts are only fetched, parsed, and evaluated once per Document or worker.

For web developers (non-normative)

modulePromise = import(specifier)

Returns a promise for the module namespace object for the module script identified by specifier. This allows dynamic importing of module scripts at runtime, instead of statically using the import statement form. The specifier will be resolved relative to the active script.

The returned promise will be rejected if an invalid specifier is given, or if a failure is encountered while evaluating the resulting module graph.

This syntax can be used inside both classic and module scripts. It thus provides a bridge into the module-script world, from the classic-script world.

url = import.meta.url

Returns the active module script's base URL. This syntax can only be used inside module scripts.

url = import.meta.resolve(specifier)

Returns specifier, resolved relative to the active script. That is, this returns the URL that would be imported by using import(specifier).

This syntax can only be used inside module scripts.
That is, URL queries and fragments can be varied to create distinct entries in the module map; they are not ignored. Thus, three separate fetches and three separate module evaluations will be performed.

In contrast, the following code would only create a single entry in the module map, since after applying the URL parser to these inputs, the resulting URL records are equal:

```javascript
import "https://example.com/module2.mjs";
import "https://example.com/module2.mjs";
import "https://example.com\module2.mjs";
import "https://example.com/foo/../module2.mjs";
```

So in this second example, only one fetch and one module evaluation will occur.

Note that this behavior is the same as how shared workers are keyed by their parsed constructor url.

The purpose of including the type in the module map key is so that an import with the wrong type attribute does not prevent a different import of the same specifier but with the correct type from succeeding.

Example

Since module type is also part of the module map key, the following code will create two separate entries in the module map (the type is "javascript" for the first, and "css" for the second):

```html
<script type="module">
  import "https://example.com/module";
</script>
<script type="module">
  import "https://example.com/module" with { type: "css" };
</script>
```

This can result in two separate fetches and two separate module evaluations being performed.

In practice, due to the as-yet-unspecified memory cache (see issue #6110) the resource may only be fetched once in WebKit and Blink-based browsers. Additionally, as long as all module types are mutually exclusive, the module type check in fetch a single module script will fail for at least one of the imports, so at most one module evaluation will occur.

Example

JavaScript module scripts are the default import type when importing from another JavaScript module; that is, when an import statement lacks a type import attribute the imported module script's type will be JavaScript. Attempting to import a JavaScript resource using an import statement with a type import attribute will fail:

```html
<script type="module">
  // All of the following will fail, assuming that the imported .mjs files are served with a
  // JavaScript MIME type. JavaScript module scripts are the default and cannot be imported with
  // any import type attribute.
  import foo from "./foo.mjs" with { type: "javascript" };
  import foo2 from "./foo2.mjs" with { type: "js" };
  import foo3 from "./foo3.mjs" with { type: "" };
  await import("./foo4.mjs", { with: { type: null } });
  await import("./foo5.mjs", { with: { type: undefined } });
</script>
```
8.1.6.5.1 HostGetImportMetaProperties(moduleRecord)

JavaScript contains an implementation-defined HostGetImportMetaProperties abstract operation. User agents must use the following implementation:

```javascript
1. Let moduleScript be moduleRecord.[[HostDefined]].
2. Assert: moduleScript's base URL is not null, as moduleScript is a JavaScript module script.
3. Let urlString be moduleScript's base URL, serialized.
4. Let steps be the following steps, given the argument specifier:
   2. Let url be the result of resolving a module specifier given moduleScript and specifier.
   3. Return the serialization of url.
5. Let resolveFunction be ! CreateBuiltinFunction(steps, 1, "resolve", « »).
6. Return « Record { [[Key]]: "url", [[Value]]: urlString }, Record { [[Key]]: "resolve", [[Value]]: resolveFunction } ».
```

8.1.6.5.2 HostGetSupportedImportAttributes()

The Import Attributes proposal contains an implementation-defined HostGetSupportedImportAttributes abstract operation. User agents must use the following implementation:

```javascript
1. Return « "type" ».
```

8.1.6.5.3 HostLoadImportedModule(referrer, moduleRequest, loadState, payload)

JavaScript contains an implementation-defined HostLoadImportedModule abstract operation. User agents must use the following implementation:

```javascript
1. Let settingsObject be the current settings object.
2. If settingsObject's global object implements WorkletGlobalScope or ServiceWorkerGlobalScope and loadState is undefined, then:
   Note: loadState is undefined when the current fetching process has been initiated by a dynamic import() call, either directly or when loading the transitive dependencies of the dynamically imported module.
   1. Let completion be Completion Record { [[Type]]: throw, [[Value]]: a new TypeError, [[Target]]: empty }.
   2. Perform FinishLoadingImportedModule(referrer, moduleRequest, payload, completion).
   3. Return.
3. Let referencingScript be null.
4. Let originalFetchOptions be the default classic script fetch options.
5. Let fetchReferrer be "client".
6. If referrer is a Script Record or a Module Record, then:
   1. Set referencingScript to referrer.[[HostDefined]].
   2. Set settingsObject to referencingScript's settings object.
   3. Set fetchReferrer to referencingScript's base URL.
   4. Set originalFetchOptions to referencingScript's fetch options.
```
7. Disallow further import maps given settingsObject.

8. Let url be the result of resolving a module specifier given referencingScript and moduleRequest.[[Specifier]], catching any exceptions. If they throw an exception, let resolutionError be the thrown exception.

9. If the previous step threw an exception, then:
   1. Let completion be Completion Record { [[Type]]: throw, [[Value]]: resolutionError, [[Target]]: empty }.
   2. Perform FinishLoadingImportedModule(referrer, moduleRequest, payload, completion).
   3. Return.

10. Let fetchOptions be the result of getting the descendant script fetch options given originalFetchOptions, url, and settingsObject.

11. Let destination be "script".

12. Let fetchClient be settingsObject.

13. If loadState is not undefined, then:
   1. Set destination to loadState.[[Destination]].
   2. Set fetchClient to loadState.[[FetchClient]].

14. Fetch a single imported module script given url, fetchClient, destination, fetchOptions, settingsObject, fetchReferrer, moduleRequest, and onSingleFetchComplete as defined below. If loadState is not undefined and loadState.[[PerformFetch]] is not null, pass loadState.[[PerformFetch]] along as well.

   onSingleFetchComplete given moduleScript is the following algorithm:
   1. Let completion be null.
   2. If moduleScript is null, then set completion to Completion Record { [[Type]]: throw, [[Value]]: a new TypeError, [[Target]]: empty }.
   3. Otherwise, if moduleScript's parse error is not null, then:
      1. Let parseError be moduleScript's parse error.
      2. Set completion to Completion Record { [[Type]]: throw, [[Value]]: parseError, [[Target]]: empty }.
      3. If loadState is not undefined and loadState.[[ParseError]] is null, set loadState.[[ParseError]] to parseError.
   4. Otherwise, set completion to Completion Record { [[Type]]: normal, [[Value]]: moduleScript's record, [[Target]]: empty }.
   5. Perform FinishLoadingImportedModule(referrer, moduleRequest, payload, completion).

8.1.7 Event loops

8.1.7.1 Definitions

To coordinate events, user interaction, scripts, rendering, networking, and so forth, user agents must use event loops as described in this section. Each agent has an associated event loop, which is unique to that agent.
The event loop of a similar-origin window agent is known as a window event loop. The event loop of a dedicated worker agent, shared worker agent, or service worker agent is known as a worker event loop. And the event loop of a worklet agent is known as a worklet event loop.

Event loops do not necessarily correspond to implementation threads. For example, multiple window event loops could be cooperatively scheduled in a single thread.

However, for the various worker agents that are allocated with [[CanBlock]] set to true, the JavaScript specification does place requirements on them regarding forward progress, which effectively amount to requiring dedicated per-agent threads in those cases.

An event loop has one or more task queues. A task queue is a set of tasks.

Task queues are sets, not queues, because the event loop processing model grabs the first runnable task from the chosen queue, instead of dequeuing the first task.

The microtask queue is not a task queue.

Note: Not all events are dispatched using the task queue; many are dispatched during other tasks.

Tasks encapsulate algorithms that are responsible for such work as:

Events

Dispatching an Event object at a particular EventTarget object is often done by a dedicated task.

Note: Not all events are dispatched using the task queue; many are dispatched during other tasks.

Parsing

The HTML parser tokenizing one or more bytes, and then processing any resulting tokens, is typically a task.

Callbacks

Calling a callback is often done by a dedicated task.

Using a resource

When an algorithm fetches a resource, if the fetching occurs in a non-blocking fashion then the processing of the resource once some or all of the resource is available is performed by a task.

Reacting to DOM manipulation

Some elements have tasks that trigger in response to DOM manipulation, e.g. when that element is inserted into the document.

Formally, a task is a struct which has:

Steps

A series of steps specifying the work to be done by the task.

A source

One of the task sources, used to group and serialize related tasks.

A document

A Document associated with the task, or null for tasks that are not in a window event loop.

A script evaluation environment settings object set

A set of environment settings objects used for tracking script evaluation during the task.

A task is runnable if its document is either null or fully active.

Per its source field, each task is defined as coming from a specific task source. For each event loop, every task
source must be associated with a specific task queue.

**Note**

Essentially, task sources are used within standards to separate logically-different types of tasks, which a user agent might wish to distinguish between. Task queues are used by user agents to coalesce task sources within a given event loop.

**Example**

For example, a user agent could have one task queue for mouse and key events (to which the user interaction task source is associated), and another to which all other task sources are associated. Then, using the freedom granted in the initial step of the event loop processing model, it could give keyboard and mouse events preference over other tasks three-quarters of the time, keeping the interface responsive but not starving other task queues. Note that in this setup, the processing model still enforces that the user agent would never process events from any one task source out of order.

Each event loop has a currently running task, which is either a task or null. Initially, this is null. It is used to handle reentrancy.

Each event loop has a microtask queue, which is a queue of microtasks, initially empty. A microtask is a colloquial way of referring to a task that was created via the queue a microtask algorithm.

Each event loop has a performing a microtask checkpoint boolean, which is initially false. It is used to prevent reentrant invocation of the perform a microtask checkpoint algorithm.

Each window event loop has a DOMHighResTimeStamp last render opportunity time, initially set to zero.

Each window event loop has a DOMHighResTimeStamp last idle period start time, initially set to zero.

To get the same-loop windows for a window event loop loop, return all Window objects whose relevant agent’s event loop is loop.

### 8.1.7.2 Queuing tasks

To queue a task on a task source source, which performs a series of steps, optionally given an event loop event loop and a document document:

1. If event loop was not given, set event loop to the implied event loop.
2. If document was not given, set document to the implied document.
3. Let task be a new task.
4. Set task’s steps to steps.
5. Set task’s source to source.
6. Set task’s document to the document.
7. Set task’s script evaluation environment settings object set to an empty set.
8. Let queue be the task queue to which source is associated on event loop.
9. Append task to queue.

**Warning!**

Failing to pass an event loop and document to queue a task means relying on the ambiguous and poorly-specified implied event loop and implied document concepts. Specification authors should either always pass these values, or use the wrapper algorithms queue a global task or queue an element task instead. Using the wrapper algorithms is recommended.

To queue a global task on a task source source, with a global object global and a series of steps steps:
1. Let event loop be global's relevant agent's event loop.
2. Let document be global's associated Document, if global is a Window object; otherwise null.
3. Queue a task given source, event loop, document, and steps.

To queue an element task on a task source source, with an element element and a series of steps steps:

1. Let global be element's relevant global object.
2. Queue a global task given source, global, and steps.

To queue a microtask which performs a series of steps steps, optionally given a document document:

1. Assert: there is a surrounding agent. I.e., this algorithm is not called while in parallel.
2. Let eventLoop be the surrounding agent's event loop.
3. If document was not given, set document to the implied document.
4. Let microtask be a new task.
5. Set microtask's steps to steps.
6. Set microtask's source to the microtask task source.
7. Set microtask's document to document.
8. Set microtask's script evaluation environment settings object set to an empty set.
9. Enqueue microtask on eventLoop's microtask queue.

Note

It is possible for a microtask to be moved to a regular task queue if, during its initial execution, it spins the event loop. This is the only case in which the source, document, and script evaluation environment settings object set of the microtask are consulted; they are ignored by the perform a microtask checkpoint algorithm.

The implied event loop when queuing a task is the one that can deduced from the context of the calling algorithm. This is generally unambiguous, as most specification algorithms only ever involve a single agent (and thus a single event loop). The exception is algorithms involving or specifying cross-agent communication (e.g., between a window and a worker); for those cases, the implied event loop concept must not be relied upon and specifications must explicitly provide an event loop when queuing a task.

The implied document when queuing a task on an event loop event loop is determined as follows:

1. If event loop is not a window event loop, then return null.
2. If the task is being queued in the context of an element, then return the element's node document.
3. If the task is being queued in the context of a browsing context, then return the browsing context's active document.
4. If the task is being queued by or for a script, then return the script's settings object's global object's associated Document.
5. Assert: this step is never reached, because one of the previous conditions is true.

Both implied event loop and implied document are vaguely-defined and have a lot of action-at-a-distance. The hope is to remove these, especially implied document. See issue #4980.

8.1.7.3 Processing model

An event loop must continually run through the following steps for as long as it exists:

1. Let oldestTask and taskStartTime be null.
2. If the event loop has a task queue with at least one runnable task, then:
1. Let taskQueue be one such task queue\textsuperscript{1105}, chosen in an implementation-defined manner.

   **Note**
   
   Remember that the microtask queue\textsuperscript{1106} is not a task queue\textsuperscript{1105}, so it will not be chosen in this step. However, a task queue\textsuperscript{1106} to which the microtask source\textsuperscript{1107} is associated might be chosen in this step. In that case, the task\textsuperscript{1105} chosen in the next step was originally a microtask\textsuperscript{1106}, but it got moved as part of spinning the event loop\textsuperscript{1113}.

2. Set taskStartTime to the unsafe shared current time.
3. Set oldestTask to the first runnable\textsuperscript{1110} task\textsuperscript{1110} in taskQueue, and remove it from taskQueue.
4. If oldestTask's document\textsuperscript{1110} is not null, then record task start time given taskStartTime and oldestTask's document\textsuperscript{1110}.
5. Set the event loop\textsuperscript{1104}'s currently running task\textsuperscript{1106} to oldestTask.
6. Perform oldestTask's steps\textsuperscript{1110}.
7. Set the event loop\textsuperscript{1104}'s currently running task\textsuperscript{1106} back to null.
8. Perform a microtask checkpoint\textsuperscript{1112}.

3. Let taskEndTime be the unsafe shared current time. [HRT]\textsuperscript{1148}
4. If oldestTask is not null, then:
   1. Let top-level browsing contexts be an empty set.
   2. For each environment settings object\textsuperscript{1106} settings of oldestTask's script evaluation environment settings object set\textsuperscript{1110}:
      1. Let global be settings's global object\textsuperscript{1065}.
      2. If global is not a Window\textsuperscript{913} object, then continue.
      3. If global's browsing context\textsuperscript{915} is null, then continue.
      4. Let tlbc be global's browsing context\textsuperscript{915}'s top-level browsing context\textsuperscript{990}.
      5. If tlbc is not null, then append it to top-level browsing contexts.
   4. If oldestTask's document\textsuperscript{1110} is not null, then record task end time given taskEndTime and oldestTask's document\textsuperscript{1110}.
5. If this is a window event loop\textsuperscript{1110} that has no runnable\textsuperscript{1110} task\textsuperscript{1110} in this event loop\textsuperscript{1110} task queues\textsuperscript{1105}, then:
   1. Set this event loop\textsuperscript{1104}'s last idle period start time\textsuperscript{1110} to the unsafe shared current time.
   2. Let computeDeadline\textsuperscript{1104} be the following steps:
      1. Let deadline be this event loop\textsuperscript{1110} last idle period start time\textsuperscript{1110} plus 50.
      2. Let hasPendingRenders be false.
   3. For each windowInSameLoop of the same-loop windows\textsuperscript{1110} for this event loop\textsuperscript{1104}:
      1. If windowInSameLoop's map of animation frame callbacks\textsuperscript{1167} is not empty, or if the user agent believes that the windowInSameLoop might have pending rendering updates, set hasPendingRenders to true.
      2. Let timerCallbackEstimates be the result of getting the values of windowInSameLoop's map of active timers\textsuperscript{1113}.

1108
3. For each `timeoutDeadline` of `timerCallbackEstimates`, if `timeoutDeadline` is less than `deadline`, set `deadline` to `timeoutDeadline`.

4. If `hasPendingRenders` is true, then:
   1. Let `nextRenderDeadline` be this `event loop`'s `last render opportunity time` plus (1000 divided by the current refresh rate).
      
      The refresh rate can be hardware- or implementation-specific. For a refresh rate of 60Hz, the `nextRenderDeadline` would be about 16.67ms after the `last render opportunity time`.
   2. If `nextRenderDeadline` is less than `deadline`, then return `nextRenderDeadline`.

5. Return `deadline`.

3. For each `win` of the same-loop windows for this `event loop`, perform the start an idle period algorithm for `win` with the following step: return the result of calling `computeDeadline`, coarsened given `win`'s relevant settings object's cross-origin isolated capability. [REQUESTIDLECALLBACK]

6. If this is a worker `event loop`, then:
   1. If this `event loop`'s `agent`'s single realm's global object is a supported `DedicatedWorkerGlobalScope` and the user agent believes that it would benefit from having its rendering updated at this time, then:
      1. Let now be the current high resolution time given the `DedicatedWorkerGlobalScope`, [HRT].
      2. Run the animation frame callbacks for that `DedicatedWorkerGlobalScope`, passing in now as the timestamp.
      3. Update the rendering of that dedicated worker to reflect the current state.

   2. If there are no tasks in the `event loop`'s `task queue` and the `WorkerGlobalScope` object's `closing` flag is true, then destroy the `event loop`, aborting these steps, resuming the run a worker steps described in the Web workers section below.

A `event loop` `eventLoop` must also run the following in parallel, as long as it exists:

1. Wait until at least one navigable whose active document's relevant agent's `event loop` is `eventLoop` might have a rendering opportunity.
2. Set `eventLoop`'s `last render opportunity time` to the unsafe shared current time.
3. For each navigable that has a rendering opportunity, queue a global task on the rendering task source given navigable's active window to update the rendering:

   This might cause redundant calls to update the rendering. However, these calls would have no observable effect because there will be no rendering necessary, as per the Unnecessary rendering step. Implementations can introduce further optimizations such as only queuing this task when it is not already queued. However, note that the document associated with the task might become inactive before the task is processed.

1. Let `frameTimestamp` be `eventLoop`'s `last render opportunity time`.
2. Let docs be all fully active Document objects whose relevant agent's `event loop` is `eventLoop`, sorted arbitrarily except that the following conditions must be met:
   - Any Document B whose container document is A must be listed after A in the list.
   - If there are two documents A and B that both have the same non-null container document, C, then the order of A and B in the list must match the shadow-including tree order of their respective navigable containers in C's node tree.

   In the steps below that iterate over docs, each Document must be processed in the order it is found in the list.
3. **Filter non-renderable documents**: Remove from `docs` any Document object `doc` for which any of the following are true:
   - `doc` is render-blocked;  
   - `doc`'s visibility state is "hidden";  
   - `doc`'s rendering is suppressed for view transitions; or  
   - `doc`'s node navigable doesn't currently have a rendering opportunity.

**Note**

We have to check for rendering opportunities here, in addition to checking that in the in parallel steps, as some documents that share the same event loop might not have a rendering opportunity at the same time.

4. **Unnecessary rendering**: Remove from `docs` any Document object `doc` for which all of the following are true:
   - the user agent believes that updating the rendering of `doc`'s node navigable would have no visible effect; and  
   - `doc`'s map of animation frame callbacks is empty.

5. Remove from `docs` all Document objects for which the user agent believes that it's preferable to skip updating the rendering for other reasons.

**Note**

The step labeled Filter non-renderable documents prevents the user agent from updating the rendering when it is unable to present new content to the user.  

The step labeled Unnecessary rendering prevents the user agent from updating the rendering when there's no new content to draw.  

This step enables the user agent to prevent the steps below from running for other reasons, for example, to ensure certain tasks are executed immediately after each other, with only microtask checkpoints interleaved (and without, e.g., animation frame callbacks interleaved). Concretely, a user agent might wish to coalesce timer callbacks together, with no intermediate rendering updates.

6. For each `doc` of `docs`, reveal doc.

7. For each `doc` of `docs`, flush autofocus candidates for `doc` if its node navigable is a top-level traversable.

8. For each `doc` of `docs`, run the resize steps for `doc`. [CSSOMVIEW]

9. For each `doc` of `docs`, run the scroll steps for `doc`. [CSSOMVIEW]

10. For each `doc` of `docs`, evaluate media queries and report changes for `doc`. [CSSOMVIEW]

11. For each `doc` of `docs`, update animations and send events for `doc`, passing in relative high resolution time given frameTimestamp and `doc`'s relevant global object as the timestamp [WEBANIMATIONS]

12. For each `doc` of `docs`, run the fullscreen steps for `doc`. [FULLSCREEN]

13. For each `doc` of `docs`, if the user agent detects that the backing storage associated with a CanvasRenderingContext2D or an OffscreenCanvasRenderingContext2D, context, has been lost, then it must run the context lost steps for each such context:
   1. Let `canvas` be the value of context's `canvas` attribute, if context is a CanvasRenderingContext2D, or the associated OffscreenCanvas object for context otherwise.
   2. Set context's `context lost` to true.
   3. Reset the rendering context to its default state given context.
   4. Let shouldRestore be the result of firing an event named `contextlost` at canvas, with the cancelable attribute initialized to true.
   5. If shouldRestore is false, then abort these steps.
6. Attempt to restore context by creating a backing storage using context's attributes and associating them with context. If this fails, then abort these steps.

7. Set context's context lost\textsuperscript{6684} to false.

8. Fire an event named contextrestored\textsuperscript{61451} at canvas.

14. For each doc of docs, run the animation frame callbacks\textsuperscript{11168} for doc, passing in the relative high resolution time given frameTimestamp and doc's relevant global object\textsuperscript{10871} as the timestamp.

15. Let unsafeLayoutStartTime be the unsafe shared current time.

16. For each doc of docs:
   1. Let resizeObserverDepth be 0.
   2. While true:
      1. Recalculate styles and update layout for doc.
      2. Let hadInitialVisibleContentVisibilityDetermination be false.
      3. For each element element with 'auto' used value of 'content-visibility':
         1. Let checkForInitialDetermination be true if element's proximity to the viewport is not determined and it is not relevant to the user. Otherwise, let checkForInitialDetermination be false.
         2. Determine proximity to the viewport for element.
         3. If checkForInitialDetermination is true and element is now relevant to the user, then set hadInitialVisibleContentVisibilityDetermination to true.
      4. If hadInitialVisibleContentVisibilityDetermination is true, then continue.
      5. Gather active resize observations at depth resizeObserverDepth for doc.
   6. If doc has active resize observations:
      1. Set resizeObserverDepth to the result of broadcasting active resize observations given doc.
      2. Continue.
   7. Otherwise, break.
   3. If doc has skipped resize observations, then deliver resize loop error given doc.

17. For each doc of docs, if the focused area\textsuperscript{830} of doc is not a focusable area\textsuperscript{8689}, then run the focusing steps\textsuperscript{836} for doc's viewport, and set doc's relevant global object\textsuperscript{10711}'s navigation API\textsuperscript{10644}'s focus changed during ongoing navigation\textsuperscript{10955} to false.

   \textbf{Example}
   
   For example, this might happen because an element has the hidden\textsuperscript{818} attribute added, causing it to stop being rendered\textsuperscript{1363}. It might also happen to an input\textsuperscript{517} element when the element gets disabled\textsuperscript{597}.

   \textbf{Note}
   
   This will usually\textsuperscript{6887} fire blur\textsuperscript{1451} events, and possibly change\textsuperscript{1451} events.

   \textbf{Note}
   
   In addition to this asynchronous fixup, if the focused area of the document\textsuperscript{830} is removed, there is a
18. For each doc of docs, perform pending transition operations for doc. [CSSVIEWTRANSITIONS]\p{1457}

19. For each doc of docs, run the update intersection observations steps for doc, passing in the relative high resolution time given now and doc's relevant global object as the timestamp. [INTERSECTIONOBSERVER]\p{1459}

20. For each doc of docs, record rendering time for doc given unsafeStyleAndLayoutStartTime.

21. For each doc of docs, mark paint timing for doc.

22. For each doc of docs, update the rendering or user interface of doc and its node navigable to reflect the current state.

23. For each doc of docs, process top layer removals given doc.

A navigable has a rendering opportunity if the user agent is currently able to present the contents of the navigable to the user, accounting for hardware refresh rate constraints and user agent throttling for performance reasons, but considering content presentable even if it’s outside the viewport.

A navigable’s rendering opportunities are determined based on hardware constraints such as display refresh rates and other factors such as page performance or whether its active document’s visibility state is "visible". Rendering opportunities typically occur at regular intervals.

Note

This specification does not mandate any particular model for selecting rendering opportunities. But for example, if the browser is attempting to achieve a 60Hz refresh rate, then rendering opportunities occur at a maximum of every 60th of a second (about 16.7ms). If the browser finds that a navigable is not able to sustain this rate, it might drop to a more sustainable 30 rendering opportunities per second for that navigable, rather than occasionally dropping frames. Similarly, if a navigable is not visible, the user agent might decide to drop that page to a much slower 4 rendering opportunities per second, or even less.

When a user agent is to perform a microtask checkpoint:

1. If the event loop’s performing a microtask checkpoint is true, then return.

2. Set the event loop’s performing a microtask checkpoint to true.

3. While the event loop’s microtask queue is not empty:
   1. Let oldestMicrotask be the result of dequeuing from the event loop’s microtask queue.
   2. Set the event loop’s currently running task to oldestMicrotask.
   3. Run oldestMicrotask.

   Note

   This might involve invoking scripted callbacks, which eventually calls the clean up after running script steps, which call this perform a microtask checkpoint algorithm again, which is why we use the performing a microtask checkpoint flag to avoid reentrancy.

4. Set the event loop’s currently running task back to null.

5. Cleanup Indexed Database transactions.

6. Perform ClearKeptObjects().

   Note

   When WeakRef.prototype.deref() returns an object, that object is kept alive until the next invocation of ClearKeptObjects(), after which it is again subject to garbage collection.

7. Set the event loop’s performing a microtask checkpoint to false.
8. Record timing info for microtask checkpoint.

When an algorithm running in parallel is to await a stable state, the user agent must queue a microtask that runs the following steps, and must then stop executing (execution of the algorithm resumes when the microtask is run, as described in the following steps):

1. Run the algorithm's synchronous section.
2. Resumes execution of the algorithm in parallel, if appropriate, as described in the algorithm's steps.

Note
Steps in synchronous sections are marked with ☢.

Algorithm steps that say to spin the event loop until a condition goal is met are equivalent to substituting in the following algorithm steps:

1. Let task be the event loop's currently running task.

   Note
task could be a microtask.

2. Let task source be task's source.
3. Let old stack be a copy of the JavaScript execution context stack.
4. Empty the JavaScript execution context stack.
5. Perform a microtask checkpoint.

   Note
   If task is a microtask this step will be a no-op due to performing a microtask checkpoint being true.

6. In parallel:
   1. Wait until the condition goal is met.
   2. Queue a task on task source to:
      1. Replace the JavaScript execution context stack with old stack.
      2. Perform any steps that appear after this spin the event loop instance in the original algorithm.

   Note
   This resumes task.

7. Stop task, allowing whatever algorithm that invoked it to resume.

   Note
   This causes the event loop's main set of steps or the perform a microtask checkpoint algorithm to continue.

Note
Unlike other algorithms in this and other specifications, which behave similar to programming-language function calls, spin the event loop is more like a macro, which saves typing and indentation at the usage site by expanding into a series of steps and operations.

Example
An algorithm whose steps are:

1. Do something.
2. Spin the event loop until awesomeness happens.
3. Do something else.

is a shorthand which, after "macro expansion", becomes

1. Do something.
2. Let old stack be a copy of the JavaScript execution context stack.
3. Empty the JavaScript execution context stack.
4. Perform a microtask checkpoint.
5. In parallel:
   1. Wait until awesomeness happens.
   2. Queue a task on the task source in which "do something" was done to:
      1. Replace the JavaScript execution context stack with old stack.
      2. Do something else.

Example
Here is a more full example of the substitution, where the event loop is spun from inside a task that is queued from work in parallel. The version using spin the event loop:

1. In parallel:
   1. Do parallel thing 1.
   2. Queue a task on the DOM manipulation task source to:
      1. Do task thing 1.
      2. Spin the event loop until awesomeness happens.
      3. Do task thing 2.
   3. Do parallel thing 2.

The fully expanded version:

1. In parallel:
   1. Do parallel thing 1.
   2. Let old stack be null.
   3. Queue a task on the DOM manipulation task source to:
      1. Do task thing 1.
      2. Set old stack to a copy of the JavaScript execution context stack.
      3. Empty the JavaScript execution context stack.
      4. Perform a microtask checkpoint.
   4. Wait until awesomeness happens.
   5. Queue a task on the DOM manipulation task source to:
      1. Replace the JavaScript execution context stack with old stack.
      2. Do task thing 2.
Some of the algorithms in this specification, for historical reasons, require the user agent to **pause** while running a **task** until a condition **goal** is met. This means running the following steps:

1. Let global be the [current global object](#) given global.
2. Let timeBeforePause be the [current high resolution time](#) given global.
3. If necessary, update the rendering or user interface of any Document or navigable to reflect the current state.
4. Wait until the condition **goal** is met. While a user agent has a paused **task**, the corresponding [event loop](#) must not run further **tasks**, and any script in the currently running **task** must block. User agents should remain responsive to user input while paused, however, albeit in a reduced capacity since the [event loop](#) will not be doing anything.
5. Record pause duration given the duration from timeBeforePause to the current high resolution time given global.

**Warning!**

**Pausing** is highly detrimental to the user experience, especially in scenarios where a single **event loop** is shared among multiple documents. User agents are encouraged to experiment with alternatives to **pausing**, such as spinning the [event loop](#) or even simply proceeding without any kind of suspended execution at all, insofar as it is possible to do so while preserving compatibility with existing content. This specification will happily change if a less-drastic alternative is discovered to be web-compatible.

In the interim, implementers should be aware that the variety of alternatives that user agents might experiment with can change subtle aspects of **event loop** behavior, including **task** and **microtask** timing. Implementations should continue experimenting even if doing so causes them to violate the exact semantics implied by the **pause** operation.

### 8.1.7.4 Generic task sources [§115](#)

The following **task sources** are used by a number of mostly unrelated features in this and other specifications.

**The DOM manipulation task source**

This **task source** is used for features that react to DOM manipulations, such as things that happen in a non-blocking fashion when an element is [inserted into the document](#).

**The user interaction task source**

This **task source** is used for features that react to user interaction, for example keyboard or mouse input.

Events sent in response to user input (e.g. [click](#) events) must be fired using **tasks** queued with the user interaction task source. [UIEVENTS](#)

**The networking task source**

This **task source** is used for features that trigger in response to network activity.

**The navigation and traversal task source**

This **task source** is used to queue tasks involved in [navigation](#) and [history traversal](#).

**The rendering task source**

This **task source** is used solely to update the rendering.

### 8.1.7.5 Dealing with the event loop from other specifications [§115](#)

Writing specifications that correctly interact with the **event loop** can be tricky. This is compounded by how this specification uses concurrency-model-independent terminology, so we say things like **event loop** and **in parallel** instead of using more familiar
model-specific terms like "main thread" or "on a background thread".

By default, specification text generally runs on the event loop. This falls out from the formal event loop processing model, in that you can eventually trace most algorithms back to a task queuing there.

From this starting point, the overriding guideline is that any work a specification needs to perform that would otherwise block the event loop must instead be performed in parallel with it. This includes (but is not limited to):

- performing heavy computation;
- displaying a user-facing prompt;
- performing operations which could require involving outside systems (i.e. "going out of process").

The next complication is that, in algorithm sections that are in parallel, you must not create or manipulate objects associated to a specific realm, global, or environment settings object. (Stated in more familiar terms, you must not directly access main-thread artifacts from a background thread.) Doing so would create data races observable to JavaScript code, since after all, your algorithm steps are running in parallel to the JavaScript code.

You can, however, manipulate specification-level data structures and values from Infra, as those are realm-agnostic. They are never directly exposed to JavaScript without a specific conversion taking place (often via Web IDL).

To affect the world of observable JavaScript objects, then, you must queue a global task to perform any such manipulations. This ensures your steps are properly interleaved with respect to other things happening on the event loop. Furthermore, you must choose a task source when queuing a global task; this governs the relative order of your steps versus others. If you are unsure which task source to use, pick one of the generic task sources that sounds most applicable. Finally, you must indicate which global object your queued task is associated with; this ensures that if that global object is inactive, the task does not run.

Putting this all together, we can provide a template for a typical algorithm that needs to do work asynchronously:

1. Do any synchronous setup work, while still on the event loop. This may include converting realm-specific JavaScript values into realm-agnostic specification-level values.
2. Perform a set of potentially-expensive steps in parallel, operating entirely on realm-agnostic values, and producing a realm-agnostic result.
3. Queue a global task on a specified task source and given an appropriate global object, to convert the realm-agnostic result back into observable effects on the observable world of JavaScript objects on the event loop.

To affect the world of observable JavaScript objects, then, you must queue a global task to perform any such manipulations. This ensures your steps are properly interleaved with respect to other things happening on the event loop. Furthermore, you must choose a task source when queuing a global task; this governs the relative order of your steps versus others. If you are unsure which task source to use, pick one of the generic task sources that sounds most applicable. Finally, you must indicate which global object your queued task is associated with; this ensures that if that global object is inactive, the task does not run.

Putting this all together, we can provide a template for a typical algorithm that needs to do work asynchronously:

1. Do any synchronous setup work, while still on the event loop. This may include converting realm-specific JavaScript values into realm-agnostic specification-level values.
2. Perform a set of potentially-expensive steps in parallel, operating entirely on realm-agnostic values, and producing a realm-agnostic result.
3. Queue a global task on a specified task source and given an appropriate global object, to convert the realm-agnostic result back into observable effects on the observable world of JavaScript objects on the event loop.

The base primitive, on which queue a global task builds, is the queue a task algorithm. In general, queue a global task is better because it automatically picks the right event loop and, where appropriate, document concepts, but this is discouraged.

Putting this all together, we can provide a template for a typical algorithm that needs to do work asynchronously:

1. Do any synchronous setup work, while still on the event loop. This may include converting realm-specific JavaScript values into realm-agnostic specification-level values.
2. Perform a set of potentially-expensive steps in parallel, operating entirely on realm-agnostic values, and producing a realm-agnostic result.
3. Queue a global task on a specified task source and given an appropriate global object, to convert the realm-agnostic result back into observable effects on the observable world of JavaScript objects on the event loop.

The following is an algorithm that "encrypts" a passed-in list of scalar value strings, after parsing them as URLs:

1. Let urls be an empty list.
2. For each string of input:
   1. Let parsed be the result of encoding-parsing a URL given string, relative to the current settings object.
   2. If parsed is failure, then return a promise rejected with a "SyntaxError" DOMException.
   3. Let serialized be the result of applying the URL serializer to parsed.
3. Append serialized to urls.
3. Let realm be the current realm.

4. Let p be a new promise.

5. Run the following steps in parallel:\(^p 43\):
   1. Let encryptedURLs be an empty list.
   2. For each url of urls:
      1. Wait 100 milliseconds, so that people think we’re doing heavy-duty encryption.
      2. Let encrypted be a new string derived from url, whose nth code unit is equal to url’s nth code unit plus 13.
      3. Append encrypted to encryptedURLs.
   3. Queue a global task\(^p 1106\) on the networking task source\(^p 1115\), given realm’s global object\(^p 1065\), to perform the following steps:
      1. Let array be the result of converting encryptedURLs to a JavaScript array, in realm.
      2. Resolve p with array.


Here are several things to notice about this algorithm:

- It does its URL parsing up front, on the event loop\(^p 1104\), before going to the in parallel\(^p 43\) steps. This is necessary, since parsing depends on the current settings object\(^p 1070\), which would no longer be current after going in parallel\(^p 43\).

- Alternately, it could have saved a reference to the current settings object\(^p 1070\)’s API base URL\(^p 1064\) and used it during the in parallel\(^p 43\) steps; that would have been equivalent. However, we recommend instead doing as much work as possible up front, as this example does. Attempting to save the correct values can be error prone; for example, if we’d saved just the current settings object\(^p 1070\), instead of its API base URL\(^p 1064\), there would have been a potential race.

- It implicitly passes a list of strings from the initial steps to the in parallel\(^p 43\) steps. This is OK, as both lists and strings are realm-agnostic.

- It performs "expensive computation" (waiting for 100 milliseconds per input URL) during the in parallel\(^p 43\) steps, thus not blocking the main event loop\(^p 1104\).

- Promises, as observable JavaScript objects, are never created and manipulated during the in parallel\(^p 43\) steps. p is created before entering those steps, and then is manipulated during a task\(^p 1106\) that is queued\(^p 1106\) specifically for that purpose.

- The creation of a JavaScript array object also happens during the queued task, and is careful to specify which realm it creates the array in since that is no longer obvious from context.

(On these last two points, see also whatwg/webidl issue #135 and whatwg/webidl issue #371, where we are still mulling over the subtleties of the above promise-resolution pattern.)

Another thing to note is that, in the event this algorithm was called from a Web IDL-specified operation taking a sequence<USVString>, there was an automatic conversion from realm-specific JavaScript objects provided by the author as input, into the realm-agnostic sequence<USVString> Web IDL type, which we then treat as a list of scalar value strings. So depending on how your specification is structured, there may be other implicit steps happening on the main event loop\(^p 1104\) that play a part in this whole process of getting you ready to go in parallel\(^p 43\).

---

8.1.8 Events  

8.1.8.1 Event handlers  

Many objects can have event handlers specified. These act as non-capture event listeners for the object on which they are specified. [DOM]
An **event handler**\(^{1117}\) is a **struct** with two **items**:

- a **value**, which is either null, a callback object, or an **internal raw uncompiled handler**\(^{1113}\). The **EventHandler**\(^{1117}\) callback function type describes how this is exposed to scripts. Initially, an **event handler**\(^{1117}\)'s **value**\(^{1118}\) must be set to null.

- a **listener**, which is either null or an **event listener** responsible for running the **event handler processing algorithm**\(^{1117}\). Initially, an **event handler**\(^{1117}\)'s **listener**\(^{1118}\) must be set to null.

Event handlers are exposed in two ways.

The first way, common to all event handlers, is as an **event handler IDL attribute**\(^{1118}\).

The second way is as an **event handler content attribute**\(^{1119}\). Event handlers on **HTML elements**\(^{45}\) and some of the event handlers on **Window**\(^{913}\) objects are exposed in this way.

For both of these two ways, the **event handler**\(^{1117}\) is exposed through a **name**, which is a string that always starts with "on" and is followed by the name of the event for which the handler is intended.

Most of the time, the object that exposes an **event handler**\(^{1117}\) is the same as the object on which the corresponding **event listener** is added. However, the **body**\(^{202}\) and **frameset**\(^{1413}\) elements expose several **event handlers**\(^{1117}\) that act upon the element's **Window**\(^{913}\) object, if one exists. In either case, we call the object an **event handler**\(^{1117}\) acts upon the **target** of that **event handler**\(^{1117}\).

To **determine the target of an event handler**, given an **EventTarget** object eventTarget on which the **event handler**\(^{1117}\) is exposed, and an **event handler name**\(^{1118}\) name, the following steps are taken:

1. If eventTarget is not a **body**\(^{202}\) element or a **frameset**\(^{1413}\) element, then return eventTarget.

2. If name is not the name of an attribute member of the **WindowEventHandlers**\(^{1128}\) interface mixin and the **Window-reflecting body element event handler set**\(^{1126}\) does not contain name, then return eventTarget.

3. If eventTarget's **node document** is not an **active document**\(^{987}\), then return null.

4. Return eventTarget's **node document**'s **relevant global object**\(^{1071}\).

Each **EventTarget** object that has one or more **event handlers**\(^{1117}\) specified has an associated **event handler map**, which is a **map** of strings representing names\(^{1118}\) of **event handlers**\(^{1117}\) to **event handlers**\(^{1117}\).

When an **EventTarget** object that has one or more **event handlers**\(^{1117}\) specified is created, its **event handler map**\(^{1118}\) must be initialized such that it contains an **entry** for each **event handler**\(^{1117}\) that has that object as **target**\(^{1118}\), with **items** in those **event handlers**\(^{1117}\) set to their initial values.

**Note**

*This could happen if this object is a **body**\(^{202}\) element without a corresponding **Window**\(^{913}\) object, for example.*

**Note**

*This check does not necessarily prevent **body**\(^{202}\) and **frameset**\(^{1413}\) elements that are not the **body element**\(^{1124}\) of their **node document** from reaching the next step. In particular, a **body**\(^{202}\) element created in an **active document**\(^{987}\) (perhaps with document.createElement()) but not **connected** will also have its corresponding **Window**\(^{913}\) object as the **target**\(^{1218}\) of several **event handlers**\(^{1117}\) exposed through it.*

**Note**

*The order of the entries of **event handler map**\(^{1118}\) could be arbitrary. It is not observable through any algorithms that operate on the map.*

**Note**

*Entries are not created in the **event handler map**\(^{1118}\) of an object for **event handlers**\(^{1117}\) that are merely exposed on that object, but have some other object as their **targets**\(^{1118}\).*

An **event handler IDL attribute** is an IDL attribute for a specific **event handler**\(^{1117}\). The name of the IDL attribute is the same as the
name \textsuperscript{p1118} of the event handler \textsuperscript{p1117}.

The getter of an event handler IDL attribute \textsuperscript{p1118} with name name, when called, must run these steps:

1. Let eventTarget be the result of determining the target of an event handler \textsuperscript{p1118} given this object and name.
2. If eventTarget is null, then return null.
3. Return the result of getting the current value of the event handler \textsuperscript{p1123} given eventTarget and name.

The setter of an event handler IDL attribute \textsuperscript{p1118} with name name, when called, must run these steps:

1. Let eventTarget be the result of determining the target of an event handler \textsuperscript{p1118} given this object and name.
2. If eventTarget is null, then return.
3. If the given value is null, then deactivate an event handler \textsuperscript{p1120} given eventTarget and name.
4. Otherwise:
   1. Let handlerMap be eventTarget's event handler map \textsuperscript{p1118}.
   2. Let eventHandler be handlerMap[name].
   3. Set eventHandler's value \textsuperscript{p1118} to the given value.
   4. Activate an event handler \textsuperscript{p1120} given eventTarget and name.

An event handler content attribute is a content attribute for a specific event handler \textsuperscript{p1117}. The name of the content attribute is the same as the name \textsuperscript{p1118} of the event handler \textsuperscript{p1117}.

Event handler content attributes \textsuperscript{p1119}, when specified, must contain valid JavaScript code which, when parsed, would match the FunctionBody production after automatic semicolon insertion.

Note: Certain event handler IDL attributes \textsuperscript{p1118} have additional requirements, in particular the onmessage \textsuperscript{p1188} attribute of MessagePort \textsuperscript{p1185} objects.

The following attribute change steps are used to synchronize between event handler content attributes \textsuperscript{p1119} and event handlers \textsuperscript{p1117}.

1. If namespace is not null, or localName is not the name of an event handler content attribute \textsuperscript{p1119} on element, then return.
2. Let eventTarget be the result of determining the target of an event handler \textsuperscript{p1118} given element and localName.
3. If eventTarget is null, then return.
4. If value is null, then deactivate an event handler \textsuperscript{p1120} given eventTarget and localName.
5. Otherwise:
   1. If the Should element's inline behavior be blocked by Content Security Policy? algorithm returns "Blocked" when executed upon element, "script attribute", and value, then return. [CSP]
   2. Let handlerMap be eventTarget's event handler map \textsuperscript{p1118}.
   3. Let eventHandler be handlerMap[localName].
   4. Let location be the script location that triggered the execution of these steps.
   5. Set eventHandler's value \textsuperscript{p1118} to the internal raw uncompiled handler \textsuperscript{p1122} value/location.
   6. Activate an event handler \textsuperscript{p1120} given eventTarget and localName.

Note: Per the DOM Standard, these steps are run even if oldValue and value are identical (setting an attribute to its current value), but not if oldValue and value are both null (removing an attribute that doesn't currently exist). [DOM]
To deactivate an event handler given an EventTarget object eventTarget and a string name that is the name of an event handler, run these steps:

1. Let `handlerMap` be eventTarget's event handler map.
2. Let `eventHandler` be `handlerMap[name]`.
3. Set `eventHandler's value` to null.
4. Let `listener` be `eventHandler's listener`.
5. If `listener` is not null, then remove an event listener with eventTarget and `listener`.
6. Set `eventHandler's listener` to null.

To erase all event listeners and handlers given an EventTarget object eventTarget, run these steps:

1. If `eventTarget` has an associated event handler map, then for each name → `eventHandler` of eventTarget's associated event handler map, deactivate an event handler given eventTarget and name.
2. Remove all event listeners given eventTarget.

Note

This algorithm is used to define `document.open()`.

To activate an event handler given an EventTarget object eventTarget and a string name that is the name of an event handler, run these steps:

1. Let `handlerMap` be eventTarget's event handler map.
2. Let `eventHandler` be `handlerMap[name]`.
3. If `eventHandler's listener` is not null, then return.
4. Let `callback` be the result of creating a Web IDL EventListener instance representing a reference to a function of one argument that executes the steps of the event handler processing algorithm, given eventTarget, name, and its argument.

The EventListener's callback context can be arbitrary; it does not impact the steps of the event handler processing algorithm. [DOM]

Note

The callback is emphatically not the event handler itself. Every event handler ends up registering the same callback, the algorithm defined below, which takes care of invoking the right code, and processing the code's return value.

5. Let `listener` be a new event listener whose type is the event handler event type corresponding to `eventHandler` and `callback` is `callback`.

Note

To be clear, an event listener is different from an EventListener.

6. Add an event listener with eventTarget and `listener`.
7. Set `eventHandler's listener` to `listener`.

Note

The event listener registration happens only if the event handler's value is being set to non-null, and the event handler is not already activated. Since listeners are called in the order they were registered, assuming no deactivation occurred, the order of event listeners for a particular event type will always be:

1. the event listeners registered with `addEventListener()` before the first time the event handler's value was set to non-null
2. then the callback to which it is currently set, if any
3. and finally the event listeners registered with `addEventListener` after the first time the event handler's value was set to non-null.

### Example

This example demonstrates the order in which event listeners are invoked. If the button in this example is clicked by the user, the page will show four alerts, with the text "ONE", "TWO", "THREE", and "FOUR" respectively.

```html
<button id="test">Start Demo</button>
<script>
    var button = document.getElementById('test');
    button.addEventListener('click', function () { alert('ONE') }, false);
    button.setAttribute('onclick', "alert('NOT CALLED')"); // event handler listener is registered here
    button.addEventListener('click', function () { alert('THREE') }, false);
    button.onclick = function () { alert('TWO'); };
    button.addEventListener('click', function () { alert('FOUR') }, false);
</script>
```

However, in the following example, the event handler is deactivated after its initial activation (and its event listener is removed), before being reactivated at a later time. The page will show five alerts with "ONE", "TWO", "THREE", "FOUR", and "FIVE" respectively, in order.

```html
<button id="test">Start Demo</button>
<script>
    var button = document.getElementById('test');
    button.addEventListener('click', function () { alert('ONE') }, false);
    button.setAttribute('onclick', "alert('NOT CALLED')"); // event handler is activated here
    button.addEventListener('click', function () { alert('TWO') }, false);
    button.onclick = null; // but deactivated here
    button.addEventListener('click', function () { alert('THREE') }, false);
    button.onclick = function () { alert('FOUR'); };
    // and re-activated here
    button.addEventListener('click', function () { alert('FIVE') }, false);
</script>
```

### Note

The interfaces implemented by the event object do not influence whether an event handler is triggered or not.

The event handler processing algorithm for an `EventTarget` object `eventTarget`, a string `name` representing the `name` of an event handler, and an `Event` object `event` is as follows:

1. Let `callback` be the result of getting the current value of the event handler given `eventTarget` and `name`.
2. If `callback` is null, then return.
3. Let special error event handling be true if event is an `ErrorEvent` object, event's `type` is "error", and event's `currentTarget` implements the `WindowOrWorkerGlobalScope` mixin. Otherwise, let special error event handling be false.
4. Process the `Event` object `event` as follows:

   - If special error event handling is true
     - Invoke `callback` with five arguments, the first one having the value of `event`'s `message` attribute, the second having the value of `event`'s `filename` attribute, the third having the value of `event`'s `lineno` attribute, the fourth having the value of `event`'s `colno` attribute, the fifth having the value of `event`'s `error` attribute, and with the `callback this value` set to `event`'s `currentTarget`. Let return value be the callback's return value.
   - Otherwise
     - Invoke `callback` with one argument, the value of which is the `Event` object `event`, with the `callback this value` set to...
event's `currentTarget`. Let `return value` be the callback's return value. [WEBIDL][1143]

If an exception gets thrown by the callback, end these steps and allow the exception to propagate. (It will propagate to the DOM event dispatch logic, which will then report the exception.)

5. Process `return value` as follows:

   ➔ If `event` is a `BeforeUnloadEvent` object and event's `type` is "beforeunload".

   **Note**
   
   In this case, the event handler IDL attribute's type will be `OnBeforeUnloadEventHandler`, so `return value` will have been coerced into either null or a `DOMString`.

   If `return value` is not null, then:

   1. Set event's `canceled` flag.

   2. If event's `returnValue` attribute's value is the empty string, then set event's `returnValue` attribute's value to `return value`.

   ➔ If special error event handling is true

   If `return value` is true, then set event's `canceled` flag.

   ➔ Otherwise

   If `return value` is false, then set event's `canceled` flag.

   **Note**
   
   If we've gotten to this "Otherwise" clause because event's `type` is "beforeunload" but event is not a `BeforeUnloadEvent` object, then `return value` will never be false, since in such cases `return value` will have been coerced into either null or a `DOMString`.

The `EventHandler` callback function type represents a callback used for event handlers. It is represented in Web IDL as follows:

```idl
[LegacyTreatNonObjectAsNull]
callback EventHandlerNonNull = any (Event event);
typedef EventHandlerNonNull? EventHandler;
```

**Note**

In JavaScript, any `Function` object implements this interface.

**Example**

For example, the following document fragment:

```html
<body onload="alert(this)" onclick="alert(this)"
```

...leads to an alert saying "[object Window]" when the document is loaded, and an alert saying "[object HTMLBodyElement]" whenever the user clicks something in the page.

**Note**

The return value of the function affects whether the event is canceled or not: as described above, if the return value is false, the event is canceled.

There are two exceptions in the platform, for historical reasons:

- The `onerror` handlers on global objects, where returning true cancels the event.
- The `onbeforeunload` handler, where returning any non-null and non-undefined value will cancel the event.
For historical reasons, the `onerror`\(^\text{1126}\) handler has different arguments:

\[
\begin{align*}
\text{callback } & \text{ OnErrorEventHandlerNonNull = any ((Event or DOMString) event, optional DOMString source,} \\
& \text{optional unsigned long lineno, optional unsigned long colno, optional any error);} \\
\text{typedef } & \text{ OnErrorEventHandlerNonNull? OnErrorEventHandler;}
\end{align*}
\]

Similarly, the `onbeforeunload`\(^\text{1126}\) handler has a different return value:

\[
\begin{align*}
\text{callback } & \text{ OnBeforeUnloadEventHandlerNonNull = DOMString? (Event event);} \\
\text{typedef } & \text{ OnBeforeUnloadEventHandlerNonNull? OnBeforeUnloadEventHandler;}
\end{align*}
\]

An **internal raw uncompiled handler** is a tuple with the following information:

- An uncompiled script body
- A location where the script body originated, in case an error needs to be reported

When the user agent is to **get the current value of the event handler** given an `EventTarget` object `eventTarget` and a string `name` that is the `name`\(^\text{1118}\) of an `event handler`\(^\text{1117}\), it must run these steps:

1. Let `handlerMap` be `eventTarget`'s `event handler map`\(^\text{1118}\).
2. Let `eventHandler` be `handlerMap[name]`.
3. If `eventHandler`'s `value`\(^\text{1118}\) is an **internal raw uncompiled handler**\(^\text{1123}\), then:
   1. If `eventTarget` is an element, then let `element` be `eventTarget`, and `document` be `element`'s `node document`. Otherwise, `eventTarget` is a `Window`\(^\text{913}\) object, let `element` be null, and `document` be `eventTarget`'s `associated Document`\(^\text{915}\).
   2. If `scripting is disabled`\(^\text{1071}\) for `document`, then return null.
   3. Let `body` be the uncompiled script body in `eventHandler`'s `value`\(^\text{1118}\).
   4. Let `location` be the location where the script body originated, as given by `eventHandler`'s `value`\(^\text{1118}\).
   5. If `element` is not null and `element` has a `form owner`\(^\text{593}\), let `form owner` be that `form owner`\(^\text{593}\). Otherwise, let `form owner` be null.
   6. Let `settings object` be the `relevant settings object`\(^\text{1071}\) of `document`.
   7. If `body` is not parsable as `FunctionBody` or if parsing detects an `early error`, then follow these substeps:
      1. Set `eventHandler`'s `value`\(^\text{1118}\) to null.
      
      **Note**
      
      *This does not deactivate\(^\text{1128}\) the event handler, which additionally removes the event handler's listener\(^\text{1118}\) (if present).*

      2. Report the error\(^\text{1085}\) for the appropriate `script`\(^\text{1072}\) and with the appropriate position (line number and column number) given by `location`, using `settings object`'s `global object`\(^\text{1065}\). If the error is still *not handled*\(^\text{1085}\) after this, then the error may be reported to a developer console.
   8. Push `settings object`'s `realm execution context`\(^\text{1064}\) onto the `JavaScript execution context stack`; it is now the `running JavaScript execution context`.  

---

1123
9. Let \textit{function} be the result of calling \texttt{OrdinaryFunctionCreate}, with arguments:

\begin{verbatim}
functionPrototype
%Function.prototype%
sourceText
\[\begin{align*}
\rightarrow \text{ If } \text{name is } \text{onerror}^{9116} \text{ and } \text{eventTarget is a } \text{Window}^{9113} \text{ object} \\
& \text{The string formed by concatenating } "\text{function }, \text{name}, "(\text{event}, \text{source}, \text{lineno}, \text{colno}, \text{error}) \\
& \{", \text{U+00A LF, body, U+00A LF, and } \\
\rightarrow \text{ Otherwise} \\
& \text{The string formed by concatenating } "\text{function }, \text{name}, "(\text{event}) \{", \text{U+00A LF, body, U+00A LF, and } \\
\end{align*}
\end{verbatim}

ParameterList
\[\begin{align*}
\rightarrow \text{ If } \text{name is } \text{onerror}^{9116} \text{ and } \text{eventTarget is a } \text{Window}^{9113} \text{ object} \\
& \text{Let the function have five arguments, named } \text{event, source, lineno, colno, and error}. \\
\rightarrow \text{ Otherwise} \\
& \text{Let the function have a single argument called } \text{event}.
\end{align*}\]

\textit{body}

The result of parsing \textit{body} above.

\textit{thisMode}

\texttt{non-lexical-this}

\textit{scope}

1. Let \textit{realm} be settings object's \texttt{realm}^{1065}.
2. Let \textit{scope} be \textit{realm}.[[GlobalEnv]].
3. If \textit{eventHandler} is an element's \texttt{event handler}^{1117}, then set \textit{scope} to \texttt{NewObjectEnvironment} (document, true, \textit{scope}).
   (Otherwise, \textit{eventHandler} is a \texttt{Window}^{9113} object's \texttt{event handler}^{1117}.)
4. If \textit{form owner} is not null, then set \textit{scope} to \texttt{NewObjectEnvironment} (form owner, true, \textit{scope}).
5. If \textit{element} is not null, then set \textit{scope} to \texttt{NewObjectEnvironment} (element, true, \textit{scope}).
6. Return \textit{scope}.

10. Remove settings object's \texttt{realm execution context}^{1064} from the \texttt{JavaScript execution context stack}.

11. Set \textit{function}.[[ScriptOrModule]] to null.

\begin{note}
This is necessary so the subsequent invocation of \texttt{OrdinaryFunctionCreate} takes place in the correct \textit{realm}.
\end{note}

12. Set \textit{eventHandler}'s \texttt{value}^{1118} to the result of creating a Web IDL \texttt{EventHandler}^{1122} callback function object whose object reference is \textit{function} and whose \texttt{callback context} is settings object.

4. Return \textit{eventHandler}'s \texttt{value}^{1118}.

\[1124\]
The following are the event handlers \(9^117\) (and their corresponding event handler event types \(9^1120\)) that must be supported by all HTML elements \(9^p11\), as both event handler content attributes \(9^1119\) and event handler IDL attributes \(9^1118\); and that must be supported by all Document \(9^p128\) and Window \(9^p913\) objects, as event handler IDL attributes \(9^1118\):

<table>
<thead>
<tr>
<th>Event handler (9^1117)</th>
<th>Event handler event type (9^1120)</th>
</tr>
</thead>
<tbody>
<tr>
<td>onabort</td>
<td>abort</td>
</tr>
<tr>
<td>onauxclick</td>
<td>auxclick</td>
</tr>
<tr>
<td>onbeforeinput</td>
<td>beforeinput</td>
</tr>
<tr>
<td>onbeforematch</td>
<td>beforematch(9^116)</td>
</tr>
<tr>
<td>onbeforetoggle</td>
<td>beforetoggle(9^116)</td>
</tr>
<tr>
<td>oncancel</td>
<td>cancel(9^116)</td>
</tr>
<tr>
<td>oncanplay</td>
<td>canplay(9^4^4^4)</td>
</tr>
<tr>
<td>oncanplaythrough</td>
<td>canplaythrough(9^4^4^4)</td>
</tr>
<tr>
<td>onchange</td>
<td>change(9^5^4)</td>
</tr>
<tr>
<td>onclick</td>
<td>click</td>
</tr>
<tr>
<td>onclose</td>
<td>close(9^116)</td>
</tr>
<tr>
<td>oncontextlost</td>
<td>contextlost(9^1^5^5)</td>
</tr>
<tr>
<td>oncontextmenu</td>
<td>contextmenu</td>
</tr>
<tr>
<td>oncontextrestored</td>
<td>contextrestored(9^1^5^5)</td>
</tr>
<tr>
<td>oncopy</td>
<td>copy</td>
</tr>
<tr>
<td>oncuechange</td>
<td>cuechange(9^5^5)</td>
</tr>
<tr>
<td>oncute</td>
<td>cut</td>
</tr>
<tr>
<td>ondblclick</td>
<td>dblclick</td>
</tr>
<tr>
<td>ondrag</td>
<td>drag(9^8^7)</td>
</tr>
<tr>
<td>ondragend</td>
<td>dragend(9^8^7)</td>
</tr>
<tr>
<td>ondragenter</td>
<td>dragenter(9^8^7)</td>
</tr>
<tr>
<td>ondragleave</td>
<td>dragleave(9^8^7)</td>
</tr>
<tr>
<td>ondragover</td>
<td>dragover(9^8^7)</td>
</tr>
<tr>
<td>ondragstart</td>
<td>dragstart(9^8^7)</td>
</tr>
<tr>
<td>ondrop</td>
<td>drop(9^8^7)</td>
</tr>
<tr>
<td>ondurationchange</td>
<td>durationchange(9^4^6^4)</td>
</tr>
<tr>
<td>onemptied</td>
<td>emptied(9^4^4^4)</td>
</tr>
<tr>
<td>onended</td>
<td>ended(9^5^5)</td>
</tr>
<tr>
<td>oniformdata</td>
<td>formdata(9^2^4^1)</td>
</tr>
<tr>
<td>oninput</td>
<td>input</td>
</tr>
<tr>
<td>oninvalid</td>
<td>invalid(9^4^5^1)</td>
</tr>
<tr>
<td>onkeydown</td>
<td>keydown</td>
</tr>
<tr>
<td>onkeypress</td>
<td>keypress</td>
</tr>
<tr>
<td>onkeyup</td>
<td>keyup</td>
</tr>
<tr>
<td>onloadeddata</td>
<td>loadeddata(9^4^6^4)</td>
</tr>
<tr>
<td>onloadedmetadata</td>
<td>loadedmetadata(9^4^6^4)</td>
</tr>
<tr>
<td>onloadstart</td>
<td>loadstart(9^2^5^3)</td>
</tr>
<tr>
<td>onmousedown</td>
<td>mousedown</td>
</tr>
<tr>
<td>onmouseover</td>
<td>mouseover</td>
</tr>
<tr>
<td>onmousemove</td>
<td>mousemove</td>
</tr>
<tr>
<td>onmouseout</td>
<td>mouseout</td>
</tr>
<tr>
<td>onmouseup</td>
<td>mouseup</td>
</tr>
<tr>
<td>onpaste</td>
<td>paste</td>
</tr>
<tr>
<td>onpause</td>
<td>pause(9^5^5)</td>
</tr>
<tr>
<td>onplay</td>
<td>play(9^4^4)</td>
</tr>
<tr>
<td>onplaying</td>
<td>playing(9^4^4)</td>
</tr>
<tr>
<td>onprogress</td>
<td>progress(9^4^4)</td>
</tr>
<tr>
<td>onratechange</td>
<td>ratechange(9^5^5)</td>
</tr>
</tbody>
</table>

8.1.8.2 Event handlers on elements, Document objects, and Window objects
### Event handlers and event handler event types

<table>
<thead>
<tr>
<th>Event handler</th>
<th>Event handler event type</th>
</tr>
</thead>
<tbody>
<tr>
<td>onreset</td>
<td>reset</td>
</tr>
<tr>
<td>onscrollend</td>
<td>scrollend</td>
</tr>
<tr>
<td>onsecuritypolicyviolation</td>
<td>securitypolicyviolation</td>
</tr>
<tr>
<td>onseeked</td>
<td>seeked</td>
</tr>
<tr>
<td>onseeking</td>
<td>seeking</td>
</tr>
<tr>
<td>onselect</td>
<td>select</td>
</tr>
<tr>
<td>onslotchange</td>
<td>slotchange</td>
</tr>
<tr>
<td>onstalled</td>
<td>stalled</td>
</tr>
<tr>
<td>onsubmit</td>
<td>submit</td>
</tr>
<tr>
<td>onsuspend</td>
<td>suspend</td>
</tr>
<tr>
<td>ontimeupdate</td>
<td>timeupdate</td>
</tr>
<tr>
<td>ontoggle</td>
<td>toggle</td>
</tr>
<tr>
<td>onvolumechange</td>
<td>volumechange</td>
</tr>
<tr>
<td>onwaiting</td>
<td>waiting</td>
</tr>
<tr>
<td>onwebkitanimationend</td>
<td>webkitAnimationEnd</td>
</tr>
<tr>
<td>onwebkitanimationiteration</td>
<td>webkitAnimationIteration</td>
</tr>
<tr>
<td>onwebkitanimationstart</td>
<td>webkitAnimationStart</td>
</tr>
<tr>
<td>onwebkittransitionend</td>
<td>webkitTransitionEnd</td>
</tr>
<tr>
<td>onwheel</td>
<td>wheel</td>
</tr>
</tbody>
</table>

The following are the event handlers (and their corresponding event handler event types) that must be supported by all HTML elements other than body and frameset elements, as both event handler content attributes and event handler IDL attributes; that must be supported by all Document objects, as event handler IDL attributes; and that must be supported by all Window objects, as event handler IDL attributes; on the Window objects themselves, and with corresponding event handler content attributes and event handler IDL attributes exposed on all body and frameset elements that are owned by that Window object's associated Document:

<table>
<thead>
<tr>
<th>Event handler</th>
<th>Event handler event type</th>
</tr>
</thead>
<tbody>
<tr>
<td>onblur</td>
<td>blur</td>
</tr>
<tr>
<td>onerror</td>
<td>error</td>
</tr>
<tr>
<td>onfocus</td>
<td>focus</td>
</tr>
<tr>
<td>onload</td>
<td>load</td>
</tr>
<tr>
<td>onresize</td>
<td>resize</td>
</tr>
<tr>
<td>onscroll</td>
<td>scroll</td>
</tr>
<tr>
<td>onafterprint</td>
<td>afterprint</td>
</tr>
<tr>
<td>onbeforeprint</td>
<td>beforeprint</td>
</tr>
<tr>
<td>onbeforeunload</td>
<td>beforeunload</td>
</tr>
<tr>
<td>onhashchange</td>
<td>hashchange</td>
</tr>
<tr>
<td>onlanguagechange</td>
<td>languagechange</td>
</tr>
<tr>
<td>onmessage</td>
<td>message</td>
</tr>
<tr>
<td>onmessageerror</td>
<td>messageerror</td>
</tr>
<tr>
<td>onoffline</td>
<td>offline</td>
</tr>
<tr>
<td>ononline</td>
<td>online</td>
</tr>
<tr>
<td>onpageswap</td>
<td>pageswap</td>
</tr>
</tbody>
</table>

We call the set of the names of the event handlers listed in the first column of this table the Window-reflecting body element event handler set.

The following are the event handlers (and their corresponding event handler event types) that must be supported by Window objects, as event handler IDL attributes on the Window objects themselves, and with corresponding event handler content attributes and event handler IDL attributes exposed on all body and frameset elements that are owned by that Window object's associated Document:

<table>
<thead>
<tr>
<th>Event handler</th>
<th>Event handler event type</th>
</tr>
</thead>
<tbody>
<tr>
<td>onafterprint</td>
<td>afterprint</td>
</tr>
<tr>
<td>onbeforeprint</td>
<td>beforeprint</td>
</tr>
<tr>
<td>onbeforeunload</td>
<td>beforeunload</td>
</tr>
<tr>
<td>onhashchange</td>
<td>hashchange</td>
</tr>
<tr>
<td>onlanguagechange</td>
<td>languagechange</td>
</tr>
<tr>
<td>onmessage</td>
<td>message</td>
</tr>
<tr>
<td>onmessageerror</td>
<td>messageerror</td>
</tr>
<tr>
<td>onoffline</td>
<td>offline</td>
</tr>
<tr>
<td>ononline</td>
<td>online</td>
</tr>
<tr>
<td>onpageswap</td>
<td>pageswap</td>
</tr>
</tbody>
</table>
This list of event handlers is reified as event handler IDL attributes through the `WindowEventHandlers` interface mixin.

The following are the event handlers (and their corresponding event handler event types) that must be supported on `Document` objects as event handler IDL attributes:

<table>
<thead>
<tr>
<th>Event handler</th>
<th>Event handler event type</th>
</tr>
</thead>
<tbody>
<tr>
<td>onreadystatechange</td>
<td>readystatechange</td>
</tr>
<tr>
<td>onvisibilitychange</td>
<td>visibilitychange</td>
</tr>
</tbody>
</table>

8.1.8.2.1 IDL definitions

```
IDL interface mixin GlobalEventHandlers {
    attribute EventHandler onabort;
    attribute EventHandler onauxclick;
    attribute EventHandler onbeforeinput;
    attribute EventHandler onbeforematch;
    attribute EventHandler onbeforetoggle;
    attribute EventHandler onblur;
    attribute EventHandler oncancel;
    attribute EventHandler oncanplay;
    attribute EventHandler oncanplaythrough;
    attribute EventHandler onchange;
    attribute EventHandler onclick;
    attribute EventHandler onclose;
    attribute EventHandler oncontextlost;
    attribute EventHandler oncontextmenu;
    attribute EventHandler oncontextrestored;
    attribute EventHandler oncopy;
    attribute EventHandler oncuechange;
    attribute EventHandler oncut;
    attribute EventHandler ondblclick;
    attribute EventHandler ondrag;
    attribute EventHandler ondragend;
    attribute EventHandler ondragenter;
    attribute EventHandler ondragleave;
    attribute EventHandler ondragover;
    attribute EventHandler ondragstart;
    attribute EventHandler ondurationchange;
    attribute EventHandler onemptied;
    attribute EventHandler onended;
    attribute OnErrorEventHandler onerror;
    attribute EventHandler onfocus;
    attribute EventHandler onformdata;
    attribute EventHandler oninput;
    attribute EventHandler oninvalid;
    attribute EventHandler onkeydown;
```
attribute EventHandler onkeypress;
attribute EventHandler onkeyup;
attribute EventHandler onload;
attribute EventHandler onloadeddata;
attribute EventHandler onloadedmetadata;
attribute EventHandler onloadstart;
attribute EventHandler onmousedown;
[LegacyLenientThis] attribute EventHandler onmouseover;
[LegacyLenientThis] attribute EventHandler onmouseout;
attribute EventHandler onmousedown;
attribute EventHandler onmouseenter;
attribute EventHandler onmouseleave;
attribute EventHandler onmousemove;
attribute EventHandler onmouseout;
attribute EventHandler onmouseover;
attribute EventHandler onmouseup;
attribute EventHandler onpaste;
attribute EventHandler onpause;
attribute EventHandler onplay;
attribute EventHandler onplaying;
attribute EventHandler onprogress;
attribute EventHandler onratechange;
attribute EventHandler onreset;
attribute EventHandler onresize;
attribute EventHandler onscroll;
attribute EventHandler onscrollend;
attribute EventHandler onsecuritypolicyviolation;
attribute EventHandler onseeked;
attribute EventHandler onseeking;
attribute EventHandler onselect;
attribute EventHandler onslotchange;
attribute EventHandler onstalled;
attribute EventHandler onsubmit;
attribute EventHandler onsuspend;
attribute EventHandler ontimeupdate;
attribute EventHandler ontoggle;
attribute EventHandler onvolumechange;
attribute EventHandler onwaiting;
attribute EventHandler onwebkitanimationend;
attribute EventHandler onwebkitanimationiteration;
attribute EventHandler onwebkitanimationstart;
attribute EventHandler onwebkittransitionend;
attribute EventHandler onwheel;
};

interface mixin WindowEventHandlers {
attribute EventHandler onafterprint;
attribute EventHandler onbeforeprint;
attribute OnBeforeUnloadEventHandler onbeforeunload;
attribute EventHandler onhashchange;
attribute EventHandler onlanguagechange;
attribute EventHandler onmessage;
attribute EventHandler onmessageerror;
attribute EventHandler onoffline;
attribute EventHandler ononline;
attribute EventHandler onpagehide;
attribute EventHandler onpagereveal;
attribute EventHandler onpageshow;
attribute EventHandler onpageswap;
attribute EventHandler onpopstate;
attribute EventHandler onrejectionhandled;
attribute EventHandler onstorage;
attribute EventHandler onunhandledrejection;
attribute EventHandler onunload;
}
8.1.8.3 Event firing

Certain operations and methods are defined as firing events on elements. For example, the `click()` method on the `HTMLElement` interface is defined as firing a `click` event on the element. [UIEVENTS]

Firing a synthetic pointer event named `e` at `target`, with an optional `not trusted flag`, means running these steps:

1. Let `event` be the result of creating an event using `PointerEvent`.
2. Initialize `event`'s `type` attribute to `e`.
3. Initialize `event`'s `bubbles` and `cancelable` attributes to true.
4. Set `event`'s `composed` flag.
5. If the `not trusted` flag is set, initialize `event`'s `isTrusted` attribute to false.
6. Initialize `event`'s `ctrlKey`, `shiftKey`, `altKey`, and `metaKey` attributes according to the current state of the key input device, if any (false for any keys that are not available).
7. Initialize `event`'s `view` attribute to `target`'s `node document`'s `Window` object, if any, and null otherwise.
8. `event`'s `getModifierState()` method is to return values appropriately describing the current state of the key input device.
9. Return the result of dispatching `event` at `target`.

Firing a `click` event at `target` means firing a synthetic pointer event named `click` at `target`.

8.2 The `WindowOrWorkerGlobalScope` mixin

The `WindowOrWorkerGlobalScope` mixin is for use of APIs that are to be exposed on `Window` and `WorkerGlobalScope` objects.

Other standards are encouraged to further extend it using partial interface mixin `WindowOrWorkerGlobalScope` along with an appropriate reference.

```idl
typedef (DOMString or Function or TrustedScript) TimerHandler;

interface mixin WindowOrWorkerGlobalScope {
  [Replaceable] readonly attribute USVString origin;
  readonly attribute boolean isSecureContext;
  readonly attribute boolean crossOriginIsolated;

  undefined reportError(any e);

  // base64 utility methods
  DOMString btoa(DOMString data);
  ByteString atob(DOMString data);

  // timers
  long setTimeout(TimerHandler handler, optional long timeout = 0, any... arguments);
  undefined clearTimeout(optional long id = 0);
  long setInterval(TimerHandler handler, optional long timeout = 0, any... arguments);
  undefined clearInterval(optional long id = 0);
};
```
// microtask queuing
undefined queueMicrotask(VoidFunction callback);

// ImageBitmap
Promise<ImageBitmap> createImageBitmap(ImageBitmapSource image, optional ImageBitmapOptions options = {});
Promise<ImageBitmap> createImageBitmap(ImageBitmapSource image, long sx, long sy, long sw, long sh, optional ImageBitmapOptions options = {});

// structured cloning
any structuredClone(any value, optional StructuredSerializeOptions options = {});

Window includes WindowOrWorkerGlobalScope;
WorkerGlobalScope includes WindowOrWorkerGlobalScope;

For web developers (non-normative)

**self.isSecureContext**

Returns whether or not this global object represents a secure context. [SECURE-CONTEXTS]

**self.origin**

Returns the global object’s origin, serialized as string.

**self.crossOriginIsolated**

Returns whether scripts running in this global are allowed to use APIs that require cross-origin isolation. This depends on the `Cross-Origin-Opener-Policy` and `Cross-Origin-Embedder-Policy` HTTP response headers and the "cross-origin-isolated" feature.

Example

Developers are strongly encouraged to use self.origin over location.origin. The former returns the origin of the environment, the latter of the URL of the environment. Imagine the following script executing in a document on https://stargate.example/:

```
var frame = document.createElement("iframe")
frame.onload = function() {
  var frameWin = frame.contentWindow
  console.log(frameWin.location.origin) // "null"
  console.log(frameWin.origin) // "https://stargate.example"
}
document.body.appendChild(frame)
```

self.origin is a more reliable security indicator.

The **isSecureContext** getter steps are to return true if this’s relevant settings object is a secure context, or false otherwise.

The **origin** getter steps are to return this’s relevant settings object’s origin, serialized.

The **crossOriginIsolated** getter steps are to return this’s relevant settings object’s cross-origin isolated capability.

**8.3 Base64 utility methods**

The **atob()** and **btoa()** methods allow developers to transform content to and from the base64 encoding.

**Note**

In these APIs, for mnemonic purposes, the "b" can be considered to stand for "binary", and the "a" for "ASCII". In practice, though, for primarily historical reasons, both the input and output of these functions are Unicode strings.
For web developers (non-normative)

\[
\text{result} = \text{self.btoa}(\text{data})
\]

Takes the input data, in the form of a Unicode string containing only characters in the range U+0000 to U+00FF, each representing a binary byte with values 0x00 to 0xFF respectively, and converts it to its base64 representation, which it returns.

Throws an "InvalidCharacterError" DOMException exception if the input string contains any out-of-range characters.

\[
\text{result} = \text{self.atob}(\text{data})
\]

Takes the input data, in the form of a Unicode string containing base64-encoded binary data, decodes it, and returns a string consisting of characters in the range U+0000 to U+00FF, each representing a binary byte with values 0x00 to 0xFF respectively, corresponding to that binary data.

Throws an "InvalidCharacterError" DOMException if the input string is not valid base64 data.

The `btoa(data)` method must throw an "InvalidCharacterError" DOMException if `data` contains any character whose code point is greater than U+00FF. Otherwise, the user agent must convert `data` to a byte sequence whose `n`th byte is the eight-bit representation of the `n`th code point of `data`, and then must apply forgiving-base64 encode to that byte sequence and return the result.

The `atob(data)` method steps are:

1. Let `decodedData` be the result of running forgiving-base64 decode on `data`.
2. If `decodedData` is failure, then throw an "InvalidCharacterError" DOMException.
3. Return `decodedData`.

8.4 Dynamic markup insertion

Note

APIS for dynamically inserting markup into the document interact with the parser, and thus their behavior varies depending on whether they are used with HTML documents (and the HTML parser) or XML documents (and the XML parser).

Document objects have a throw-on-dynamic-markup-insertion counter, which is used in conjunction with the create an element for the token algorithm to prevent custom element constructors from being able to use `document.open()`, `document.close()`, and `document.write()` when they are invoked by the parser. Initially, the counter must be set to zero.

8.4.1 Opening the input stream

For web developers (non-normative)

\[
\text{document} = \text{document.open}()
\]

Causes the Document to be replaced in-place, as if it was a new Document object, but reusing the previous object, which is then returned.

The resulting Document has an HTML parser associated with it, which can be given data to parse using `document.write()`.

The method has no effect if the Document is still being parsed.

Throws an "InvalidStateError" DOMException if the Document is an XML document.

Throws an "InvalidStateError" DOMException if the parser is currently executing a custom element constructor.

\[
\text{window} = \text{document.open}(\text{url}, \text{name}, \text{features})
\]

Works like the `window.open()` method.

Document objects have an active parser was aborted boolean, which is used to prevent scripts from invoking the `document.open()` and `document.write()` methods (directly or indirectly) after the document's active parser has been aborted. It is initially false.

The document open steps, given a document, are as follows:
1. If `document` is an XML document, then throw an "InvalidStateError" DOMException exception.

2. If `document`'s throw-on-dynamic-markup-insertion counter is greater than 0, then throw an "InvalidStateError" DOMException.

3. Let `entryDocument` be the entry global object's associated Document.

4. If `document`'s origin is not same origin to `entryDocument`'s origin, then throw a "SecurityError" DOMException.

5. Let `entryDocument` be the entry global object's associated Document.

6. If `document`'s origin is not same origin to `entryDocument`'s origin, then throw a "SecurityError" DOMException.

7. Similarly, if `document`'s unload counter is greater than 0, then return `document`.

8. If `document` has an active parser whose script nesting level is greater than 0, then return `document`.

9. If `document` is the associated Document of `document`'s relevant global object, then return `document`.

10. If `document` is the associated Document of `document`'s relevant global object, then return `document`.

11. Let `oldFlag` be the value of `document`'s fire mutation events flag.

12. Set `document`'s fire mutation events flag to false.

13. Replace all with null within `document`.

14. Set `document`'s fire mutation events flag to `oldFlag`.

15. If `document` is fully active, then:
   1. Let `newURL` be a copy of `entryDocument`'s URL.
   2. If `entryDocument` is not `document`, then set `newURL`'s fragment to null.
   3. Run the URL and history update steps with `document` and `newURL`.

16. Set `document`'s is initial about:blank to false.

17. If `document`'s iframe load in progress flag is set, then set `document`'s mute iframe load flag.

18. Set `document` to no-quirks mode.

19. Create a new HTML parser and associate it with `document`. This is a script-created parser (meaning that it can be closed by the `document.open()` and `document.close()` methods, and that the tokenizer will wait for an explicit call to `document.close()` before emitting an end-of-file token). The encoding confidence is irrelevant.

20. Set the insertion point to point at just before the end of the input stream (which at this point will be empty).

21. Update the current document readiness of `document` to "loading".

Note: This causes a readystatechange event to fire, but the event is actually unobservable to author code, because of the previous step which erased all event listeners and handlers that could observe it.
22. Return document.

Note

The document open steps\(^{p1131}\) do not affect whether a Document\(^{p128}\) is ready for post-load tasks\(^{p1340}\) or completely loaded\(^{p1052}\).

The open(unused1, unused2) method must return the result of running the document open steps\(^{p1131}\) with this.

Note

The unused1 and unused2 arguments are ignored, but kept in the IDL to allow code that calls the function with one or two arguments to continue working. They are necessary due to Web IDL overload resolution algorithm rules, which would throw a TypeError exception for such calls had the arguments not been there. whatwg/webidl issue #581 investigates changing the algorithm to allow for their removal. [WEBIDL]\(^{p1463}\)

The open(url, name, features) method must run these steps:

1. If this is not fully active\(^{p992}\), then throw an "InvalidAccessError" DOMException exception.
2. Return the result of running the window open steps\(^{p916}\) with url, name, and features.

8.4.2 Closing the input stream \(^{§p11}\)

For web developers (non-normative)

document.close()\(^{p1132}\)

Closes the input stream that was opened by the document.open() method.

Throws an "InvalidStateError" DOMException if the Document is an XML document.

Throws an "InvalidStateError" DOMException if the parser is currently executing a custom element constructor\(^{p754}\).

The close() method must run the following steps:

1. If this is an XML document, then throw an "InvalidStateError" DOMException.
2. If this's throw-on-dynamic-markup-insertion counter\(^{p1111}\) is greater than zero, then throw an "InvalidStateError" DOMException.
3. If there is no script-created parser\(^{p1132}\) associated with this, then return.
4. Insert an explicit "EOF" character\(^{p1266}\) at the end of the parser's input stream\(^{p1265}\).
5. If this's pending parsing-blocking script\(^{p659}\) is not null, then return.
6. Run the tokenizer, processing resulting tokens as they are emitted, and stopping when the tokenizer reaches the explicit "EOF" character\(^{p1266}\) or spins the event loop\(^{p1113}\).

8.4.3 document.write()\(^{p1134}\) \(^{§p11}\)

For web developers (non-normative)

document.write(...text)\(^{p1134}\)

In general, adds the given string(s) to the Document's input stream.

⚠️ Warning!

This method has very idiosyncratic behavior. In some cases, this method can affect the state of the HTML parser\(^{p1252}\) while the parser is running, resulting in a DOM that does not correspond to the source of the document (e.g. if the string written is the string "<plaintext>" or "<!--"). In other cases, the call can clear the current page first, as if document.open() had been called. In yet more cases, the method is simply ignored, or throws an exception. Users agents are explicitly allowed to avoid executing script elements inserted via
**Document** objects have an **ignore-destructive-writes counter**, which is used in conjunction with the processing of `script` elements to prevent external scripts from being able to use `document.write()` to blow away the document by implicitly calling `document.open()`.

Initially, the counter must be set to zero.

The **document write steps**, given a `Document` object `document`, a list `text`, a boolean `lineFeed` and a string `sink`, are as follows:

1. Let `string` be the empty string.
2. Let `isTrusted` be false if `text` contains a string; otherwise true.
3. For each `value` of `text`:
   1. If `value` is a `TrustedHTML` object, then append `value`'s associated `data` to `string`.
   2. Otherwise, append `value` to `string`.
4. If `isTrusted` is false, set `string` to the result of invoking the Get Trusted Type compliant string algorithm with `TrustedHTML`, `this`'s relevant global object, `string`, `sink`, and "script".
5. If `lineFeed` is true, append U+000A LINE FEED to `string`.
6. If `document` is an XML document, then throw an "InvalidStateError" DOMException.
7. If `document`'s `throw-on-dynamic-markup-insertion counter` is greater than 0, then throw an "InvalidStateError" DOMException.
8. If `document`'s `active parser was aborted` is true, then return.
9. If the `insertion point` is undefined, then:
   1. If `document`'s `unload counter` is greater than 0 or `document`'s `ignore-destructive-writes counter` is greater than 0, then return.
   2. Run the document open steps with `document`.
10. Insert `string` into the input stream just before the `insertion point`.
11. If `document`'s `pending parsing-blocking script` is null, then have the `HTML parser` process `string`, one code point at a time, processing resulting tokens as they are emitted, and stopping when the tokenizer reaches the insertion point or when the processing of the tokenizer is aborted by the tree construction stage (this can happen if a `script` end tag token is emitted by the tokenizer).

**Note**

If the `document.write()` method was called from script executing inline (i.e. executing because the parser parsed a set of `script` tags), then this is a reentrant invocation of the parser. If the `parser pause flag` is set, the tokenizer will abort immediately and no HTML will be parsed, per the tokenizer's parser pause flag check.

The `document.write(...) text` method steps are to run the document write steps with this, `text`, false and "Document write".

⚠ **Warning!**

This method performs no sanitization to remove potentially-dangerous elements and attributes like `script` or event handler content attributes.
8.4.4 `document.writeln()`

For web developers (non-normative)

`document.writeln(text)`

Adds the given string(s) to the `Document`'s input stream, followed by a newline character. If necessary, calls the `open()` method implicitly first.

Throws an "`InvalidStateError`" `DOMException` when invoked on XML documents.

Throws an "`InvalidStateError`" `DOMException` if the parser is currently executing a custom element constructor.

⚠ Warning!

This method performs no sanitization to remove potentially-dangerous elements and attributes like `script` or event handler content attributes.

The `document.writeln(...text)` method steps are to run the `document write steps` with `this`, `text`, `true` and "Document writeln".

8.5 DOM parsing and serialization APIs

IDL

```
partial interface Element {
  [CEReactions] undefined setHTMLUnsafe(HTMLString html);
  DOMString getHTML(Helper GetHTMLOptions options = {});

  [CEReactions] attribute [LegacyNullToEmptyString] HTMLString innerHTML;
  [CEReactions] attribute [LegacyNullToEmptyString] HTMLString outerHTML;
  [CEReactions] undefined insertAdjacentHTML(DOMString position, HTMLString string);
};

partial interface ShadowRoot {
  [CEReactions] undefined setHTMLUnsafe(HTMLString html);
  DOMString getHTML(Helper GetHTMLOptions options = {});

  [CEReactions] attribute [LegacyNullToEmptyString] HTMLString innerHTML;
};

dictionary GetHTMLOptions {
  boolean serializableShadowRoots = false;
  sequence<ShadowRoot> shadowRoots = [];
};
```
Note that script elements are not evaluated during parsing, and the resulting document's encoding will always be UTF-8. The document's URL will be inherited from parser's relevant global object.

Values other than the above for type will cause a TypeError exception to be thrown.

The design of DOMParser, as a class that needs to be constructed and then have its parseFromString() method called, is an unfortunate historical artifact. If we were designing this functionality today it would be a standalone function. For parsing HTML, the modern alternative is Document.parseHTMLUnsafe().

⚠Warning!
- This method performs no sanitization to remove potentially-dangerous elements and attributes like script or event handler content attributes.

The new DOMParser() constructor steps are to do nothing.

The parseFromString(string, type) method steps are:

1. Let document be a new Document, whose content type is type and URL is this's relevant global object's associated Document's URL.

   The document's encoding will be left as its default, of UTF-8. In particular, any XML declarations or meta elements found while parsing string will have no effect.

2. Switch on type:
   
   → "text/html"
   
   1. Parse HTML from a string given document and string.

      Since document does not have a browsing context, scripting is disabled.

   → Otherwise
      
      1. Create an XML parser parse, associated with document, and with XML scripting support disabled.
      
      2. Parse string using parser.
      
      3. If the previous step resulted in an XML well-formedness or XML namespace well-formedness error, then:
         
         1. Assert: document has no child nodes.
         
         2. Let root be the result of creating an element given document, "parsererror", and "http://www.mozilla.org/newlayout/xml/parsererror.xml".

IDL

[Exposed=Window]
interface DOMParser {
    constructor();

    [NewObject] Document parseFromString(HTMLString string, DOMParserSupportedType type);
};

enum DOMParserSupportedType {
    "text/html",
    "text/xml",
    "application/xml",
    "application/xhtml+xml",
    "image/svg+xml"
};
3. Optionally, add attributes or children to root to describe the nature of the parsing error.

4. Append root to document.

To parse HTML from a string, given a Document document and a string html:

1. Set document's type to "html".
2. Create an HTML parser, associated with document.
3. Place html into the input stream for parser. The encoding confidence is irrelevant.
4. Start parser and let it run until it has consumed all the characters just inserted into the input stream.

Note
This might mutate the document's mode.

8.5.2 Unsafe HTML parsing methods

For web developers (non-normative)

**element.setHTMLUnsafe(html)**

Parses html using the HTML parser, and replaces the children of element with the result. element provides context for the HTML parser.

**shadowRoot.setHTMLUnsafe(html)**

Parses html using the HTML parser, and replaces the children of shadowRoot with the result. shadowRoot's host provides context for the HTML parser.

**doc = Document.parseHTMLUnsafe(html)**

Parses html using the HTML parser, and returns the resulting Document. Note that script elements are not evaluated during parsing, and the resulting document's encoding will always be UTF-8. The document's URL will be about:blank.

⚠ Warning!
These methods perform no sanitization to remove potentially-dangerous elements and attributes like script or event handler content attributes.

**Element**'s setHTMLUnsafe(html) method steps are:

1. Let target be this's template contents if this is a template element; otherwise this.
2. Unsafely set HTML given target, this, and html.

**ShadowRoot**'s setHTMLUnsafe(html) method steps are to unsafely set HTML given this, this's shadow host, and html.

To unsafely set HTML, given an Element or DocumentFragment target, an Element contextElement, and a string html:

1. Let newChildren be the result of the HTML fragment parsing algorithm given contextElement, html, and true.
2. Let fragment be a new DocumentFragment whose node document is contextElement's node document.
3. For each node in newChildren, append node to fragment.
4. Replace all with fragment within target.

The static parseHTMLUnsafe(html) method steps are:

1. Let document be a new Document, whose content type is "text/html".
2. Set document's allow declarative shadow roots to true.
3. Parse HTML from a string given document and html.

8.5.3 HTML serialization methods

For web developers (non-normative)

```javascript
html = element.getHTML(serializableShadowRoots, shadowRoots)
```

Returns the result of serializing element to HTML. Shadow roots within element are serialized according to the provided options:

- If serializableShadowRoots is true, then all shadow roots marked as serializable are serialized.
- If the shadowRoots array is provided, then all shadow roots specified in the array are serialized, regardless of whether or not they are marked as serializable.

If neither option is provided, then no shadow roots are serialized.

```javascript
html = shadowRoot.getHTML(serializableShadowRoots, shadowRoots)
```

Returns the result of serializing shadowRoot to HTML, using its shadow host as the context element. Shadow roots within shadowRoot are serialized according to the provided options, as above.

Element's `getHTML(options)` method steps are to return the result of HTML fragment serialization algorithm with this, options["serializableShadowRoots"], and options["shadowRoots"].

ShadowRoot's `getHTML(options)` method steps are to return the result of HTML fragment serialization algorithm with this, options["serializableShadowRoots"], and options["shadowRoots"].

8.5.4 The `innerHTML` property

The `innerHTML` property has a number of outstanding issues in the DOM Parsing and Serialization issue tracker, documenting various problems with its specification.

For web developers (non-normative)

```javascript
element.innerHTML
```

Returns a fragment of HTML or XML that represents the element's contents.

In the case of an XML document, throws a "InvalidStateError" DOMException if the element cannot be serialized to XML.

```javascript
element.innerHTML = value
```

Replaces the contents of the element with nodes parsed from the given string.

In the case of an XML document, throws a "SyntaxError" DOMException if the given string is not well-formed.

```javascript
shadowRoot.innerHTML
```

Returns a fragment of HTML that represents the shadow roots's contents.

```javascript
shadowRoot.innerHTML = value
```

Replaces the contents of the shadow root with nodes parsed from the given string.

⚠️ Warning!

These properties' setters perform no sanitization to remove potentially-dangerous elements and attributes like script or event handler content attributes.
The **fragment serializing algorithm steps**, given an `Element` or `DocumentFragment` node and a boolean `require well-formed`, are:

1. Let `context document` be node's `node document`.
2. If `context document` is an `HTML document`, return the result of `HTML fragment serialization algorithm` with node, false, and « ».
3. Return the `XML serialization` of node given `require well-formed`.

The **fragment parsing algorithm steps**, given an `Element` or `DocumentFragment` context and a string `markup`, are:

1. Let `algorithm` be the `HTML fragment parsing algorithm`.
2. If context's `node document` is an `XML document`, then set `algorithm` to the `XML fragment parsing algorithm`.
3. Let `new children` be the result of invoking `algorithm` given `markup`, with `context` set to context.
4. Let `fragment` be a new `DocumentFragment` whose `node document` is context's `node document`.
5. Append each `Node` in new children to `fragment` (in tree order).
6. Return `fragment`.

**Element's `innerHTML`** getter steps are to return the result of running `fragment serializing algorithm steps` with `this` and true.

**ShadowRoot's `innerHTML`** getter steps are to return the result of running `fragment serializing algorithm steps` with `this` and true.

**Element's `innerHTML`** setter steps are:

1. Let `context` be `this`.
2. Let `fragment` be the result of invoking the `fragment parsing algorithm steps` with context and the given value.
3. If context is a `template` element, then set context to the `template` element's `template contents` (a `DocumentFragment`).
4. Replace all with `fragment` within context.

**ShadowRoot's `innerHTML`** setter steps are:

1. Let `context` be `this`'s `host`.
2. Let `fragment` be the result of invoking the `fragment parsing algorithm steps` with context and the given value.
3. Replace all with `fragment` within `this`.

### 8.5.5 The `outerHTML` property

The `outerHTML` property has a number of outstanding issues in the **DOM Parsing and Serialization** issue tracker, documenting various problems with its specification.

**For web developers (non-normative)**

`element.outerHTML`

Returns a fragment of HTML or XML that represents the element and its contents.

In the case of an XML document, throws a "`InvalidStateError`" `DOMException` if the element cannot be serialized to XML.
**element.outerHTML**

Replaces the element with nodes parsed from the given string.

In the case of an XML document, throws a "SyntaxError" DOMException if the given string is not well-formed.

Throws a "NoModificationAllowedError" DOMException if the parent of the element is a Document.

---

**⚠ Warning!**

*This property's setter performs no sanitization to remove potentially-dangerous elements and attributes like script or event handler content attributes.*

---

Element's outerHTML getter steps are:

1. Let element be a fictional node whose only child is this.
2. Return the result of running fragment serializing algorithm steps with element and true.

---

Element's outerHTML setter steps are:

1. Let parent be this's parent.
2. If parent is null, return. There would be no way to obtain a reference to the nodes created even if the remaining steps were run.
3. If parent is a Document, throw a "NoModificationAllowedError" DOMException.
4. If parent is a DocumentFragment, set parent to the result of creating an element given this's node document, body, and the HTML namespace.
5. Let fragment be the result of invoking the fragment parsing algorithm steps given parent and the given value.
6. Replace this with fragment within this's parent.

---

### 8.5.6 The insertAdjacentHTML() method

The insertAdjacentHTML() method has a number of outstanding issues in the DOM Parsing and Serialization issue tracker, documenting various problems with its specification.

---

**For web developers (non-normative)**

**element.insertAdjacentHTML(position, string)**

Parses string as HTML or XML and inserts the resulting nodes into the tree in the position given by the position argument, as follows:

"beforebegin"

Before the element itself (i.e., after element's previous sibling)

"afterbegin"

Just inside the element, before its first child.

"beforeend"

Just inside the element, after its last child.

"afterend"

After the element itself (i.e., before element's next sibling)

Throws a "SyntaxError" DOMException if the arguments have invalid values (e.g., in the case of an XML document, if the given string is not well-formed).

Throws a "NoModificationAllowedError" DOMException if the given position isn't possible (e.g. inserting elements after the root element of a Document).

---

**⚠ Warning!**

*This method performs no sanitization to remove potentially-dangerous elements and attributes like script or event handler content attributes.*
**Element**'s `insertAdjacentHTML(position, string)` method steps are:

1. Let context be null.

2. Use the first matching item from this list:
   - If `position` is an ASCII case-insensitive match for the string "beforebegin"
   - If `position` is an ASCII case-insensitive match for the string "afterend"
     1. Set context to this's parent.
     2. If context is null or a `Document`, throw a "NoModificationAllowedError" `DOMException`.
   - If `position` is an ASCII case-insensitive match for the string "afterbegin"
   - If `position` is an ASCII case-insensitive match for the string "beforeend"
     Set context to this.
   - Otherwise
     Throw a "SyntaxError" `DOMException`.

3. If context is not an `Element` or all of the following are true:
   - context's node document is an HTML document;
   - context's local name is "html"; and
   - context's namespace is the HTML namespace,
   set context to the result of creating an element given this's node document, body, and the HTML namespace.

4. Let fragment be the result of invoking the fragment parsing algorithm steps with context and string.

5. Use the first matching item from this list:
   - If `position` is an ASCII case-insensitive match for the string "beforebegin"
     Insert fragment into this's parent before this.
   - If `position` is an ASCII case-insensitive match for the string "afterend"
     Insert fragment into this before its first child.
   - If `position` is an ASCII case-insensitive match for the string "afterbegin"
     Append fragment to this.
   - If `position` is an ASCII case-insensitive match for the string "beforeend"
     Insert fragment into this's parent before this's next sibling.

---

**Note**

As with other direct Node-manipulation APIs (and unlike `innerHTML`, `insertAdjacentHTML()` does not include any special handling for `template` elements. In most cases you will want to use `templateEl.content`, `insertAdjacentHTML()` instead of directly manipulating the child nodes of a `template` element.

8.5.7 The `createContextualFragment()` method

The `createContextualFragment()` method has a number of outstanding issues in the DOM Parsing and Serialization issue tracker, documenting various problems with its specification.
Range's `createContextualFragment(string)` method steps are:

1. Let `node` be `this`'s start node.
2. Let `element` be null.
3. If `node` implements `Element`, set `element` to `node`.
4. Otherwise, if `node` implements `Text` or `Comment`, set `element` to `node`'s parent element.
5. If `element` is null or all of the following are true:
   - `element`'s `node document` is an HTML document;
   - `element`'s `local name` is `"html"`;
   - `element`'s `namespace` is the HTML namespace,
     then set `element` to the result of creating an element given `this`'s `node document`, `body`, and the HTML namespace.
6. Let `fragment node` be the result of invoking the fragment parsing algorithm steps with `element` and `string`.
7. For each script of `fragment node`'s `script` element descendants:
   1. Set script's already started to false.
   2. Set script's parser document to null.
8. Return `fragment node`.

---

**8.6 Timers**

The `setTimeout()` and `setInterval()` methods allow authors to schedule timer-based callbacks.

For web developers (non-normative)

```javascript
id = self.setTimeout(handler [, timeout [, ...arguments ] ])
Schedules a timeout to run `handler` after `timeout` milliseconds. Any `arguments` are passed straight through to the `handler`.
```

```javascript
id = self.setTimeout(code [, timeout ])
Schedules a timeout to compile and run `code` after `timeout` milliseconds.
```

```javascript
self.clearTimeout(id)
Cancels the timeout set with `setTimeout()` or `setInterval()` identified by `id`.
```

```javascript
id = self.setTimeout(handler [, timeout [, ...arguments ] ])
Schedules a timeout to run `handler` every `timeout` milliseconds. Any `arguments` are passed straight through to the `handler`.
```

```javascript
id = self.setInterval(code [, timeout ])
Schedules a timeout to compile and run `code` every `timeout` milliseconds.
```
Objects that implement the `WindowOrWorkerGlobalScope` mixin have a map of active timers, which is a `map`, initially empty. Each `key` in this map is an identifier for a timer, and each `value` is a `DOMHighResTimeStamp`, representing the expiry time for that timer.

The `setTimeout(handler, timeout, ...)` method steps are to return the result of running the timer initialization steps given `this`, `handler`, `timeout`, `arguments`, and false.

The `setInterval(handler, timeout, ...)` method steps are to return the result of running the timer initialization steps given `this`, `handler`, `timeout`, `arguments`, and true.

The `clearTimeout(id)` and `clearInterval(id)` method steps are to remove this’s map of active timers \([id]\).

The timer initialization steps, given a `WindowOrWorkerGlobalScope` `global`, a string or `Function` or `TrustedScript` `handler`, a number `timeout`, a list `arguments`, a boolean `repeat`, and optionally (and only if `repeat` is true) a number `previousId`, are:

1. Let `thisArg` be `global` if that is a `WorkerGlobalScope` object; otherwise let `thisArg` be the `WindowProxy` that corresponds to `global`.
2. If `previousId` was given, let `id` be `previousId`; otherwise, let `id` be an implementation-defined integer that is greater than zero and does not already exist in `global`’s map of active timers.
3. If the surrounding agent’s event loop’s currently running task is a task that was created by this algorithm, then let `nesting level` be the task’s timer nesting level. Otherwise, let `nesting level` be zero.

The task’s timer nesting level is used both for nested calls to `setTimeout()` and for the repeating timers created by `setInterval()`. (Or, indeed, for any combination of the two.) In other words, it represents nested invocations of this algorithm, not of a particular method.

4. If `timeout` is less than 0, then set `timeout` to 0.
5. If `nesting level` is greater than 5, and `timeout` is less than 4, then set `timeout` to 4.
6. Let `realm` be `global`’s relevant realm.
7. Let `initiating script` be the active script.
8. Let task be a task that runs the following substeps:
1. If *id* does not exist in global's map of active timers\[^1\] and abort these steps.

2. Record timing info for timer handler given *handler*, global's relevant settings object\[^1\], and repeat.

3. If *handler* is a **Function**, then invoke *handler* given arguments with the **callback this value** set to **thisArg**. If this throws an exception, catch it, and **report the exception**\[^1\].

4. Otherwise:
   
   1. If *previousId* was not given:
      
      1. Let *globalName* be "Window" if this's relevant global object\[^1\] is a **Window** object; "Worker" otherwise.
      
      2. Let *methodName* be "**setInterval**" if *repeat* is true; "**setTimeout**" otherwise.
      
      3. Let *sink* be a concatenation of *globalName*, U+0020 SPACE, and *methodName*.
      
      4. Set *handler* to the result of invoking the **Get Trusted Type compliant string** algorithm with **TrustedScript**, this's relevant global object\[^1\], *handler*, *sink*, and "script".

      2. **Assert**: *handler* is a string.

      3. Perform **HostEnsureCanCompileStrings**\[^1\] ((realm)). If this throws an exception, catch it, **report the exception**\[^1\], and abort these steps.

      4. Let *settings object* be global's relevant settings object\[^1\].

      5. Let *fetch options* be the default classic script fetch options\[^1\].

      6. Let *base URL* be settings object's API base URL\[^1\].

      7. If *initiating script* is not null, then:

         1. Set *fetch options* to a script fetch options\[^1\] whose cryptographic nonce\[^1\] is *initiating script*'s fetch options\[^1\]'s cryptographic nonce\[^1\], integrity metadata\[^1\] is the empty string, parser metadata\[^1\] is "not-parser-inserted", credentials mode\[^1\] is *initiating script*'s fetch options\[^1\]'s credentials mode\[^1\], referrer policy\[^1\] is the empty string, and fetch priority\[^1\] is "auto".

         2. Set *base URL* to *initiating script*'s base URL\[^1\].

   2. Run the classic script\[^1\] *script*.

5. If *id* does not exist in global's map of active timers\[^1\], then abort these steps.

   **Note**

   The effect of these steps ensures that the string compilation done by **setTimeout()**\[^1\] and **setInterval()**\[^1\] behaves equivalently to that done by **eval()**. That is, module script\[^1\] fetches via **import()** will behave the same in both contexts.

8. Let *script* be the result of creating a classic script\[^1\] given *handler*, settings object, *base URL*, and *fetch options*.

9. Run the classic script\[^1\] *script*.

5. If *id* does not exist in global's map of active timers\[^1\], then abort these steps.

   **Note**

   It might have been removed via the author code in *handler* calling **clearTimeout()**\[^1\] or **clearInterval()**\[^1\].

6. If *repeat* is true, then perform the **timer initialization steps**\[^1\] again, given global, *handler*, *timeout*, arguments, true, and *id*.

7. Otherwise, remove global's map of active timers\[^1\][*id*].

9. Increment nesting level by one.

10. Set task's timer nesting level to nesting level.

11. Let completionStep be an algorithm step which queues a global task\[^1\] on the timer task source given global to run task.
12. Run steps after a timeout\textsuperscript{p1145} given \textit{global}, \textit{setTimeout/setInterval}, \textit{timeout}, \textit{completionStep}, and \textit{id}.

13. Return \textit{id}.

\textbf{Note}

Argument conversion as defined by Web IDL (for example, invoking \texttt{toString()} methods on objects passed as the first argument) happens in the algorithms defined in Web IDL, before this algorithm is invoked.

\textbf{Example}

So for example, the following rather silly code will result in the log containing "ONE TWO ":

```javascript
var log = '';
function logger(s) { log += s + ' '; }

setTimeout({
    toString: function () {
        setTimeout("logger('ONE')", 100);
        return "logger('TWO')";
    }
}, 100);
```

\textbf{Example}

To run tasks of several milliseconds back to back without any delay, while still yielding back to the browser to avoid starving the user interface (and to avoid the browser killing the script for hogging the CPU), simply queue the next timer before performing work:

```javascript
function doExpensiveWork() {
    var done = false;
    // ...
    // this part of the function takes up to five milliseconds
    // set done to true if we're done
    // ...
    return done;
}

function rescheduleWork() {
    var id = setTimeout(rescheduleWork, 0); // preschedule next iteration
    if (doExpensiveWork())
        clearTimeout(id); // clear the timeout if we don't need it
}

function scheduleWork() {
    setTimeout(rescheduleWork, 0);
}

scheduleWork(); // queues a task to do lots of work
```

To run steps after a timeout, given a \texttt{WindowOrWorkerGlobalScope} \textsuperscript{p1129} \textit{global}, a string \textit{orderingIdentifier}, a number \textit{milliseconds}, a set of steps \textit{completionSteps}, and an optional value \textit{timerKey}:

1. \textbf{Assert}: if \textit{timerKey} is given, then the caller of this algorithm is the \textit{timer initialization steps} \textsuperscript{p1143}. (Other specifications must not pass \textit{timerKey}.)

2. If \textit{timerKey} is not given, then set it to a new unique non-numeric value.

3. Let \textit{startTime} be the \textit{current high resolution time} given \textit{global}.

4. Set \textit{global}'s map of active timers \textsuperscript{p1143} \textit{[timerKey]} to \textit{startTime} plus \textit{milliseconds}.

5. Run the following steps \textit{in parallel}\textsuperscript{p43}:

   1. If \textit{global} is a \texttt{Window} \textsuperscript{p913} object, wait until \textit{global}'s \texttt{associated Document} \textsuperscript{p915} has been \texttt{fully active} \textsuperscript{p992} for a further \textit{milliseconds} milliseconds (not necessarily consecutively).
Otherwise, `global` is a `WorkerGlobalScope` object; wait until `milliseconds` milliseconds have passed with the worker not suspended (not necessarily consecutively).

2. Wait until any invocations of this algorithm that had the same `global` and `orderingIdentifier`, that started before this one, and whose `milliseconds` is less than or equal to this one's, have completed.

3. Optionally, wait a further `implementation-defined` length of time.

4. Perform `completionSteps`.

5. If `timerKey` is a non-numeric value, remove `global`'s map of active timers

```
Note
This is intended to allow user agents to pad timeouts as needed to optimize the power usage of the device. For example, some processors have a low-power mode where the granularity of timers is reduced; on such platforms, user agents can slow timers down to fit this schedule instead of requiring the processor to use the more accurate mode with its associated higher power usage.
```

```
Note
Run steps after a timeout is meant to be used by other specifications that want to execute developer-supplied code after a developer-supplied timeout, in a similar manner to `setTimeout()`. (Note, however, it does not have the nesting and clamping behavior of `setTimeout()`) Such specifications can choose an ordering identifier to ensure ordering within their specification’s timeouts, while not constraining ordering with respect to other specification’s timeouts.
```

### 8.7 Microtask queuing

For web developers (non-normative)

```javascript
self.queueMicrotask(callback)
```

Queues a microtask to run the given callback.

The `queueMicrotask(callback)` method must `queue a microtask` to invoke `callback`, and if `callback` throws an exception, `report the exception`.

The `queueMicrotask()` method allows authors to schedule a callback on the microtask queue. This allows their code to run once the JavaScript execution context stack is next empty, which happens once all currently executing synchronous JavaScript has run to completion. This doesn't yield control back to the event loop, as would be the case when using, for example, `setTimeout(f, 0)`.

Authors ought to be aware that scheduling a lot of microtasks has the same performance downsides as running a lot of synchronous code. Both will prevent the browser from doing its own work, such as rendering. In many cases, `requestAnimationFrame()` or `requestIdleCallback()` is a better choice. In particular, if the goal is to run code before the next rendering cycle, that is the purpose of `requestAnimationFrame()`.

As can be seen from the following examples, the best way of thinking about `queueMicrotask()` is as a mechanism for rearranging synchronous code, effectively placing the queued code immediately after the currently executing synchronous JavaScript has run to completion.

```
Example

The most common reason for using `queueMicrotask()` is to create consistent ordering, even in the cases where information is available synchronously, without introducing undue delay.

For example, consider a custom element firing a load event, that also maintains an internal cache of previously-loaded data. A naïve implementation might look like:

```
MyElement.prototype.loadData = function (url) {
    if (this._cache[url]) {
        this._setData(this._cache[url]);
        this.dispatchEvent(new Event("load"));
    }

    if (this._timeout) {
        clearTimeout(this._timeout);
        delete this._timeout;
    }
}```
This naïve implementation is problematic, however, in that it causes its users to experience inconsistent behavior. For example, code such as

```javascript
element.addEventListener("load", () => console.log("loaded"));
console.log(1);
element.loadData();
console.log(2);
```

will sometimes log "1, 2, loaded" (if the data needs to be fetched), and sometimes log "1, loaded, 2" (if the data is already cached). Similarly, after the call to `loadData()`, it will be inconsistent whether or not the data is set on the element.

To get a consistent ordering, `queueMicrotask()` can be used:

```javascript
MyElement.prototype.loadData = function (url) {
  if (this._cache[url]) {
    queueMicrotask(() => {
      this._setData(this._cache[url]);
      this.dispatchEvent(new Event("load"));
    });
  } else {
    fetch(url).then(res => res.arrayBuffer()).then(data => {
      this._cache[url] = data;
      this._setData(data);
      this.dispatchEvent(new Event("load"));
    });
  }
};
```

By essentially rearranging the queued code to be after the `JavaScript execution context stack` empties, this ensures a consistent ordering and update of the element's state.

Example

Another interesting use of `queueMicrotask()` is to allow uncoordinated "batching" of work by multiple callers. For example, consider a library function that wants to send data somewhere as soon as possible, but doesn't want to make multiple network requests if doing so is easily avoidable. One way to balance this would be like so:

```javascript
const queuedToSend = [];

function sendData(data) {
  queuedToSend.push(data);

  if (queuedToSend.length === 1) {
    queueMicrotask(() => {
      const stringToSend = JSON.stringify(queuedToSend);
      queuedToSend.length = 0;

      fetch("/endpoint", stringToSend);
    });
  }
}
```
With this architecture, multiple subsequent calls to `sendData()` within the currently executing synchronous JavaScript will be batched together into one `fetch()` call, but with no intervening event loop tasks preempting the fetch (as would have happened with similar code that instead used `setTimeout()`).

8.8 User prompts

8.8.1 Simple dialogs

For web developers (non-normative)

`window.alert(message)`

Displays a modal alert with the given message, and waits for the user to dismiss it.

`result = window.confirm(message)`

Displays a modal OK/Cancel prompt with the given message, waits for the user to dismiss it, and returns true if the user clicks OK and false if the user clicks Cancel.

`result = window.prompt(message [, default])`

Displays a modal text control prompt with the given message, waits for the user to dismiss it, and returns the value that the user entered. If the user cancels the prompt, then returns null instead. If the second argument is present, then the given value is used as a default.

Note

Logic that depends on tasks or microtasks, such as media elements loading their media data, are stalled when these methods are invoked.

The `alert()` and `alert(message)` method steps are:

1. If we cannot show simple dialogs for this, then return.
2. If the method was invoked with no arguments, then let message be the empty string; otherwise, let message be the method's first argument.
3. Set message to the result of normalizing newlines given message.
4. Set message to the result of optionally truncating message.
5. Show message to the user, treating U+000A LF as a line break.
6. Invoke WebDriver BiDi user prompt opened with this, "alert", and message.
7. Optionally, pause while waiting for the user to acknowledge the message.
8. Invoke WebDriver BiDi user prompt closed with this and true.

Note

This method is defined using two overloads, instead of using an optional argument, for historical reasons. The practical impact of this is that `alert(undefined)` is treated as `alert("undefined")`, but `alert()` is treated as `alert(""").`
response.

5. Invoke WebDriver BiDi user prompt opened with this, "confirm", and message.

6. Pause until the user responds either positively or negatively.

7. Invoke WebDriver BiDi user prompt closed with this, and true if the user responded positively or false otherwise.

8. If the user responded positively, return true; otherwise, the user responded negatively: return false.

The prompt(message, default) method steps are:

1. If we cannot show simple dialogs for this, then return null.

2. Set message to the result of normalizing newlines given message.

3. Set message to the result of optionally truncating message.

4. Set default to the result of optionally truncating default.

5. Show message to the user, treating U+000A LF as a line break, and ask the user to either respond with a string value or abort. The response must be defaulted to the value given by default.

6. Invoke WebDriver BiDi user prompt opened with this, "prompt", message, and default.

7. Pause while waiting for the user's response.

8. Let result be null if the user aborts, or otherwise the string that the user responded with.

9. Invoke WebDriver BiDi user prompt closed with this, false if result is null or true otherwise, and result.

10. Return result.

The print() method steps are:

For example, a user agent might want to only display the first 100 characters of a message. Or, a user agent might replace the middle of the string with "...". These types of modifications can be useful in limiting the abuse potential of unnaturally large, trustworthy-looking system dialogs.

To optionally truncate a simple dialog string s, return either s itself or some string derived from s that is shorter. User agents should not provide UI for displaying the elided portion of s, as this makes it too easy for abusers to create dialogs of the form "Important security alert! Click 'Show More' for full details!".

We cannot show simple dialogs for a Window window when the following algorithm returns true:

1. If the active sandboxing flag set of window's associated Document has the sandboxed modals flag set, then return true.

2. If window's relevant settings object's origin and window's relevant settings object's top-level origin are not same origin-domain, then return true.

3. If window's relevant agent's event loop's termination nesting level is nonzero, then optionally return true.

4. Optionally, return true. (For example, the user agent might give the user the option to ignore all modal dialogs, and would thus abort at this step whenever the method was invoked.)

5. Return false.

8.8.2 Printing

For web developers (non-normative)

window.print() Prompts the user to print the page.
1. Let document be this's associated Document.
2. If document is not fully active, then return.
3. If document's upload counter is greater than 0, then return.
4. If document is ready for post-load tasks, then run the printing steps for document.
5. Otherwise, set document's print when loaded flag.

User agents should also run the printing steps whenever the user asks for the opportunity to obtain a physical form (e.g. printed copy), or the representation of a physical form (e.g. PDF copy), of a document.

The printing steps for a Document document are:

1. The user agent may display a message to the user or return (or both).

   For instance, a kiosk browser could silently ignore any invocations of the print method.

   For instance, a browser on a mobile device could detect that there are no printers in the vicinity and display a message saying so before continuing to offer a “save to PDF” option.

2. If the active sandboxing flag set of document has the sandboxed modals flag set, then return.

   If the printing dialog is blocked by a Document's sandbox, then neither the beforeprint nor afterprint events will be fired.

3. The user agent must fire an event named beforeprint at the relevant global object of document, as well as any child navigables in it.

   Firing in children only doesn't seem right here, and some tasks likely need to be queued. See issue #5096.

   The beforeprint event can be used to annotate the printed copy, for instance adding the time at which the document was printed.

4. The user agent should offer the user the opportunity to obtain a physical form (or the representation of a physical form) of document. The user agent may wait for the user to either accept or decline before returning; if so, the user agent must pause while the method is waiting. Even if the user agent doesn't wait at this point, the user agent must use the state of the relevant documents as they are at this point in the algorithm if and when it eventually creates the alternate form.

5. The user agent must fire an event named afterprint at the relevant global object of document, as well as any child navigables in it.

   Firing in children only doesn't seem right here, and some tasks likely need to be queued. See issue #5096.

   The afterprint event can be used to revert annotations added in the earlier event, as well as showing post-printing UI. For instance, if a page is walking the user through the steps of applying for a home loan, the script could automatically advance to the next step after having printed a form or other.

8.9.1 The Navigator object

Instances of Navigator represent the identity and state of the user agent (the client). They also serve as a generic global under
which various APIs are located in this and other specifications.

```idl
[Exposed=Window]
interface Navigator {
    // objects implementing this interface also implement the interfaces given below
};
Navigator includes NavigatorID;
Navigator includes NavigatorLanguage;
Navigator includes NavigatorOnline;
Navigator includes NavigatorContentUtils;
Navigator includes NavigatorCookies;
Navigator includes NavigatorPlugins;
Navigator includes NavigatorConcurrentHardware;
```

**Note**

These interface mixins are defined separately so that WorkerNavigator can reuse parts of the Navigator interface.

Each Window has an associated Navigator, which is a Navigator object. Upon creation of the Window object, its associated Navigator must be set to a new Navigator object created in the Window object's relevant realm.

The navigator and clientInformation getter steps are to return this's associated Navigator.

### 8.9.1.1 Client identification

```idl
interface mixin NavigatorID {
    readonly attribute DOMString appCodeName; // constant "Mozilla"
    readonly attribute DOMString appName; // constant "Netscape"
    readonly attribute DOMString appVersion;
    readonly attribute DOMString platform;
    readonly attribute DOMString product; // constant "Gecko"
    [Exposed=Window] readonly attribute DOMString productSub;
    readonly attribute DOMString userAgent;
    [Exposed=Window] readonly attribute DOMString vendor;
    [Exposed=Window] readonly attribute DOMString vendorSub; // constant ""
}
```

In certain cases, despite the best efforts of the entire industry, web browsers have bugs and limitations that web authors are forced to work around.

This section defines a collection of attributes that can be used to determine, from script, the kind of user agent in use, in order to work around these issues.

The user agent has a navigator compatibility mode, which is either Chrome, Gecko, or WebKit.

**Note**

The navigator compatibility mode constrains the NavigatorID mixin to the combinations of attribute values and presence of taintEnabled() and oscpu that are known to be compatible with existing web content.

Client detection should always be limited to detecting known current versions; future versions and unknown versions should always be assumed to be fully compliant.

For web developers (non-normative)

- `self.navigator.appCodeName` returns the string "Mozilla".
- `self.navigator.appName` returns the string "Netscape".
self.navigator.appVersion
Returns the version of the browser.

self.navigator.platform
Returns the name of the platform.

self.navigator.product
Returns the string "Gecko".

window.navigator.productSub
Returns either the string "20030107", or the string "20100101".

self.navigator.userAgent
Returns the complete 'User-Agent' header.

window.navigator.vendor
Returns either the empty string, the string "Apple Computer, Inc.", or the string "Google Inc."

window.navigator.vendorSub
Returns the empty string.

**appCodeName**

Must return the string "Mozilla".

**appName**

Must return the string "Netscape".

**appVersion**

Must return the appropriate string that starts with "5.0 (*) as follows:

Let trail be the substring of default 'User-Agent' value that follows the "Mozilla/" prefix.

→ If the navigator compatibility mode is Chrome or WebKit
    
    Return trail.

→ If the navigator compatibility mode is Gecko
    
    If trail starts with "5.0 (Windows)", then return "5.0 (Windows)".
    
    Otherwise, return the prefix of trail up to but not including the first U+003B (;), concatenated with the character U+0029 RIGHT PARENTHESIS. For example, "5.0 (Macintosh)", "5.0 (Android 10)", or "5.0 (X11)".

**platform**

Must return a string representing the platform on which the browser is executing (e.g. "MacIntel", "Win32", "Linux x86_64", "Linux armv8l") or, for privacy and compatibility, a string that is commonly returned on another platform.

**product**

Must return the string "Gecko".

**productSub**

Must return the appropriate string from the following list:

→ If the navigator compatibility mode is Chrome or WebKit
    
    The string "20030107".

→ If the navigator compatibility mode is Gecko
    
    The string "20100101".

**userAgent**

Must return the default 'User-Agent' value.

**vendor**

Must return the appropriate string from the following list:
If the `navigator compatibility mode` is Chrome
The string "Google Inc.".

If the `navigator compatibility mode` is Gecko
The empty string.

If the `navigator compatibility mode` is WebKit
The string "Apple Computer, Inc.".

**vendorSub**
Must return the empty string.

If the `navigator compatibility mode` is Gecko, then the user agent must also support the following partial interface:

```idl
partial interface mixin NavigatorID {
    [Exposed=Window] boolean taintEnabled(); // constant false
    [Exposed=Window] readonly attribute DOMString oscpu;
};
```

The `taintEnabled()` method must return false.

The `oscpu` attribute's getter must return either the empty string or a string representing the platform on which the browser is executing, e.g. "Windows NT 10.0; Win64; x64","Linux x86_64".

⚠️ **Warning!**
Any information in this API that varies from user to user can be used to profile the user. In fact, if enough such information is available, a user can actually be uniquely identified. For this reason, user agent implementers are strongly urged to include as little information in this API as possible.

### 8.9.1.2 Language preferences

```idl
interface mixin NavigatorLanguage {
    readonly attribute DOMString language;
    readonly attribute FrozenArray<DOMString> languages;
};
```

**For web developers (non-normative)**

`self.navigator.language`
Returns a language tag representing the user's preferred language.

`self.navigator.languages`
Returns an array of language tags representing the user's preferred languages, with the most preferred language first. The most preferred language is the one returned by `navigator.language`.

**Note**
A `Languagechange` event is fired at the `Window` or `WorkerGlobalScope` object when the user agent's understanding of what the user's preferred languages are changes.

**language**
Must return a valid BCP 47 language tag representing either a plausible language or the user's most preferred language. [BCP47]

**languages**
Must return a `frozen array` of valid BCP 47 language tags representing either one or more plausible languages, or the user's preferred languages, ordered by preference with the most preferred language first. The same object must be returned until the user agent needs to return different values, or values in a different order. [BCP47]

Whenever the user agent needs to make the `navigator.languages` attribute of a `Window` or `WorkerGlobalScope` object
global return a new set of language tags, the user agent must queue a global task\(^\mathrm{\text{\textcopyright}}\text{\textregistered}\) on the DOM manipulation task source\(^\text{\textcopyright}\text{\textregistered}\) given global to fire an event named languagechange at global, and wait until that task begins to be executed before actually returning a new value.

To determine a plausible language, the user agent should bear in mind the following:

- Any information in this API that varies from user to user can be used to profile or identify the user.
- If the user is not using a service that obfuscates the user’s point of origin (e.g. the Tor anonymity network), then the value that is least likely to distinguish the user from other users with similar origins (e.g. from the same IP address block) is the language used by the majority of such users. [TOR]
- If the user is using an anonymizing service, then the value "en-US" is suggested; if all users of the service use that same value, that reduces the possibility of distinguishing the users from each other.

To avoid introducing any more fingerprinting vectors, user agents should use the same list for the APIs defined in this function as for the HTTP `Accept-Language` header.

8.9.1.3 Browser state

```idl
IDL interface mixin NavigatorOnLine {
  readonly attribute boolean onLine;
};
```

For web developers (non-normative)

```javascript
self.navigator.onLine
```

Returns false if the user agent is definitely offline (disconnected from the network). Returns true if the user agent might be online.

The events `online` and `offline` are fired when the value of this attribute changes.

The `onLine` attribute must return false if the user agent will not contact the network when the user follows links or when a script requests a remote page (or knows that such an attempt would fail), and must return true otherwise.

When the value that would be returned by the `navigator.onLine` attribute of a `Window` or `WorkerGlobalScope` global changes from true to false, the user agent must queue a global task on the networking task source given global to fire an event named `offline` at global.

On the other hand, when the value that would be returned by the `navigator.onLine` attribute of a `Window` or `WorkerGlobalScope` global changes from false to true, the user agent must queue a global task on the networking task source given global to fire an event named `online` at the `Window` or `WorkerGlobalScope` object.

**Note**

This attribute is inherently unreliable. A computer can be connected to a network without having Internet access.

**Example**

In this example, an indicator is updated as the browser goes online and offline.

```html
<!DOCTYPE HTML>
<html lang="en">
<head>
  <title>Online status</title>
  <script>
    function updateIndicator() {
      document.getElementById('indicator').textContent = navigator.onLine ? 'online' : 'offline';
    }
  </script>
</head>
<body onload="updateIndicator()" ononline="updateIndicator()" onoffline="updateIndicator()">
```

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8.9.1.4 Custom scheme handlers: the `registerProtocolHandler()` method

```
interface mixin NavigatorContentUtils {
  [SecureContext] undefined registerProtocolHandler(DOMString scheme, USVString url);
  [SecureContext] undefined unregisterProtocolHandler(DOMString scheme, USVString url);
};
```

For web developers (non-normative)

```javascript
window.navigator.registerProtocolHandler(scheme, url)
```

Registers a handler for `scheme` at `url`. For example, an online telephone messaging service could register itself as a handler of the `sms:` scheme, so that if the user clicks on such a link, they are given the opportunity to use that web site. [SMS]

The string "%s" in `url` is used as a placeholder for where to put the URL of the content to be handled.

Throws a "SecurityError" DOMException if the user agent blocks the registration (this might happen if trying to register as a handler for "http", for instance).

Throws a "SyntaxError" DOMException if the "%s" string is missing in `url`.

```javascript
window.navigator.unregisterProtocolHandler(scheme, url)
```

Unregisters the handler given by the arguments.

Throws a "SecurityError" DOMException if the user agent blocks the deregistration (this might happen if with invalid schemes, for instance).

Throws a "SyntaxError" DOMException if the "%s" string is missing in `url`.

The `registerProtocolHandler(scheme, url)` method steps are:

1. Let `(normalizedScheme, normalizedURLString)` be the result of running `normalize protocol handler parameters` with `scheme`, `url`, and this's relevant settings object.

2. In parallel: register a protocol handler for `normalizedScheme` and `normalizedURLString`. User agents may, within the constraints described, do whatever they like. A user agent could, for instance, prompt the user and offer the user the opportunity to add the site to a shortlist of handlers, or make the handlers their default, or cancel the request. User agents could also silently collect the information, providing it only when relevant to the user.

User agents should keep track of which sites have registered handlers (even if the user has declined such registrations) so that the user is not repeatedly prompted with the same request.

If the `registerProtocolHandler() automation mode` of this's relevant global object's associated Documents is not "none", the user agent should first verify that it is in an automation context (see WebDriver's security considerations). The user agent should then bypass the above communication of information and gathering of user consent, and instead do the following based on the value of the `registerProtocolHandler() automation mode`.

"autoAccept"

Act as if the user has seen the registration details and accepted the request.

"autoReject"

Act as if the user has seen the registration details and rejected the request.

When the user agent uses this handler for a URL `inputURL`:

1. Assert: `inputURL`'s `scheme` is `normalizedScheme`.
2. Set the username given `inputURL` and the empty string.
3. Set the password given `inputURL` and the empty string.
4. Let `inputURLString` be the serialization of `inputURL`.

5. Let `encodedURL` be the result of running UTF-8 percent-encode on `inputURLString` using the component percent-encode set.

6. Let `handlerURLString` be `normalizedURLString`.

7. Replace the first instance of "%s" in `handlerURLString` with `encodedURL`.

8. Let `resultURL` be the result of parsing `handlerURLString`.

9. Navigate an appropriate navigable to `resultURL`.

---

Example

If the user had visited a site at https://example.com/ that made the following call:

```javascript
navigator.registerProtocolHandler('web+soup', 'soup?url=%s')
```

...and then, much later, while visiting https://www.example.net/, clicked on a link such as:

```html
<a href="web+soup:chicken-kiwi">Download our Chicken Kïwi soup!</a>
```

...then the UA might navigate to the following URL:

https://example.com/soup?url=web+soup:chicken-k%C3%AFwi

This site could then do whatever it is that it does with soup (synthesize it and ship it to the user, or whatever).

This does not define when the handler is used. To some extent, the processing model for navigating across documents defines some cases where it is relevant, but in general user agents may use this information wherever they would otherwise consider handing schemes to native plugins or helper applications.

The `unregisterProtocolHandler(scheme, url)` method steps are:

1. Let `(normalizedScheme, normalizedURLString)` be the result of running normalize protocol handler parameters with `scheme`, `url`, and this's relevant settings object.

2. In parallel: unregister the handler described by `normalizedScheme` and `normalizedURLString`.

To normalize protocol handler parameters, given a string `scheme`, a string `url`, and an environment settings object, run these steps:

1. Set `scheme` to `scheme`, converted to ASCII lowercase.

2. If `scheme` is neither a safelisted scheme nor a string starting with "web+" followed by one or more ASCII lower alphas, then throw a "SecurityError" DOMException.

Note

This means that including a colon in scheme (as in "mailto:"") will throw.

The following schemes are the safelisted schemes:

- bitcoin
- ftp
- ftsp
- geo
- im
- irc
- ircs
- magnet
- mailto
- matrix
- mms
- news
- nntp
- openpgp4fpr
- sftp
- sip
3. If `url` does not contain "%s", then throw a "SyntaxError" DOMException.

4. Let `urlRecord` be the result of encoding-parsing a URL given `url`, relative to `environment`.

5. If `urlRecord` is failure, then throw a "SyntaxError" DOMException.

6. If `urlRecord`'s `scheme` is not an HTTP(S) scheme or `urlRecord`'s `origin` is not same origin with `environment`'s `origin`, then throw a "SecurityError" DOMException.

7. Assert: the result of `Is url potentially trustworthy?` given `urlRecord` is "Potentially Trustworthy".

8. Return `(scheme, urlRecord)`.

Custom scheme handlers can introduce a number of concerns, in particular privacy concerns.

**Hijacking all web usage.** User agents should not allow schemes that are key to its normal operation, such as an HTTP(S) scheme, to be rerouted through third-party sites. This would allow a user's activities to be trivially tracked, and would allow user information, even in secure connections, to be collected.

**Hijacking defaults.** User agents are strongly urged to not automatically change any defaults, as this could lead the user to send data to remote hosts that the user is not expecting. New handlers registering themselves should never automatically cause those sites to be used.

**Registration spamming.** User agents should consider the possibility that a site will attempt to register a large number of handlers, possibly from multiple domains (e.g., by redirecting through a series of pages each on a different domain, and each registering a handler for `web+spam`—analogue practices abusing other web browser features have been used by pornography web sites for many years). User agents should gracefully handle such hostile attempts, protecting the user.

**Hostile handler metadata.** User agents should protect against typical attacks against strings embedded in their interface, for example ensuring that markup or escape characters in such strings are not executed, that null bytes are properly handled, that over-long strings do not cause crashes or buffer overruns, and so forth.

**Leaking private data.** Web page authors may reference a custom scheme handler using URL data considered private. They might do so with the expectation that the user's choice of handler points to a page inside the organization, ensuring that sensitive data will not be exposed to third parties. However, a user may have registered a handler pointing to an external site, resulting in a data leak to that third party. Implementers might wish to consider allowing administrators to disable custom handlers on certain subdomains, content types, or schemes.

**Interface interference.** User agents should be prepared to handle intentionally long arguments to the methods. For example, if the
user interface exposed consists of an "accept" button and a "deny" button, with the "accept" binding containing the name of the handler, it's important that a long name not cause the "deny" button to be pushed off the screen.

8.9.1.2 User agent automation

Each `Document` has a `registerProtocolHandler()` automation mode. It defaults to "none", but it also can be either "autoAccept" or "autoReject".

For the purposes of user agent automation and website testing, this standard defines `Set RPH Registration Mode` WebDriver extension command. It instructs the user agent to place a `Document` into a mode where it will automatically simulate a user either accepting or rejecting and registration confirmation prompt dialog.

<table>
<thead>
<tr>
<th>HTTP Method</th>
<th>URI Template</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;POST&quot;</td>
<td>/session/{session id}/custom-handlers/set-mode</td>
</tr>
</tbody>
</table>

The remote end steps are:

1. If `parameters` is not a JSON Object, return a WebDriver error with WebDriver error code invalid argument.
2. Let `mode` be the result of getting a property named "mode" from `parameters`.
3. If `mode` is not "autoAccept", "autoReject", or "none", return a WebDriver error with WebDriver error code invalid argument.
4. Let `document` be the current browsing context's active document.
5. Set `document`'s `registerProtocolHandler()` automation mode to `mode`.
6. Return success with data null.

8.9.1.5 Cookies

```
IDL interface mixin NavigatorCookies {
    readonly attribute boolean cookieEnabled;
};
```

For web developers (non-normative)

`window.navigator.cookieEnabled`

Returns false if setting a cookie will be ignored, and true otherwise.

The `cookieEnabled` attribute must return true if the user agent attempts to handle cookies according to HTTP State Management Mechanism, and false if it ignores cookie change requests. [COOKIES]

8.9.1.6 PDF viewing support

For web developers (non-normative)

`window.navigator.pdfViewerEnabled`

Returns true if the user agent supports inline viewing of PDF files when `navigating` to them, or false otherwise. In the latter case, PDF files will be handled by external software.

```
IDL interface mixin NavigatorPlugins {
    [SameObject] readonly attribute PluginArray plugins;
    [SameObject] readonly attribute MimeArray mimeTypes;
    boolean javaEnabled();
    readonly attribute boolean pdfViewerEnabled;
};
```
Although these days detecting PDF viewer support can be done via `navigator.pdfViewerEnabled`, for historical reasons, there are a number of complex and intertwined interfaces that provide the same capability, which legacy code relies on. This section specifies both the simple modern variant and the complicated historical one.

Each user agent has a **PDF viewer supported** boolean, whose value is *implementation-defined* (and might vary according to user preferences).

**Note**

This value also impacts the **navigation** processing model.

Each **Window** object has a **PDF viewer plugin objects** list. If the user agent's **PDF viewer supported** is false, then it is the empty list. Otherwise, it is a list containing five **Plugin** objects, whose **names** are, respectively:

0. "PDF Viewer"
1. "Chrome PDF Viewer"
2. "Chromium PDF Viewer"
3. "Microsoft Edge PDF Viewer"
4. "WebKit built-in PDF"

The values of the above list form the **PDF viewer plugin names** list.

**Note**

These names were chosen based on evidence of what websites historically search for, and thus what is necessary for user agents
to expose in order to maintain compatibility with existing content. They are ordered alphabetically. The "PDF Viewer" name was then inserted in the 0th position so that the enabledPlugingetter could point to a generic plugin name.

Each Window object has a PDF viewer mime type objects list. If the user agent's PDF viewer supported is false, then it is the empty list. Otherwise, it is a list containing two MimeType objects, whose types are, respectively:

0. "application/pdf"
1. "text/pdf"

The values of the above list form the PDF viewer mime types list.

Each NavigatorPlugins object has a plugins array, which is a new PluginArray, and a mime types array, which is a new MimeTypeArray.

The NavigatorPlugins mixin's plugins getter steps are to return this's plugins array.

The NavigatorPlugins mixin's mimeTypes getter steps are to return this's mime types array.

The NavigatorPlugins mixin's javaEnabled() method steps are to return false.

The NavigatorPlugins mixin's pdfViewerEnabled getter steps are to return the user agent's PDF viewer supported.

The PluginArray interface supports named properties. If the user agent's PDF viewer supported is true, then they are the PDF viewer plugin names. Otherwise, they are the empty list.

The PluginArray interface's namedItem(name) method steps are:

1. For each Plugin plugin of this's relevant global object's PDF viewer plugin objects: if plugin's name is name, then return plugin.
2. Return null.

The PluginArray interface supports indexed properties. The supported property indices are the indices of this's relevant global object's PDF viewer plugin objects.

The PluginArray interface's item(index) method steps are:

1. Let plugins be this's relevant global object's PDF viewer plugin objects.
2. If index < plugins's size, then return plugins[index].
3. Return null.

The PluginArray interface's length getter steps are to return this's relevant global object's PDF viewer plugin objects's size.

The PluginArray interface's refresh() method steps are to do nothing.

The MimeTypeArray interface supports named properties. If the user agent's PDF viewer supported is true, then they are the PDF viewer mime types. Otherwise, they are the empty list.

The MimeTypeArray interface's namedItem(name) method steps are:

1. For each MimeType mimeType of this's relevant global object's PDF viewer mime type objects: if mimeType's type is name, then return mimeType.
2. Return null.

The MimeTypeArray interface supports indexed properties. The supported property indices are the indices of this's relevant global object's PDF viewer mime type objects.

The MimeTypeArray interface's item(index) method steps are:
1. Let mimeTypes be this's `relevant global object`'s PDF viewer mime type objects.
2. If index < mimeTypes's size, then return mimeTypes[index].
3. Return null.

The `MimeTypeArray` interface's `length` getter steps are to return this's `relevant global object`'s PDF viewer mime type objects's size.

Each `Plugin` object has a `name`, which is set when the object is created.

The `Plugin` object's `name` getter steps are to return this's `name`.

The `Plugin` object's `description` getter steps are to return "Portable Document Format".

The `Plugin` object's `filename` getter steps are to return "internal-pdf-viewer".

The `Plugin` interface supports named properties. If the user agent's `PDF viewer supported` is true, then they are the `PDF viewer mime types`. Otherwise, they are the empty list.

The `Plugin` interface's `namedItem(name)` method steps are:
   1. For each `MimeType` mimeType of this's `relevant global object`'s PDF viewer mime type objects: if mimeType's `type` is name, then return mimeType.
   2. Return null.

The `Plugin` interface supports indexed properties. The `supported property indices` are the indices of this's `relevant global object`'s PDF viewer mime type objects.

The `Plugin` interface's `item(index)` method steps are:
   1. Let mimeTypes be this's `relevant global object`'s PDF viewer mime type objects.
   2. If index < mimeType's size, then return mimeType.
   3. Return null.

The `Plugin` interface's `length` getter steps are to return this's `relevant global object`'s PDF viewer mime type objects's size.

Each `MimeType` object has a `type`, which is set when the object is created.

The `MimeType` object's `type` getter steps are to return this's `type`.

The `MimeType` object's `description` getter steps are to return "Portable Document Format".

The `MimeType` object's `suffixes` getter steps are to return "pdf".

The `MimeType` interface's `enabledPlugin` getter steps are to return this's `relevant global object`'s PDF viewer plugin objects[0] (i.e., the generic "PDF Viewer" one).

### 8.10 Images

```idl
[Exposed=(Window,Worker), Serializable, Transferable]
interface ImageBitmap {
    readonly attribute unsigned long width;
    readonly attribute unsigned long height;
    undefined close();
};
```
typedef (CanvasImageSource or Blob or ImageData) ImageBitmapSource;

dictionary ImageBitmapOptions {
  ImageOrientation imageOrientation = "from-image";
  PremultiplyAlpha premultiplyAlpha = "default";
  ColorSpaceConversion colorSpaceConversion = "default";
  [EnforceRange] unsigned long resizeWidth;
  [EnforceRange] unsigned long resizeHeight;
  ResizeQuality resizeQuality = "low";
};

An ImageBitmap object represents a bitmap image that can be painted to a canvas without undue latency.

Note
The exact judgement of what is undue latency of this is left up to the implementer, but in general if making use of the bitmap requires network I/O, or even local disk I/O, then the latency is probably undue; whereas if it only requires a blocking read from a GPU or system RAM, the latency is probably acceptable.

For web developers (non-normative)

```
promise = self.createImageBitmap(image [, options ])
promise = self.createImageBitmap(image, sx, sy, sw, sh [, options ])
```

Takes image, which can be an img element, an SVG image element, a video element, a canvas element, a Blob object, an ImageData object, or another ImageBitmap object, and returns a promise that is resolved when a new ImageBitmap is created.

If no ImageBitmap object can be constructed, for example because the provided image data is not actually an image, then the promise is rejected instead.

If sx, sy, sw, and sh arguments are provided, the source image is cropped to the given pixels, with any pixels missing in the original replaced by transparent black. These coordinates are in the source image's pixel coordinate space, not in CSS pixels.

If options is provided, the ImageBitmap object's bitmap data is modified according to options. For example, if the premultiplyAlpha option is set to "premultiply", the bitmap data's color channels are premultiplied by its alpha channel.

Rejects the promise with an "InvalidStateError" DOMException if the source image is not in a valid state (e.g., an img element that hasn't loaded successfully, an ImageBitmap object whose [[Detached]] internal slot value is true, an ImageData object whose data attribute value's [[ViewedArrayBuffer]] internal slot is detached, or a Blob whose data cannot be interpreted as a bitmap image).

Rejects the promise with a "SecurityError" DOMException if the script is not allowed to access the image data of the source image (e.g. a video that is CORS-cross-origin, or a canvas being drawn on by a script in a worker from another origin).

imageBitmap.close() ()

 Releases imageBitmap's underlying bitmap data.

imageBitmap.width

Returns the natural width of the image, in CSS pixels.

imageBitmap.height

Returns the natural height of the image, in CSS pixels.

An ImageBitmap object whose [[Detached]] internal slot value is false always has associated bitmap data, with a width and a height. However, it is possible for this data to be corrupted. If an ImageBitmap object's media data can be decoded without errors, it is said to be fully decodable.
An `ImageBitmap` object's bitmap has an `origin-clean` flag, which indicates whether the bitmap is tainted by content from a different `origin`. The flag is initially set to true and may be changed to false by the steps of `createImageBitmap()`.

`ImageBitmap` objects are serializable objects and transferable objects.

Their serialization steps, given value and serialized, are:

1. If value's `origin-clean` flag is not set, then throw a "DataCloneError" DOMException.
2. Set `serialized.[[BitmapData]]` to a copy of value's `bitmap data`.

Their deserialization steps, given `serialized`, value, and `targetRealm`, are:

1. Set value's `bitmap data` to `serialized.[[BitmapData]]`.

Their transfer steps, given value and `dataHolder`, are:

1. If value's `origin-clean` flag is not set, then throw a "DataCloneError" DOMException.
2. Set `dataHolder.[[BitmapData]]` to value's `bitmap data`.
3. Unset value's `bitmap data`.

Their transfer-receiving steps, given `dataHolder` and value, are:

1. Set value's `bitmap data` to `dataHolder.[[BitmapData]]`.

The `createImageBitmap(image, options)` and `createImageBitmap(image sx, sy, sw, sh, options)` methods, when invoked, must run these steps:

1. If either `sw` or `sh` is given and is 0, then return a promise rejected with a RangeError.
2. If either options's `resizeWidth` or options's `resizeHeight` is present and is 0, then return a promise rejected with an "InvalidStateError" DOMException.
3. Check the usability of the `image` argument. If this throws an exception or returns bad, then return a promise rejected with an "InvalidStateError" DOMException.
4. Let `p` be a new promise.
5. Let `imageBitmap` be a new `ImageBitmap` object.
6. Switch on `image`:

   1. If `image`'s media data has no natural dimensions (e.g., it's a vector graphic with no specified content size) and either options's `resizeWidth` or options's `resizeHeight` is not present, then a promise rejected with an "InvalidStateError" DOMException.
   2. If `image`'s media data has no natural dimensions (e.g., it's a vector graphics with no specified content size), it should be rendered to a bitmap of the size specified by the `resizeWidth` and the `resizeHeight` options.
   3. Set `imageBitmap`'s `bitmap data` to a copy of `image`'s media data, cropped to the source rectangle with formatting. If this is an animated image, `imageBitmap`'s `bitmap data` must only be taken from the default image of the animation (the one that the format defines is to be used when animation is not supported or is disabled), or, if there is no such image, the first frame of the animation.
   4. If `image` is not `origin-clean`, then set the `origin-clean` flag of `imageBitmap`'s bitmap to false.
5. Run this step in parallel:

   1. Resolve `p` with `imageBitmap`. 
If image's `networkState` attribute is `NETWORK_EMPTY`, then return a promise rejected with an "InvalidStateError" DOMException.

2. Set `imageBitmap`'s `bitmap data` to a copy of the frame at the current playback position, at the media resource's natural width and natural height (i.e., after any aspect-ratio correction has been applied), cropped to the source rectangle with formatting.

3. If image is not origin-clean, then set the origin-clean flag of `imageBitmap`'s bitmap to false.

4. Run this step in parallel:
   1. Resolve `p` with `imageBitmap`.

`canvas`

1. Set `imageBitmap`'s `bitmap data` to a copy of image's `bitmap data`, cropped to the source rectangle with formatting.

2. Set the origin-clean flag of `imageBitmap`'s bitmap to the same value as the origin-clean flag of image's bitmap.

3. Run this step in parallel:
   1. Resolve `p` with `imageBitmap`.

`Blob`

Run these step in parallel:

1. Let `imageData` be the result of reading image's data. If an error occurs during reading of the object, then reject `p` with an "InvalidStateError" DOMException and abort these steps.

2. Apply the image sniffing rules to determine the file format of `imageData`, with MIME type of image (as given by image's `type` attribute) giving the official type.

3. If `imageData` is not in a supported image file format (e.g., it's not an image at all), or if `imageData` is corrupted in some fatal way such that the image dimensions cannot be obtained (e.g., a vector graphic with no natural size), then reject `p` with an "InvalidStateError" DOMException and abort these steps.

4. Set `imageBitmap`'s `bitmap data` to `imageData`, cropped to the source rectangle with formatting. If this is an animated image, `imageBitmap`'s `bitmap data` must only be taken from the default image of the animation (the one that the format defines is to be used when animation is not supported or is disabled), or, if there is no such image, the first frame of the animation.

5. Resolve `p` with `imageBitmap`.

`ImageData`

1. Let `buffer` be image's `data` attribute value's [[ViewedArrayBuffer]] internal slot.

2. If `IsDetachedBuffer(buffer)` is true, then return a promise rejected with an "InvalidStateError" DOMException.

3. Set `imageBitmap`'s `bitmap data` to image's image data, cropped to the source rectangle with formatting.

4. Run this step in parallel:
   1. Resolve `p` with `imageBitmap`.

`ImageBitmap`

1. Set `imageBitmap`'s `bitmap data` to a copy of image's `bitmap data`, cropped to the source rectangle with formatting.

2. Set the origin-clean flag of `imageBitmap`'s bitmap to the same value as the origin-clean flag of image's bitmap.

3. Run this step in parallel:
1. Resolve $p$ with `imageBitmap`.

→ VideoFrame

1. Set `imageBitmap`'s bitmap data to a copy of `image`'s visible pixel data, cropped to the source rectangle with formatting.

2. Run this step in parallel.

1. Resolve $p$ with `imageBitmap`.


When the steps above require that the user agent crop bitmap data to the source rectangle with formatting, the user agent must run the following steps:

1. Let `input` be the bitmap data being transformed.

2. If $sx$, $sy$, $sw$ and $sh$ are specified, let `sourceRectangle` be a rectangle whose corners are the four points $(sx, sy)$, $(sx+sw, sy)$, $(sx+sw, sy+sh)$, $(sx, sy+sh)$. Otherwise let `sourceRectangle` be a rectangle whose corners are the four points $(0, 0)$, $(width$ of $input$, $0)$, $(width$ of $input$, $height$ of $input)$, $(0$, $height$ of $input)$.

Note

If either $sw$ or $sh$ are negative, then the top-left corner of this rectangle will be to the left or above the $(sx, sy)$ point.

3. Let `outputWidth` be determined as follows:

→ If the `resizeWidth` member of `options` is specified
  the value of the `resizeWidth` member of `options`

→ If the `resizeWidth` member of `options` is not specified, but the `resizeHeight` member is specified
  the width of `sourceRectangle`, times the value of the `resizeHeight` member of `options`, divided by the height of `sourceRectangle`, rounded up to the nearest integer

→ If neither `resizeWidth` nor `resizeHeight` are specified
  the width of `sourceRectangle`

4. Let `outputHeight` be determined as follows:

→ If the `resizeHeight` member of `options` is specified
  the value of the `resizeHeight` member of `options`

→ If the `resizeHeight` member of `options` is not specified, but the `resizeWidth` member is specified
  the height of `sourceRectangle`, times the value of the `resizeWidth` member of `options`, divided by the width of `sourceRectangle`, rounded up to the nearest integer

→ If neither `resizeWidth` nor `resizeHeight` are specified
  the height of `sourceRectangle`

5. Place `input` on an infinite transparent black grid plane, positioned so that its top left corner is at the origin of the plane, with the x-coordinate increasing to the right, and the y-coordinate increasing down, and with each pixel in the `input` image data occupying a cell on the plane's grid.

6. Let `output` be the rectangle on the plane denoted by `sourceRectangle`.

7. Scale `output` to the size specified by `outputWidth` and `outputHeight`. The user agent should use the value of the `resizeQuality` option to guide the choice of scaling algorithm.

8. If the value of the `imageOrientation` member of `options` is "flipY", `output` must be flipped vertically, disregarding any image orientation metadata of the source (such as EXIF metadata), if any. [EXIF]

Note

If the value is "from-image", no extra step is needed.

Note

There used to be a "none" enum value. It was renamed to "from-image". In the future, "none" will be added back with a different meaning.
9. If `image` is an `img` element or a `Blob` object, let `val` be the value of the `colorSpaceConversion` member of `options`, and then run these substeps:

   1. If `val` is "default", the color space conversion behavior is implementation-specific, and should be chosen according to the default color space that the implementation uses for drawing images onto the canvas.

   2. If `val` is "none", output must be decoded without performing any color space conversions. This means that the image decoding algorithm must ignore color profile metadata embedded in the source data as well as the display device color profile.

10. Let `val` be the value of `premultiplyAlpha` member of `options`, and then run these substeps:

   1. If `val` is "default", the alpha premultiplication behavior is implementation-specific, and should be chosen according to implementation deems optimal for drawing images onto the canvas.

   2. If `val` is "premultiply", the output that is not premultiplied by alpha must have its color components multiplied by alpha and that is premultiplied by alpha must be left untouched.

   3. If `val` is "none", the output that is not premultiplied by alpha must be left untouched and that is premultiplied by alpha must have its color components divided by alpha.

11. Return `output`.

The `close()` method steps are:

   1. Set this's `[[Detached]]` internal slot value to true.

   2. Unset this's `bitmap data`.

The `width` getter steps are:

   1. If this's `[[Detached]]` internal slot's value is true, then return 0.

   2. Return this's width, in CSS pixels.

The `height` getter steps are:

   1. If this's `[[Detached]]` internal slot's value is true, then return 0.

   2. Return this's height, in CSS pixels.

The `ResizeQuality` enumeration is used to express a preference for the interpolation quality to use when scaling images.

The "pixelated" value indicates a preference to scale the image that maximizes the appearance. Scaling algorithms that "smooth" colors are acceptable, such as bilinear interpolation.

The "low" value indicates a preference for a low level of image interpolation quality. Low-quality image interpolation may be more computationally efficient than higher settings.

The "medium" value indicates a preference for a medium level of image interpolation quality.

The "high" value indicates a preference for a high level of image interpolation quality. High-quality image interpolation may be more computationally expensive than lower settings.

**Note**

Bilinear scaling is an example of a relatively fast, lower-quality image-smoothing algorithm. Bicubic or Lanczos scaling are examples of image-scaling algorithms that produce higher-quality output. This specification does not mandate that specific interpolation algorithms be used unless the value is "pixelated".

**Example**

Using this API, a sprite sheet can be precut and prepared:

```javascript
var sprites = {};
function loadMySprites() {
    var image = new Image();
```
Some objects include the `AnimationFrameProvider` interface mixin.

```javascript
var resolver;
var promise = new Promise({
  resolve: function (arg) {
    resolver = arg;
  }
});
image.onload = function () {
  resolver(Promise.all([
    createImageBitmap(image, 0, 0, 40, 40).then(function (image) {
      sprites.person = image;
    }),
    createImageBitmap(image, 40, 0, 40, 40).then(function (image) {
      sprites.grass = image;
    }),
    createImageBitmap(image, 80, 0, 40, 40).then(function (image) {
      sprites.tree = image;
    }),
    createImageBitmap(image, 0, 40, 40, 40).then(function (image) {
      sprites.hut = image;
    }),
    createImageBitmap(image, 40, 40, 40, 40).then(function (image) {
      sprites.apple = image;
    }),
    createImageBitmap(image, 80, 40, 40, 40).then(function (image) {
      sprites.snake = image;
    })
  ]));
};
return promise;
}

function runDemo() {
  var canvas = document.querySelector('canvas#demo');
  var context = canvas.getContext('2d');
  context.drawImage(sprites.tree, 30, 10);
  context.drawImage(sprites.snake, 70, 10);
}
loadMySprites().then(runDemo);
```

### 8.11 Animation frames

Some objects include the `AnimationFrameProvider` interface mixin.

**IDL**

```idl
callback FrameRequestCallback = undefined (DOMHighResTimeStamp time);

interface mixin AnimationFrameProvider {
  unsigned long requestAnimationFrame(FrameRequestCallback callback);
  undefined cancelAnimationFrame(unsigned long handle);
};
Window includes AnimationFrameProvider;
DedicatedWorkerGlobalScope includes AnimationFrameProvider;
```

Each `AnimationFrameProvider` object also has a target object that stores the provider's internal state. It is defined as follows:

- If the `AnimationFrameProvider` is a `Window`:
  - The `Window`'s associated `Document`.
- If the `AnimationFrameProvider` is a `DedicatedWorkerGlobalScope`:
  - The `DedicatedWorkerGlobalScope`.

Each target object has a map of animation frame callbacks, which is an ordered map that must be initially empty, and an animation frame callback identifier, which is a number that must initially be zero.

An `AnimationFrameProvider` provider is considered supported if any of the following are true:

- provider is a `Window`.
- provider's `owner set` contains a `Document` object.
- Any of the `DedicatedWorkerGlobalScope` objects in provider's `owner set` are supported.
The `requestAnimationFrame(callback)` method steps are:

1. If `this` is not supported, then throw a "`NotSupportedError`" DOMException.
2. Let target be `this`'s target object.
3. Increment target's animation frame callback identifier by one, and let handle be the result.
4. Let callbacks be target's map of animation frame callbacks.
5. Set callbacks[handle] to callback.
6. Return handle.

The `cancelAnimationFrame(handle)` method steps are:

1. If `this` is not supported, then throw a "`NotSupportedError`" DOMException.
2. Let callbacks be this's target object's map of animation frame callbacks.
3. Remove callbacks[handle].

To run the animation frame callbacks for a target object target with a timestamp now:

1. Let callbacks be target's map of animation frame callbacks.
2. Let callbackHandles be the result of getting the keys of callbacks.
3. For each handle in callbackHandles, if handle exists in callbacks:
   1. Let callback be callbacks[handle].
   2. Remove callbacks[handle].
   3. Invoke callback, passing now as the only argument, and if an exception is thrown, report the exception.

Example

Inside workers, `requestAnimationFrame()` can be used together with an `OffscreenCanvas` transferred from a canvas element. First, in the document, transfer control to the worker:

```javascript
const offscreenCanvas = document.getElementById("c").transferControlToOffscreen();
worker.postMessage(offscreenCanvas, [offscreenCanvas]);
```

Then, in the worker, the following code will draw a rectangle moving from left to right:

```javascript
let ctx, pos = 0;
function draw(dt) {
  ctx.clearRect(0, 0, 100, 100);
  ctx.fillRect(pos, 0, 10, 10);
  pos += 10 * dt;
  requestAnimationFrame(draw);
}

self.onmessage = function(ev) {
  const transferredCanvas = ev.data;
  ctx = transferredCanvas.getContext("2d");
  draw();
};
```
9 Communication

Note

The WebSocket interface used to be defined here. It is now defined in WebSockets. [WEBSOCKETS]

9.1 The MessageEvent interface

Messages in server-sent events, cross-document messaging, channel messaging, broadcast channels, and WebSockets use the MessageEvent interface for their message events: [WEBSOCKETS]

IDL

```idl
[Exposed=(Window, Worker, AudioWorklet)]
interface MessageEvent : Event {
    constructor(DOMString type, optional MessageEventInit eventInitDict = {});

    readonly attribute any data;
    readonly attribute USVString origin;
    readonly attribute DOMString lastEventId;
    readonly attribute MessageEventSource? source;
    readonly attribute FrozenArray<MessagePort> ports;

    undefined initMessageEvent(DOMString type, optional boolean bubbles = false, optional boolean cancelable = false, optional any data = null, optional USVString origin = "", optional DOMString lastEventId = "", optional MessageEventSource? source = null, optional sequence<MessagePort> ports = []);
};
```

dictionary MessageEventInit : EventInit {
    any data = null;
    USVString origin = "";
    DOMString lastEventId = "";
    MessageEventSource? source = null;
    sequence<MessagePort> ports = [];
};

typedef (WindowProxy or MessagePort or ServiceWorker) MessageEventSource;

For web developers (non-normative)

- **event.data**
  
  Returns the data of the message.

- **event.origin**
  
  Returns the origin of the message, for server-sent events and cross-document messaging.

- **event.lastEventId**
  
  Returns the last event ID string, for server-sent events.

- **event.source**
  
  Returns the WindowProxy of the source window, for cross-document messaging, and the MessagePort being attached, in the `connect` event fired at SharedWorkerGlobalScope objects.

- **event.ports**
  
  Returns the MessagePort array sent with the message, for cross-document messaging and channel messaging.

The data attribute must return the value it was initialized to. It represents the message being sent.
The **origin** attribute must return the value it was initialized to. It represents, in server-sent events and cross-document messaging, the **origin** of the document that sent the message (typically the scheme, hostname, and port of the document, but not its path or fragment).

The **lastEventId** attribute must return the value it was initialized to. It represents, in server-sent events, the last event ID string of the event source.

The **source** attribute must return the value it was initialized to. It represents, in cross-document messaging, the **source** attribute of the **WindowProxy** of the browsing context of the **Window** object from which the message came; and in the **connect** events used by shared workers, the newly connecting **MessagePort**.

The **ports** attribute must return the value it was initialized to. It represents, in cross-document messaging and channel messaging, the **MessagePort** array being sent.

The `initMessageEvent(type, bubbles, cancelable, data, origin, lastEventId, source, ports)` method must initialize the event in a manner analogous to the similarly-named `initEvent()` method. [DOM](https://developer.mozilla.org/en-US/docs/Web/API/Event/Event)

---

**Note**

Various APIs (e.g., WebSocket, EventSource) use the `MessageEvent` interface for their message event without using the `MessagePort` API.

---

### 9.2 Server-sent events

#### 9.2.1 Introduction

This section is non-normative.

To enable servers to push data to web pages over HTTP or using dedicated server-push protocols, this specification introduces the **EventSource** interface.

Using this API consists of creating an **EventSource** object and registering an event listener.

```javascript
var source = new EventSource('updates.cgi');
source.onmessage = function (event) {
  alert(event.data);
};
```

On the server-side, the script ("updates.cgi" in this case) sends messages in the following form, with the `text/event-stream` MIME type:

```
data: This is the first message.

data: This is the second message, it
data: has two lines.

data: This is the third message.
```

Authors can separate events by using different event types. Here is a stream that has two event types, "add" and "remove":

```
event: add
data: 73857293

event: remove
data: 2153

event: add
```
The script to handle such a stream would look like this (where `addHandler` and `removeHandler` are functions that take one argument, the event):

```javascript
var source = new EventSource('updates.cgi');
source.addEventListener('add', addHandler, false);
source.addEventListener('remove', removeHandler, false);
```

The default event type is "message".

Event streams are always decoded as UTF-8. There is no way to specify another character encoding.

Event stream requests can be redirected using HTTP 301 and 307 redirects as with normal HTTP requests. Clients will reconnect if the connection is closed; a client can be told to stop reconnecting using the HTTP 204 No Content response code.

Using this API rather than emulating it using `XMLHttpRequest` or an `iframe` allows the user agent to make better use of network resources in cases where the user agent implementer and the network operator are able to coordinate in advance. Amongst other benefits, this can result in significant savings in battery life on portable devices. This is discussed further in the section below on connectionless push.

### 9.2.2 The `EventSource` interface

```idl
[Exposed=(Window,Worker)]
interface EventSource : EventTarget {
    constructor(USVString url, optional EventSourceInit eventSourceInitDict = {});

    readonly attribute USVString url;
    readonly attribute boolean withCredentials;

    // ready state
    const unsigned short CONNECTING = 0;
    const unsigned short OPEN = 1;
    const unsigned short CLOSED = 2;
    readonly attribute unsigned short readyState;

    // networking
    attribute EventListener onopen;
    attribute EventListener onmessage;
    attribute EventListener onerror;
    undefined close();
};
```

dictionary EventSourceInit {
    boolean withCredentials = false;
};

Each `EventSource` object has the following associated with it:

- A `url` (a `URL record`). Set during construction.
- A `request`. This must initially be null.
- A `reconnection time`, in milliseconds. This must initially be an `implementation-defined` value, probably in the region of a few seconds.
- A `last event ID string`. This must initially be the empty string.

Apart from `url`, these are not currently exposed on the `EventSource` object.
source = new EventSource(url [, { withCredentials: true } ])

Creates a new EventSource object.
url is a string giving the URL that will provide the event stream.
Setting withCredentials to true will set the credentials mode for connection requests to url to "include".

source.close()

Aborts any instances of the fetch algorithm started for this EventSource object, and sets the readyState attribute to CLOSED.

source.url

Returns the URL providing the event stream.

source.withCredentials

Returns true if the credentials mode for connection requests to the URL providing the event stream is set to "include", and false otherwise.

source.readyState

Returns the state of this EventSource object's connection. It can have the values described below.

For web developers (non-normative)

The EventSource(url, eventSourceInitDict) constructor, when invoked, must run these steps:

1. Let ev be a new EventSource object.
2. Let settings be ev's relevant settings object.
3. Let urlRecord be the result of encoding-parsing a URL given url, relative to settings.
4. If urlRecord is failure, then throw a "SyntaxError" DOMException.
5. Set ev's url to urlRecord.
7. If the value of eventSourceInitDict's withCredentials member is true, then set corsAttributeState to Use Credentials and set ev's withCredentials attribute to true.
8. Let request be the result of creating a potential-CORS request given urlRecord, the empty string, and corsAttributeState.
9. Set request's client to settings.
10. User agents may set (`Accept`, `text/event-stream`) in request's header list.
11. Set request's cache mode to "no-store".
12. Set request's initiator type to "other".
13. Set ev's request to request.
14. Let processEventSourceEndOfBody given response be the following step: if res is not a network error, then reestablish the connection.
15. Fetch request, with processResponseEndOfBody set to processEventSourceEndOfBody and processResponse set to the following steps given response res:
   1. If res is an aborted network error, then fail the connection.
   2. Otherwise, if res is a network error, then reestablish the connection, unless the user agent knows that to be futile, in which case the user agent may fail the connection.
   3. Otherwise, if res's status is not 200, or if res's `Content-Type` is not `text/event-stream`, then fail the connection.
   4. Otherwise, announce the connection and interpret res's body line by line.
16. Return ev.
The `url` attribute's getter must return the serialization of this `EventSource` object's `url`.

The `withCredentials` attribute must return the value to which it was last initialized. When the object is created, it must be initialized to false.

The `readyState` attribute represents the state of the connection. It can have the following values:

**CONNECTING (numeric value 0)**
- The connection has not yet been established, or it was closed and the user agent is reconnecting.

**OPEN (numeric value 1)**
- The user agent has an open connection and is dispatching events as it receives them.

**CLOSED (numeric value 2)**
- The connection is not open, and the user agent is not trying to reconnect. Either there was a fatal error or the `close()` method was invoked.

When the object is created its `readyState` must be set to `CONNECTING` (0). The rules given below for handling the connection define when the value changes.

The `close()` method must abort any instances of the `fetch` algorithm started for this `EventSource` object, and must set the `readyState` attribute to `CLOSED`.

The following are the `event handlers` (and their corresponding `event handler event types`) that must be supported, as `event IDL attributes`, by all objects implementing the `EventSource` interface:

<table>
<thead>
<tr>
<th>Event handler</th>
<th>Event handler event type</th>
</tr>
</thead>
<tbody>
<tr>
<td>onopen</td>
<td>open</td>
</tr>
<tr>
<td>onmessage</td>
<td>message</td>
</tr>
<tr>
<td>onerror</td>
<td>error</td>
</tr>
</tbody>
</table>

When a user agent is to announce the connection, the user agent must queue a task which, if the `readyState` attribute is set to a value other than `CLOSED`, sets the `readyState` attribute to `OPEN` and fires an event named `open` at the `EventSource` object.

When a user agent is to reestablish the connection, the user agent must run the following steps. These steps are run in parallel, not as part of a task. (The tasks that it queues, of course, are run like normal tasks and not themselves in parallel.)

1. Queue a task to run the following steps:
   1. If the `readyState` attribute is set to `CLOSED`, abort the task.
   2. Set the `readyState` attribute to `CONNECTING`.
   3. Fire an event named `error` at the `EventSource` object.
2. Wait a delay equal to the reconnection time of the event source.
3. Optionally, wait some more. In particular, if the previous attempt failed, then user agents might introduce an exponential backoff delay to avoid overloading a potentially already overloaded server. Alternatively, if the operating system has reported that there is no network connectivity, user agents might wait for the operating system to announce that the network connection has returned before retrying.
4. Wait until the aforementioned task has run, if it has not yet run.
5. Queue a task to run the following steps:
   1. If the `EventSource` object's `readyState` attribute is not set to `CONNECTING`, then return.
   2. Let `request` be the `EventSource` object's `request`.
   3. If the `EventSource` object's `last event ID string` is not the empty string, then:
1. Let `lastEventIDValue` be the `EventSource` object's `last event ID string`, encoded as UTF-8.

2. Set (`Last-Event-ID`, `lastEventIDValue`) in request's `header list`.

4. Fetch request and process the response obtained in this fashion, if any, as described earlier in this section.

When a user agent is to fail the connection, the user agent must queue a task which, if the `readyState` attribute is set to a value other than `CLOSED`, sets the `readyState` attribute to `CLOSED` and fires an event named `error` at the `EventSource` object. Once the user agent has failed the connection, it does not attempt to reconnect.

The `task source` for any `tasks` that are queued by `EventSource` objects is the `remote event task source`.

9.2.4 The `Last-Event-ID` header

The `Last-Event-ID` HTTP request header reports an `EventSource` object's `last event ID string` to the server when the user agent is to reestablish the connection.

See whatwg/html issue #7363 to define the value space better. It is essentially any UTF-8 encoded string, that does not contain U+0000 NULL, U+000A LF, or U+000D CR.

9.2.5 Parsing an event stream

This event stream format's MIME type is `text/event-stream`.

The event stream format is as described by the stream production of the following ABNF, the character set for which is Unicode.

[ABNF]

```
stream = [ bom ] *event
  event = *( comment / field ) end-of-line
  comment = colon *any-char end-of-line
  field = *name-char [ colon [ space ] *any-char ] end-of-line
  end-of-line = ( cr lf / cr / lf )

; characters
lf = %x000A ; U+0000 LINE FEED (LF)
cr = %x000D ; U+0000 CARRIAGE RETURN (CR)
space = %x0020 ; U+0020 SPACE
colon = %x003A ; U+003A COLON (:) 
bom = %x00FF ; %x00FF BYTE ORDER MARK
name-char = %x0000-0009 / %x000B-000C / %x000D-0039 / %x003B-10FFFF
           ; a scalar value other than U+000A LINE FEED (LF), U+000D CARRIAGE RETURN (CR), or U+003A COLON (:) 
any-char = %x0000-0009 / %x000B-000C / %x000D-0039 / %x003B-10FFFF
           ; a scalar value other than U+000A LINE FEED (LF) or U+000D CARRIAGE RETURN (CR)
```

Event streams in this format must always be encoded as UTF-8. [ENCODING]

Lines must be separated by either a U+000D CARRIAGE RETURN U+000A LINE FEED (CRLF) character pair, a single U+000A LINE FEED (LF) character, or a single U+000D CARRIAGE RETURN (CR) character.

Since connections established to remote servers for such resources are expected to be long-lived, UAs should ensure that appropriate buffering is used. In particular, while line buffering with lines are defined to end with a single U+000A LINE FEED (LF) character is safe, block buffering or line buffering with different expected line endings can cause delays in event dispatch.
9.2.6 Interpreting an event stream

Streams must be decoded using the UTF-8 decode algorithm.

Note
The UTF-8 decode algorithm strips one leading UTF-8 Byte Order Mark (BOM), if any.

The stream must then be parsed by reading everything line by line, with a U+000D CARRIAGE RETURN U+000A LINE FEED (CRLF) character pair, a single U+000A LINE FEED (LF) character not preceded by a U+000D CARRIAGE RETURN (CR) character, and a single U+000D CARRIAGE RETURN (CR) character not followed by a U+000A LINE FEED (LF) character being the ways in which a line can end.

When a stream is parsed, a data buffer, an event type buffer, and a last event ID buffer must be associated with it. They must be initialized to the empty string.

Lines must be processed, in the order they are received, as follows:

↪ If the line is empty (a blank line)
Dispatch the event\(^{1175}\), as defined below.

↪ If the line starts with a U+003A COLON character (:)  
Ignore the line.

↪ If the line contains a U+003A COLON character (:)  
Collect the characters on the line before the first U+003A COLON character (:), and let field be that string. Collect the characters on the line after the first U+003A COLON character (:), and let value be that string. If value starts with a U+0020 SPACE character, remove it from value.

Process the field\(^{1175}\) using the steps described below, using field as the field name and value as the field value.

↪ Otherwise, the string is not empty but does not contain a U+003A COLON character (:)  
Process the field\(^{1175}\) using the steps described below, using the whole line as the field name, and the empty string as the field value.

Once the end of the file is reached, any pending data must be discarded. (If the file ends in the middle of an event, before the final empty line, the incomplete event is not dispatched.)

The steps to process the field given a field name and a field value depend on the field name, as given in the following list. Field names must be compared literally, with no case folding performed.

↪ If the field name is "event"  
Set the event type buffer to field value.

↪ If the field name is "data"  
Append the field value to the data buffer, then append a single U+000A LINE FEED (LF) character to the data buffer.

↪ If the field name is "id"  
If the field value does not contain U+0000 NULL, then set the last event ID buffer to the field value. Otherwise, ignore the field.

↪ If the field name is "retry"  
If the field value consists of only ASCII digits, then interpret the field value as an integer in base ten, and set the event stream's reconnection time\(^{1171}\) to that integer. Otherwise, ignore the field.

↪ Otherwise  
The field is ignored.

When the user agent is required to dispatch the event, the user agent must process the data buffer, the event type buffer, and the last event ID buffer using steps appropriate for the user agent.

For web browsers, the appropriate steps to dispatch the event\(^{1175}\) are as follows:

1. Set the last event ID string\(^{1171}\) of the event source to the value of the last event ID buffer. The buffer does not get reset, so
the last event ID string\(^{\text{p1171}}\) of the event source remains set to this value until the next time it is set by the server.

2. If the data buffer is an empty string, set the data buffer and the event type buffer to the empty string and return.

3. If the data buffer's last character is a U+000A LINE FEED (LF) character, then remove the last character from the data buffer.

4. Let event be the result of creating an event using `MessageEvent`\(^{\text{p1169}}\), in the relevant realm\(^{\text{p1071}}\) of the EventSource\(^{\text{p1171}}\) object.

5. Initialize event's type attribute to "message"\(^{\text{p1451}}\), its data\(^{\text{p1169}}\) attribute to data, its origin\(^{\text{p1170}}\) attribute to the serialization\(^{\text{p890}}\) of the origin of the event stream's final URL (i.e., the URL after redirects), and its lastEventId\(^{\text{p1170}}\) attribute to the last event ID string\(^{\text{p1171}}\) of the event source.

6. If the event type buffer has a value other than the empty string, change the type of the newly created event to equal the value of the event type buffer.

7. Set the data buffer and the event type buffer to the empty string.

8. Queue a task\(^{\text{p1106}}\) which, if the readyState\(^{\text{p1173}}\) attribute is set to a value other than CLOSED\(^{\text{p1173}}\), dispatches the newly created event at the EventSource\(^{\text{p1171}}\) object.

For other user agents, the appropriate steps to dispatch the event\(^{\text{p1175}}\) are implementation dependent, but at a minimum they must set the data and event type buffers to the empty string before returning.

**Note**

If an event doesn't have an "id" field, but an earlier event did set the event source's last event ID string\(^{\text{p1171}}\), then the event's lastEventId\(^{\text{p1170}}\) field will be set to the value of whatever the last seen "id" field was.

Example

The following event stream, once followed by a blank line:

```
data: YHOO
data: +2
data: 10
```

...would cause an event message\(^{\text{p1451}}\) with the interface MessageEvent\(^{\text{p1169}}\) to be dispatched on the EventSource\(^{\text{p1171}}\) object. The event's data\(^{\text{p1169}}\) attribute would contain the string "YHOO\n+2\n10" (where \"\n\" represents a newline).

This could be used as follows:

```javascript
var stocks = new EventSource("https://stocks.example.com/ticker.php");
stocks.onmessage = function (event) {
  var data = event.data.split('\n');
  updateStocks(data[0], data[1], data[2]);
};
```

...where updateStocks() is a function defined as:

```javascript
function updateStocks(symbol, delta, value) { ... }
```

...or some such.

Example

The following stream contains four blocks. The first block has just a comment, and will fire nothing. The second block has two fields with names "data" and "id" respectively; an event will be fired for this block, with the data "first event", and will then set the last event ID to "1" so that if the connection died between this block and the next, the server would be sent a \`Last-Event-ID\`\(^{\text{p1174}}\) header with the value "1". The third block fires an event with data "second event", and also has an "id" field, this time with no value, which resets the last event ID to the empty string (meaning no \`Last-Event-ID\`\(^{\text{p1174}}\) header will now be sent in the event of a reconnection being attempted). Finally, the last block just fires an event with the data "third event" (with a single leading space character). Note that the last still has to end with a blank line, the end of the stream is not enough to trigger the dispatch of the last event.
Legacy proxy servers are known to, in certain cases, drop HTTP connections after a short timeout. To protect against such proxy servers, authors can include a comment line (one starting with a ':' character) every 15 seconds or so.

Authors wishing to relate event source connections to each other or to specific documents previously served might find that relying on IP addresses doesn’t work, as individual clients can have multiple IP addresses (due to having multiple proxy servers) and individual IP addresses can have multiple clients (due to sharing a proxy server). It is better to include a unique identifier in the document when it is served and then pass that identifier as part of the URL when the connection is established.

Authors are also cautioned that HTTP chunking can have unexpected negative effects on the reliability of this protocol, in particular if the chunking is done by a different layer unaware of the timing requirements. If this is a problem, chunking can be disabled for serving event streams.

Clients that support HTTP’s per-server connection limitation might run into trouble when opening multiple pages from a site if each page has an EventSource to the same domain. Authors can avoid this using the relatively complex mechanism of using unique domain names per connection, or by allowing the user to enable or disable the EventSource functionality on a per-page basis, or by sharing a single EventSource object using a shared worker.

Example

The following stream fires two events:

```
data
data
data
```

The first block fires events with the data set to the empty string, as would the last block if it was followed by a blank line. The middle block fires an event with the data set to a single newline character. The last block is discarded because it is not followed by a blank line.

Example

The following stream fires two identical events:

```
data:test
data: test
```

This is because the space after the colon is ignored if present.

9.2.7 Authoring notes

Legacy proxy servers are known to, in certain cases, drop HTTP connections after a short timeout. To protect against such proxy servers, authors can include a comment line (one starting with a ':' character) every 15 seconds or so.

Authors wishing to relate event source connections to each other or to specific documents previously served might find that relying on IP addresses doesn’t work, as individual clients can have multiple IP addresses (due to having multiple proxy servers) and individual IP addresses can have multiple clients (due to sharing a proxy server). It is better to include a unique identifier in the document when it is served and then pass that identifier as part of the URL when the connection is established.

Authors are also cautioned that HTTP chunking can have unexpected negative effects on the reliability of this protocol, in particular if the chunking is done by a different layer unaware of the timing requirements. If this is a problem, chunking can be disabled for serving event streams.

Clients that support HTTP’s per-server connection limitation might run into trouble when opening multiple pages from a site if each page has an EventSource to the same domain. Authors can avoid this using the relatively complex mechanism of using unique domain names per connection, or by allowing the user to enable or disable the EventSource functionality on a per-page basis, or by sharing a single EventSource object using a shared worker.

9.2.8 Connectionless push and other features

User agents running in controlled environments, e.g. browsers on mobile handsets tied to specific carriers, may offload the management of the connection to a proxy on the network. In such a situation, the user agent for the purposes of conformance is
considered to include both the handset software and the network proxy.

**Example**

For example, a browser on a mobile device, after having established a connection, might detect that it is on a supporting network and request that a proxy server on the network take over the management of the connection. The timeline for such a situation might be as follows:

1. Browser connects to a remote HTTP server and requests the resource specified by the author in the `EventSource` constructor.
2. The server sends occasional messages.
3. In between two messages, the browser detects that it is idle except for the network activity involved in keeping the TCP connection alive, and decides to switch to sleep mode to save power.
4. The browser disconnects from the server.
5. The browser contacts a service on the network, and requests that the service, a "push proxy", maintain the connection instead.
6. The "push proxy" service contacts the remote HTTP server and requests the resource specified by the author in the `EventSource` constructor (possibly including a `Last-Event-ID` HTTP header, etc.).
7. The browser allows the mobile device to go to sleep.
8. The server sends another message.
9. The "push proxy" service uses a technology such as OMA push to convey the event to the mobile device, which wakes only enough to process the event and then returns to sleep.

This can reduce the total data usage, and can therefore result in considerable power savings.

As well as implementing the existing API and the `text/event-stream` wire format as defined by this specification and in more distributed ways as described above, formats of event framing defined by other applicable specifications may be supported. This specification does not define how they are to be parsed or processed.

### 9.2.9 Garbage collection

While an `EventSource` object's `readyState` is `CONNECTING`, and the object has one or more event listeners registered for `open`, `message`, or `error` events, there must be a strong reference from the `Window` or `WorkerGlobalScope` object that the `EventSource` object's constructor was invoked from to the `EventSource` object itself.

While an `EventSource` object's `readyState` is `OPEN`, and the object has one or more event listeners registered for `message` or `error` events, there must be a strong reference from the `Window` or `WorkerGlobalScope` object that the `EventSource` object's constructor was invoked from to the `EventSource` object itself.

While there is a task queued by an `EventSource` object on the `remote event task source`, there must be a strong reference from the `Window` or `WorkerGlobalScope` object that the `EventSource` object's constructor was invoked from to that `EventSource` object.

If a user agent is to forcibly close an `EventSource` object (this happens when a `Document` object goes away permanently), the user agent must abort any instances of the `fetch` algorithm started for this `EventSource` object, and must set the `readyState` attribute to `CLOSED`.

If an `EventSource` object is garbage collected while its connection is still open, the user agent must abort any instance of the `fetch` algorithm opened by this `EventSource`.

### 9.2.10 Implementation advice

This section is non-normative.
User agents are strongly urged to provide detailed diagnostic information about EventSource objects and their related network connections in their development consoles, to aid authors in debugging code using this API.

For example, a user agent could have a panel displaying all the EventSource objects a page has created, each listing the constructor’s arguments, whether there was a network error, what the CORS status of the connection is and what headers were sent by the client and received from the server to lead to that status, the messages that were received and how they were parsed, and so forth.

Implementations are especially encouraged to report detailed information to their development consoles whenever an error event is fired, since little to no information can be made available in the events themselves.

9.3 Cross-document messaging

Web browsers, for security and privacy reasons, prevent documents in different domains from affecting each other; that is, cross-site scripting is disallowed.

While this is an important security feature, it prevents pages from different domains from communicating even when those pages are not hostile. This section introduces a messaging system that allows documents to communicate with each other regardless of their source domain, in a way designed to not enable cross-site scripting attacks.

### Example

For example, if document A contains an iframe element that contains document B, and script in document A calls postMessage() on the Window object of document B, then a message event will be fired on that object, marked as originating from the Window of document A. The script in document A might look like:

```javascript
var o = document.getElementsByTagName('iframe')[0];
o.contentWindow.postMessage('Hello world', 'https://b.example.org/');
```

To register an event handler for incoming events, the script would use addEventListener() (or similar mechanisms). For example, the script in document B might look like:

```javascript
window.addEventListener('message', receiver, false);
function receiver(e) {
  if (e.origin == 'https://example.com') {
    if (e.data == 'Hello world') {
      e.source.postMessage('Hello', e.origin);
    } else {
      alert(e.data);
    }
  }
}
```

This script first checks the domain is the expected domain, and then looks at the message, which it either displays to the user, or responds to by sending a message back to the document which sent the message in the first place.
9.3.2 Security §80
9.3.2.1 Authors §80

⚠ Warning!

Use of this API requires extra care to protect users from hostile entities abusing a site for their own purposes.

Authors should check the `origin` attribute to ensure that messages are only accepted from domains that they expect to receive messages from. Otherwise, bugs in the author's message handling code could be exploited by hostile sites.

Furthermore, even after checking the `origin` attribute, authors should also check that the data in question is of the expected format. Otherwise, if the source of the event has been attacked using a cross-site scripting flaw, further unchecked processing of information sent using the `postMessage()` method could result in the attack being propagated into the receiver.

Authors should not use the wildcard keyword (*) in the `targetOrigin` argument in messages that contain any confidential information, as otherwise there is no way to guarantee that the message is only delivered to the recipient to which it was intended.

Authors who accept messages from any origin are encouraged to consider the risks of a denial-of-service attack. An attacker could send a high volume of messages; if the receiving page performs expensive computation or causes network traffic to be sent for each such message, the attacker's message could be multiplied into a denial-of-service attack. Authors are encouraged to employ rate limiting (only accepting a certain number of messages per minute) to make such attacks impractical.

9.3.2 User agents §80

The integrity of this API is based on the inability for scripts of one `origin` to post arbitrary events (using `dispatchEvent()` or otherwise) to objects in other origins (those that are not the `same`).

Note

Implementers are urged to take extra care in the implementation of this feature. It allows authors to transmit information from one domain to another domain, which is normally disallowed for security reasons. It also requires that UAs be careful to allow access to certain properties but not others.

User agents are also encouraged to consider rate-limiting message traffic between different `origins`, to protect naïve sites from denial-of-service attacks.

9.3.3 Posting messages §80

For web developers (non-normative)

`window.postMessage(message [, options ])`

Posts a message to the given window. Messages can be structured objects, e.g. nested objects and arrays, can contain JavaScript values (strings, numbers, `Date` objects, etc.), and can contain certain data objects such as `File Blob`, `FileList`, and `ArrayBuffer` objects.

Objects listed in the `transfer` member of `options` are transferred, not just cloned, meaning that they are no longer usable on the sending side.

A target origin can be specified using the `targetOrigin` member of `options`. If not provided, it defaults to "/". This default restricts the message to same-origin targets only.

If the origin of the target window doesn't match the given target origin, the message is discarded, to avoid information leakage. To send the message to the target regardless of origin, set the target origin to "*".

Throws a "DataCloneError" `DOMException` if `transfer` array contains duplicate objects or if `message` could not be cloned.

`window.postMessage(message, targetOrigin [, transfer ])`

This is an alternate version of `postMessage()` where the target origin is specified as a parameter. Calling `window.postMessage(message, target, transfer)` is equivalent to `window.postMessage(message, {targetOrigin, transfer})`. 
The window post message steps, given a targetWindow, message, and options, are as follows:

1. Let targetRealm be targetWindow's realm.
2. Let incumbentSettings be the incumbent settings object.
3. Let targetOrigin be options[targetOrigin].
4. If targetOrigin is a single U+002F SOLIDUS character (/), then set targetOrigin to incumbentSettings's origin.
5. Otherwise, if targetOrigin is not a single U+002A ASTERISK character (*), then:
   1. Let parsedURL be the result of running the URL parser on targetOrigin.
   2. If parsedURL is failure, then throw a "SyntaxError" DOMException.
   3. Set targetOrigin to parsedURL's origin.
6. Let transfer be options[transfer].
7. Let serializeWithTransferResult be StructuredSerializeWithTransfer(message, transfer). Rethrow any exceptions.
8. Queue a global task on the posted message task source given targetWindow to run the following steps:
   1. If the targetOrigin argument is not a single literal U+002A ASTERISK character (*) and targetWindow's associated Document's origin is not same origin with targetOrigin, then return.
   2. Let origin be the serialization of incumbentSettings's origin.
   3. Let source be the WindowProxy object corresponding to incumbentSettings's global object (a Window object).
   4. Let deserializeRecord be StructuredDeserializeWithTransfer(serializeWithTransferResult, targetRealm).
      If this throws an exception, catch it, fire an event named messageerror at targetWindow, using MessageEvent, with the origin attribute initialized to origin and the source attribute initialized to source, and then return.
   5. Let messageClone be deserializeRecord.[[Deserialized]].
   6. Let newPorts be a new frozen array consisting of all MessagePort objects in deserializeRecord.[[TransferredValues]], if any, maintaining their relative order.
   7. Fire an event named message at targetWindow, using MessageEvent, with the origin attribute initialized to origin, the source attribute initialized to source, the data attribute initialized to messageClone, and the ports attribute initialized to newPorts.

The window interface's postMessage(message, options) method steps are to run the window post message steps given this, message, and options.

The window interface's postMessage(message, targetOrigin, transfer) method steps are to run the window post message steps given this, message, and »["targetOrigin" → targetOrigin, "transfer" → transfer]». 

Note: When posting a message to a Window of a browsing context that has just been navigated to a new Document is likely to result in the message not receiving its intended recipient: the scripts in the target browsing context have to have had time to set up listeners for the messages. Thus, for instance, in situations where a message is to be sent to the Window of newly created child iframe, authors are advised to have the child Document post a message to their parent announcing their readiness to receive messages, and for the parent to wait for this message before beginning posting messages.
9.4 Channel messaging

9.4.1 Introduction

This section is non-normative.

To enable independent pieces of code (e.g. running in different browsing contexts) to communicate directly, authors can use channel messaging.

Communication channels in this mechanism are implemented as two-ways pipes, with a port at each end. Messages sent in one port are delivered at the other port, and vice-versa. Messages are delivered as DOM events, without interrupting or blocking running tasks.

To create a connection (two "entangled" ports), the `MessageChannel()` constructor is called:

```javascript
var channel = new MessageChannel();
```

One of the ports is kept as the local port, and the other port is sent to the remote code, e.g. using `postMessage()`:

```javascript
otherWindow.postMessage('hello', 'https://example.com', [channel.port2]);
```

To send messages, the `postMessage()` method on the port is used:

```javascript
channel.port1.postMessage('hello');
```

To receive messages, one listens to `message` events:

```javascript
channel.port1.onmessage = handleMessage;
function handleMessage(event) {
    // message is in event.data
    // ...
}
```

Data sent on a port can be structured data; for example here an array of strings is passed on a `MessagePort`:

```javascript
port1.postMessage(['hello', 'world']);
```

9.4.1.1 Examples

This section is non-normative.

Example

In this example, two JavaScript libraries are connected to each other using `MessagePort`s. This allows the libraries to later be hosted in different frames, or in `Worker` objects, without any change to the APIs.

```html
<script src="contacts.js"></script> <!-- exposes a contacts object -->
<script src="compose-mail.js"></script> <!-- exposes a composer object -->
<script>
    var channel = new MessageChannel();
    composer.addContactsProvider(channel.port1);
    contacts.registerConsumer(channel.port2);
</script>
```

Here's what the "addContactsProvider()" function's implementation could look like:
This section is non-normative.

Ports can be viewed as a way to expose limited capabilities (in the object-capability model sense) to other actors in the system. This can either be a weak capability system, where the ports are merely used as a convenient model within a particular origin, or as a strong capability model, where they are provided by one origin as the only mechanism by which another origin can effect change in or obtain information from.

For example, consider a situation in which a social website embeds in one iframe the user's email contacts provider, an address book site, from a second origin, and in a second iframe a game from a third origin. The outer social site and the game in the second iframe cannot access anything inside the first iframe; together they can only:

- Navigate the iframe to a new URL, such as the same URL but with a different fragment, causing the Window in the iframe to receive a hashchange event.
- Resize the iframe, causing the Window in the iframe to receive a resize event.
- Send a message event to the Window in the iframe, using the window.postMessage() API.

The contacts provider can use these methods, most particularly the third one, to provide an API that can be accessed by other origins to manipulate the user's address book. For example, it could respond to a message "add-contact Guillaume Tell"
To avoid any site on the web being able to manipulate the user's contacts, the contacts provider might only allow certain trusted sites, such as the social site, to do this.

Now suppose the game wanted to add a contact to the user's address book, and that the social site was willing to allow it to do so on its behalf, essentially "sharing" the trust that the contacts provider had with the social site. There are several ways it could do this; most simply, it could just proxy messages between the game site and the contacts site. However, this solution has a number of difficulties: it requires the social site to either completely trust the game site not to abuse the privilege, or it requires that the social site verify each request to make sure it's not a request that it doesn't want to allow (such as adding multiple contacts, reading the contacts, or deleting them); it also requires some additional complexity if there's ever the possibility of multiple games simultaneously trying to interact with the contacts provider.

Using message channels and MessagePort objects, however, all of these problems can go away. When the game tells the social site that it wants to add a contact, the social site can ask the contacts provider not for it to add a contact, but for the capability to add a single contact. The contacts provider then creates a pair of MessagePort objects, and sends one of them back to the social site, who forwards it on to the game. The game and the contacts provider then have a direct connection, and the contacts provider knows to only honor a single "add contact" request, nothing else. In other words, the game has been granted the capability to add a single contact.

### 9.4.1.3 Ports as the basis of abstracting out service implementations

This section is non-normative.

Continuing the example from the previous section, consider the contacts provider in particular. While an initial implementation might have simply used XMLHttpRequest objects in the service's iframe, an evolution of the service might instead want to use a shared worker with a single WebSocket connection.

If the initial design used MessagePort objects to grant capabilities, or even just to allow multiple simultaneous independent sessions, the service implementation can switch from the XMLHttpRequests-in-each-iframe model to the shared-WebSocket model without changing the API at all: the ports on the service provider side can all be forwarded to the shared worker without it affecting the users of the API in the slightest.

### 9.4.2 Message channels

**IDL**

```
[Exposed=(Window,Worker)]
interface MessageChannel {
  constructor();
  readonly attribute MessagePort port1;
  readonly attribute MessagePort port2;
};
```

For web developers (non-normative)

- `channel = new MessageChannel()`
  - Returns a new MessageChannel object with two new MessagePort objects.
- `channel.port1`
  - Returns the first MessagePort object.
- `channel.port2`
  - Returns the second MessagePort object.

A MessageChannel object has an associated port 1 and an associated port 2, both MessagePort objects.

The `new MessageChannel()` constructor steps are:

1. Set this's port 1 to a new MessagePort in this's relevant realm.
2. Set this’s port 2 to a new MessagePort in this’s relevant realm.

3. Entangle this’s port 1 and this’s port 2.

The port1 getter steps are to return this’s port 1.

The port2 getter steps are to return this’s port 2.

9.4.3 Message ports

Each channel has two message ports. Data sent through one port is received by the other port, and vice versa.

```idl
[Exposed=(Window, Worker, AudioWorklet), Transferable]
interface MessagePort : EventTarget {
    undefined postMessage(any message, sequence<object> transfer);  
    undefined postMessage(any message, optional StructuredSerializeOptions options = {});
    undefined start();
    undefined close();

    // event handlers
    attribute EventHandler onmessage;
    attribute EventHandler onmessageerror;
    attribute (EventHandler, onclose);
};

dictionary StructuredSerializeOptions {
    sequence<object> transfer = [];
};
```

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```javascript
port.postMessage(message [, transfer])
port.postMessage(message [, { transfer }])
```

Posts a message through the channel. Objects listed in transfer are transferred, not just cloned, meaning that they are no longer usable on the sending side.

Throws a "DataCloneError" DOMException if transfer contains duplicate objects or port, or if message could not be cloned.

```javascript
port.start()
```

Begins dispatching messages received on the port.

```javascript
port.close()
```

Disconnects the port, so that it is no longer active.

Each MessagePort object can be entangled with another (a symmetric relationship). Each MessagePort object also has a task source called the port message queue, initially empty. A port message queue can be enabled or disabled, and is initially disabled. Once enabled, a port can never be disabled again (though messages in the queue can get moved to another queue or removed altogether, which has much the same effect). A MessagePort also has a has been shipped flag, which must initially be false.

When a port’s port message queue is enabled, the event loop must use it as one of its task sources. When a port’s relevant global object is a Window, all tasks queued on its port message queue must be associated with the port’s relevant global object’s associated Document.

Note

If the document is fully active, but the event listeners were all created in the context of documents that are not fully active, then the messages will not be received unless and until the documents become fully active again.

Each event loop has a task source called the unshipped port message queue. This is a virtual task source; it must act as if it contained the tasks of each port message queue of each MessagePort whose has been shipped flag is false.
whose `port message queue` flag is enabled, and whose `relevant agent`'s `event loop` is that `event loop`, in the order in which they were added to their respective `task source`. When a `task` would be removed from the `unshipped port message queue`, it must instead be removed from its `port message queue`.

When a `MessagePort`'s `has been shipped` flag is false, its `port message queue` must be ignored for the purposes of the `event loop`. (The `unshipped port message queue` is used instead.)

**Note**

The `has been shipped` flag is set to true when a port, its twin, or the object it was cloned from, is or has been transferred. When a `MessagePort`'s `has been shipped` flag is true, its `port message queue` acts as a first-class `task source`, unaffected to any `unshipped port message queue`.

When the user agent is to entangle two `MessagePort` objects, it must run the following steps:

1. If one of the ports is already entangled, then disentangle it and the port that it was entangled with.

   **Note**

   If those two previously entangled ports were the two ports of a `MessageChannel` object, then that `MessageChannel` object no longer represents an actual channel: the two ports in that object are no longer entangled.

2. Associate the two ports to be entangled, so that they form the two parts of a new channel. (There is no `MessageChannel` object that represents this channel.)

   Two ports `A` and `B` that have gone through this step are now said to be entangled; one is entangled to the other, and vice versa.

   **Note**

   While this specification describes this process as instantaneous, implementations are more likely to implement it via message passing. As with all algorithms, the key is “merely” that the end result be indistinguishable, in a black-box sense, from the specification.

The `disentangle` steps, given a `MessagePort` `initiatorPort` which initiates disentangling, are as follows:

1. Let `otherPort` be the `MessagePort` which `initiatorPort` was entangled with.

   **Note**

   The `close` event will be fired even if the port is not explicitly closed. The cases where this event is dispatched are:
   
   - the `close()` method was called;
   - the `Document` was destroyed, or
   - the `MessagePort` was garbage collected.

   We only dispatch the event on `otherPort` because `initiatorPort` explicitly triggered the close, its `Document` no longer exists, or it was already garbage collected, as described above.

`MessagePort` objects are `transferable objects`. Their `transfer steps`, given `value` and `dataHolder`, are:

1. Set `value`'s `has been shipped` flag to true.

2. Set `dataHolder.[[PortMessageQueue]]` to `value`'s `port message queue`.

3. If `value` is entangled with another port `remotePort`, then:
   
   1. Set `remotePort`'s `has been shipped` flag to true.
2. Set `dataHolder.[[RemotePort]]` to `remotePort`.

4. Otherwise, set `dataHolder.[[RemotePort]]` to null.

Their transfer-receiving steps, given `dataHolder` and `value`, are:

1. Set `value`'s `has been shipped` flag to true.

2. Move all the tasks that are to fire `message` events in `dataHolder.[[PortMessageQueue]]` to the port message queue of `value`, if any, leaving `value`'s port message queue in its initial disabled state, and, if `value`'s relevant global object is a `Window`, associating the moved tasks with `value`'s relevant global object's associated Document.

3. If `dataHolder.[[RemotePort]]` is not null, then entangle `dataHolder.[[RemotePort]]` and `value`. (This will disentangle `dataHolder.[[RemotePort]]` from the original port that was transferred.)

The message port post message steps, given `sourcePort`, `targetPort`, `message` and `options` are as follows:

1. Let `transfer` be `options["transfer"]`.

2. If `transfer` contains `sourcePort`, then throw a "DataCloneError" DOMException.

3. Let `doomed` be false.

4. If `targetPort` is not null and `transfer` contains `targetPort`, then set `doomed` to true and optionally report to a developer console that the target port was posted to itself, causing the communication channel to be lost.

5. Let `serializeWithTransferResult` be `StructuredSerializeWithTransfer`(`message`, `transfer`). Rethrow any exceptions.

6. If `targetPort` is null, or if `doomed` is true, then return.

7. Add a task that runs the following steps to the port message queue of `targetPort`:

   1. Let `finalTargetPort` be the `MessagePort` in whose port message queue the task now finds itself.

   2. Let `targetRealm` be `finalTargetPort`'s relevant realm.

   3. Let `deserializeRecord` be `StructuredDeserializeWithTransfer`(`serializeWithTransferResult`, `targetRealm`).

      If this throws an exception, catch it, fire an event named `messageerror` at `finalTargetPort`, using `MessageEvent`, and then return.

   4. Let `messageClone` be `deserializeRecord`'s `Deserialized`.

   5. Let `newPorts` be a new frozen array consisting of all `MessagePort` objects in `deserializeRecord`'s `TransferredValues`, if any, maintaining their relative order.

The postMessage(`message`, `options`) method steps are:

1. Let `targetPort` be the port with which this is entangled, if any; otherwise let it be null.

2. Run the message port post message steps providing this, `targetPort`, `message` and `options`.

The postMessage(`message`, `transfer`) method steps are:

1. Let `targetPort` be the port with which this is entangled, if any; otherwise let it be null.

2. Let `options` be «[ "transfer" → `transfer` ]».

3. Run the message port post message steps providing this, `targetPort`, `message` and `options`.  

1187
The `start()` method steps are to enable this's port message queue\(^{1185}\), if it is not already enabled.

The `close()` method steps are:

1. Set this's \([\text{[Detached]}]\)\(^{117}\) internal slot value to true.
2. If this is entangled, disentangle\(^{1186}\) it.

The following are the event handlers\(^{1117}\) (and their corresponding event handler event types\(^{1120}\)) that must be supported, as event handler IDL attributes\(^{1118}\), by all objects implementing the `MessagePort`\(^{1185}\) interface:

<table>
<thead>
<tr>
<th>Event handler(^{1117})</th>
<th>Event handler event type(^{1120})</th>
</tr>
</thead>
<tbody>
<tr>
<td>onmessage</td>
<td>message(^{1451})</td>
</tr>
<tr>
<td>onmessageerror</td>
<td>messageerror(^{1451})</td>
</tr>
<tr>
<td>onclose</td>
<td>close(^{1451})</td>
</tr>
</tbody>
</table>

The first time a `MessagePort`\(^{1185}\) object's `onmessage`\(^{1188}\) IDL attribute is set, the port's `port message queue`\(^{1185}\) must be enabled, as if the `start()`\(^{1188}\) method had been called.

### 9.4.4 Ports and garbage collection\(^{88}\)

When a `MessagePort`\(^{1185}\) object \(o\) is garbage collected, if \(o\) is entangled, then the user agent must disentangle\(^{1186}\) \(o\).

When a `MessagePort`\(^{1185}\) object \(o\) is entangled and `message`\(^{1451}\) or `messageerror`\(^{1451}\) event listener is registered, user agents must act as if \(o\)'s entangled `MessagePort`\(^{1185}\) object has a strong reference to \(o\).

Furthermore, a `MessagePort`\(^{1185}\) object must not be garbage collected while there exists an event referenced by a `task`\(^{1105}\) in a `task queue`\(^{1105}\) that is to be dispatched on that `MessagePort`\(^{1185}\) object, or while the `MessagePort`\(^{1185}\) object's `port message queue`\(^{1185}\) is enabled and not empty.

**Note**

Thus, a message port can be received, given an event listener, and then forgotten, and so long as that event listener could receive a message, the channel will be maintained.

Of course, if this was to occur on both sides of the channel, then both ports could be garbage collected, since they would not be reachable from live code, despite having a strong reference to each other. However, if a message port has a pending message, it is not garbage collected.

**Note**

Authors are strongly encouraged to explicitly close `MessagePort`\(^{1185}\) objects to disentangle them, so that their resources can be recollected. Creating many `MessagePort`\(^{1185}\) objects and discarding them without closing them can lead to high transient memory usage since garbage collection is not necessarily performed promptly, especially for `MessagePort`\(^{1185}\)'s where garbage collection can involve cross-process coordination.

### 9.5 Broadcasting to other browsing contexts\(^{88}\)

Pages on a single `origin`\(^{890}\) opened by the same user in the same user agent but in different unrelated `browsing contexts`\(^{897}\) sometimes need to send notifications to each other, for example "hey, the user logged in over here, check your credentials again".

For elaborate cases, e.g. to manage locking of shared state, to manage synchronization of resources between a server and multiple local clients, to share a `WebSocket` connection with a remote host, and so forth, `shared workers`\(^{1218}\) are the most appropriate solution.

For simple cases, though, where a shared worker would be an unreasonable overhead, authors can use the simple channel-based broadcast mechanism described in this section.
interface BroadcastChannel : EventTarget {
    constructor(DOMString name);

    readonly attribute DOMString name;
    undefined postMessage(any message);
    undefined close();
    attribute EventHandler onmessage;
    attribute EventHandler onmessageerror;
};

A BroadcastChannel object has a channel name and a closed flag.

The new BroadcastChannel(name) constructor steps are:

1. Set this's channel name to name.
2. Set this's closed flag to false.

The name getter steps are to return this's channel name.

A BroadcastChannel object is said to be eligible for messaging when its relevant global object is either:

- a Window object whose associated Document is fully active, or
- a WorkerGlobalScope object whose closing flag is false and whose worker is not a suspendable worker.

The postMessage(message) method steps are:

1. If this is not eligible for messaging, then return.
2. If this's closed flag is true, then throw an "InvalidStateError" DOMException.
4. Let sourceOrigin be this's relevant settings object's origin.
5. Let sourceStorageKey be the result of running obtain a storage key for non-storage purposes with this's relevant settings object.
6. Let destinations be a list of BroadcastChannel objects that match the following criteria:
   - They are eligible for messaging.
   - The result of running obtain a storage key for non-storage purposes with their relevant settings object equals sourceStorageKey.
   - Their channel name is this's channel name.
7. Remove source from destinations.
8. Sort destinations such that all BroadcastChannel objects whose relevant agents are the same are sorted in creation order.

For web developers (non-normative)

broadcastChannel = new BroadcastChannel(name)
Returns a new BroadcastChannel object via which messages for the given channel name can be sent and received.

broadcastChannel.name
Returns the channel name (as passed to the constructor).

broadcastChannel.postMessage(message)
Sends the given message to other BroadcastChannel objects set up for this channel. Messages can be structured objects, e.g. nested objects and arrays.

broadcastChannel.close()
Closes the BroadcastChannel object, opening it up to garbage collection.
order, oldest first. (This does not define a complete ordering. Within this constraint, user agents may sort the list in any implementation-defined manner.)

9. For each destination in destinations, queue a global task\孚 on the DOM manipulation task source孚 given destination's relevant global object孚 to perform the following steps:

1. If destination's closed flag孚 is true, then abort these steps.
2. Let targetRealm be destination's relevant realm孚.
3. Let data be StructuredDeserialize\孚 (serialized, targetRealm).
   If this throws an exception, catch it, fire an event named messageerror孚 at destination, using MessageEvent孚, with the origin孚 attribute initialized to the serialization孚 of sourceOrigin, and then abort these steps.
4. Fire an event named message孚 at destination, using MessageEvent孚, with the data孚 attribute initialized to data and the origin孚 attribute initialized to the serialization孚 of sourceOrigin.

While a BroadcastChannel孚 object whose closed flag孚 is false has an event listener registered for message孚 or messageerror孚 events, there must be a strong reference from the BroadcastChannel孚 object's relevant global object孚 to the BroadcastChannel孚 object itself.

The close() method steps are to set this's closed flag孚 to true.

**Note**

Authors are strongly encouraged to explicitly close BroadcastChannel孚 objects when they are no longer needed, so that they can be garbage collected. Creating many BroadcastChannel孚 objects and discarding them while leaving them with an event listener and without closing them can lead to an apparent memory leak, since the objects will continue to live for as long as they have an event listener (or until their page or worker is closed).

The following are the event handlers孚 (and their corresponding event handler event types孚) that must be supported, as event handler IDL attributes孚, by all objects implementing the BroadcastChannel孚 interface:

<table>
<thead>
<tr>
<th>Event handler孚</th>
<th>Event handler event type孚</th>
</tr>
</thead>
<tbody>
<tr>
<td>onmessage</td>
<td>message孚</td>
</tr>
<tr>
<td>onmessageerror</td>
<td>messageerror孚</td>
</tr>
</tbody>
</table>

**Example**

Suppose a page wants to know when the user logs out, even when the user does so from another tab at the same site:

```javascript
var authChannel = new BroadcastChannel('auth');
authChannel.onmessage = function (event) {
  if (event.data == 'logout')
    showLogout();
};

function logoutRequested() {
  // called when the user asks us to log them out
  doLogout();
  showLogout();
  authChannel.postMessage('logout');
}

function doLogout() {
  // actually log the user out (e.g. clearing cookies)
  // ...
}

function showLogout() {
  // update the UI to indicate we're logged out
```

// ...
}

This section is non-normative.

This specification defines an API for running scripts in the background independently of any user interface scripts.

This allows for long-running scripts that are not interrupted by scripts that respond to clicks or other user interactions, and allows long tasks to be executed without yielding to keep the page responsive.

Workers (as these background scripts are called herein) are relatively heavy-weight, and are not intended to be used in large numbers. For example, it would be inappropriate to launch one worker for each pixel of a four megapixel image. The examples below show some appropriate uses of workers.

Generally, workers are expected to be long-lived, have a high start-up performance cost, and a high per-instance memory cost.

10.1.2 Examples

This section is non-normative.

There are a variety of uses that workers can be put to. The following subsections show various examples of this use.

10.1.2.1 A background number-crunching worker

This section is non-normative.

The simplest use of workers is for performing a computationally expensive task without interrupting the user interface.

In this example, the main document spawns a worker to (naïvely) compute prime numbers, and progressively displays the most recently found prime number.

The main page is as follows:

```html
<!DOCTYPE HTML>
<html lang="en">
<head>
  <meta charset="utf-8">
  <title>Worker example: One-core computation</title>
</head>
<body>
  <p>The highest prime number discovered so far is: <output id="result"></output></p>
  <script>
    var worker = new Worker('worker.js');
    worker.onmessage = function (event) {
      document.getElementById('result').textContent = event.data;
    };
  </script>
</body>
</html>
```

The `Worker()` constructor call creates a worker and returns a `Worker` object representing that worker, which is used to...
communicate with the worker. That object’s `onmessage` event handler allows the code to receive messages from the worker.

The worker itself is as follows:

```javascript
var n = 1;
search: while (true) {
  n += 1;
  for (var i = 2; i <= Math.sqrt(n); i += 1)
    if (n % i == 0)
      continue search;
  // found a prime!
  postMessage(n);
}
```

The bulk of this code is simply an unoptimized search for a prime number. The `postMessage()` method is used to send a message back to the page when a prime is found.

View this example online.

### 10.1.2.2 Using a JavaScript module as a worker

This section is non-normative.

All of our examples so far show workers that run `classic scripts`. Workers can instead be instantiated using `module scripts`, which have the usual benefits: the ability to use the JavaScript `import` statement to import other modules; strict mode by default; and top-level declarations not polluting the worker’s global scope.

As the `import` statement is available, the `importScripts()` method will automatically fail inside module workers.

In this example, the main document uses a worker to do off-main-thread image manipulation. It imports the filters used from another module.

The main page is as follows:

```html
<!DOCTYPE html>
<html lang="en">
<meta charset="utf-8">
<title>Worker example: image decoding</title>

<p>
  <label>
    Type an image URL to decode
    <input type="url" id="image-url" list="image-list">
    <datalist id="image-list">
      <option value="https://html.spec.whatwg.org/images/drawImage.png">
      <option value="https://html.spec.whatwg.org/images/robots.jpeg">
      <option value="https://html.spec.whatwg.org/images/arcTo2.png">
    </datalist>
  </label>
</p>

<p>
  <label>
    Choose a filter to apply
    <select id="filter">
      <option value="none">none</option>
      <option value="grayscale">grayscale</option>
      <option value="brighten">brighten by 20%</option>
    </select>
  </label>
</p>
```
The worker file is then:

```javascript
import * as filters from "./filters.js";

self.onmessage = e => {
  const { imageData, filter } = e.data;
  filters[filter](imageData);
  self.postMessage(imageData, [imageData.data.buffer]);
};
```

Which imports the file filters.js:

```javascript
export function none() {}

export function grayscale({ data: d }) {
  for (let i = 0; i < d.length; i += 4) {
    const [r, g, b] = [d[i], d[i + 1], d[i + 2]];
  }
}
```
// CIE luminance for the RGB
// The human eye is bad at seeing red and blue, so we de-emphasize them.
d[i] = d[i + 1] = d[i + 2] = 0.2126 * r + 0.7152 * g + 0.0722 * b;
}

export function brighten({ data }) {
    for (let i = 0; i < data.length; ++i) {
        data[i] *= 1.2;
    }
}

View this example online.

10.1.2.3 Shared workers introduction

This section is non-normative.

This section introduces shared workers using a Hello World example. Shared workers use slightly different APIs, since each worker can have multiple connections.

This first example shows how you connect to a worker and how a worker can send a message back to the page when it connects to it. Received messages are displayed in a log.

Here is the HTML page:

```html
<!DOCTYPE HTML>
<html lang="en">
<meta charset="utf-8">
<title>Shared workers: demo 1</title>
<pre id="log">Log:</pre>
<script>
    var worker = new SharedWorker('test.js');
    var log = document.getElementById('log');
    worker.port.onmessage = function(e) {
        log.textContent += '\n' + e.data;
    }
</script>
</html>
```

Here is the JavaScript worker:

```javascript
onconnect = function(e) {
    var port = e.ports[0];
    port.postMessage('Hello World!');
}
```

View this example online.

This second example extends the first one by changing two things: first, messages are received using addEventListener() instead of an event handler IDL attribute, and second, a message is sent to the worker, causing the worker to send another message in return. Received messages are again displayed in a log.

Here is the HTML page:

```html
<!DOCTYPE HTML>
<html lang="en">
<meta charset="utf-8">
<title>Shared workers: demo 2</title>
<pre id="log">Log:</pre>
</html>
```

View this example online.
Here is the JavaScript worker:

```javascript
onconnect = function(e) {
    var port = e.ports[0];
    port.postMessage('Hello World!');
    port.onmessage = function(e) {
        // not e.ports[0].postMessage!
        // e.target.postMessage('pong'); would work also
        port.postMessage('pong');
    }
};
```

View this example online.

Finally, the example is extended to show how two pages can connect to the same worker; in this case, the second page is merely in an `iframe` on the first page, but the same principle would apply to an entirely separate page in a separate top-level traversable.

Here is the outer HTML page:

```html
<!DOCTYPE HTML>
<html lang="en">
<meta charset="utf-8">
<title>Shared workers: demo 3</title>
<pre id="log">Log:</pre>
<script>
    var worker = new SharedWorker('test.js');
    var log = document.getElementById('log');
    worker.port.addEventListener('message', function(e) {
        log.textContent += '\n' + e.data;
    }, false);
    worker.port.start(); // note: need this when using addEventListener
    worker.port.postMessage('ping');
</script>
<iframe src="inner.html"></iframe>
```

Here is the inner HTML page:

```html
<!DOCTYPE HTML>
<html lang="en">
<meta charset="utf-8">
<title>Shared workers: demo 3 inner frame</title>
<pre id="log">Inner log:</pre>
<script>
    var worker = new SharedWorker('test.js');
    var log = document.getElementById('log');
    worker.port.onmessage = function(e) {
        log.textContent += '\n' + e.data;
    }
</script>
```

Here is the JavaScript worker:
```javascript
var count = 0;
onconnect = function(e) {
    count += 1;
    var port = e.ports[0];
    port.postMessage('Hello World! You are connection #' + count);
    port.onmessage = function(e) {
        port.postMessage('pong');
    }
}
```

View this example online.

10.1.2.4 Shared state using a shared worker

This section is non-normative.

In this example, multiple windows (viewers) can be opened that are all viewing the same map. All the windows share the same map information, with a single worker coordinating all the viewers. Each viewer can move around independently, but if they set any data on the map, all the viewers are updated.

The main page isn't interesting, it merely provides a way to open the viewers:

```html
<!DOCTYPE HTML>
<html lang="en">
<head>
    <meta charset="utf-8">
    <title>Workers example: Multiviewer</title>
    <script>
        function openViewer() {
            window.open('viewer.html');
        }
    </script>
</head>
<body>
    <p><button type="button" onclick="openViewer()">Open a new viewer</button></p>
    <p>Each viewer opens in a new window. You can have as many viewers as you like, they all view the same data.</p>
</body>
</html>
```

The viewer is more involved:

```html
<!DOCTYPE HTML>
<html lang="en">
<head>
    <meta charset="utf-8">
    <title>Workers example: Multiviewer viewer</title>
    <script>
        var worker = new SharedWorker('worker.js', 'core');

        // CONFIGURATION
        function configure(event) {
            if (event.data.substr(0, 4) != 'cfg ') return;
            var name = event.data.substr(4).split(' ', 1)[0];
            // update display to mention our name is name
            document.getElementsByTagName('h1')[0].textContent += ' ' + name;
            // no longer need this listener
            worker.port.removeEventListener('message', configure, false);
        }
    </script>
</head>
<body>
    // CONFIGURATION
    function configure(event) {
        if (event.data.substr(0, 4) != 'cfg ') return;
        var name = event.data.substr(4).split(' ', 1)[0];
        // update display to mention our name is name
        document.getElementsByTagName('h1')[0].textContent += ' ' + name;
        // no longer need this listener
        worker.port.removeEventListener('message', configure, false);
    }
</body>
</html>
```
worker.port.addEventListener('message', configure, false);

// MAP
function paintMap(event) {
    if (event.data.substr(0, 4) != 'map ') return;
    var data = event.data.substr(4).split(',', '');
    // display tiles data[0] .. data[8]
    var canvas = document.getElementById('map');
    var context = canvas.getContext('2d');
    for (var y = 0; y < 3; y++) {
        for (var x = 0; x < 3; x++) {
            var tile = data[y * 3 + x];
            if (tile == '0')
                context.fillStyle = 'green';
            else
                context.fillStyle = 'maroon';
            context.fillRect(x * 50, y * 50, 50, 50);
        }
    }
}
worker.port.addEventListener('message', paintMap, false);

// PUBLIC CHAT
function updatePublicChat(event) {
    if (event.data.substr(0, 4) != 'txt ') return;
    var name = event.data.substr(4).split(' ', 1)[0];
    var message = event.data.substr(4 + name.length + 1);
    // display "<name> message" in public chat
    var public = document.getElementById('public');
    var p = document.createElement('p');
    var n = document.createElement('button');
    n.textContent = '<' + name + '>';
    n.onclick = function() { worker.port.postMessage('msg ' + name); }
    p.appendChild(n);
    var m = document.createElement('span');
    m.textContent = message;
    p.appendChild(m);
    public.appendChild(p);
}
worker.port.addEventListener('message', updatePublicChat, false);

// PRIVATE CHAT
function startPrivateChat(event) {
    if (event.data.substr(0, 4) != 'msg ') return;
    var name = event.data.substr(4).split(' ', 1)[0];
    var port = event.ports[0];
    // display a private chat UI
    var ul = document.getElementById('private');
    var li = document.createElement('li');
    var h3 = document.createElement('h3');
    h3.textContent = 'Private chat with ' + name;
    li.appendChild(h3);
    var div = document.createElement('div');
    var addMessage = function(name, message) {
        var p = document.createElement('p');
        var n = document.createElement('strong');
        n.textContent = '<' + name + '>';
        p.appendChild(n);
        var t = document.createElement('span');
        t.textContent = message;
        p.appendChild(t);
        div.appendChild(p);
    }
There are several key things worth noting about the way the viewer is written.

**Multiple listeners.** Instead of a single message processing function, the code here attaches multiple event listeners, each one performing a quick check to see if it is relevant for the message. In this example it doesn't make much difference, but if multiple authors wanted to collaborate using a single port to communicate with a worker, it would allow for independent code instead of changes having to be made to a single event handling function.

Registering event listeners in this way also allows you to unregister specific listeners when you are done with them, as is done with the `configure()` method in this example.
Finally, the worker:

```javascript
var nextName = 0;
function getNextName() {
    // this could use more friendly names
    // but for now just return a number
    return nextName++;
}

var map = [
    [0, 0, 0, 0, 0, 0, 0],
    [1, 1, 0, 1, 0, 1, 1],
    [0, 1, 0, 1, 0, 0, 0],
    [0, 1, 0, 1, 0, 1, 1],
    [0, 0, 1, 0, 0, 0, 0],
    [1, 0, 1, 1, 1, 1, 0],
    [1, 1, 1, 1, 0, 1, 1],
];

function wrapX(x) {
    if (x < 0) return wrapX(x + map[0].length);
    if (x >= map[0].length) return wrapX(x - map[0].length);
    return x;
}

function wrapY(y) {
    if (y < 0) return wrapY(y + map.length);
    if (y >= map[0].length) return wrapY(y - map.length);
    return y;
}

function wrap(val, min, max) {
    if (val < min)
        return val + (max-min)+1;
    if (val > max)
        return val - (max-min)-1;
    return val;
}

function sendMapData(viewer) {
    var data = '';
    for (var y = viewer.y-1; y <= viewer.y+1; y += 1) {
        for (var x = viewer.x-1; x <= viewer.x+1; x += 1) {
            if (data != '')
                data += ',
            data += map[wrap(y, 0, map[0].length-1)][wrap(x, 0, map.length-1)];
        }
    }
    viewer.port.postMessage('map ' + data);
}

var viewers = {};
onconnect = function (event) {
    var name = getNextName();
    event.ports[0]._data = { port: event.ports[0], name: name, x: 0, y: 0, };
    viewers[name] = event.ports[0]._data;
    event.ports[0].postMessage('cfg ' + name);
    event.ports[0].onmessage = getMessage;
    sendMapData(event.ports[0]._data);
};

function getMessage(event) {
```
Connecting to multiple pages. The script uses the `onconnect` event listener to listen for multiple connections.

Direct channels. When the worker receives a "msg" message from one viewer naming another viewer, it sets up a direct connection between the two, so that the two viewers can communicate directly without the worker having to proxy all the messages.

View this example online.

10.1.2.5 Delegation

This section is non-normative.

With multicores CPUs becoming prevalent, one way to obtain better performance is to split computationally expensive tasks amongst multiple workers. In this example, a computationally expensive task that is to be performed for every number from 1 to 10,000,000 is farmed out to ten subworkers.

The main page is as follows, it just reports the result:

```html
<!DOCTYPE HTML>
<html lang="en">
<head>
  <meta charset="utf-8">
  <title>Worker example: Multicore computation</title>
</head>
```
The worker itself is as follows:

```javascript
// settings
var num_workers = 10;
var items_per_worker = 1000000;

// start the workers
var result = 0;
var pending_workers = num_workers;
for (var i = 0; i < num_workers; i += 1) {
    var worker = new Worker('core.js');
    worker.postMessage(i * items_per_worker);
    worker.postMessage((i+1) * items_per_worker);
    worker.onmessage = storeResult;
}

// handle the results
function storeResult(event) {
    result += 1*event.data;
    pending_workers -= 1;
    if (pending_workers <= 0)
        postMessage(result); // finished!
}
```

It consists of a loop to start the subworkers, and then a handler that waits for all the subworkers to respond.

The subworkers are implemented as follows:

```javascript
var start;
onmessage = getStart;
function getStart(event) {
    start = 1*event.data;
onmessage = getEnd;
}

var end;
function getEnd(event) {
    end = 1*event.data;
onmessage = null;
work();
}

function work() {
    var result = 0;
    for (var i = start; i < end; i += 1) {
        // perform some complex calculation here
        result += 1;
    }
    postMessage(result);
close();
```
They receive two numbers in two events, perform the computation for the range of numbers thus specified, and then report the result back to the parent.

*View this example online.*

### 10.1.2.6 Providing libraries

*This section is non-normative.*

Suppose that a cryptography library is made available that provides three tasks:

**Generate a public/private key pair**

Takes a port, on which it will send two messages, first the public key and then the private key.

**Given a plaintext and a public key, return the corresponding ciphertext**

Takes a port, to which any number of messages can be sent, the first giving the public key, and the remainder giving the plaintext, each of which is encrypted and then sent on that same channel as the ciphertext. The user can close the port when it is done encrypting content.

**Given a ciphertext and a private key, return the corresponding plaintext**

Takes a port, to which any number of messages can be sent, the first giving the private key, and the remainder giving the ciphertext, each of which is decrypted and then sent on that same channel as the plaintext. The user can close the port when it is done decrypting content.

The library itself is as follows:

```javascript
function handleMessage(e) {
    if (e.data == "genkeys")
        genkeys(e.ports[0]);
    else if (e.data == "encrypt")
        encrypt(e.ports[0]);
    else if (e.data == "decrypt")
        decrypt(e.ports[0]);
}

function genkeys(p) {
    var keys = _generateKeyPair();
    p.postMessage(keys[0]);
    p.postMessage(keys[1]);
}

function encrypt(p) {
    var key, state = 0;
    p.onmessage = function (e) {
        if (state == 0) {
            key = e.data;
            state = 1;
        } else {
            p.postMessage(_encrypt(key, e.data));
        }
    };
}

function decrypt(p) {
    var key, state = 0;
    p.onmessage = function (e) {
        if (state == 0) {
            key = e.data;
            state = 1;
```
// support being used as a shared worker as well as a dedicated worker
if ('onmessage' in this) // dedicated worker
    onmessage = handleMessage;
else // shared worker
    onconnect = function (e) { e.port.onmessage = handleMessage; }

// the "crypto" functions:

function _generateKeyPair() {
    return [Math.random(), Math.random()];
}

function _encrypt(k, s) {
    return 'encrypted-' + k + ' ' + s;
}

function _decrypt(k, s) {
    return s.substr(s.indexOf(' ') + 1);
}

Note that the crypto functions here are just stubs and don't do real cryptography.

This library could be used as follows:

```html
<!DOCTYPE HTML>
<html lang="en">
<head>
<meta charset="utf-8">
<title>Worker example: Crypto library</title>
<script>
    const cryptoLib = new Worker('libcrypto-v1.js'); // or could use 'libcrypto-v2.js'
    function startConversation(source, message) {
        const messageChannel = new MessageChannel();
        source.postMessage(message, [messageChannel.port2]);
        return messageChannel.port1;
    }
    function getKeys() {
        let state = 0;
        startConversation(cryptoLib, "genkeys").onmessage = function (e) {
            if (state === 0)
                document.getElementById('public').value = e.data;
            else if (state === 1)
                document.getElementById('private').value = e.data;
            state += 1;
        };
    }
    function enc() {
        const port = startConversation(cryptoLib, "encrypt");
        port.postMessage(document.getElementById('public').value);
        port.postMessage(document.getElementById('input').value);
        port.onmessage = function (e) {
            document.getElementById('input').value = e.data;
            port.close();
        };
    }
</script>
</head>
<body>
</body>
</html>
```
function dec() {
    const port = startConversation(cryptoLib, "decrypt");
    port.postMessage(document.getElementById('private').value);
    port.postMessage(document.getElementById('input').value);
    port.onmessage = function(e) {
        document.getElementById('input').value = e.data;
        port.close();
    };
}
</script>
<style>
textarea { display: block; }
</style>
</head>
<body onload="getKeys()"

<form>

<fieldset>
<legend>Keys</legend>
<p><label>Public Key: <textarea id="public"></textarea></label></p>
<p><label>Private Key: <textarea id="private"></textarea></label></p>
</fieldset>
<p><label>Input: <textarea id="input"></textarea></label></p>
<button onclick="enc()">Encrypt</button> <button onclick="dec()">Decrypt</button>
</form>

A later version of the API, though, might want to offload all the crypto work onto subworkers. This could be done as follows:

```javascript
function handleMessage(e) {
    if (e.data == "genkeys")
        genkeys(e.ports[0]);
    else if (e.data == "encrypt")
        encrypt(e.ports[0]);
    else if (e.data == "decrypt")
        decrypt(e.ports[0]);
}

function genkeys(p) {
    var generator = new Worker('libcrypto-v2-generator.js');
    generator.postMessage('', [p]);
}

function encrypt(p) {
    p.onmessage = function(e) {
        var key = e.data;
        var encryptor = new Worker('libcrypto-v2-encryptor.js');
        encryptor.postMessage(key, [p]);
    };
}

function decrypt(p) {
    p.onmessage = function(e) {
        var key = e.data;
        var decryptor = new Worker('libcrypto-v2-decryptor.js');
        decryptor.postMessage(key, [p]);
    };
}

// support being used as a shared worker as well as a dedicated worker
if ('onmessage' in this) // dedicated worker
    onmessage = handleMessage;
else // shared worker
    onconnect = function(e) { e.ports[0].onmessage = handleMessage;};
```
The little subworkers would then be as follows.

For generating key pairs:

```javascript
onmessage = function (e) {
    var k = _generateKeyPair();
    e.ports[0].postMessage(k[0]);
    e.ports[0].postMessage(k[1]);
    close();
}

function _generateKeyPair() {
    return [Math.random(), Math.random()];
}
```

For encrypting:

```javascript
onmessage = function (e) {
    var key = e.data;
    e.ports[0].onmessage = function (e) {
        var s = e.data;
        postMessage(_encrypt(key, s));
    }
}

function _encrypt(k, s) {
    return 'encrypted-' + k + ' ' + s;
}
```

For decrypting:

```javascript
onmessage = function (e) {
    var key = e.data;
    e.ports[0].onmessage = function (e) {
        var s = e.data;
        postMessage(_decrypt(key, s));
    }
}

function _decrypt(k, s) {
    return s.substr(s.indexOf(' ') + 1);
}
```

Notice how the users of the API don't have to even know that this is happening — the API hasn't changed; the library can delegate to subworkers without changing its API, even though it is accepting data using message channels.

View this example online.

---

10.1.3 Tutorials

10.1.3.1 Creating a dedicated worker

This section is non-normative.

Creating a worker requires a URL to a JavaScript file. The `Worker()` constructor is invoked with the URL to that file as its only argument; a worker is then created and returned:

```javascript
var worker = new Worker('helper.js');
```

If you want your worker script to be interpreted as a module script instead of the default classic script, you need to use a
slightly different signature:

```javascript
var worker = new Worker('helper.mjs', { type: "module" });
```

### 10.1.3.2 Communicating with a dedicated worker

This section is non-normative.

Dedicated workers use `MessagePort` objects behind the scenes, and thus support all the same features, such as sending structured data, transferring binary data, and transferring other ports.

To receive messages from a dedicated worker, use the `onmessage` event handler IDL attribute on the `Worker` object:

```javascript
worker.onmessage = function (event) { ... ;
```

You can also use the `addEventListener()` method.

**Note**

The implicit `MessagePort` used by dedicated workers has its `port message queue` implicitly enabled when it is created, so there is no equivalent to the `MessagePort` interface's `start()` method on the `Worker` interface.

To send data to a worker, use the `postMessage()` method. Structured data can be sent over this communication channel. To send `ArrayBuffer` objects efficiently (by transferring them rather than cloning them), list them in an array in the second argument.

```javascript
worker.postMessage(
    {
        operation: 'find-edges',
        input: buffer, // an ArrayBuffer object
        threshold: 0.6,
    }, [buffer]);
```

To receive a message inside the worker, the `onmessage` event handler IDL attribute is used.

```javascript
onmessage = function (event) { ... ;
```

You can again also use the `addEventListener()` method.

In either case, the data is provided in the event object's `data` attribute.

To send messages back, you again use `postMessage()`. It supports the structured data in the same manner.

```javascript
postMessage(event.data.input, [event.data.input]); // transfer the buffer back
```

### 10.1.3.3 Shared workers

This section is non-normative.

Shared workers are identified by the URL of the script used to create it, optionally with an explicit name. The name allows multiple instances of a particular shared worker to be started.

Shared workers are scoped by `origin`. Two different sites using the same names will not collide. However, if a page tries to use the same shared worker name as another page on the same site, but with a different script URL, it will fail.

Creating shared workers is done using the `SharedWorker()` constructor. This constructor takes the URL to the script to use for its first argument, and the name of the worker, if any, as the second argument.

```javascript
var worker = new SharedWorker('service.js');
```
Communicating with shared workers is done with explicit `MessagePort` objects. The object returned by the `SharedWorker()` constructor holds a reference to the port on its `port` attribute.

```javascript
worker.port.onmessage = function (event) { ... }; 
worker.port.postMessage('some message'); 
worker.port.postMessage({ foo: 'structured', bar: ['data', 'also', 'possible'] });
```

Inside the shared worker, new clients of the worker are announced using the `connect` event. The port for the new client is given by the event object's `source` attribute.

```javascript
onconnect = function (event) {
  var newPort = event.source;
  // set up a listener
  newPort.onmessage = function (event) { ... };
  // send a message back to the port
  newPort.postMessage('ready!'); // can also send structured data, of course
};
```

### 10.2 Infrastructure

This standard defines two kinds of workers: dedicated workers, and shared workers. Dedicated workers, once created, are linked to their creator, but message ports can be used to communicate from a dedicated worker to multiple other browsing contexts or workers. Shared workers, on the other hand, are named, and once created any script running in the same `origin` can obtain a reference to that worker and communicate with it. *Service Workers* defines a third kind. [SW]  

#### 10.2.1 The global scope

The global scope is the "inside" of a worker.

#### 10.2.1.1 The `WorkerGlobalScope` common interface

IDL

```javascript
[Exposed=Worker]
interface WorkerGlobalScope : EventTarget {
  readonly attribute WorkerGlobalScope self;
  readonly attribute WorkerLocation location;
  readonly attribute WorkerNavigator navigator;
  undefined importScripts(ScriptURLString... urls);

  attribute OnErrorEventHandler onerror;
  attribute EventHandler onlanguagechange;
  attribute EventHandler onoffline;
  attribute EventHandler ononline;
  attribute EventHandler onrejectionhandled;
  attribute EventHandler onunhandledrejection;
};
```

A `WorkerGlobalScope` object has an associated `owner set` (a `set` of `Document` and `WorkerGlobalScope` objects). It is initially empty and populated when the worker is created or obtained.

**Note**

It is a `set`, instead of a single owner, to accommodate `SharedWorkerGlobalScope` objects.
A WorkerGlobalScope object has an associated type ("classic" or "module"). It is set during creation.

A WorkerGlobalScope object has an associated url (null or a URL). It is initially null.

A WorkerGlobalScope object has an associated name (a string). It is set during creation.

A WorkerGlobalScope object has an associated policy container (a policy container). It is initially a new policy container.

A WorkerGlobalScope object has an associated embedder policy (an embedder policy). For ServiceWorkerGlobalScope objects, it doesn't make sense (and as such isn't exposed through the JavaScript API at all).

A WorkerGlobalScope object has an associated module map. It is a module map, initially empty.

A WorkerGlobalScope object has an associated cross-origin isolated capability boolean. It is initially false.

The self attribute must return the WorkerGlobalScope object itself.

The location attribute must return the WorkerLocation object whose associated WorkerGlobalScope object is the WorkerGlobalScope object.

The name can have different semantics for each subclass of WorkerGlobalScope. For DedicatedWorkerGlobalScope instances, it is simply a developer-supplied name, useful mostly for debugging purposes. For SharedWorkerGlobalScope instances, it allows obtaining a reference to a common shared worker via the SharedWorker constructor. For ServiceWorkerGlobalScope objects, it doesn't make sense (and as such isn't exposed through the JavaScript API at all).

For web developers (non-normative)

workerGlobal.self Returns workerGlobal.

workerGlobal.location Returns workerGlobal's WorkerLocation object.

workerGlobal.navigator Returns workerGlobal's WorkerNavigator object.

workerGlobal.importScripts( ...urls) Fetches each URL in urls, executes them one-by-one in the order they are passed, and then returns (or throws if something went amiss).

The self attribute must return the WorkerGlobalScope object itself.

The location attribute must return the WorkerLocation object whose associated WorkerGlobalScope object is the WorkerGlobalScope object.

For web developers (non-normative)

workerGlobal.self

workerGlobal.location

workerGlobal.navigator

workerGlobal.importScripts( ...urls)

The following are the event handlers (and their corresponding event handler event types) that must be supported, as event handler IDL attributes, by objects implementing the WorkerGlobalScope interface:

<table>
<thead>
<tr>
<th>Event handler</th>
<th>Event handler event type</th>
</tr>
</thead>
<tbody>
<tr>
<td>onerror</td>
<td>error</td>
</tr>
<tr>
<td>onlanguagechange</td>
<td>languagelanguage</td>
</tr>
<tr>
<td>onoffline</td>
<td>offline</td>
</tr>
<tr>
<td>ononline</td>
<td>online</td>
</tr>
<tr>
<td>onrejectionhandled</td>
<td>rejectionrejection</td>
</tr>
<tr>
<td>onunhandledrejection</td>
<td>unhandledrejection</td>
</tr>
</tbody>
</table>

10.2.1.2 Dedicated workers and the DedicatedWorkerGlobalScope interface

IDL [Global=(Worker,DedicatedWorker),Exposed=DedicatedWorker]
DedicatedWorkerGlobalScope objects act as if they had an implicit MessagePort associated with them. This port is part of a channel that is set up when the worker is created, but it is not exposed. This object must never be garbage collected before the DedicatedWorkerGlobalScope object.

All messages received by that port must immediately be retargeted at the DedicatedWorkerGlobalScope object.

For web developers (non-normative)

`dedicatedWorkerGlobal.name` returns `dedicatedWorkerGlobal.name`, i.e. the value given to the Worker constructor. Primarily useful for debugging.

`dedicatedWorkerGlobal.postMessage(message [, transfer])` clones `message` and transmits it to the Worker object associated with `dedicatedWorkerGlobal`. `transfer` can be passed as a list of objects that are to be transferred rather than cloned.

`dedicatedWorkerGlobal.close()` aborts `dedicatedWorkerGlobal`.

The `name` getter steps are to return `this.name`, its value represents the name given to the worker using the Worker constructor, used primarily for debugging purposes.

The `postMessage(message, transfer)` and `postMessage(message, options)` methods on DedicatedWorkerGlobalScope objects act as if, when invoked, it immediately invoked the respective `postMessage(message, transfer)` and `postMessage(message, options)` on the port, with the same arguments, and returned the same return value.

To close a worker, given a `workerGlobal`, run these steps:

1. Discard any `tasks` that have been added to `workerGlobal`'s `relevant agent`'s event loop's task queues.
2. Set `workerGlobal`'s closing flag to true. (This prevents any further tasks from being queued.)

The `close()` method steps are to close a worker given this.

The following are the event handlers (and their corresponding event handler event types) that must be supported, as event handler IDL attributes, by objects implementing the DedicatedWorkerGlobalScope interface:

<table>
<thead>
<tr>
<th>Event handler</th>
<th>Event handler event type</th>
</tr>
</thead>
<tbody>
<tr>
<td>onmessage</td>
<td>message</td>
</tr>
<tr>
<td>onmessageerror</td>
<td>messageerror</td>
</tr>
</tbody>
</table>

10.2.1.3 Shared workers and the SharedWorkerGlobalScope interface

IDL `[Global=(Worker,SharedWorker),Exposed=SharedWorker]` interface

```
interface SharedWorkerGlobalScope : WorkerGlobalScope {
    [Replaceable] readonly attribute DOMString name;
}
```
A `SharedWorkerGlobalScope` object has an associated `constructor origin`, `constructor url`, and `credentials`. They are initialized when the `SharedWorkerGlobalScope` object is created, in the `run a worker` algorithm.

Shared workers receive message ports through `connect` events on their `SharedWorkerGlobalScope` object for each connection.

### For web developers (non-normative)

**`sharedWorkerGlobal.name`**

Returns `sharedWorkerGlobal`'s `name`, i.e. the value given to the `SharedWorker` constructor. Multiple `SharedWorker` objects can correspond to the same shared worker (and `SharedWorkerGlobalScope`), by reusing the same name.

**`sharedWorkerGlobal.close()`**

Aborts `sharedWorkerGlobal`.

The `name` getter steps are to return this's `name`, its value represents the name that can be used to obtain a reference to the worker using the `SharedWorker` constructor.

The `close()` method steps are to close a worker given this.

The following are the `event handlers` (and their corresponding `event handler event types`) that must be supported, as `event handler IDL attributes`, by objects implementing the `SharedWorkerGlobalScope` interface:

<table>
<thead>
<tr>
<th>Event handler</th>
<th>Event handler event type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>onconnect</code></td>
<td><code>connect</code></td>
</tr>
</tbody>
</table>

### 10.2.2 The event loop

A `worker event loop`'s task queues only have events, callbacks, and networking activity as `tasks`. These `worker event loops` are created by the `run a worker` algorithm.

Each `WorkerGlobalScope` object has a `closing` flag, which must be initially false, but which can get set to true by the algorithms in the processing model section below.

Once the `WorkerGlobalScope`'s `closing` flag is set to true, the `event loop`'s `task queues` must discard any further `tasks` that would be added to them (tasks already on the queue are unaffected except where otherwise specified). Effectively, once the `closing` flag is true, timers stop firing, notifications for all pending background operations are dropped, etc.

### 10.2.3 The worker's lifetime

Workers communicate with other workers and with `Window`s through `message channels` and their `MessagePort` objects.

Each `WorkerGlobalScope` object worker global scope has a list of the worker's ports, which consists of all the `MessagePort` objects that are entangled with another port and that have one (but only one) port owned by worker global scope. This list includes the implicit `MessagePort` in the case of dedicated workers.

Given an environment settings object, when creating or obtaining a worker, the relevant owner to add depends on the type of global object specified by o. If o's `global object` is a `WorkerGlobalScope` object (i.e., if we are creating a nested dedicated worker), then the relevant owner is that global object. Otherwise, o's `global object` is a `Window` object, and the relevant owner is that `Window`'s associated `Document`.
A worker is said to be a **permissible worker** if its `WorkerGlobalScope`'s `owner set` is not `empty` or:

- its `owner set` has been `empty` for no more than a short implementation-defined timeout value,
- its `WorkerGlobalScope` object is a `SharedWorkerGlobalScope` object (i.e., the worker is a shared worker), and
- the user agent has a `navigator` whose `active document` is not `completely loaded`.

Note

The second part of this definition allows a shared worker to survive for a short time while a page is loading, in case that page is going to contact the shared worker again. This can be used by user agents as a way to avoid the cost of restarting a shared worker used by a site when the user is navigating from page to page within that site.

A worker is said to be an **active needed worker** if any of its owners are either `Document` objects that are fully active or `active needed workers`.

A worker is said to be a **protected worker** if it is an `active needed worker` and either it has outstanding timers, database transactions, or network connections, or its list of the worker's ports is not empty, or its `WorkerGlobalScope` is actually a `SharedWorkerGlobalScope` object (i.e., the worker is a shared worker).

A worker is said to be a **suspendable worker** if it is not an `active needed worker` but it is a `permissible worker`.

10.2.4 Processing model

When a user agent is to **run a worker** for a script with `Worker` or `SharedWorker` object `worker`, `URL` `url`, `environment settings object` `outside settings`, `MessagePort` `outside port`, and a `WorkerOptions` dictionary `options`, it must run the following steps.

1. Let `is shared` be true if `worker` is a `SharedWorker` object, and false otherwise.

2. Let `owner` be the `relevant owner` given `outside settings`.

3. Let `unsafeWorkerCreationTime` be the `unsafe shared current time`.

4. Let `agent` be the result of `obtaining a dedicated/shared worker agent` given `outside settings` and `is shared`. Run the rest of these steps in that agent.

5. Let `realm execution context` be the result of `creating a new realm` given `agent` and the following customizations:

   - For the global object, if `is shared` is true, create a new `SharedWorkerGlobalScope` object. Otherwise, create a new `DedicatedWorkerGlobalScope` object.

6. Let `worker global scope` be the `global object` of `realm execution context`'s Realm component.

   Note

   This is the `DedicatedWorkerGlobalScope` or `SharedWorkerGlobalScope` object created in the previous step.

7. Set up a `worker environment settings object` with `realm execution context`, `outside settings`, and `unsafeWorkerCreationTime`, and let `inside settings` be the result.

8. Set `worker global scope`'s `name` to the value of `options`'s `name` member.


10. If `is shared` is true, then:

    1. Set `worker global scope`'s `constructor origin` to `outside settings`' `origin`.
    2. Set `worker global scope`'s `constructor url` to `url`.
    3. Set `worker global scope`'s `type` to the value of `options`'s `type` member.
    4. Set `worker global scope`'s `credentials` to the value of `options`'s `credentials` member.

11. Let `destination` be "sharedworker" if `is shared` is true, and "worker" otherwise.

12. Obtain `script` by switching on the value of `options`'s `type` member:
"classic"

Fetch a classic worker script given url, outside settings, destination, inside settings, and with onComplete and performFetch as defined below.

"module"

Fetch a module worker script graph given url, outside settings, destination, the value of the credentials member of options, inside settings, and with onComplete and performFetch as defined below.

In both cases, let performFetch be the following perform the fetch hook given request, isTopLevel and performCustomFetchResponse:

1. If isTopLevel is false, fetch request with processResponseConsumeBody set to performCustomFetchResponse, and abort these steps.
2. Set request's reserved client to inside settings.
3. Fetch request with processResponseConsumeBody set to the following steps given response response and null, failure, or a byte sequence bodyBytes:
   1. Set worker global scope's url to response's url.
   2. Initialize worker global scope's policy container given worker global scope, response, and inside settings.
   3. If the Run CSP initialization for a global object algorithm returns "Blocked" when executed upon worker global scope, set response to a network error.
   4. If worker global scope's embedder policy's value is compatible with cross-origin isolation and is shared is true, then set agent's agent cluster's cross-origin isolation mode to "logical" or "concrete". The one chosen is implementation-defined.

This really ought to be set when the agent cluster is created, which requires a redesign of this section.

5. If the result of checking a global object's embedder policy with worker global scope, outside settings, and response is false, then set response to a network error.
6. Set worker global scope's cross-origin isolated capability to true if agent's agent cluster's cross-origin isolation mode is "concrete".
7. If is shared is false and owner's cross-origin isolated capability is false, then set worker global scope's cross-origin isolated capability to false.
8. If is shared is false and response's url's scheme is "data", then set worker global scope's cross-origin isolated capability to false.

Note

This is a conservative default for now, while we figure out how workers in general, and data: URL workers in particular (which are cross-origin from their owner), will be treated in the context of permissions policies. See w3c/webappsec-permissions-policy issue #207 for more details.


In both cases, let onComplete given script be the following steps:

1. If script is null or if script's error to rethrow is non-null, then:
   1. Queue a global task on the DOM manipulation task source given worker's relevant global object to fire an event named error at worker.
   2. Run the environment discarding steps for inside settings.
   3. Abort these steps.
2. Associate worker with worker global scope.
3. Let inside port be a new MessagePort object in inside settings's realm.
4. Associate inside port with worker global scope.

5. **Entangle** outside port and inside port.

6. Create a new `WorkerLocation` object and associate it with worker global scope.

7. **Closing orphan workers**: Start monitoring the worker such that no sooner than it stops being a protected worker, and no later than it stops being a permissible worker, worker global scope's `closing` flag is set to true.

8. **Suspending workers**: Start monitoring the worker, such that whenever worker global scope's `closing` flag is false and the worker is a suspensible worker, the user agent suspends execution of script in that worker until such time as either the `closing` flag switches to true or the worker stops being a suspensible worker.

9. **Set inside settings's `execution ready flag`**.

10. If script is a *classic script*, then run the classic script script. Otherwise, it is a *module script*; run the module script script.

   **Note**
   In addition to the usual possibilities of returning a value or failing due to an exception, this could be prematurely aborted by the terminate a worker algorithm defined below.

11. Enable outside port's port message queue.

12. If is shared is false, enable the port message queue of the worker's implicit port.

13. If is shared is true, then queue a global task on DOM manipulation task source given worker global scope to fire an event named `connect` at worker global scope, using `MessageEvent`, with the `data` attribute initialized to the empty string, the `ports` attribute initialized to a new frozen array containing inside port, and the `source` attribute initialized to inside port.

14. Enable the client message queue of the `ServiceWorkerContainer` object whose associated service worker client is worker global scope's relevant settings object.

15. **Event loop**: Run the responsible event loop specified by inside settings until it is destroyed.

   **Note**
   The handling of events or the execution of callbacks by tasks run by the event loop might get prematurely aborted by the terminate a worker algorithm defined below.

   **Note**
   The worker processing model remains on this step until the event loop is destroyed, which happens after the `closing` flag is set to true, as described in the event loop processing model.

16. Clear the worker global scope's map of active timers.

17. Disentangle all the ports in the list of the worker's ports.

18. Empty worker global scope's owner set.

When a user agent is to **terminate a worker** it must run the following steps in parallel, with the worker's main loop (the "run a worker" processing model defined above):

1. Set the worker's `WorkerGlobalScope` object's `closing` flag to true.

2. If there are any tasks queued in the `WorkerGlobalScope` object's relevant agent's event loop's task queues, discard them without processing them.

3. **Abort the script** currently running in the worker.

4. If the worker's `WorkerGlobalScope` object is actually a DedicatedWorkerGlobalScope object (i.e. the worker is a dedicated worker), then empty the port message queue of the port that the worker's implicit port is entangled with.

User agents may invoke the **terminate a worker** algorithm when a worker stops being an active needed worker and the worker...
continues executing even after its `closing` flag was set to true.

### 10.2.5 Runtime script errors

Whenever an uncaught runtime script error occurs in one of the worker's scripts, if the error did not occur while handling a previous script error, the user agent must report the error for that script, with the position (line number and column number) where the error occurred, using the `WorkerGlobalScope` object as the target.

For shared workers, if the error is still not handled afterwards, the error may be reported to a developer console.

For dedicated workers, if the error is still not handled afterwards, the user agent must queue a task to run these steps:

1. Let `notHandled` be the result of firing an event named `error` at the `Worker` object associated with the worker, using `ErrorEvent`, with the `cancelable` attribute initialized to true, the `message`, `filename`, `lineno`, and `colno` attributes initialized appropriately, and the `error` attribute initialized to null.

2. If `notHandled` is true, then the user agent must act as if the uncaught runtime script error had occurred in the global scope that the `Worker` object is in, thus repeating the entire runtime script error reporting process one level up.

If the implicit port connecting the worker to its `Worker` object has been disentangled (i.e. if the parent worker has been terminated), then the user agent must act as if the `Worker` object had no `error` event handler and as if that worker's `onerror` attribute was null, but must otherwise act as described above.

**Note**

Thus, error reports propagate up to the chain of dedicated workers up to the original `Document`, even if some of the workers along this chain have been terminated and garbage collected.

The task source for the task mentioned above is the DOM manipulation task source.

### 10.2.6 Creating workers

#### 10.2.6.1 The `AbstractWorker` mixin

```idl
interface mixin AbstractWorker {
    attribute EventHandler onerror;
};
```

The following are the event handlers (and their corresponding event handler event types) that must be supported, as event handler IDL attributes, by objects implementing the `AbstractWorker` interface:

- `onerror` event type
- `error` event

#### 10.2.6.2 Script settings for workers

To set up a worker environment settings object, given a JavaScript execution context, an environment settings object outside settings, and a number `unsafeWorkerCreationTime`:

1. Let `inherited origin` be outside settings's `origin`.
2. Let `realm` be the value of execution context's Realm component.
3. Let `worker global scope` be `realm`'s `global object`.
4. Let `settings object` be a new `environment settings object` whose algorithms are defined as follows:
The **realm execution context**

Return execution context.

The **module map**

Return worker global scope's **module map**.

The **API base URL**

Return worker global scope's **url**.

The **origin**

Return a unique **opaque origin** if worker global scope's **url**'s **scheme** is "data", and inherited origin otherwise.

The **policy container**

Return worker global scope's **policy container**.

The **cross-origin isolated capability**

Return worker global scope's **cross-origin isolated capability**.

The **time origin**

Return the result of coarsening unsafeWorkerCreationTime with worker global scope's **cross-origin isolated capability**.

5. Set settings object's **id** to a new unique opaque string, **creation URL** to worker global scope's **url**, **top-level creation URL** to null, **target browsing context** to null, and **active service worker** to null.

6. If worker global scope is a **DedicatedWorkerGlobalScope** object, then set settings object's **top-level origin** to outside settings's **top-level origin**.

7. Otherwise, set settings object's **top-level origin** to an implementation-defined value.

8. Set realm's [[HostDefined]] field to settings object.

9. Return settings object.

### 10.2.6.3 Dedicated workers and the **Worker** interface

```idl
[Exposed=(Window,DedicatedWorker,SharedWorker)]
interface Worker : EventTarget {
    constructor(ScriptURLString scriptURL, optional WorkerOptions options = {});

    undefined terminate();

    undefined postMessage(any message, sequence<object> transfer);
    undefined postMessage(any message, optional StructuredSerializeOptions options = {});
    attribute EventHandler onmessage;
    attribute EventHandler onmessageerror;
};

dictionary WorkerOptions {
    WorkerType type = "classic";
    RequestCredentials credentials = "same-origin"; // credentials is only used if type is "module"
    DOMString name = "";
};

denum WorkerType { "classic", "module" };

Worker includes AbstractWorker;
```
The `terminate()` method, when invoked, must cause the terminate a worker algorithm to be run on the worker with which the object is associated. `Worker` objects act as if they had an implicit `MessagePort` associated with them. This port is part of a channel that is set up when the worker is created, but it is not exposed. This object must never be garbage collected before the `Worker` object. All messages received by that port must immediately be retargeted at the `Worker` object.

The `postMessage(message, transfer)` and `postMessage(message, options)` methods on `Worker` objects act as if, when invoked, they immediately invoked the respective `postMessage(message, transfer)` and `postMessage(message, options)` on the port, with the same arguments, and returned the same return value.

The following are the event handlers (and their corresponding event handler event types) that must be supported, as event handler IDL attributes, by objects implementing the `Worker` interface:

<table>
<thead>
<tr>
<th>Event handler</th>
<th>Event handler event type</th>
</tr>
</thead>
<tbody>
<tr>
<td>onmessage</td>
<td>message</td>
</tr>
<tr>
<td>onmessageerror</td>
<td>messageerror</td>
</tr>
</tbody>
</table>

When the `Worker(scriptURL, options)` constructor is invoked, the user agent must run the following steps:

1. Let outside settings be the current settings object.
2. Let worker URL be the result of encoding-parsing a URL given scriptURL, relative to outside settings.
3. If worker URL is failure, then throw a "SyntaxError" DOMException.
4. Let worker be a new `Worker` object.
5. Let outside port be a new `MessagePort` in outside settings's realm.
6. Associate the outside port with worker.
7. Run this step in parallel.
   1. Run a worker given worker, worker URL, outside settings, outside port, and options.

For web developers (non-normative)

```javascript
worker = new Worker(scriptURL [, options ])
```

Returns a new `Worker` object. `scriptURL` will be fetched and executed in the background, creating a new global environment for which `worker` represents the communication channel. `options` can be used to define the `name` of that global environment via the `name` option, primarily for debugging purposes. It can also ensure this new global environment supports JavaScript modules (specify type: "module"), and if that is specified, can also be used to specify how `scriptURL` is fetched through the `credentials` option.

```javascript
worker.terminate()
```

Aborts `worker`'s associated global environment.

```javascript
worker.postMessage(message [, transfer ])
worker.postMessage(message [, { transfer } ])
```

Clones `message` and transmits it to `worker`'s global environment. `transfer` can be passed as a list of objects that are to be transferred rather than cloned.

The `postMessage()` method's first argument can be structured data:

```javascript
worker.postMessage({opcode: 'activate', device: 1938, parameters: [23, 102]})
```

Example

Any same-origin URL (including `blob:` URLs) can be used. `data:` URLs can also be used, but they create a worker with an opaque origin.

Note

Any same-origin URL (including `blob:` URLs) can be used. `data:` URLs can also be used, but they create a worker with an opaque origin.
10.2.6.4 Shared workers and the `SharedWorker` interface

```
IDL [Exposed=Window]
interface SharedWorker : EventTarget {
  constructor(ScriptURLString scriptURL, optional (DOMString or WorkerOptions) options = {});
    readonly attribute MessagePort port;
};
SharedWorker includes AbstractWorker;
```

For web developers (non-normative)

`sharedWorker = new SharedWorker(scriptURL [, name ])`

Returns a new `SharedWorker` object. `scriptURL` will be fetched and executed in the background, creating a new global environment for which `sharedWorker` represents the communication channel. `name` can be used to define the `name` of that global environment.

`sharedWorker = new SharedWorker(scriptURL [, options ])`

Returns a new `SharedWorker` object. `scriptURL` will be fetched and executed in the background, creating a new global environment for which `sharedWorker` represents the communication channel. `options` can be used to define the `name` of that global environment via the `name` option. It can also ensure this new global environment supports JavaScript modules (specify type: "module"), and if that is specified, can also be used to specify how `scriptURL` is fetched through the credentials option. Note that attempting to construct a shared worker with `options` whose `type` or `credentials` values mismatch an existing shared worker will cause the returned `sharedWorker` to fire an error event and not connect to the existing shared worker.

`sharedWorker.port`

Returns `sharedWorker`'s `MessagePort` object which can be used to communicate with the global environment.

The `port` attribute must return the value it was assigned by the object's constructor. It represents the `MessagePort` for communicating with the shared worker.

A user agent has an associated `shared worker manager` which is the result of starting a new parallel queue.

**Note**

Each user agent has a single `shared worker manager` for simplicity. Implementations could use one per `origin`; that would not be observably different and enables more concurrency.

When the `SharedWorker(scriptURL, options)` constructor is invoked:

1. If `options` is a `DOMString`, set `options` to a new `WorkerOptions` dictionary whose `name` member is set to the value of `options` and whose other members are set to their default values.
2. Let `outside settings` be the `current settings object`.
3. Let `urlRecord` be the result of encoding-parsing a URL given `scriptURL`, relative to `outside settings`.

```
Note
Any same-origin URL (including blob: URLs) can be used. data: URLs can also be used, but they create a worker with an opaque origin.
```
4. If `urlRecord` is failure, then throw a "SyntaxError" `DOMException`.
5. Let `worker` be a new `SharedWorker` object.
6. Let `outside port` be a new `MessagePort` in `outside settings`'s `realm`.
7. Assign `outside port` to the `port` attribute of `worker`.
8. Let `callerIsSecureContext` be true if `outside settings` is a `secure context`; otherwise, false.
9. Let outside storage key be the result of running obtain a storage key for non-storage purposes given outside settings.

10. Enqueue the following steps¹⁴³ to the shared worker manager¹²¹⁸:
    1. Let worker global scope be null.
    2. For each scope in the list of all SharedWorkerGlobalScope¹²¹⁰ objects:
        1. Let worker storage key be the result of running obtain a storage key for non-storage purposes given scope's relevant settings object¹⁰⁷¹.
        2. If all of the following are true:
            ▪ worker storage key equals outside storage key;
            ▪ scope's closing¹²¹¹ flag is false;
            ▪ scope's constructor url¹²¹¹ equals urlRecord; and
            ▪ scope's name¹²⁰⁹ equals the value of option's name member
        then:
            1. Set worker global scope to scope.
            2. Break.
    3. If worker global scope is not null, but the user agent has been configured to disallow communication between the worker represented by the worker global scope and the scripts¹⁰⁷² whose settings object¹⁰⁷² is outside settings, then set worker global scope to null.
    4. If worker global scope is not null, then check if worker global scope's type¹²⁰⁹ and credentials¹²¹¹ match the options values. If not, queue a task to fire an event named error¹⁴⁵¹ and abort these steps.
    5. If worker global scope is not null, then run these subsubsteps:
        1. Let settings object be the relevant settings object¹⁰⁷¹ for worker global scope.
        2. Let workerIsSecureContext be true if settings object is a secure context¹⁰⁷¹; otherwise, false.
        3. If workerIsSecureContext is not callerIsSecureContext, then queue a task to fire an event named error¹⁴⁵¹ at worker and abort these steps. [SECURE-CONTEXTS]¹¹⁴⁶²
        4. Associate worker with worker global scope.
        5. Let inside port be a new MessagePort¹¹⁸⁵ in settings object's realm¹⁰⁶⁵.
        6. Entangle¹¹⁸⁶ outside port and inside port.
        7. Queue a task, using the DOM manipulation task source¹¹¹⁵, to fire an event named connect¹¹¹⁵ at worker global scope, using MessageEvent¹¹⁶⁹, with the data¹¹⁶⁹ attribute initialized to the empty string, the ports¹¹⁷⁸ attribute initialized to a new frozen array containing only inside port, and the source¹¹⁷⁸ attribute initialized to inside port.
        8. Append the relevant owner to add¹²¹¹ given outside settings to worker global scope's owner set¹²⁰⁸.
    6. Otherwise, in parallel, run a worker given worker, urlRecord, outside settings, outside port, and options.

11. Return worker.
interface mixin NavigatorConcurrentHardware {
  readonly attribute unsigned long long hardwareConcurrency;
}

For web developers (non-normative)

self.navigator.hardwareConcurrency

Returns the number of logical processors potentially available to the user agent.

The navigator.hardwareConcurrency attribute's getter must return a number between 1 and the number of logical processors potentially available to the user agent. If this cannot be determined, the getter must return 1.

User agents should err toward exposing the number of logical processors available, using lower values only in cases where there are user-agent specific limits in place (such as a limitation on the number of workers that can be created) or when the user agent desires to limit fingerprinting possibilities.

10.3 APIs available to workers

10.3.1 Importing scripts and libraries

The importScripts(...urls) method steps are to import scripts into worker global scope given this and urls.

To import scripts into worker global scope, given a WorkerGlobalScope object worker global scope, a list of scalar value strings urls, and an optional perform the fetch hook performFetch:

1. If worker global scope's type is "module", throw a TypeError exception.
2. Let settings object be the current settings object.
3. If urls is empty, return.
4. Let urlRecords be « ».
5. For each url of urls:
   1. Let urlRecord be the result of encoding-parsing a URL given url, relative to settings object.
   2. If urlRecord is failure, then throw a "SyntaxError" DOMException.
   3. Append urlRecord to urlRecords.
6. For each urlRecord of urlRecords:
   1. Fetch a classic worker-imported script given urlRecord and settings object, passing along performFetch if provided. If this succeeds, let script be the result. Otherwise, rethrow the exception.
   2. Run the classic script script, with the rethrow errors argument set to true.

Note

script will run until it either returns, fails to parse, fails to catch an exception, or gets prematurely aborted by the terminate a worker algorithm defined above.

If an exception was thrown or if the script was prematurely aborted, then abort all these steps, letting the exception or aborting continue to be processed by the calling script.

Note

Service Workers is an example of a specification that runs this algorithm with its own perform the fetch hook. [SW]
10.3.2 The `WorkerNavigator` interface

The `navigator` attribute of the `WorkerGlobalScope` interface must return an instance of the `WorkerNavigator` interface, which represents the identity and state of the user agent (the client):

```idl
[Exposed=Worker]
interface WorkerNavigator {
    WorkerNavigator includes NavigatorID;
    WorkerNavigator includes NavigatorLanguage;
    WorkerNavigator includes NavigatorOnline;
    WorkerNavigator includes NavigatorConcurrentHardware;
}
```

10.3.3 The `WorkerLocation` interface

```idl
[Exposed=Worker]
interface WorkerLocation {
    stringifier readonly attribute USVString href;
    readonly attribute USVString origin;
    readonly attribute USVString protocol;
    readonly attribute USVString host;
    readonly attribute USVString hostname;
    readonly attribute USVString port;
    readonly attribute USVString pathname;
    readonly attribute USVString search;
    readonly attribute USVString hash;
};
```

A `WorkerLocation` object has an associated `WorkerGlobalScope` object (a `WorkerGlobalScope` object).

The `href` getter steps are to return this's `WorkerGlobalScope` object's `url`, serialized.

The `origin` getter steps are to return the serialization of this's `WorkerGlobalScope` object's `url`'s `origin`.

The `protocol` getter steps are to return this's `WorkerGlobalScope` object's `url`'s `scheme`, followed by `:`.

The `host` getter steps are:

1. Let `url` be this's `WorkerGlobalScope` object's `url`.
2. If `url`'s `host` is null, return the empty string.
3. If `url`'s `port` is null, return `url`'s `host`, serialized.
4. Return `url`'s `host`, serialized, followed by `:` and `url`'s `port`, serialized.

The `hostname` getter steps are:

1. Let `host` be this's `WorkerGlobalScope` object's `url`'s `host`.
2. If `host` is null, return the empty string.
3. Return `host`, serialized.

The `port` getter steps are:

1. Let `port` be this's `WorkerGlobalScope` object's `url`'s `port`.
2. If `port` is null, return the empty string.
3. Return `port`, serialized.

The `pathname` getter steps are to return the result of URL path serializing this's `WorkerGlobalScope` object's `url`.


The **search** getter steps are:

1. Let `query` be this's `WorkerGlobalScope`'s `url`'s `query`.
2. If `query` is either null or the empty string, return the empty string.
3. Return `"?"`, followed by `query`.

The **hash** getter steps are:

1. Let `fragment` be this's `WorkerGlobalScope`'s `url`'s `fragment`.
2. If `fragment` is either null or the empty string, return the empty string.
3. Return `"#"`, followed by `fragment`. 
This section is non-normative.

Worklets are a piece of specification infrastructure which can be used for running scripts independent of the main JavaScript execution environment, while not requiring any particular implementation model.

The worklet infrastructure specified here cannot be used directly by web developers. Instead, other specifications build upon it to create directly usable worklet types, specialized for running in particular parts of the browser implementation pipeline.

This section is non-normative.

Allowing extension points to rendering, or other sensitive parts of the implementation pipeline such as audio output, is difficult. If extension points were done with full access to the APIs available on `Window`, engines would need to abandon previously-held assumptions for what could happen in the middle of those phases. For example, during the layout phase, rendering engines assume that no DOM will be modified.

Additionally, defining extension points in the `Window` environment would restrict user agents to performing work in the same thread as the `Window` object. (Unless implementations added complex, high-overhead infrastructure to allow thread-safe APIs, as well as thread-joining guarantees.)

Worklets are designed to allow extension points, while keeping guarantees that user agents currently rely on. This is done through new global environments, based on subclasses of `WorkletGlobalScope`.

Worklets are similar to web workers. However, they:

- Are thread-agnostic. That is, they are not designed to run on a dedicated separate thread, like each worker is. Implementations can run worklets wherever they choose (including on the main thread).
- Are able to have multiple duplicate instances of the global scope created, for the purpose of parallelism.
- Do not use an event-based API. Instead, classes are registered on the global scope, whose methods are invoked by the user agent.
- Have a reduced API surface on the global scope.
- Have a lifetime for their global object, which is defined by other specifications, often in an implementation-defined manner.

As worklets have relatively high overhead, they are best used sparingly. Due to this, a given `WorkletGlobalScope` is expected to be shared between multiple separate scripts. (This is similar to how a single `Window` is shared between multiple separate scripts.)

Worklets are a general technology that serve different use cases. Some worklets, such as those defined in CSS Painting API, provide extension points intended for stateless, idempotent, and short-running computations, which have special considerations as described in the next couple of sections. Others, such as those defined in Web Audio API, are used for stateful, long-running operations. [CSSPAINT] [WEBAUDIO]

This section is non-normative.

Some specifications which use worklets are intended to allow user agents to parallelize work over multiple threads, or to move work between threads as required. In these specifications, user agents might invoke methods on a web-developer-provided class in an implementation-defined order.

As a result of this, to prevent interoperability issues, authors who register classes on such `WorkletGlobalScope`s should make their
code idempotent. That is, a method or set of methods on the class should produce the same output given a particular input.

This specification uses the following techniques in order to encourage authors to write code in an idempotent way:

- No reference to the global object is available (i.e., there is no counterpart to `self` on `WorkletGlobalScope`).

  Although this was the intention when worklets were first specified, the introduction of `globalThis` has made it no longer true. See issue #6059 for more discussion.

- Code is loaded as a module script, which results in the code being executed in strict mode and with no shared referencing the global proxy.

Together, these restrictions help prevent two different scripts from sharing state using properties of the `global object`.

Additionally, specifications which use worklets and intend to allow implementation-defined behavior must obey the following:

- They must require user agents to always have at least two `WorkletGlobalScope` instances per `Worklet`, and randomly assign a method or set of methods on a class to a particular `WorkletGlobalScope` instance. These specifications may provide an opt-out under memory constraints.

- These specifications must allow user agents to create and destroy instances of their `WorkletGlobalScope` subclasses at any time.

### 11.1.3 Speculative evaluation

Some specifications which use worklets can invoke methods on a web-developer-provided class based on the state of the user agent. To increase concurrency between threads, a user agent may invoke a method speculatively, based on potential future states.

In these specifications, user agents might invoke such methods at any time, and with any arguments, not just ones corresponding to the current state of the user agent. The results of such speculative evaluations are not displayed immediately, but can be cached for use if the user agent state matches the speculated state. This can increase the concurrency between the user agent and worklet threads.

As a result of this, to prevent interoperability risks between user agents, authors who register classes on such `WorkletGlobalScope`s should make their code stateless. That is, the only effect of invoking a method should be its result, and not any side effects such as updating mutable state.

The same techniques which encourage code idempotence also encourage authors to write stateless code.

### 11.2 Examples

This section is non-normative.

For these examples, we'll use a fake worklet. The `Window` object provides two `Worklet` instances, which each run code in their own collection of `FakeWorkletGlobalScope`s:

```idl
partial interface Window {
  [SameObject, SecureContext] readonly attribute Worklet fakeWorklet1;
  [SameObject, SecureContext] readonly attribute Worklet fakeWorklet2;
};
```

Each `Window` has two `Worklet` instances, fake worklet 1 and fake worklet 2. Both of these have their `worklet global scope type` set to `FakeWorkletGlobalScope`, and their `worklet destination type` set to "fakeworklet". User agents should create at least two `FakeWorkletGlobalScope` instances per worklet.

**Note**

"fakeworklet" is not actually a valid destination per Fetch. But this illustrates how real worklets would generally have their own worklet-type-specific destination. [FETCH]

1224
The `fakeWorklet1` getter steps are to return this's `fake worklet 1`.

The `fakeWorklet2` getter steps are to return this's `fake worklet 2`.

```
IDL

[Global=(Worklet,FakeWorklet),
Exposed=FakeWorklet,
SecureContext]
interface FakeWorkletGlobalScope : WorkletGlobalScope {
  undefined registerFake(DOMString type, Function classConstructor);
};
```

Each `FakeWorkletGlobalScope` has a registered class constructors map, which is an ordered map, initially empty.

The `registerFake(type, classConstructor)` method steps are to set this's registered class constructors map to `classConstructor`.

### 11.2.1 Loading scripts

This section is non-normative.

To load scripts into `fake worklet 1`, a web developer would write:

```javascript
window.fakeWorklet1.addModule('script1.mjs');
window.fakeWorklet1.addModule('script2.mjs');
```

Note that which script finishes fetching and runs first is dependent on network timing: it could be either `script1.mjs` or `script2.mjs`. This generally won't matter for well-written scripts intended to be loaded in worklets, if they follow the suggestions about preparing for speculative evaluation.

If a web developer wants to perform a task only after the scripts have successfully run and loaded into some worklets, they could write:

```javascript
Promise.all([window.fakeWorklet1.addModule('script1.mjs'),
window.fakeWorklet2.addModule('script2.mjs')]).then(() => {
  // Do something which relies on those scripts being loaded.
});
```

Another important point about script-loading is that loaded scripts can be run in multiple `WorkletGlobalScope`s per `Worklet`, as discussed in the section on code idempotence. In particular, the specification above for `fake worklet 1` and `fake worklet 2` require this. So, consider a scenario such as the following:

```javascript
// script.mjs
console.log("Hello from a FakeWorkletGlobalScope!");

// app.mjs
window.fakeWorklet1.addModule("script.mjs");
```

This could result in output such as the following from a user agent's console:

```
[fakeWorklet1#1] Hello from a FakeWorkletGlobalScope!
[fakeWorklet1#4] Hello from a FakeWorkletGlobalScope!
[fakeWorklet1#2] Hello from a FakeWorkletGlobalScope!
[fakeWorklet1#3] Hello from a FakeWorkletGlobalScope!
```
If the user agent at some point decided to kill and restart the third instance of `FakeWorkletGlobalScope`, the console would again print `Hello from a FakeWorkletGlobalScope!` when this occurs.

### 11.2.2 Registering a class and invoking its methods

This section is non-normative.

Let’s say that one of the intended usages of our fake worklet by web developers is to allow them to customize the highly-complex process of boolean negation. They might register their customization as follows:

```javascript
// script.mjs
registerFake('negation-processor', class {
    process(arg) {
        return !arg;
    }
});

// app.mjs
window.fakeWorklet1.addModule("script.mjs");
```

To make use of such registered classes, the specification for fake worklets could define a find the opposite of true algorithm, given a `Worklet` worklet:

1. Optionally, create a worklet global scope for `worklet`.
2. Let `workletGlobalScope` be one of `worklet`'s `global scopes`, chosen in an implementation-defined manner.
3. Let `classConstructor be workletGlobalScope's registered class constructors map` for `"negation-processor"`.
4. Let `classInstance` be the result of constructing `classConstructor` with no arguments.
5. Let `function` be `Get(classInstance, "process")`. Rethrow any exceptions.
6. Let `callback` be the result of converting `function` to a Web IDL `Function` instance.
7. Return the result of invoking `callback` with the arguments « true » and with `classInstance` as the `callback this value`.

**Note**

Another, perhaps better, specification architecture would be to extract the "process" property and convert it into a `Function` at registration time, as part of the `registerFake()` method steps.

### 11.3 Infrastructure

#### 11.3.1 The global scope

Subclasses of `WorkletGlobalScope` are used to create `global objects` wherein code loaded into a particular `Worklet` can execute.

```idl
[Exposed=Worklet, SecureContext]
interface WorkletGlobalScope {};
```

**Note**

Other specifications are intended to subclass `WorkletGlobalScope`, adding APIs to register a class, as well as other APIs specific for their worklet type.

Each `WorkletGlobalScope` has an associated `module map`. It is a `module map`, initially empty.
11.3.1.1 Agents and event loops

This section is non-normative.

Each WorkletGlobalScope is contained in its own worklet agent, which has its corresponding event loop. However, in practice, implementation of these agents and event loops is expected to be different from most others.

A worklet agent exists for each WorkletGlobalScope since, in theory, an implementation could use a separate thread for each WorkletGlobalScope instance, and allowing this level of parallelism is best done using agents. However, because their [[CanBlock]] value is false, there is no requirement that agents and threads are one-to-one. This allows implementations the freedom to execute scripts loaded into a worklet on any thread, including one running code from other agents with [[CanBlock]] of false, such as the thread of a similar-origin window agent ("the main thread"). Contrast this with dedicated worker agents, whose true value for [[CanBlock]] effectively requires them to get a dedicated operating system thread.

Worklet event loops are also somewhat special. They are only used for tasks associated with addModule(), tasks wherein the user agent invokes author-defined methods, and microtasks. Thus, even though the event loop processing model specifies that all event loops run continuously, implementations can achieve observably-equivalent results using a simpler strategy, which just invokes author-provided methods and then relies on that process to perform a microtask checkpoint.

To create a worklet global scope for a Worklet worklet:

1. Let outsideSettings be worklet's relevant settings object.
2. Let agent be the result of obtaining a worklet agent given outsideSettings. Run the rest of these steps in that agent.
3. Let realmExecutionContext be the result of creating a new realm given agent and the following customizations:
   - For the global object, create a new object of the type given by worklet's worklet global scope type.
4. Let workletGlobalScope be the global object of realmExecutionContext's Realm component.
5. Let insideSettings be the result of setting up a worklet environment settings object given realmExecutionContext and outsideSettings.
6. Let pendingAddedModules be a clone of worklet's added modules list.
7. Let runNextAddedModule be the following steps:
   1. If pendingAddedModules is not empty, then:
      1. Let moduleURL be the result of dequeuing from pendingAddedModules.
      2. Fetch a worklet script graph given moduleURL, insideSettings, worklet's worklet destination type, what credentials mode? insideSettings, worklet's module responses map, and with the following steps given script:

         Note
         This will not actually perform a network request, as it will just reuse responses from worklet's module responses map. The main purpose of this step is to create a new workletGlobalScope-specific module script from the response.

         1. Assert: script is not null, since the fetch succeeded and the source text was successfully parsed when worklet's module responses map was initially populated with moduleURL.
         2. Run a module script given script.
         3. Run runNextAddedModule.
   2. Append workletGlobalScope to outsideSettings's global object's associated Document's worklet global scopes.
   3. Append workletGlobalScope to worklet's global scopes.
4. Run the responsible event loop specified by insideSettings.

8. Run runNextAddedModule.

To terminate a worklet global scope given a WorkletGlobalScope workletGlobalScope:

1. Let eventLoop be workletGlobalScope's relevant agent's event loop.
2. If there are any tasks queued in eventLoop's task queues, discard them without processing them.
3. Wait for eventLoop to complete the currently running task.
4. If the previous step doesn't complete within an implementation-defined period of time, then abort the script currently running in the worklet.
5. Destroy eventLoop.
6. Remove workletGlobalScope from the global scopes of the Worklet whose global scopes contains workletGlobalScope.
7. Remove workletGlobalScope from the worklet global scopes of the Document whose worklet global scopes contains workletGlobalScope.

11.3.1.3 Script settings for worklets

To set up a worklet environment settings object, given a JavaScript execution context executionContext and an environment settings object outsideSettings:

1. Let origin be a unique opaque origin.
2. Let inheritedAPIBaseURL be outsideSettings's API URL.
3. Let inheritedPolicyContainer be a clone of outsideSettings's policy container.
4. Let realm be the value of executionContext's Realm component.
5. Let workletGlobalScope be realm's global object.
6. Let settingsGlobalScope be a new environment settings object whose algorithms are defined as follows:

   The realm execution context
   Return executionContext.

   The module map
   Return workletGlobalScope's module map.

   The API base URL
   Return inheritedAPIBaseURL.

   Note
   Unlike workers or other globals derived from a single resource, worklets have no primary resource; instead, multiple scripts, each with their own URL, are loaded into the global scope via worklet.addModule(). So this API base URL is rather unlike that of other globals. However, so far this doesn't matter, as no APIs available to worklet code make use of the API base URL.

   The origin
   Return origin.

   The policy container
   Return inheritedPolicyContainer.

   The cross-origin isolated capability
   Return TODO.
The time origin\(^{p1064}\)

**Assert**: this algorithm is never called, because the time origin\(^{p1064}\) is not available in a worklet context.

7. Set settingsObject's id\(^{p1063}\) to a new unique opaque string, creation URL\(^{p1063}\) to inheritedAPIBaseURL, top-level creation URL\(^{p1063}\) to null, top-level origin\(^{p1064}\) to outsideSettings's top-level origin\(^{p1064}\), target browsing context\(^{p1064}\) to null, and active service worker\(^{p1064}\) to null.

8. Set realm's [[HostDefined]] field to settingsObject.


### 11.3.2 The Worklet\(^{p1229}\) class\(^{p112}\)

The Worklet\(^{p1229}\) class provides the capability to add module scripts into its associated WorkletGlobalScope\(^{p1226}\)'s. The user agent can then create classes registered on the WorkletGlobalScope\(^{p1226}\)'s and invoke their methods.

```idl
[Exposed=Window, SecureContext]
interface Worklet {
    [NewObject] Promise<undefined> addModule(USVString moduleURL, optional WorkletOptions options = {});
}

dictionary WorkletOptions {
    RequestCredentials credentials = "same-origin";
}
```

Specifications that create Worklet\(^{p1229}\) instances must specify the following for a given instance:

- its worklet global scope type, which must be a Web IDL type that inherits from WorkletGlobalScope\(^{p1226}\), and
- its worklet destination type, which must be a destination, and is used when fetching scripts.

**For web developers (non-normative)**

```javascript
await worklet.addModule(moduleURL, { credentials })
```

Loads and executes the module script\(^{p1072}\) given by moduleURL into all of worklet's global scopes\(^{p1229}\). It can also create additional global scopes as part of this process, depending on the worklet type. The returned promise will fulfill once the script has been successfully loaded and run in all global scopes.

The credentials\(^{p1229}\) option can be set to a credentials mode to modify the script-fetching process. It defaults to "same-origin".

Any failures in fetching the script or its dependencies will cause the returned promise to be rejected with an "AbortError" DOMException. Any errors in parsing the script or its dependencies will cause the returned promise to be rejected with the exception generated during parsing.

A Worklet\(^{p1229}\) has a list of global scopes, which contains instances of the Worklet\(^{p1229}\)'s worklet global scope type\(^{p1229}\). It is initially empty.

A Worklet\(^{p1229}\) has an added modules list, which is a list of URLs, initially empty. Access to this list should be thread-safe.

A Worklet\(^{p1229}\) has a module responses map, which is an ordered map from URLs to either "fetching" or tuples consisting of a response and either null, failure, or a byte sequence representing the response body. This map is initially empty, and access to it should be thread-safe.

**Note**

The added modules list\(^{p1229}\) and module responses map\(^{p1229}\) exist to ensure that WorkletGlobalScope\(^{p1226}\)'s created at different times get equivalent module scripts\(^{p1072}\) run in them, based on the same source text. This allows the creation of additional WorkletGlobalScope\(^{p1226}\)'s to be transparent to the author.

In practice, user agents are not expected to implement these data structures, and the algorithms that consult them, using thread-safe programming techniques. Instead, when addModule()\(^{p1230}\) is called, user agents can fetch the module graph on the main
The `addModule(moduleURL, options)` method steps are:

1. Let `outsideSettings` be the relevant settings object of this.
2. Let `moduleURLRecord` be the result of encoding-parsing a URL given `moduleURL`, relative to `outsideSettings`.
3. If `moduleURLRecord` is failure, then return a promise rejected with a "SyntaxError" DOMException.
4. Let `promise` be a new promise.
5. Run the following steps in parallel:
   1. If this's global scopes is empty, then:
      1. Create a worklet global scope given this.
      2. Optionally, create additional global scope instances given this, depending on the specific worklet in question and its specification.
      3. Wait for all steps of the creation process(es) — including those taking place within the worklet agents — to complete, before moving on.
   2. Let `pendingTasks` be this's global scopes's size.
   3. Let `addedSuccessfully` be false.
   4. For each `workletGlobalScope` of this's global scopes, queue a global task on the networking task source given `workletGlobalScope` to fetch a worklet script graph given `moduleURLRecord`, `outsideSettings`, this's worklet destination type, options("credentials"), `workletGlobalScope`'s relevant settings object, `this`'s module responses map, and the following steps given `script`:
      1. If `script` is null, then:
         1. Queue a global task on the networking task source given this's relevant global object to perform the following steps:
            1. If `pendingTasks` is not −1, then:
               1. Set `pendingTasks` to −1.
               2. Reject promise with an "AbortError" DOMException.
            2. Abort these steps.
      2. If `script`'s error to rethrow is not null, then:
         1. Queue a global task on the networking task source given this's relevant global object to perform the following steps:
            1. If `pendingTasks` is not −1, then:
               1. Set `pendingTasks` to −1.
               2. Reject promise with `script`'s error to rethrow.
         2. Abort these steps.

Note

Only the first of these fetches will actually perform a network request; the ones for other `WorkletGlobalScope`'s will reuse responses from this's module responses map.
3. If `addedSuccessfully` is false, then:
   1. Append `moduleURLRecord` to `this`'s added modules list\textsuperscript{1229}.
   2. Set `addedSuccessfully` to true.
4. Run a module script\textsuperscript{1084} given `script`.
5. Queue a global task\textsuperscript{1106} on the networking task source\textsuperscript{1115} given `this`'s relevant global object\textsuperscript{1071} to perform the following steps:
   1. If `pendingTasks` is not −1, then:
      1. Set `pendingTasks` to `pendingTasks` − 1.
      2. If `pendingTasks` is 0, then resolve `promise`.
6. Return `promise`.

### 11.3.3 The worklet’s lifetime \textsuperscript{5\textsuperscript{p12}}

The lifetime of a Worklet\textsuperscript{1229} has no special considerations; it is tied to the object it belongs to, such as the Window\textsuperscript{913}.

Each Document\textsuperscript{128} has a worklet global scopes, which is a set of WorkletGlobalScope\textsuperscript{1226}s, initially empty.

The lifetime of a WorkletGlobalScope\textsuperscript{1226} is, at a minimum, tied to the Document\textsuperscript{128} whose worklet global scopes\textsuperscript{1231} contain it. In particular, destroying\textsuperscript{1094} the Document\textsuperscript{128} will terminate\textsuperscript{1228} the corresponding WorkletGlobalScope\textsuperscript{1226} and allow it to be garbage-collected.

Additionally, user agents may, at any time, terminate\textsuperscript{1228} a given WorkletGlobalScope\textsuperscript{1226}, unless the specification defining the corresponding worklet type says otherwise. For example, they might terminate them if the worklet agent\textsuperscript{1060}’s event loop\textsuperscript{1104} has no tasks\textsuperscript{1105} queued, or if the user agent has no pending operations planning to make use of the worklet, or if the user agent detects abnormal operations such as infinite loops or callbacks exceeding imposed time limits.

Finally, specifications for specific worklet types can give more specific details on when to create\textsuperscript{1227} WorkletGlobalScope\textsuperscript{1226}s for a given worklet type. For example, they might create them during specific processes that call upon worklet code, as in the example\textsuperscript{1228}.
12 Web storage

12.1 Introduction

This section is non-normative.

This specification introduces two related mechanisms, similar to HTTP session cookies, for storing name-value pairs on the client side.

The first is designed for scenarios where the user is carrying out a single transaction, but could be carrying out multiple transactions in different windows at the same time.

Cookies don't really handle this case well. For example, a user could be buying plane tickets in two different windows, using the same site. If the site used cookies to keep track of which ticket the user was buying, then as the user clicked from page to page in both windows, the ticket currently being purchased would "leak" from one window to the other, potentially causing the user to buy two tickets for the same flight without noticing.

To address this, this specification introduces the sessionStorage getter. Sites can add data to the session storage, and it will be accessible to any page from the same site opened in that window.

Example

For example, a page could have a checkbox that the user ticks to indicate that they want insurance:

```html
<label>
  <input type="checkbox" onchange="sessionStorage.insurance = checked ? 'true' : ''">
  I want insurance on this trip.
</label>
```

A later page could then check, from script, whether the user had checked the checkbox or not:

```javascript
if (sessionStorage.insurance) { ... }
```

If the user had multiple windows opened on the site, each one would have its own individual copy of the session storage object.

The second storage mechanism is designed for storage that spans multiple windows, and lasts beyond the current session. In particular, web applications might wish to store megabytes of user data, such as entire user-authored documents or a user's mailbox, on the client side for performance reasons.

Again, cookies do not handle this case well, because they are transmitted with every request.

The localStorage getter is used to access a page's local storage area.

Example

The site at example.com can display a count of how many times the user has loaded its page by putting the following at the bottom of its page:

```html
<p>
  You have viewed this page an untold number of time(s).
</p>
<script>
  if (!localStorage.pageLoadCount) {
    localStorage.pageLoadCount = 0;
  }
</script>
```
Each site has its own separate storage area.

⚠️ **Warning!**

The `localStorage` getter provides access to shared state. This specification does not define the interaction with other agent clusters in a multiprocess user agent, and authors are encouraged to assume that there is no locking mechanism. A site could, for instance, try to read the value of a key, increment its value, then write it back out, using the new value as a unique identifier for the session; if the site does this twice in two different browser windows at the same time, it might end up using the same "unique" identifier for both sessions, with potentially disastrous effects.

### 12.2 The API

#### 12.2.1 The `Storage` interface

```idl
[Exposed=Window]
interface Storage {
    readonly attribute unsigned long length;
    DOMString? key(unsigned long index);
    getter DOMString? getItem(DOMString key);
    setter undefined setItem(DOMString key, DOMString value);
    deleter undefined removeItem(DOMString key);
    undefined clear();
};
```

For web developers (non-normative)

- **`storage.length`**
  - Returns the number of key/value pairs.

- **`storage.key(n)`**
  - Returns the name of the `n`th key, or null if `n` is greater than or equal to the number of key/value pairs.

- **`value = storage.getItem(key)`**

- **`value = storage[key]`**
  - Returns the current value associated with the given `key`, or null if the given `key` does not exist.

- **`storage.setItem(key, value)`**

- **`storage[key] = value`**
  - Sets the value of the pair identified by `key` to `value`, creating a new key/value pair if none existed for `key` previously.
  
  Throws a `QuotaExceededError` DOMException exception if the new value couldn't be set. (Setting could fail if, e.g., the user has disabled storage for the site, or if the quota has been exceeded.)

  Dispatches a `storage` event on `Window` objects holding an equivalent `Storage` object.

- **`storage.removeItem(key)`**

- **`delete storage[key]`**
  - Removes the key/value pair with the given `key`, if a key/value pair with the given `key` exists.

  Dispatches a `storage` event on `Window` objects holding an equivalent `Storage` object.
A `Storage` object has an associated:

**map**

A `storage proxy map`.

**type**

"local" or "session".

To reorder a `Storage` object storage, reorder storage's `map`'s entries in an implementation-defined manner.

To broadcast a `Storage` object storage, given a key, oldValue, and newValue, run these steps:

1. Let `thisDocument` be storage's relevant global object's associated `Document`.
2. Let `url` be `thisDocument`'s URL.
3. Let `remoteStorages` be all `Storage` objects excluding storage whose:
   - `type` is storage's `type`.
   - `relevant settings object`'s `origin` is same origin with storage's `relevant settings object`'s `origin`.
   and, if `type` is "session", whose `relevant settings object`'s associated `Document`'s `node navigable`'s `traversable navigable` is `thisDocument`'s `node navigable`'s `traversable navigable`.
4. For each remoteStorage of `remoteStorages`, queue a global task on the DOM manipulation task source given remoteStorage's `relevant global object` to fire an event named `storage` at remoteStorage's `relevant global object` using `StorageEvent`, with `key` initialized to key, `oldValue` initialized to oldValue, `newValue` initialized to newValue, `url` initialized to url, and `storageArea` initialized to remoteStorage.

The `length` getter steps are to return this's `map`'s `size`.

The `key(index)` method steps are:

1. If `index` is greater than or equal to this's `map`'s `size`, then return null.
2. Let `keys` be the result of running `get the keys` on this's `map`.

The `supported property names` on a `Storage` object storage are the result of running `get the keys` on storage's `map`.

The `getItem(key)` method steps are:

1. If this's `map`[key] does not exist, then return null.
2. Return this's `map`[key].

The `setItem(key, value)` method are:

1. Let `oldValue` be null.
2. Let reorder be true.

3. If this’s `map[key]` exists:
   1. Set oldValue to this’s `map[key]`.
   2. If oldValue is value, then return.
   3. Set reorder to false.

4. If value cannot be stored, then throw a "QuotaExceededError" DOMException exception.

5. Set this’s `map[key]` to value.

6. If reorder is true, then reorder this.

7. Broadcast this with key, oldValue, and value.

The `removeItem(key)` method steps are:

1. If this’s `map[key]` does not exist, then return null.

2. Set oldValue to this’s `map[key]`.

3. Remove this’s `map[key]`.

4. Reorder this.

5. Broadcast this with key, oldValue, and null.

The `clear()` method steps are:

1. Clear this’s map.

2. Broadcast this with null, null, and null.

12.2.2 The `sessionStorage` getter

```idl
interface mixin WindowSessionStorage {
  readonly attribute Storage sessionStorage;
};
```

For web developers (non-normative)

```javascript
window.sessionStorage
```

Returns the `Storage` object associated with that window’s origin’s session storage area.

Throws a "SecurityError" DOMException if the Document’s origin is an opaque origin or if the request violates a policy decision (e.g., if the user agent is configured to not allow the page to persist data).

A `Document` object has an associated session storage holder, which is null or a `Storage` object. It is initially null.

The `sessionStorage` getter steps are:

1. If this’s associated Document’s `sessionStorage` is non-null, then return this’s associated Document’s `sessionStorage`.

2. Let map be the result of running `obtain a session storage bottle map` with this’s relevant settings object and "sessionStorage".

3. If map is failure, then throw a "SecurityError" DOMException.

4. Let storage be a new `Storage` object whose `map` is map.

5. Set this’s associated Document’s `session storage holder` to storage.
6. Return storage.

Note
After creating a new auxiliary browsing context and document, the session storage is copied over.

12.2.3 The **localStorage** getter

IDL interface mixin WindowLocalStorage {
   readonly attribute Storage localStorage;
};

Window includes WindowLocalStorage;

For web developers (non-normative)

*window.localStorage*

Returns the Storage object associated with window's origin's local storage area.
Threws a "SecurityError" DOMException if the Document's origin is an opaque origin or if the request violates a policy decision (e.g., if the user agent is configured to not allow the page to persist data).

A Document object has an associated local storage holder, which is null or a Storage object. It is initially null.

The **localStorage** getter steps are:

1. If *this's* associated Document's local storage holder is non-null, then return *this's* associated Document's local storage holder.
2. Let *map* be the result of running obtain a local storage bottle map with *this's* relevant settings object and "localStorage".
3. If *map* is failure, then throw a "SecurityError" DOMException.
4. Let *storage* be a new Storage object whose *map* is *map*.
5. Set *this's* associated Document's local storage holder to *storage*.
6. Return *storage*.

12.2.4 The **StorageEvent** interface

IDL [Exposed=Window]

interface StorageEvent : Event {
   constructor(DOMString type, optional StorageEventInit eventInitDict = {});

   readonly attribute DOMString? *key*;
   readonly attribute DOMString? *oldValue*;
   readonly attribute DOMString? *newValue*;
   readonly attribute USVString *url*;
   readonly attribute Storage? *storageArea*;
}

undefined initStorageEvent(DOMString type, optional boolean bubbles = false, optional boolean cancelable = false, optional DOMString? *key* = null, optional DOMString? *oldValue* = null, optional DOMString? *newValue* = null, optional USVString *url* = "", optional Storage? *storageArea* = null);

dictionary StorageEventInit : EventInit {
   DOMString? *key* = null;
   DOMString? *oldValue* = null;
DOMString? newValue = null;
USVString url = "";
Storage? storageArea = null;
};

For web developers (non-normative)

**event.key**
Returns the key of the storage item being changed.

**event.oldValue**
Returns the old value of the key of the storage item whose value is being changed.

**event.newValue**
Returns the new value of the key of the storage item whose value is being changed.

**event.url**
Returns the URL of the document whose storage item changed.

**event.storageArea**
Returns the Storage object that was affected.

The `key`, `oldValue`, `newValue`, `url`, and `storageArea` attributes must return the values they were initialized to.

The `initStorageEvent(type, bubbles, cancelable, key, oldValue, newValue, url, storageArea)` method must initialize the event in a manner analogous to the similarly-named `initEvent()` method. [DOM]

12.3 Privacy § 12.3

12.3.1 User tracking § 12.3

A third-party advertiser (or any entity capable of getting content distributed to multiple sites) could use a unique identifier stored in its local storage area to track a user across multiple sessions, building a profile of the user's interests to allow for highly targeted advertising. In conjunction with a site that is aware of the user's real identity (for example an e-commerce site that requires authenticated credentials), this could allow oppressive groups to target individuals with greater accuracy than in a world with purely anonymous web usage.

There are a number of techniques that can be used to mitigate the risk of user tracking:

**Blocking third-party storage**
User agents may restrict access to the `localStorage` objects to scripts originating at the domain of the `active document` of the top-level traversable, for instance denying access to the API for pages from other domains running in `iframe` s.

**Expiring stored data**
User agents may, possibly in a manner configured by the user, automatically delete stored data after a period of time.

For example, a user agent could be configured to treat third-party local storage areas as session-only storage, deleting the data once the user had closed all the navigables that could access it.

This can restrict the ability of a site to track a user, as the site would then only be able to track the user across multiple sessions when they authenticate with the site itself (e.g. by making a purchase or logging in to a service).

However, this also reduces the usefulness of the API as a long-term storage mechanism. It can also put the user's data at risk, if the user does not fully understand the implications of data expiration.

**Treating persistent storage as cookies**
If users attempt to protect their privacy by clearing cookies without also clearing data stored in the local storage area, sites can defeat those attempts by using the two features as redundant backup for each other. User agents should present the interfaces for clearing these in a way that helps users to understand this possibility and enables them to delete data in all persistent storage features simultaneously. [COOKIES]
Site-specific safelisting of access to local storage areas

User agents may allow sites to access session storage areas in an unrestricted manner, but require the user to authorize access to local storage areas.

Origin-tracking of stored data

User agents may record the origins of sites that contained content from third-party origins that caused data to be stored.

If this information is then used to present the view of data currently in persistent storage, it would allow the user to make informed decisions about which parts of the persistent storage to prune. Combined with a blocklist ("delete this data and prevent this domain from ever storing data again"), the user can restrict the use of persistent storage to sites that they trust.

Shared blocklists

User agents may allow users to share their persistent storage domain blocklists.

This would allow communities to act together to protect their privacy.

While these suggestions prevent trivial use of this API for user tracking, they do not block it altogether. Within a single domain, a site can continue to track the user during a session, and can then pass all this information to the third party along with any identifying information (names, credit card numbers, addresses) obtained by the site. If a third party cooperates with multiple sites to obtain such information, a profile can still be created.

However, user tracking is to some extent possible even with no cooperation from the user agent whatsoever, for instance by using session identifiers in URLs, a technique already commonly used for innocuous purposes but easily repurposed for user tracking (even retroactively). This information can then be shared with other sites, using visitors’ IP addresses and other user-specific data (e.g. user-agent headers and configuration settings) to combine separate sessions into coherent user profiles.

12.3.2 Sensitivity of data

User agents should treat persistently stored data as potentially sensitive; it’s quite possible for emails, calendar appointments, health records, or other confidential documents to be stored in this mechanism.

To this end, user agents should ensure that when deleting data, it is promptly deleted from the underlying storage.

12.4 Security

12.4.1 DNS spoofing attacks

Because of the potential for DNS spoofing attacks, one cannot guarantee that a host claiming to be in a certain domain really is from that domain. To mitigate this, pages can use TLS. Pages using TLS can be sure that only the user, software working on behalf of the user, and other pages using TLS that have certificates identifying them as being from the same domain, can access their storage areas.

12.4.2 Cross-directory attacks

Different authors sharing one host name, for example users hosting content on the now defunct geocities.com, all share one local storage object. There is no feature to restrict the access by pathname. Authors on shared hosts are therefore urged to avoid using these features, as it would be trivial for other authors to read the data and overwrite it.

Note

Even if a path-restriction feature was made available, the usual DOM scripting security model would make it trivial to bypass this protection and access the data from any path.
The two primary risks when implementing these persistent storage features are letting hostile sites read information from other domains, and letting hostile sites write information that is then read from other domains.

Letting third-party sites read data that is not supposed to be read from their domain causes information leakage. For example, a user's shopping wishlist on one domain could be used by another domain for targeted advertising; or a user's work-in-progress confidential documents stored by a word-processing site could be examined by the site of a competing company.

Letting third-party sites write data to the persistent storage of other domains can result in information spoofing, which is equally dangerous. For example, a hostile site could add items to a user's wishlist; or a hostile site could set a user's session identifier to a known ID that the hostile site can then use to track the user's actions on the victim site.

Thus, strictly following the origin model described in this specification is important for user security.
13 The HTML syntax

Note
This section only describes the rules for resources labeled with an HTML MIME type. Rules for XML resources are discussed in the section below entitled "The XML syntax".

13.1 Writing HTML documents

This section only applies to documents, authoring tools, and markup generators. In particular, it does not apply to conformance checkers; conformance checkers must use the requirements given in the next section ("parsing HTML documents").

Documents must consist of the following parts, in the given order:

1. Optionally, a single U+FEFF BYTE ORDER MARK (BOM) character.
2. Any number of comments and ASCII whitespace.
3. A DOCTYPE.
4. Any number of comments and ASCII whitespace.
5. The document element, in the form of an html element.
6. Any number of comments and ASCII whitespace.

The various types of content mentioned above are described in the next few sections.

In addition, there are some restrictions on how character encoding declarations are to be serialized, as discussed in the section on that topic.

Note
ASCII whitespace before the html element, at the start of the html element and before the head element, will be dropped when the document is parsed; ASCII whitespace after the html element will be parsed as if it were at the end of the body element. Thus, ASCII whitespace around the document element does not round-trip.

It is suggested that newlines be inserted after the DOCTYPE, after any comments that are before the document element, after the html element's start tag (if it is not omitted), and after any comments that are inside the html element but before the head element.

Many strings in the HTML syntax (e.g. the names of elements and their attributes) are case-insensitive, but only for ASCII upper alphas and ASCII lower alphas. For convenience, in this section this is just referred to as "case-insensitive".

13.1.1 The DOCTYPE

A DOCTYPE is a required preamble.

Note
DOCTYPEs are required for legacy reasons. When omitted, browsers tend to use a different rendering mode that is incompatible with some specifications. Including the DOCTYPE in a document ensures that the browser makes a best-effort attempt at following the relevant specifications.

A DOCTYPE must consist of the following components, in this order:

1. A string that is an ASCII case-insensitive match for the string "<!DOCTYPE",
2. One or more ASCII whitespace.
3. A string that is an ASCII case-insensitive match for the string "html".
4. Optionally, a DOCTYPE legacy string.
5. Zero or more ASCII whitespace.
6. A U+003E GREATER-THAN SIGN character (>).

**Note**

In other words, `<!DOCTYPE html>`, case-insensitively.

For the purposes of HTML generators that cannot output HTML markup with the short DOCTYPE "<!DOCTYPE html>", a **DOCTYPE legacy string** may be inserted into the DOCTYPE (in the position defined above). This string must consist of:

1. One or more ASCII whitespace.
2. A string that is an ASCII case-insensitive match for the string "SYSTEM".
3. One or more ASCII whitespace.
4. A U+0022 QUOTATION MARK or U+0027 APOSTROPHE character (the quote mark).
5. The literal string "about:legacy-compat".
6. A matching U+0022 QUOTATION MARK or U+0027 APOSTROPHE character (i.e. the same character as in the earlier step labeled quote mark).

**Note**

In other words, `<!DOCTYPE html SYSTEM "about:legacy-compat">` or `<!DOCTYPE html SYSTEM 'about:legacy-compat'>`, case-insensitively except for the part in single or double quotes.

The **DOCTYPE legacy string** should not be used unless the document is generated from a system that cannot output the shorter string.

13.1.2 Elements

There are six different kinds of **elements**: void elements, the template element, raw text elements, escapable raw text elements, foreign elements, and normal elements.

**Void elements**

- `area`
- `base`
- `br`
- `col`
- `embed`
- `hr`
- `img`
- `input`
- `link`
- `meta`
- `source`
- `track`
- `wbr`

**The template element**

- `template`

**Raw text elements**

- `script`
- `style`

**Escapable raw text elements**

- `textarea`
- `title`

**Foreign elements**

Elements from the **MathML namespace** and the **SVG namespace**.

**Normal elements**

All other allowed **HTML elements** are normal elements.

**Tags** are used to delimit the start and end of elements in the markup. **Raw text**, **escapable raw text**, and **normal** elements have a **start tag** to indicate where they begin, and an **end tag** to indicate where they end. The start and end tags of certain **normal elements** can be **omitted**, as described below in the section on **optional tags**. Those that cannot be omitted must not be omitted. **Void elements** only have a start tag; end tags must not be specified for **void elements**. **Foreign elements** must either have a start tag and an end tag, or a start tag that is marked as self-closing, in which case they must not have an end tag.

The **contents** of the element must be placed between just after the start tag (which **might be implied, in certain cases**) and just before the end tag (which again, **might be implied in certain cases**). The exact allowed contents of each individual element depend on the **content model** of that element, as described earlier in this specification. Elements must not contain content that their content model disallows. In addition to the restrictions placed on the contents by those content models, however, the five types of elements have additional **syntactic** requirements.

**Void elements** can't have any contents (since there's no end tag, no content can be put between the start tag and the end tag).
The template element\textsuperscript{1241} can have template contents\textsuperscript{667}, but such template contents\textsuperscript{667} are not children of the template\textsuperscript{666} element itself. Instead, they are stored in a DocumentFragment associated with a different Document\textsuperscript{128} — without a browsing context\textsuperscript{987} — so as to avoid the template\textsuperscript{666} contents interfering with the main Document\textsuperscript{128}. The markup for the template contents\textsuperscript{667} of a template\textsuperscript{666} element is placed just after the template\textsuperscript{666} element's start tag and just before template\textsuperscript{666} element's end tag (as with other elements), and may consist of any text\textsuperscript{61250}, character references\textsuperscript{1250}, elements\textsuperscript{1241}, and comments\textsuperscript{1251}, but the text must not contain the character U+003C LESS-THAN SIGN (<) or an ambiguous ampersand\textsuperscript{1251}.

Raw text elements\textsuperscript{1241} can have text\textsuperscript{61250}, though it has restrictions\textsuperscript{61250} described below.

Escapable raw text elements\textsuperscript{1241} can have text\textsuperscript{61250} and character references\textsuperscript{1250}, but the text must not contain an ambiguous ampersand\textsuperscript{1251}. There are also further restrictions\textsuperscript{61250} described below.

Foreign elements\textsuperscript{1241} whose start tag is marked as self-closing can't have any contents (since, again, as there's no end tag, no content can be put between the start tag and the end tag). Foreign elements\textsuperscript{1241} whose start tag is not marked as self-closing can have text\textsuperscript{61250}, character references\textsuperscript{1250}, CDATA sections\textsuperscript{1251}, other elements\textsuperscript{1241}, and comments\textsuperscript{1251}, but the text must not contain the character U+003C LESS-THAN SIGN (<) or an ambiguous ampersand\textsuperscript{1251}.

Normal elements\textsuperscript{1241} can have text\textsuperscript{61250}, character references\textsuperscript{1250}, other elements\textsuperscript{1241}, and comments\textsuperscript{1251}, but the text must not contain the character U+003C LESS-THAN SIGN (<) or an ambiguous ampersand\textsuperscript{1251}. Some normal elements\textsuperscript{1241} also have yet more restrictions\textsuperscript{61250} on what content they are allowed to hold, beyond the restrictions imposed by the content model and those described in this paragraph. Those restrictions are described below.

Tags contain a tag name, giving the element's name. HTML elements all have names that only use ASCII alphanumerics. In the HTML syntax, tag names, even those for foreign elements\textsuperscript{1241}, may be written with any mix of lower- and uppercase letters that, when converted to all-lowercase, matches the element's tag name; tag names are case-insensitive.

13.1.2.1 Start tags\textsuperscript{122}

Start tags\textsuperscript{42} must have the following format:

1. The first character of a start tag must be a U+003C LESS-THAN SIGN character (<).
2. The next few characters of a start tag must be the element's tag name\textsuperscript{1242}.
3. If there are to be any attributes in the next step, there must first be one or more ASCII whitespace.
4. Then, the start tag may have a number of attributes, the syntax for which\textsuperscript{1243} is described below. Attributes must be separated from each other by one or more ASCII whitespace.
5. After the attributes, or after the tag name\textsuperscript{1242} if there are no attributes, there may be one or more ASCII whitespace. (Some attributes are required to be followed by a space. See the attributes section\textsuperscript{1243} below.)
6. Then, if the element is one of the void elements\textsuperscript{1241}, or if the element is a foreign element\textsuperscript{1241}, then there may be a single U+002F SOLIDUS character (/), which on foreign elements\textsuperscript{1241} marks the start tag as self-closing. On void elements\textsuperscript{1241}, it
does not mark the start tag as self-closing but instead is unnecessary and has no effect of any kind. For such void elements, it should be used only with caution — especially since, if directly preceded by an unquoted attribute value, it becomes part of the attribute value rather than being discarded by the parser.

7. Finally, start tags must be closed by a U+003E GREATER-THEAN SIGN character (>).

13.1.2.2 End tags

End tags must have the following format:

1. The first character of an end tag must be a U+003C LESS-THEAN SIGN character (<).
2. The second character of an end tag must be a U+002F SOLIDUS character (/).
3. The next few characters of an end tag must be the element's tag name.
4. After the tag name, there may be one or more ASCII whitespace.
5. Finally, end tags must be closed by a U+003E GREATER-THEAN SIGN character (>).

13.1.2.3 Attributes

Attributes for an element are expressed inside the element's start tag.

Attributes have a name and a value. Attribute names must consist of one or more characters other than controls, U+0020 SPACE, U+0022 QUOTATION MARK characters ("), U+0027 APOSTROPHE characters ('), U+003D EQUALS SIGN characters (=), U+003C LESS-THEAN SIGN characters (<), U+003E GREATER-THEAN SIGN characters (>), and noncharacters. In the HTML syntax, attribute names, even those for foreign elements, may be written with any mix of ASCII lower and ASCII upper alphas.

Attribute values are a mixture of text and character references, except with the additional restriction that the text cannot contain an ambiguous ampersand.

Attributes can be specified in four different ways:

Empty attribute syntax

Just the attribute name. The value is implicitly the empty string.

Example

In the following example, the disabled attribute is given with the empty attribute syntax:

```html
<input disabled>
```

If an attribute using the empty attribute syntax is to be followed by another attribute, then there must be ASCII whitespace separating the two.

Unquoted attribute value syntax

The attribute name, followed by zero or more ASCII whitespace, followed by a single U+003D EQUALS SIGN character, followed by zero or more ASCII whitespace, followed by the attribute value, which, in addition to the requirements given above for attribute values, must not contain any literal ASCII whitespace, any U+0022 QUOTATION MARK characters ("), U+0027 APOSTROPHE characters ('), U+003D EQUALS SIGN characters (=), U+003C LESS-THEAN SIGN characters (<), U+003E GREATER-THEAN SIGN characters (>), or U+0060 GRAVE ACCENT characters (`), and must not be the empty string.

Example

In the following example, the value attribute is given with the unquoted attribute value syntax:

```html
<input value=yes>
```

If an attribute using the unquoted attribute syntax is to be followed by another attribute or by the optional U+002F SOLIDUS character (/) allowed in step 6 of the start tag syntax above, then there must be ASCII whitespace separating the two.
Single-quoted attribute value syntax

The attribute name, followed by zero or more ASCII whitespace, followed by a single U+003D EQUALS SIGN character, followed by zero or more ASCII whitespace, followed by a single U+0027 APOSTROPHE character ('), followed by the attribute value, which, in addition to the requirements given above for attribute values, must not contain any literal U+0027 APOSTROPHE characters ('), and finally followed by a second single U+0027 APOSTROPHE character (').

Example

In the following example, the type attribute is given with the single-quoted attribute value syntax:

```xml
<input type='checkbox'>
```

If an attribute using the single-quoted attribute syntax is to be followed by another attribute, then there must be ASCII whitespace separating the two.

Double-quoted attribute value syntax

The attribute name, followed by zero or more ASCII whitespace, followed by a single U+003D EQUALS SIGN character, followed by zero or more ASCII whitespace, followed by a single U+0022 QUOTATION MARK character ("), followed by the attribute value, which, in addition to the requirements given above for attribute values, must not contain any literal U+0022 QUOTATION MARK characters ("), and finally followed by a second single U+0022 QUOTATION MARK character (").

Example

In the following example, the name attribute is given with the double-quoted attribute value syntax:

```xml
<input name="be evil">
```

If an attribute using the double-quoted attribute syntax is to be followed by another attribute, then there must be ASCII whitespace separating the two.

There must never be two or more attributes on the same start tag whose names are an ASCII case-insensitive match for each other.

When a foreign element has one of the namespaced attributes given by the local name and namespace of the first and second cells of a row from the following table, it must be written using the name given by the third cell from the same row.

<table>
<thead>
<tr>
<th>Local name</th>
<th>Namespace</th>
<th>Attribute name</th>
</tr>
</thead>
<tbody>
<tr>
<td>actuate</td>
<td>XLink namespace</td>
<td>xlink:actuate</td>
</tr>
<tr>
<td>arcrole</td>
<td>XLink namespace</td>
<td>xlink:arcrole</td>
</tr>
<tr>
<td>href</td>
<td>XLink namespace</td>
<td>xlink:href</td>
</tr>
<tr>
<td>role</td>
<td>XLink namespace</td>
<td>xlink:role</td>
</tr>
<tr>
<td>show</td>
<td>XLink namespace</td>
<td>xlink:show</td>
</tr>
<tr>
<td>title</td>
<td>XLink namespace</td>
<td>xlink:title</td>
</tr>
<tr>
<td>type</td>
<td>XLink namespace</td>
<td>xlink:type</td>
</tr>
<tr>
<td>lang</td>
<td>XML namespace</td>
<td>xml:lang</td>
</tr>
<tr>
<td>space</td>
<td>XML namespace</td>
<td>xml:space</td>
</tr>
<tr>
<td>xmlns</td>
<td>XMLNS namespace</td>
<td>xmlns</td>
</tr>
<tr>
<td>xlink</td>
<td>XMLNS namespace</td>
<td>xmlns:xlink</td>
</tr>
</tbody>
</table>

No other namespaced attribute can be expressed in the HTML syntax.

Note

Whether the attributes in the table above are conforming or not is defined by other specifications (e.g. SVG 2 and MathML); this section only describes the syntax rules if the attributes are serialized using the HTML syntax.

13.1.2.4 Optional tags

Certain tags can be omitted.
An `html` element's start tag may be omitted if the first thing inside the `html` element is not a comment. Omitting an element's start tag in the situations described below does not mean the element is not present; it is implied, but it is still there. For example, an HTML document always has a root `html` element, even if the string `<html>` doesn't appear anywhere in the markup.

Example

For example, in the following case it's ok to remove the "<html>" tag:

```
<!DOCTYPE HTML>
<html>
  <head>
    <title>Hello</title>
  </head>
  <body>
    <p>Welcome to this example.</p>
  </body>
</html>
```

Doing so would make the document look like this:

```
<!DOCTYPE HTML>

  <head>
    <title>Hello</title>
  </head>
  <body>
    <p>Welcome to this example.</p>
  </body>
</html>
```

This has the exact same DOM. In particular, note that whitespace around the document element is ignored by the parser. The following example would also have the exact same DOM:

```
<!DOCTYPE HTML>

  <head>
    <title>Hello</title>
  </head>
  <body>
    <p>Welcome to this example.</p>
  </body>
</html>
```

However, in the following example, removing the start tag moves the comment to before the `html` element:

```
<!DOCTYPE HTML>
<html>
  <!-- where is this comment in the DOM? -->
  <head>
    <title>Hello</title>
  </head>
  <body>
    <p>Welcome to this example.</p>
  </body>
</html>
```

With the tag removed, the document actually turns into the same as this:

```
<!DOCTYPE HTML>
```
An \texttt{html} element's end tag may be omitted if the \texttt{html} element is not immediately followed by a comment.

A \texttt{head} element's start tag may be omitted if the element is empty, or if the first thing inside the \texttt{head} element is an element.

A head element's end tag may be omitted if the head element is not immediately followed by ASCII whitespace or a comment.

A body element's start tag may be omitted if the element is empty, or if the first thing inside the body element is not ASCII whitespace or a comment, except if the first thing inside the body element is a meta, noscript, link, script, style, or template element.

A body element's end tag may be omitted if the body element is not immediately followed by a comment.

\textbf{Example}

Note that in the example above, the head element start and end tags, and the body element start tag, can't be omitted, because they are surrounded by whitespace:

```html
<!DOCTYPE HTML>
<html>
  <head>
    <title>Hello</title>
  </head>
  <body>
    <p>Welcome to this example.</p>
  </body>
</html>
```

(The body and html element end tags could be omitted without trouble; any spaces after those get parsed into the body element anyway.)

Usually, however, whitespace isn't an issue. If we first remove the whitespace we don't care about:

```html
<!DOCTYPE HTML><html><head><title>Hello</title></head><body><p>Welcome to this example.</p></body></html>
```

Then we can omit a number of tags without affecting the DOM:

```html
<!DOCTYPE HTML><title>Hello</title><p>Welcome to this example.</p>
```

At that point, we can also add some whitespace back:

```html
<!DOCTYPE HTML>
<title>Hello</title>
```
This would be equivalent to this document, with the omitted tags shown in their parser-implied positions; the only whitespace text node that results from this is the newline at the end of the head element:

```html
<!DOCTYPE HTML>
<html><head><title>Hello</title></head>
<body><p>Welcome to this example.</p></body></html>
```

An `li` element's `end tag` may be omitted if the `li` element is immediately followed by another `li` element or if there is no more content in the parent element.

A `dt` element's `end tag` may be omitted if the `dt` element is immediately followed by another `dt` element or a `dd` element.

A `dd` element's `end tag` may be omitted if the `dd` element is immediately followed by another `dd` element or a `dt` element, or if there is no more content in the parent element.

A `p` element's `end tag` may be omitted if the `p` element is immediately followed by an `address`, `article`, `aside`, `blockquote`, `details`, `div`, `dl`, `fieldset`, `figcaption`, `figure`, `footer`, `form`, `h1`, `h2`, `h3`, `h4`, `h5`, `header`, `hr`, `main`, `menu`, `nav`, `ol`, `p`, `pre`, `search`, `section`, `table`, `ul`, or `video` element, or if there is no more content in the parent element and the parent element is an `HTML element` that is not an `article`, `audio`, `del`, `ins`, `map`, `noscript`, or `video` element, or an autonomous custom element.

Example

We can thus simplify the earlier example further:

```html
<!DOCTYPE HTML><title>Hello</title><p>Welcome to this example.</p>
```

An `rt` element's `end tag` may be omitted if the `rt` element is immediately followed by an `rt` or `rp` element, or if there is no more content in the parent element.

An `rp` element's `end tag` may be omitted if the `rp` element is immediately followed by an `rt` or `rp` element, or if there is no more content in the parent element.

An `optgroup` element's `end tag` may be omitted if the `optgroup` element is immediately followed by another `optgroup` element, if it is immediately followed by an `hr` element, or if there is no more content in the parent element.

An `option` element's `end tag` may be omitted if the `option` element is immediately followed by another `option` element, if it is immediately followed by an `optgroup` element, if it is immediately followed by an `hr` element, or if there is no more content in the parent element.

An `colgroup` element's `start tag` may be omitted if the first thing inside the `colgroup` element is a `col` element, and if the element is not immediately preceded by another `colgroup` element whose `end tag` has been omitted. (It can't be omitted if the element is empty.)

An `colgroup` element's `end tag` may be omitted if the `colgroup` element is not immediately followed by ASCII whitespace or a `comment`.

An `caption` element's `end tag` may be omitted if the `caption` element is not immediately followed by ASCII whitespace or a `comment`.

A `thead` element's `end tag` may be omitted if the `thead` element is immediately followed by a `tbody` or `tfoot` element.

A `tbody` element's `start tag` may be omitted if the first thing inside the `tbody` element is a `tr` element, and if the element is not immediately preceded by a `tbody`, `thead`, or `tfoot` element whose `end tag` has been omitted. (It can't be omitted if the element is empty.)

A `tbody` element's `end tag` may be omitted if the `tbody` element is immediately followed by a `tbody` or `tfoot` element.
element, or if there is no more content in the parent element.

A `tfoot` element's end tag may be omitted if there is no more content in the parent element.

A `tr` element's end tag may be omitted if the `tr` element is immediately followed by another `tr` element, or if there is no more content in the parent element.

A `td` element's end tag may be omitted if the `td` element is immediately followed by a `td` or `th` element, or if there is no more content in the parent element.

A `th` element's end tag may be omitted if the `th` element is immediately followed by a `td` or `th` element, or if there is no more content in the parent element.

The ability to omit all these table-related tags makes table markup much terser.

Take this example:

```html
<table>
  <caption>37547 TEE Electric Powered Rail Car Train Functions (Abbreviated)</caption>
  <colgroup><col><col><col></colgroup>
  <thead>
    <tr>
      <th>Function</th>
      <th>Control Unit</th>
      <th>Central Station</th>
    </tr>
  </thead>
  <tbody>
    <tr>
      <td>Headlights</td>
      <td>✔</td>
      <td>✔</td>
    </tr>
    <tr>
      <td>Interior Lights</td>
      <td>✔</td>
      <td>✔</td>
    </tr>
    <tr>
      <td>Electric locomotive operating sounds</td>
      <td>✔</td>
      <td>✔</td>
    </tr>
    <tr>
      <td>Engineer's cab lighting</td>
      <td></td>
      <td>✔</td>
    </tr>
    <tr>
      <td>Station Announcements - Swiss</td>
      <td></td>
      <td>✔</td>
    </tr>
  </tbody>
</table>
```

The exact same table, modulo some whitespace differences, could be marked up as follows:

```html
<table>
  <caption>37547 TEE Electric Powered Rail Car Train Functions (Abbreviated)
```
However, a start tag must never be omitted if it has any attributes.

Since the cells take up much less room this way, this can be made even terser by having each row on one line:

```
<caption>37547 TEE Electric Powered Rail Car Train Functions (Abbreviated)</caption>
<colgroup><col><col><col>
<thead>
<tr><th>Function</th><th>Control Unit</th><th>Central Station</th></tr>
<tbody>
<tr><td>Headlights</td><td>✔</td><td>✔</td></tr>
<tr><td>Interior Lights</td><td>✔</td><td>✔</td></tr>
<tr><td>Electric locomotive operating sounds</td><td>✔</td><td>✔</td></tr>
<tr><td>Engineer's cab lighting</td><td></td><td>✔</td></tr>
<tr><td>Station Announcements - Swiss</td><td></td><td>✔</td></tr>
</tbody>
</table>
```

The only differences between these tables, at the DOM level, is with the precise position of the (in any case semantically-neutral) whitespace.

However, a start tag must never be omitted if it has any attributes.

**Example**

Returning to the earlier example with all the whitespace removed and then all the optional tags removed:

```html
<!DOCTYPE HTML><title>Hello</title><p>Welcome to this example.
```

If the `body` element in this example had to have a `class` attribute and the `html` element had to have a `lang` attribute, the markup would have to become:

```html
<!DOCTYPE HTML><html lang="en"><title>Hello</title><body class="demo"><p>Welcome to this example.
```
13.1.2.5 Restrictions on content models

For historical reasons, certain elements have extra restrictions beyond even the restrictions given by their content model.

A *table* element must not contain *tr* elements, even though these elements are technically allowed inside *table* elements according to the content models described in this specification. (If a *tr* element is put inside a *table* element in the markup, it will in fact imply a *tbody* start tag before it.)

A single `newline` may be placed immediately after the start tag of *pre* and *textarea* elements. This does not affect the processing of the element. The otherwise optional `newline` must be included if the element’s contents themselves start with a `newline` (because otherwise the leading newline in the contents would be treated like the optional newline, and ignored).

Example

The following two *pre* blocks are equivalent:

```
<pre>Hello</pre>

<pre>Hello</pre>
```

13.1.2.6 Restrictions on the contents of raw text and escapable raw text elements

The text in *raw text* and *escapable raw text elements* must not contain any occurrences of the string "</" (U+003C LESS-THAN SIGN, U+0002F SOLIDUS) followed by characters that case-insensitively match the tag name of the element followed by one of U+0009 CHARACTER TABULATION (tab), U+000A LINE FEED (LF), U+000C FORM FEED (FF), U+000D CARRIAGE RETURN (CR), U+0020 SPACE, U+003E GREATER-THAN SIGN (>, or U+002F SOLIDUS (/).

13.1.3 Text

*Text* is allowed inside elements, attribute values, and comments. Extra constraints are placed on what is and what is not allowed in text based on where the text is to be put, as described in the other sections.

13.1.3.1 Newlines

*Newlines* in HTML may be represented either as U+000D CARRIAGE RETURN (CR) characters, U+000A LINE FEED (LF) characters, or pairs of U+000D CARRIAGE RETURN (CR), U+000A LINE FEED (LF) characters in that order.

Where *character references* are allowed, a character reference of a U+000A LINE FEED (LF) character (but not a U+000D CARRIAGE RETURN (CR) character) also represents a `newline`.

13.1.4 Character references

In certain cases described in other sections, *text* may be mixed with *character references*. These can be used to escape characters that couldn't otherwise legally be included in *text*.

Character references must start with a U+0026 AMPERSAND character (&). Following this, there are three possible kinds of character references:
**Named character references**

The ampersand must be followed by one of the names given in the named character references\(^{p1355}\) section, using the same case. The name must be one that is terminated by a U+003B SEMICOLON character (;).

**Decimal numeric character reference**

The ampersand must be followed by a U+0023 NUMBER SIGN character (#), followed by one or more ASCII digits, representing a base-ten integer that corresponds to a code point that is allowed according to the definition below. The digits must then be followed by a U+003B SEMICOLON character (;).

**Hexadecimal numeric character reference**

The ampersand must be followed by a U+0023 NUMBER SIGN character (#), which must be followed by either a U+0078 LATIN SMALL LETTER X character (x) or a U+0058 LATIN CAPITAL LETTER X character (X), which must then be followed by one or more ASCII hex digits, representing a hexadecimal integer that corresponds to a code point that is allowed according to the definition below. The digits must then be followed by a U+003B SEMICOLON character (;).

The numeric character reference forms described above are allowed to reference any code point excluding U+000D CR, noncharacters, and controls other than ASCII whitespace.

An **ambiguous ampersand** is a U+0026 AMPERSAND character (&) that is followed by one or more ASCII alphanumerics, followed by a U+003B SEMICOLON character (;), where these characters do not match any of the names given in the named character references\(^{p1355}\) section.

### 13.1.5 CDATA sections \(^{p1251}\)

**CDATA sections** must consist of the following components, in this order:

1. The string "<![CDATA[.
2. Optionally, text\(^{p1250}\), with the additional restriction that the text must not contain the string "]]>".
3. The string "]]>".

**Example**

CDATA sections can only be used in foreign content (MathML or SVG). In this example, a CDATA section is used to escape the contents of a MathML `ms` element:

```xml
<p>You can add a string to a number, but this stringifies the number:</p>
<math>
  <ms>&lt; ![CDATA[x<y]] &gt;</ms>
  <mo>+</mo>
  <mn>3</mn>
  <mo>=</mo>
  <ms>&lt; ![CDATA[x<y3]] &gt;</ms>
</math>
```

### 13.1.6 Comments \(^{p1251}\)

**Comments** must have the following format:

1. The string "<!- ".
2. Optionally, text\(^{p1250}\), with the additional restriction that the text must not start with the string ">", nor start with the string "->", nor contain the strings "<!-", "->", or "--!", nor end with the string "<!-".
3. The string "-->".

**Note**

The text\(^{p1250}\) is allowed to end with the string "!", as in <!--My favorite operators are > and <!--.
13.2 Parsing HTML documents

This section only applies to user agents, data mining tools, and conformance checkers.

Note

The rules for parsing XML documents into DOM trees are covered by the next section, entitled “The XML syntax”.

User agents must use the parsing rules described in this section to generate the DOM trees from text/html resources. Together, these rules define what is referred to as the HTML parser.

Note

While the HTML syntax described in this specification bears a close resemblance to SGML and XML, it is a separate language with its own parsing rules.

Some earlier versions of HTML (in particular from HTML2 to HTML4) were based on SGML and used SGML parsing rules. However, few (if any) web browsers ever implemented true SGML parsing for HTML documents; the only user agents to strictly handle HTML as an SGML application have historically been validators. The resulting confusion — with validators claiming documents to have one representation while widely deployed web browsers interoperably implemented a different representation — has wasted decades of productivity. This version of HTML thus returns to a non-SGML basis.

Authors interested in using SGML tools in their authoring pipeline are encouraged to use XML tools and the XML serialization of HTML.

For the purposes of conformance checkers, if a resource is determined to be in the HTML syntax, then it is an HTML document.

Note

As stated in the terminology section, references to element types that do not explicitly specify a namespace always refer to elements in the HTML namespace. For example, if the spec talks about "a menu element", then that is an element with the local name "menu", the namespace "http://www.w3.org/1999/xhtml", and the interface HTMLMenuElement. Where possible, references to such elements are hyperlinked to their definition.
The input to the HTML parsing process consists of a stream of code points, which is passed through a tokenization stage followed by a tree construction stage. The output is a Document object.

In the common case, the data handled by the tokenization stage comes from the network, but it can also come from script running in the user agent, e.g. using the `document.write()` API.

There is only one set of states for the tokenizer stage and the tree construction stage, but the tree construction stage is reentrant, meaning that while the tree construction stage is handling one token, the tokenizer might be resumed, causing further tokens to be emitted and processed before the first token's processing is complete.

Example

In the following example, the tree construction stage will be called upon to handle a "p" start tag token while handling the "script" end tag token:

```html
...
<script>
    document.write('<p>');</n
</script>
...
```
This specification defines the parsing rules for HTML documents, whether they are syntactically correct or not. Certain points in the parsing algorithm are said to be **parse errors**. The error handling for parse errors is well-defined (that's the processing rules described throughout this specification), but user agents, while parsing an HTML document, may **abort the parser** at the first **parse error** that they encounter for which they do not wish to apply the rules described in this specification.

Conformance checkers must report at least one parse error condition to the user if one or more parse error conditions exist in the document and must not report parse error conditions if none exist in the document. Conformance checkers may report more than one parse error condition if more than one parse error condition exists in the document.

---

**Parse errors are only errors with the syntax of HTML. In addition to checking for parse errors, conformance checkers will also verify that the document obeys all the other conformance requirements described in this specification.**

Some parse errors have dedicated codes outlined in the table below that should be used by conformance checkers in reports.

<table>
<thead>
<tr>
<th>Error descriptions in the table below are non-normative.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>abrupt-closing-of-empty-comment</td>
<td>This error occurs if the parser encounters an empty <code>comment</code> that is abruptly closed by a U+003E (<code>&gt;</code>) <code>code point</code> (i.e., <code>&lt;!--</code> or <code>&lt;!--</code>). The parser behaves as if the comment is closed correctly.</td>
</tr>
<tr>
<td>abrupt-doctype-public-identifier</td>
<td>This error occurs if the parser encounters a U+003E (<code>&gt;</code>) <code>code point</code> in the DOCTYPE public identifier (e.g., <code>&lt;!DOCTYPE html PUBLIC &quot;foo&quot;&gt;</code>). In such a case, if the DOCTYPE is correctly placed as a document preamble, the parser sets the <strong>Document</strong> to quirks mode.</td>
</tr>
<tr>
<td>abrupt-doctype-system-identifier</td>
<td>This error occurs if the parser encounters a U+003E (<code>&gt;</code>) <code>code point</code> in the DOCTYPE system identifier (e.g., <code>&lt;!DOCTYPE html PUBLIC &quot;/W3C/DTD HTML 4.01/EN&quot; &quot;foo&quot;&gt;</code>). In such a case, if the DOCTYPE is correctly placed as a document preamble, the parser sets the <strong>Document</strong> to quirks mode.</td>
</tr>
<tr>
<td>absence-of-digits-in-numeric-character-reference</td>
<td>This error occurs if the parser encounters a numeric <code>character reference</code> that doesn't contain any digits (e.g., <code>&amp;qux;</code>). In this case the parser doesn't resolve the character reference.</td>
</tr>
<tr>
<td>cdata-in-html-content</td>
<td>This error occurs if the parser encounters a <code>CDATA section</code> outside of foreign content (SVG or MathML). The parser treats such CDATA sections (including leading `&quot;[CDATA[&quot; and trailing &quot;]&quot; strings) as comments.</td>
</tr>
<tr>
<td>character-reference-outside-unicode-range</td>
<td>This error occurs if the parser encounters a <code>character reference</code> that references a <code>code point</code> that is greater than the valid Unicode range. The parser resolves such a character reference to a U+FFFD REPLACEMENT CHARACTER.</td>
</tr>
<tr>
<td>control-character-in-input-stream</td>
<td>This error occurs if the input stream contains a <code>control code point</code> that is not ASCII whitespace or U+0000 NULL. Such code points are parsed as-is and usually, where parsing rules don't apply any additional restrictions, make their way into the DOM.</td>
</tr>
<tr>
<td>control-character-reference</td>
<td>This error occurs if the parser encounters a numeric <code>character reference</code> that references a <code>control code point</code> that is not ASCII whitespace or is a U+000D CARRIAGE RETURN. The parser resolves such character references as-is except C1 control references that are replaced according to the numeric character reference end state.</td>
</tr>
<tr>
<td>duplicate-attribute</td>
<td>This error occurs if the parser encounters an <code>attribute</code> in a tag that already has an attribute with the same name. The parser ignores all such duplicate occurrences of the attribute.</td>
</tr>
<tr>
<td>end-tag-with-attributes</td>
<td>This error occurs if the parser encounters an <code>end tag</code> with <code>attributes</code>. Attributes in end tags are ignored and do not make their way into the DOM.</td>
</tr>
<tr>
<td>end-tag-with-trailing-solidus</td>
<td>This error occurs if the parser encounters an <code>end tag</code> that has a U+002F (<code>/) </code>code point<code> right before the closing U+003E (</code>&gt;<code>) </code>code point<code>(e.g.,</code>&lt;/div/&gt;`). Such a tag is treated as a regular end tag.</td>
</tr>
<tr>
<td>eof-before-tag-name</td>
<td>This error occurs if the parser encounters the end of the input stream where a tag name is expected. In this case the parser treats the beginning of a <code>start tag</code> (i.e., <code>&lt;</code>) or an <code>end tag</code> (i.e., <code>&lt;/</code>) as text content.</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>eof-in-cdata</td>
<td>This error occurs if the parser encounters the end of the input stream in a CDATA section. The parser treats such CDATA sections as if they are closed immediately before the end of the input stream.</td>
</tr>
<tr>
<td>eof-in-comment</td>
<td>This error occurs if the parser encounters the end of the input stream in a comment. The parser treats such comments as if they are closed immediately before the end of the input stream.</td>
</tr>
<tr>
<td>eof-in-doctype</td>
<td>This error occurs if the parser encounters the end of the input stream in a DOCTYPE. In such a case, if the DOCTYPE is correctly placed as a document preamble, the parser sets the quirks mode.</td>
</tr>
<tr>
<td>eof-in-script-html-comment-like-text</td>
<td>This error occurs if the parser encounters the end of the input stream in text that resembles an HTML comment inside a script element content (e.g., <code>&lt;script&gt;</code>). The parser treats such comments as if they are closed immediately before the end of the input stream.</td>
</tr>
<tr>
<td>eof-in-tag</td>
<td>This error occurs if the parser encounters the end of the input stream in a start tag or an end tag (e.g., <code>&lt;div id&gt;</code>). Such a tag is ignored.</td>
</tr>
<tr>
<td>incorrectly-closed-comment</td>
<td>This error occurs if the parser encounters a comment that is closed by the <code>&quot;--!&gt;&quot; code point sequence. The parser treats such comments as if they are correctly closed by the </code>&quot;--!&gt;&quot; code point sequence.</td>
</tr>
<tr>
<td>incorrectly-opened-comment</td>
<td>This error occurs if the parser encounters the <code>&quot;&lt;!&quot; code point sequence that is not immediately followed by two U+002D (-) code points and that is not the start of a DOCTYPE or a CDATA section. All content that follows the </code>&quot;&lt;!&quot; code point sequence up to a U+003E (&gt; code point (if present) or to the end of the input stream is treated as a comment.</td>
</tr>
<tr>
<td>invalid-character-sequence-after-doctype-name</td>
<td>This error occurs if the parser encounters any code point other than &quot;PUBLIC&quot; and &quot;SYSTEM&quot; keywords after a DOCTYPE name. In such a case, the parser ignores any following public or system identifiers, and if the DOCTYPE is correctly placed as a document preamble, and if the parser cannot change the mode flag is false, sets the quirks mode.</td>
</tr>
<tr>
<td>invalid-first-character-of-tag-name</td>
<td>This error occurs if the parser encounters a code point that is not an ASCII alpha where first code point of a start tag name or an end tag name is expected. If a start tag was expected such code point and a preceding U+003C (&lt;) is treated as text content, and all content that follows is treated as markup. Whereas, if an end tag was expected, such code point and all content that follows up to a U+003E (&gt; code point (if present) or to the end of the input stream is treated as a comment.</td>
</tr>
<tr>
<td>missing-attribute-value</td>
<td>This error occurs if the parser encounters a U+003E (&gt; code point where an attribute value is expected (e.g., <code>&lt;div id&gt;</code>). The parser treats the attribute as having an empty value.</td>
</tr>
<tr>
<td>missing-doctype-name</td>
<td>This error occurs if the parser encounters a DOCTYPE that is missing a name (e.g., <code>&lt;!DOCTYPE&gt;</code>). In such a case, if the DOCTYPE is correctly placed as a document preamble, the parser sets the quirks mode.</td>
</tr>
<tr>
<td>missing-doctype-public-identifier</td>
<td>This error occurs if the parser encounters a U+003E (&gt; code point where start of the DOCTYPE public identifier is expected (e.g., <code>&lt;!DOCTYPE html PUBLIC &gt;</code>). In such a case, if the DOCTYPE is correctly placed as a document preamble, the parser sets the quirks mode.</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>missing-doctype-system-identifier</td>
<td>This error occurs if the parser encounters a U+003E (&gt;) code point where start of the <code>DOCTYPE</code> system identifier is expected (e.g., <code>&lt;!DOCTYPE html SYSTEM&gt;</code>). In such a case, if the DOCTYPE is correctly placed as a document preamble, the parser sets the <code>Document</code> to quirks mode.</td>
</tr>
<tr>
<td>missing-end-tag-name</td>
<td>This error occurs if the parser encounters a U+003E (&gt;) code point where an end tag name is expected, i.e., <code>&lt;!&gt;</code>. The parser ignores the whole <code>&quot;/&gt;&quot;</code> code point sequence.</td>
</tr>
<tr>
<td>missing-quote-before-doctype-public-identifier</td>
<td>This error occurs if the parser encounters the <code>DOCTYPE</code> public identifier that is not preceded by a quote (e.g., <code>&lt;!DOCTYPE html PUBLIC -//W3C//DTD HTML 4.01//EN&gt;</code>). In such a case, the parser ignores the public identifier, and if the DOCTYPE is correctly placed as a document preamble, sets the <code>Document</code> to quirks mode.</td>
</tr>
<tr>
<td>missing-quote-before-doctype-system-identifier</td>
<td>This error occurs if the parser encounters the <code>DOCTYPE</code> system identifier that is not preceded by a quote (e.g., <code>&lt;!DOCTYPE html SYSTEM http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd&gt;</code>). In such a case, the parser ignores the system identifier, and if the DOCTYPE is correctly placed as a document preamble, sets the <code>Document</code> to quirks mode.</td>
</tr>
<tr>
<td>missing-semicolon-after-character-reference</td>
<td>This error occurs if the parser encounters a character reference that is not terminated by a U+003B (;) code point. Usually the parser behaves as if character reference is terminated by the U+003B (;) code point; however, there are some ambiguous cases in which the parser includes subsequent code points in the character reference. Example: For example, <code>&amp;notin;</code> will be parsed as <code>&quot;~in&quot;</code> whereas <code>&amp;notin;</code> will be parsed as <code>&quot;notin&quot;</code>.</td>
</tr>
<tr>
<td>missing-whitespace-after-doctype-public-keyword</td>
<td>This error occurs if the parser encounters a <code>DOCTYPE</code> whose &quot;PUBLIC&quot; keyword and public identifier are not separated by ASCII whitespace. In this case the parser parses as if ASCII whitespace is present.</td>
</tr>
<tr>
<td>missing-whitespace-after-doctype-system-keyword</td>
<td>This error occurs if the parser encounters a <code>DOCTYPE</code> whose &quot;SYSTEM&quot; keyword and system identifier are not separated by ASCII whitespace. In this case the parser parses as if ASCII whitespace is present.</td>
</tr>
<tr>
<td>missing-whitespace-before-doctype-name</td>
<td>This error occurs if the parser encounters a <code>DOCTYPE</code> whose &quot;DOCTYPE&quot; keyword and name are not separated by ASCII whitespace. In this case the parser parses as if ASCII whitespace is present.</td>
</tr>
<tr>
<td>missing-whitespace-between-attributes</td>
<td>This error occurs if the parser encounters attributes that are not separated by ASCII whitespace (e.g., <code>&lt;div id=&quot;foo&quot; class=&quot;bar&quot;&gt;</code>). In this case the parser parses as if ASCII whitespace is present.</td>
</tr>
<tr>
<td>missing-whitespace-between-doctype-public-and-system-identifiers</td>
<td>This error occurs if the parser encounters a <code>DOCTYPE</code> whose public and system identifiers are not separated by ASCII whitespace. In this case the parser parses as if ASCII whitespace is present.</td>
</tr>
<tr>
<td>nested-comment</td>
<td>This error occurs if the parser encounters a nested comment (e.g., <code>&lt;!-- &lt;!-- nested --&gt; --&gt;</code>). Such a comment will be closed by the first occurring &quot;--&quot; code point sequence and everything that follows will be treated as markup.</td>
</tr>
<tr>
<td>noncharacter-character-reference</td>
<td>This error occurs if the parser encounters a numeric character reference that references a noncharacter. The parser resolves such character references as-is.</td>
</tr>
<tr>
<td>noncharacter-in-input-stream</td>
<td>This error occurs if the input stream contains a noncharacter. Such code points are parsed as-is and usually, where parsing rules don't apply any additional restrictions, make their way into the DOM.</td>
</tr>
<tr>
<td>non-void-html-element-start-tag-with-trailing-solidus</td>
<td>This error occurs if the parser encounters a start tag for an element that is not in the list of void elements or is not a part of foreign content (i.e., not an SVG or MathML element) that has a U+002F (/) code point right before the closing U+003E (&gt;) code point. The parser behaves as if the U+002F (/) is not present. Example: For example, consider the following markup: <code>&lt;div/&gt;&lt;span/&lt;/span&gt;&lt;span/&gt;&lt;/span&gt;</code> This will be parsed into: <code>&lt;div/&gt;&lt;span/&lt;/span&gt;&lt;span/&gt;&lt;/span&gt;</code></td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>null-character-reference</td>
<td>This error occurs if the parser encounters a numeric character reference that references a U+0000 NULL code point. The parser resolves such character references to a U+FFFD REPLACEMENT CHARACTER.</td>
</tr>
<tr>
<td>surrogate-character-reference</td>
<td>This error occurs if the parser encounters a numeric character reference that references a surrogate. The parser resolves such character references to a U+FFFD REPLACEMENT CHARACTER.</td>
</tr>
<tr>
<td>surrogate-in-input-stream</td>
<td>This error occurs if the input stream contains a surrogate. Such code points are parsed as-is and usually, where parsing rules don't apply any additional restrictions, make their way into the DOM.</td>
</tr>
<tr>
<td>unexpected-character-after-doctype-system-identifier</td>
<td>This error occurs if the parser encounters any code points other than ASCII whitespace or closing U+003E (&gt;) after the DOCTYPE system identifier. The parser ignores these code points.</td>
</tr>
<tr>
<td>unexpected-character-in-attribute-name</td>
<td>This error occurs if the parser encounters a U+0022 (&quot;), U+0027 (’), or U+003C (&lt;) code point in an attribute name. The parser includes such code points in the attribute name.</td>
</tr>
<tr>
<td>expected-character-in-unquoted-attribute-value</td>
<td>This error occurs if the parser encounters a U+0022 (&quot;), U+0027 (’), U+003C (&lt;), U+003D (=), or U+0060 (’') code point in an unquoted attribute value. The parser includes such code points in the attribute value.</td>
</tr>
</tbody>
</table>

**Note**

The trailing U+002F (/) in a start tag name can be used only in foreign content to specify self-closing tags. (Self-closing tags don't exist in HTML.) It is also allowed for void elements, but doesn't have any effect in this case.

Note

Surrogates can only find their way into the input stream via script APIs such as `document.write()`.

Note

Code points that trigger this error are usually a part of another syntactic construct and can be a sign of a typo around the attribute name.

**Example**

For example, consider the following markup:

```html
<div foo><div>
```

Due to a forgotten U+003E (>) code point after `foo` the parser treats this markup as a single `div` element with a "foo<div" attribute.

As another example of this error, consider the following markup:

```html
<div id='bar'>
```

Due to a forgotten U+003D (=) code point between an attribute name and value the parser treats this markup as a `div` element with the attribute "id='bar'" that has an empty value.

**Note**

U+0060 (’) is in the list of code points that trigger this error because certain legacy user agents treat it as a quote.

**Example**

For example, consider the following markup:

```html
<div foo=b’ar’>
```

Due to a misplaced U+0027 (’) code point the parser sets the value of the "foo" attribute to "b’ar'".
### Table of Errors

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>unexpected-equals-sign-before-attribute-name</td>
<td>This error occurs if the parser encounters a U+003D (=) code point before an attribute name. In this case the parser treats U+003D (=) as the first code point of the attribute name.</td>
</tr>
<tr>
<td><strong>Example</strong></td>
<td>For example, consider the following markup:</td>
</tr>
<tr>
<td></td>
<td><code>&lt;div foo=&quot;bar&quot; =&quot;baz&quot;&gt;</code></td>
</tr>
<tr>
<td></td>
<td>Due to a forgotten attribute name the parser treats this markup as a div element with two attributes: a &quot;foo&quot; attribute with a &quot;bar&quot; value and a &quot;=&quot; attribute with an empty value.</td>
</tr>
<tr>
<td>unexpected-null-character</td>
<td>This error occurs if the parser encounters a U+0000 NULL code point in the input stream in certain positions. In general, such code points are either ignored or, for security reasons, replaced with a U+FFFD REPLACEMENT CHARACTER.</td>
</tr>
<tr>
<td>unexpected-question-mark-instead-of-tag-name</td>
<td>This error occurs if the parser encounters a U+003F (?) code point where first code point of a start tag name is expected. The U+003F (?) and all content that follows up to a U+003E (&gt;) code point (if present) or to the end of the input stream is treated as a comment.</td>
</tr>
<tr>
<td><strong>Example</strong></td>
<td>For example, consider the following markup:</td>
</tr>
<tr>
<td></td>
<td><code>&lt;?xml-stylesheet type=&quot;text/css&quot; href=&quot;style.css&quot;&gt;</code></td>
</tr>
<tr>
<td></td>
<td>This will be parsed into:</td>
</tr>
<tr>
<td></td>
<td><code>#comment: xml-stylesheet type=&quot;text/css&quot; href=&quot;style.css&quot;</code></td>
</tr>
<tr>
<td></td>
<td>Note: The common reason for this error is an XML processing instruction (e.g., <code>&lt;?xml-stylesheet type=&quot;text/css&quot; href=&quot;style.css&quot;&gt;</code>) or an XML declaration (e.g., <code>&lt;xml version=&quot;1.0&quot; encoding=&quot;UTF-8&quot;&gt;</code>) being used in HTML.</td>
</tr>
<tr>
<td>unexpected-solidus-in-tag</td>
<td>This error occurs if the parser encounters a U+002F (/) code point that is not a part of a quoted attribute value and not immediately followed by a U+003E (&gt;) code point in a tag (e.g., <code>&lt;div / id=&quot;foo&quot;&gt;</code>). In this case the parser behaves as if it encountered ASCII whitespace.</td>
</tr>
<tr>
<td>unknown-named-character-reference</td>
<td>This error occurs if the parser encounters an ambiguous ampersand. In this case the parser doesn’t resolve the character reference.</td>
</tr>
</tbody>
</table>

### 13.2.3 The input byte stream

The stream of code points that comprises the input to the tokenization stage will be initially seen by the user agent as a stream of bytes (typically coming over the network or from the local file system). The bytes encode the actual characters according to a particular character encoding, which the user agent uses to decode the bytes into characters.

**Note**

For XML documents, the algorithm user agents are required to use to determine the character encoding is given by XML. This section does not apply to XML documents. [XML](#)

Usually, the encoding sniffing algorithm defined below is used to determine the character encoding.

Given a character encoding, the bytes in the input byte stream must be converted to characters for the tokenizer’s input stream, by passing the input byte stream and character encoding to decode.

**Note**

A leading Byte Order Mark (BOM) causes the character encoding argument to be ignored and will itself be skipped.
When the HTML parser is decoding an input byte stream, it uses a character encoding and a confidence. The confidence is either tentative, certain, or irrelevant. The encoding used, and whether the confidence in that encoding is tentative or certain, is used during the parsing to determine whether to change the encoding. If no encoding is necessary, e.g. because the parser is operating on a Unicode stream and doesn't have to use a character encoding at all, then the confidence is irrelevant.

Some algorithms feed the parser by directly adding characters to the input stream, rather than adding bytes to the input byte stream.

### 13.2.3.1 Parsing with a known character encoding

When the HTML parser is to operate on an input byte stream that has a known definite encoding, then the character encoding is that encoding and the confidence is certain.

### 13.2.3.2 Determining the character encoding

In some cases, it might be impractical to unambiguously determine the encoding before parsing the document. Because of this, this specification provides for a two-pass mechanism with an optional pre-scan. Implementations are allowed, as described below, to apply a simplified parsing algorithm to whatever bytes they have available before beginning to parse the document. Then, the real parser is started, using a tentative encoding derived from this pre-parse and other out-of-band metadata. If, while the document is being loaded, the user agent discovers a character encoding declaration that conflicts with this information, then the parser can get reinvoked to perform a parse of the document with the real encoding.

User agents must use the following algorithm, called the encoding sniffing algorithm, to determine the character encoding to use when decoding a document in the first pass. This algorithm takes as input any out-of-band metadata available to the user agent (e.g. the Content-Type metadata of the document) and all the bytes available so far, and returns a character encoding and a confidence that is either tentative or certain.

1. If the result of BOM sniffing is an encoding, return that encoding with confidence certain.

   **Note**

   Although the decode algorithm will itself change the encoding to use based on the presence of a byte order mark, this algorithm sniffs the BOM as well in order to set the correct document's character encoding and confidence.

2. If the user has explicitly instructed the user agent to override the document's character encoding with a specific encoding, optionally return that encoding with the confidence certain.

   **Note**

   Typically, user agents remember such user requests across sessions, and in some cases apply them to documents in iframe's as well.

3. The user agent may wait for more bytes of the resource to be available, either in this step or at any later step in this algorithm. For instance, a user agent might wait 500ms or 1024 bytes, whichever came first. In general preparing the source to find the encoding improves performance, as it reduces the need to throw away the data structures used when parsing upon finding the encoding information. However, if the user agent delays too long to obtain data to determine the encoding, then the cost of the delay could outweigh any performance improvements from the preparse.
4. If the transport layer specifies a character encoding, and it is supported, return that encoding with the confidence certain.

5. Optionally prescan the byte stream to determine its encoding, with the end condition being when the user agent decides that scanning further bytes would not be efficient. User agents are encouraged to only prescan the first 1024 bytes. User agents may decide that scanning any bytes is not efficient, in which case these substeps are entirely skipped.

The aforementioned algorithm returns either a character encoding or failure. If it returns a character encoding, then return the same encoding, with confidence tentative.

6. If the HTML parser for which this algorithm is being run is associated with a Document whose container document is non-null, then:
   1. Let parentDocument be d's container document.
   2. If parentDocument's origin is same origin with d's origin and parentDocument's character encoding is not UTF-16BE/LE, then return parentDocument's character encoding, with the confidence tentative.

7. Otherwise, if the user agent has information on the likely encoding for this page, e.g. based on the encoding of the page when it was last visited, then return that encoding, with the confidence tentative.

8. The user agent may attempt to autodetect the character encoding from applying frequency analysis or other algorithms to the data stream. Such algorithms may use information about the resource other than the resource's contents, including the address of the resource. If autodetection succeeds in determining a character encoding, and that encoding is a supported encoding, then return that encoding, with the confidence tentative.

9. Otherwise, return an implementation-defined or user-specified default character encoding, with the confidence tentative.

In controlled environments or in environments where the encoding of documents can be prescribed (for example, for user agents intended for dedicated use in new networks), the comprehensive UTF-8 encoding is suggested.

In other environments, the default encoding is typically dependent on the user's locale (an approximation of the languages, and thus often encodings, of the pages that the user is likely to frequent). The following table gives suggested defaults based on the user's locale, for compatibility with legacy content. Locales are identified by BCP 47 language tags.

<table>
<thead>
<tr>
<th>Locale language</th>
<th>Suggested default encoding</th>
</tr>
</thead>
<tbody>
<tr>
<td>ar</td>
<td>Arabic windows-1256</td>
</tr>
<tr>
<td>az</td>
<td>Azeri windows-1254</td>
</tr>
<tr>
<td>ba</td>
<td>Bashkir windows-1251</td>
</tr>
<tr>
<td>be</td>
<td>Belarusian windows-1251</td>
</tr>
<tr>
<td>bg</td>
<td>Bulgarian windows-1251</td>
</tr>
<tr>
<td>cs</td>
<td>Czech windows-1250</td>
</tr>
<tr>
<td>el</td>
<td>Greek ISO-8859-7</td>
</tr>
<tr>
<td>et</td>
<td>Estonian windows-1257</td>
</tr>
<tr>
<td>fa</td>
<td>Persian windows-1256</td>
</tr>
<tr>
<td>he</td>
<td>Hebrew windows-1255</td>
</tr>
</tbody>
</table>

Note: The UTF-8 encoding has a highly detectable bit pattern. Files from the local file system that contain bytes with values greater than 0x7F which match the UTF-8 pattern are very likely to be UTF-8, while documents with byte sequences that do not match it are very likely not. When a user agent can examine the whole file, rather than just the preamble, detecting for UTF-8 specifically can be especially effective.

Note: User agents are generally discouraged from attempting to autodetect encodings for resources obtained over the network, since doing so involves inherently non-interoperable heuristics. Attempting to detect encodings based on an HTML document's preamble is especially tricky since HTML markup typically uses only ASCII characters, and HTML documents tend to begin with a lot of markup rather than with text content.
<table>
<thead>
<tr>
<th>Locale language</th>
<th>Suggested default encoding</th>
</tr>
</thead>
<tbody>
<tr>
<td>hr</td>
<td>Croatian windows-1250</td>
</tr>
<tr>
<td>hu</td>
<td>Hungarian ISO-8859-2</td>
</tr>
<tr>
<td>ja</td>
<td>Japanese Shift_JIS</td>
</tr>
<tr>
<td>kk</td>
<td>Kazakh windows-1251</td>
</tr>
<tr>
<td>ko</td>
<td>Korean EUC-KR</td>
</tr>
<tr>
<td>ku</td>
<td>Kurdish windows-1254</td>
</tr>
<tr>
<td>ky</td>
<td>Kyrgyz windows-1251</td>
</tr>
<tr>
<td>it</td>
<td>Lithuanian windows-1257</td>
</tr>
<tr>
<td>lv</td>
<td>Latvian windows-1257</td>
</tr>
<tr>
<td>mk</td>
<td>Macedonian windows-1251</td>
</tr>
<tr>
<td>pl</td>
<td>Polish ISO-8859-2</td>
</tr>
<tr>
<td>ru</td>
<td>Russian windows-1251</td>
</tr>
<tr>
<td>sah</td>
<td>Yakut windows-1251</td>
</tr>
<tr>
<td>sk</td>
<td>Slovak windows-1250</td>
</tr>
<tr>
<td>sl</td>
<td>Slovenian ISO-8859-2</td>
</tr>
<tr>
<td>sr</td>
<td>Serbian windows-1251</td>
</tr>
<tr>
<td>tg</td>
<td>Tajik windows-1251</td>
</tr>
<tr>
<td>th</td>
<td>Thai windows-874</td>
</tr>
<tr>
<td>tr</td>
<td>Turkish windows-1254</td>
</tr>
<tr>
<td>tt</td>
<td>Tatar windows-1251</td>
</tr>
<tr>
<td>uk</td>
<td>Ukrainian windows-1251</td>
</tr>
<tr>
<td>vi</td>
<td>Vietnamese windows-1258</td>
</tr>
<tr>
<td>zh-Hans, zh-CN, zh-SG</td>
<td>Chinese, Simplified GBK</td>
</tr>
<tr>
<td>zh-Hant, zh-HK, zh-MO, zh-TW</td>
<td>Chinese, Traditional Big5</td>
</tr>
<tr>
<td>All other locales</td>
<td>windows-1252</td>
</tr>
</tbody>
</table>

The contents of this table are derived from the intersection of Windows, Chrome, and Firefox defaults.

The document's character encoding must immediately be set to the value returned from this algorithm, at the same time as the user agent uses the returned value to select the decoder to use for the input byte stream.

When an algorithm requires a user agent to prescan a byte stream to determine its encoding, given some defined end condition, then it must run the following steps. If at any point during these steps (including during instances of the get an attribute algorithm invoked by this one) the user agent either runs out of bytes (meaning the position pointer created in the first step below goes beyond the end of the byte stream obtained so far) or reaches its end condition, then abort the prescan a byte stream to determine its encoding algorithm and return the result get an XML encoding applied to the same bytes that the prescan a byte stream to determine its encoding algorithm was applied to. Otherwise, these steps will return a character encoding.

1. Let fallback encoding be null.
2. Let position be a pointer to a byte in the input byte stream, initially pointing at the first byte.
3. Prescan for UTF-16 XML declarations: If position points to:
   → A sequence of bytes starting with: 0x3C, 0x0, 0x3F, 0x0, 0x78, 0x0 (case-sensitive UTF-16 little-endian `<?x`)  
      Return UTF-16LE.
   
   → A sequence of bytes starting with: 0x0, 0x3C, 0x0, 0x3F, 0x0, 0x78 (case-sensitive UTF-16 big-endian `<?x`)  
      Return UTF-16BE.

   **Note**

   For historical reasons, the prefix is two bytes longer than in Appendix F of XML and the encoding name is not checked.

4. Loop: If position points to:
   → A sequence of bytes starting with: 0x3C 0x21 0x2D 0x2D (`<!-`)
      Advance the position pointer so that it points at the first 0x3E byte which is preceded by two 0x2D bytes (i.e. at the end of an ASCII `-->' sequence) and comes after the 0x3C byte that was found. (The two 0x2D bytes can be the same
A sequence of bytes starting with: 0x3C, 0x4D or 0x6D, 0x45 or 0x65, 0x54 or 0x74, 0x41 or 0x61, and one of 0x09, 0x0A, 0x0C, 0x0D, 0x20, 0x2F (case-insensitive ASCII '<meta>' followed by a space or slash)

1. Advance the position pointer so that it points at the next 0x09, 0x0A, 0x0C, 0x0D, 0x20, or 0x2F byte (the one in sequence of characters matched above).

2. Let attribute list be an empty list of strings.

3. Let got pragma be false.

4. Let need pragma be null.

5. Let charset be the null value (which, for the purposes of this algorithm, is distinct from an unrecognized encoding or the empty string).

6. Attributes: Get an attribute\textsuperscript{1263} and its value. If no attribute was sniffed, then jump to the processing step below.

7. If the attribute's name is already in attribute list, then return to the step labeled attributes.

8. Add the attribute's name to attribute list.

9. Run the appropriate step from the following list, if one applies:

   - If the attribute's name is "http-equiv"
     If the attribute's value is "content-type", then set got pragma to true.

   - If the attribute's name is "content"
     Apply the algorithm for extracting a character encoding from a meta element\textsuperscript{997}, giving the attribute's value as the string to parse. If a character encoding is returned, and if charset is still set to null, let charset be the encoding returned, and set need pragma to true.

   - If the attribute's name is "charset"
     Let charset be the result of getting an encoding from the attribute's value, and set need pragma to false.

10. Return to the step labeled attributes.

11. Processing: If need pragma is null, then jump to the step below labeled next byte.

12. If need pragma is true but got pragma is false, then jump to the step below labeled next byte.

13. If charset is failure, then jump to the step below labeled next byte.

14. If charset is UTF-16BE/LE, then set charset to UTF-8.

15. If charset is x-user-defined, then set charset to windows-1252.

16. Return charset.

A sequence of bytes starting with a 0x3C byte (<), optionally a 0x2F byte (/), and finally a byte in the range 0x41-0x5A or 0x61-0x7A (A-Z or a-z)

1. Advance the position pointer so that it points at the next 0x09 (HT), 0x0A (LF), 0x0C (FF), 0x0D (CR), 0x20 (SP), or 0x3E (>) byte.

2. Repeatedly get an attribute\textsuperscript{1263} until no further attributes can be found, then jump to the step below labeled next byte.

A sequence of bytes starting with: 0x3C 0x21 ('<!')

A sequence of bytes starting with: 0x3C 0x2F ('</')

A sequence of bytes starting with: 0x3C 0x3F ('<?>')

Advance the position pointer so that it points at the first 0x3E byte (>) that comes after the 0x3C byte that was found.

Any other byte

Do nothing with that byte.
5. Next byte: Move position so it points at the next byte in the input byte stream, and return to the step above labeled loop.

When the prescan a byte stream to determine its encoding\textsuperscript{1263} algorithm says to get an attribute, it means doing this:

1. If the byte at position is one of 0x09 (HT), 0x0A (LF), 0x0C (FF), 0x0D (CR), 0x20 (SP), or 0x2F (/) then advance position to the next byte and redo this step.
2. If the byte at position is 0x3E (>), then abort the get an attribute\textsuperscript{1263} algorithm. There isn't one.
3. Otherwise, the byte at position is the start of the attribute name. Let attribute name and attribute value be the empty string.
4. Process the byte at position as follows:
   \begin{itemize}
   \item[↪] If it is 0x3D (=), and the attribute name is longer than the empty string
      Advance position to the next byte and jump to the step below labeled value.
   \item[↪] If it is 0x09 (HT), 0x0A (LF), 0x0C (FF), 0x0D (CR), or 0x20 (SP)
      Jump to the step below labeled spaces.
   \item[↪] If it is 0x2F (/) or 0x3E (>)
      Abort the get an attribute\textsuperscript{1263} algorithm. The attribute's name is the value of attribute name, its value is the empty string.
   \item[↪] If it is in the range 0x41 (A) to 0x5A (Z)
      Append the code point b+0x20 to attribute name (where b is the value of the byte at position). (This converts the input to lowercase.)
   \item[↪] Anything else
      Append the code point with the same value as the byte at position to attribute name. (It doesn't actually matter how bytes outside the ASCII range are handled here, since only ASCII bytes can contribute to the detection of a character encoding.)
   \end{itemize}
5. Advance position to the next byte and return to the previous step.
6. Spaces: If the byte at position is one of 0x09 (HT), 0x0A (LF), 0x0C (FF), 0x0D (CR), or 0x20 (SP) then advance position to the next byte, then, repeat this step.
7. If the byte at position is not 0x3D (=), abort the get an attribute\textsuperscript{1263} algorithm. The attribute's name is the value of attribute name, its value is the empty string.
8. Advance position past the 0x3D (=) byte.
9. Value: If the byte at position is one of 0x09 (HT), 0x0A (LF), 0x0C (FF), 0x0D (CR), or 0x20 (SP) then advance position to the next byte, then, repeat this step.
10. Process the byte at position as follows:
   \begin{itemize}
   \item[↪] If it is 0x22 (" ) or 0x27 (' )
      \begin{itemize}
      \item[1.] Let b be the value of the byte at position.
      \item[2.] Quote loop: Advance position to the next byte.
      \item[3.] If the value of the byte at position is the value of b, then advance position to the next byte and abort the "get an attribute" algorithm. The attribute's name is the value of attribute name, and its value is the value of attribute value.
      \item[4.] Otherwise, if the value of the byte at position is in the range 0x41 (A) to 0x5A (Z), then append a code point to attribute value whose value is 0x20 more than the value of the byte at position.
      \item[5.] Otherwise, append a code point to attribute value whose value is the same as the value of the byte at position.
      \item[6.] Return to the step above labeled quote loop.
      \end{itemize}
   \item[↪] If it is 0x3E (>)
      Abort the get an attribute\textsuperscript{1263} algorithm. The attribute's name is the value of attribute name, its value is the empty string.
   \end{itemize}
If it is in the range 0x41 (A) to 0x5A (Z)
Append a code point \( b + 0x20 \) to \( \text{attribute value} \) (where \( b \) is the value of the byte at \( \text{position} \)). Advance \( \text{position} \) to the next byte.

Anything else
Append a code point with the same value as the byte at \( \text{position} \) to \( \text{attribute value} \). Advance \( \text{position} \) to the next byte.

11. Process the byte at \( \text{position} \) as follows:
   - If it is 0x09 (HT), 0x0A (LF), 0x0C (FF), 0x0D (CR), 0x20 (SP), or 0x3E (>)
     Abort the \text{get an attribute} \(^{1263}\) algorithm. The attribute's name is the value of \( \text{attribute name} \) and its value is the value of \( \text{attribute value} \).
   - If it is in the range 0x41 (A) to 0x5A (Z)
     Append a code point \( b + 0x20 \) to \( \text{attribute value} \) (where \( b \) is the value of the byte at \( \text{position} \)).
   - Anything else
     Append a code point with the same value as the byte at \( \text{position} \) to \( \text{attribute value} \).

12. Advance \( \text{position} \) to the next byte and return to the previous step.

When the \text{prescan a byte stream to determine its encoding} \(^{1261}\) algorithm is aborted without returning an encoding, \text{get an XML encoding} means doing this.

\[\text{Looking for syntax resembling an XML declaration, even in text/html}^{1424}\text{, is necessary for compatibility with existing content.}\]

1. Let \( \text{encodingPosition} \) be a pointer to the start of the stream.
2. If \( \text{encodingPosition} \) does not point to the start of a byte sequence 0x3C, 0x3F, 0x78, 0x6D, 0x6C (`<?xml`), then return failure.
3. Let \( \text{xmlDeclarationEnd} \) be a pointer to the next byte in the input byte stream which is 0x3E (>). If there is no such byte, then return failure.
4. Set \( \text{encodingPosition} \) to the position of the first occurrence of the subsequence of bytes 0x65, 0x6E, 0x63, 0x6F, 0x64, 0x69, 0x66, 0x67 (`encoding`) at or after the current \( \text{encodingPosition} \). If there is no such sequence, then return failure.
5. Advance \( \text{encodingPosition} \) past the 0x67 (g) byte.
6. While the byte at \( \text{encodingPosition} \) is less than or equal to 0x20 (i.e., it is either an ASCII space or control character), advance \( \text{encodingPosition} \) to the next byte.
7. If the byte at \( \text{encodingPosition} \) is not 0x3D (=), then return failure.
8. Advance \( \text{encodingPosition} \) to the next byte.
9. While the byte at \( \text{encodingPosition} \) is less than or equal to 0x20 (i.e., it is either an ASCII space or control character), advance \( \text{encodingPosition} \) to the next byte.
10. Let \( \text{quoteMark} \) be the byte at \( \text{encodingPosition} \).
11. If \( \text{quoteMark} \) is not either 0x22 (") or 0x27 ('), then return failure.
12. Advance \( \text{encodingPosition} \) to the next byte.
13. Let \( \text{encodingEndPosition} \) be the position of the next occurrence of \( \text{quoteMark} \) at or after \( \text{encodingPosition} \). If \( \text{quoteMark} \) does not occur again, then return failure.
14. Let \( \text{potentialEncoding} \) be the sequence of the bytes between \( \text{encodingPosition} \) (inclusive) and \( \text{encodingEndPosition} \) (exclusive).
15. If \( \text{potentialEncoding} \) contains one or more bytes whose byte value is 0x20 or below, then return failure.
16. Let \( \text{encoding} \) be the result of \text{getting an encoding} given \( \text{potentialEncoding} \) \text{isomorphic decoded}.
17. If the \( \text{encoding} \) is UTF-16BE/LE, then change it to UTF-8.
18. Return \( \text{encoding} \).
For the sake of interoperability, user agents should not use a pre-scan algorithm that returns different results than the one described above. (But, if you do, please at least let us know, so that we can improve this algorithm and benefit everyone...)

13.2.3.3 Character encodings


Note: The above prohibits supporting, for example, CESU-8, UTF-7, BOCU-1, SCSU, EBCDIC, and UTF-32. This specification does not make any attempt to support prohibited encodings in its algorithms; support and use of prohibited encodings would thus lead to unexpected behavior. [CESU8] [UTF7] [BOCU1] [SCSU]

13.2.3.4 Changing the encoding while parsing

When the parser requires the user agent to change the encoding, it must run the following steps. This might happen if the encoding sniffing algorithm described above failed to find a character encoding, or if it found a character encoding that was not the actual encoding of the file.

1. If the encoding that is already being used to interpret the input stream is UTF-16BE/LE, then set the confidence to certain and return. The new encoding is ignored; if it was anything but the same encoding, then it would be clearly incorrect.

2. If the new encoding is UTF-16BE/LE, then change it to UTF-8.

3. If the new encoding is x-user-defined, then change it to windows-1252.

4. If the new encoding is identical or equivalent to the encoding that is already being used to interpret the input stream, then set the confidence to certain and return. This happens when the encoding information found in the file matches what the encoding sniffing algorithm determined to be the encoding, and in the second pass through the parser if the first pass found that the encoding sniffing algorithm described in the earlier section failed to find the right encoding.

5. If all the bytes up to the last byte converted by the current decoder have the same Unicode interpretations in both the current encoding and the new encoding, and if the user agent supports changing the converter on the fly, then the user agent may change to the new converter for the encoding on the fly. Set the document's character encoding and the encoding used to convert the input stream to the new encoding, set the confidence to certain, and return.

6. Otherwise, restart the navigate algorithm, with historyHandling set to "replace" and other inputs kept the same, but this time skip the encoding sniffing algorithm and instead just set the encoding to the new encoding and the confidence to certain. Whenever possible, this should be done without actually contacting the network layer (the bytes should be re-parsed from memory), even if, e.g., the document is marked as not being cacheable. If this is not possible and contacting the network layer would involve repeating a request that uses a method other than `GET`, then instead set the confidence to certain and ignore the new encoding. The resource will be misinterpreted. User agents may notify the user of the situation, to aid in application development.

Note: This algorithm is only invoked when a new encoding is found declared on a meta element.

13.2.3.5 Preprocessing the input stream

The input stream consists of the characters pushed into it as the input byte stream is decoded or from the various APIs that directly manipulate the input stream.

Any occurrences of surrogates are surrogate-in-input-stream parse errors. Any occurrences of noncharacters are noncharacter-in-input-stream parse errors and any occurrences of controls other than ASCII whitespace and U+0000 NULL characters are control-character-in-input-stream parse errors.
The handling of U+0000 NULL characters varies based on where the characters are found and happens at the later stages of the parsing. They are either ignored or, for security reasons, replaced with a U+FFFD REPLACEMENT CHARACTER. This handling is, by necessity, spread across both the tokenization stage and the tree construction stage.

Before the tokenization stage, the input stream must be preprocessed by normalizing newlines. Thus, newlines in HTML DOMs are represented by U+000A LF characters, and there are never any U+000D CR characters in the input to the tokenization stage.

The next input character is the first character in the input stream that has not yet been consumed or explicitly ignored by the requirements in this section. Initially, the next input character is the first character in the input. The current input character is the last character to have been consumed.

When the steps below require the UA to reset the insertion mode appropriately, it means the UA must follow these steps:

1. Let last be false.
2. Let node be the last node in the stack of open elements.
3. Loop: If node is the first node in the stack of open elements, then set last to true, and, if the parser was created as part of the HTML fragment parsing algorithm (fragment case), set node to the context element passed to that algorithm.
4. If node is a select element, run these substeps:
1. If `last` is true, jump to the step below labeled `done`.
2. Let `ancestor be node`.
3. Loop: If `ancestor` is the first node in the stack of open elements, jump to the step below labeled `done`.
4. Let `ancestor be the node before ancestor in the stack of open elements`.
5. If `ancestor` is a `template` node, jump to the step below labeled `done`.
6. If `ancestor` is a `table` node, switch the `insertion mode` to `in select in table` and return.
7. Jump back to the step labeled `loop`.
8. Done: Switch the `insertion mode` to `in select` and return.
   5. If `node` is a `td` or `th` element and `last` is false, then switch the `insertion mode` to `in cell` and return.
   6. If `node` is a `tr` element, then switch the `insertion mode` to `in row` and return.
   7. If `node` is a `tbody`, `thead`, or `tfoot` element, then switch the `insertion mode` to `in table body` and return.
   8. If `node` is a `caption` element, then switch the `insertion mode` to `in caption` and return.
   9. If `node` is a `colgroup` element, then switch the `insertion mode` to `in column group` and return.
10. If `node` is a `table` element, then switch the `insertion mode` to `in table` and return.
11. If `node` is a `template` element, then switch the `insertion mode` to the current template insertion mode and return.
12. If `node` is a `head` element and `last` is false, then switch the `insertion mode` to `in head` and return.
13. If `node` is a `body` element, then switch the `insertion mode` to `in body` and return.
14. If `node` is a `frameset` element, then switch the `insertion mode` to `in frameset` and return. (fragment case)
15. If `node` is an `html` element, run these substeps:
   1. If the `head element pointer` is null, switch the `insertion mode` to `before head` and return. (fragment case)
   2. Otherwise, the `head element pointer` is not null, switch the `insertion mode` to `after head` and return. (fragment case)
16. If `last` is true, then switch the `insertion mode` to `in body` and return. (fragment case)
17. Let `node now be the node before node in the stack of open elements`.
18. Return to the step labeled `loop`.

### 13.2.4.2 The stack of open elements

Initially, the stack of open elements is empty. The stack grows downwards; the topmost node on the stack is the first one added to the stack, and the bottommost node of the stack is the most recently added node in the stack (notwithstanding when the stack is manipulated in a random access fashion as part of the handling for misnested tags).

**Note**

The `before html` insertion mode creates the `html` document element, which is then added to the stack.

**Note**

In the fragment case, the stack of open elements is initialized to contain an `html` element that is created as part of that algorithm. (The fragment case skips the `before html` insertion mode.)

The `html` node, however it is created, is the topmost node of the stack. It only gets popped off the stack when the parser finishes.

The current node is the bottommost node in this stack of open elements.
The **adjusted current node** is the **context** element if the parser was created as part of the **HTML fragment parsing algorithm** and the **stack of open elements** has only one element in it (fragment case); otherwise, the **adjusted current node** is the **current node**.

When the **current node** is removed from the **stack of open elements**, **process internal resource links** given the **current node**'s node document.

Elements in the **stack of open elements** fall into the following categories:

**Special**

The following elements have varying levels of special parsing rules: HTML's **address**, **applet**, **area**, **article**, **aside**, **base**, **b** (see **p1407**), **bgsound** (**p486**), **blockquote** (**p257**), **body** (**p387**), **button**, **caption**, **center** (**p1407**), **col** (**p484**), **colgroup** (**p632**), **dd** (**p245**), **dfn** (**p666**), **dir** (**p564**), **div** (**p339**), **dl** (**p172**), **dt** (**p171**), **embed** (**p206**), **fieldset** (**p339**), **figcaption** (**p249**), **figure** (**p246**), **footer** (**p127**), **form** (**p510**), **frameset** (**p632**), **hl** (**p1413**), **h2** (**p483**), **h3** (**p387**), **h4** (**p491**), **h5** (**p490**), **h6** (**p490**), **head** (**p174**), **header** (**p125**), **hgroup** (**p202**), **hr** (**p125**), **html** (**p1354**), **iframe** (**p1267**), **img** (**p1407**), **input** (**p1267**), **keygen** (**p1407**), **li** (**p1407**), **listing** (**p1406**), **main** (**p1267**), **marquee** (**p241**), **menu** (**p1407**), **meta** (**p561**), **nav** (**p1268**), **noframes** (**p230**), **object** (**p339**), **ol** (**p225**), **p** (**p226**), **param** (**p1486**), **plaintext** (**p1406**), **pre** (**p236**), **script** (**p644**), **search** (**p251**), **section** (**p304**), **select** (**p156**), **source** (**p339**), **style** (**p197**), **summary** (**p639**), **table** (**p474**), **tbody** (**p485**), **td** (**p490**), **template** (**p666**), **textarea** (**p575**), **tfoot** (**p487**), **th** (**p91**), **thead** (**p1407**), **title** (**p1267**), **tr** (**p488**), **track** (**p283**), **u** (**p226**), **ul** (**p236**), **wbr** (**p297**), **xmp** (**p1407**), **MathML mi** (**p482**), **MathML mo** (**p387**), **MathML mn** (**p510**), **MathML ms** (**p482**), **MathML mtext**, and **MathML annotation-xml**; and **SVG foreignObject**, **SVG desc**, and **SVG title**.

**Formatting**

The following HTML elements are those that end up in the **list of active formatting elements**: **a**, **b**, **big**, **code**, **em**, **font**, **i**, **nobr**, **small**, **strong**, **style**, **strike**, **tt**, **u**, **y**.

**Ordinary**

All other elements found while parsing an HTML document.

Typically, the **special** elements have the start and end tag tokens handled specifically, while **ordinary** elements' tokens fall into "any other start tag" and "any other end tag" clauses, and some parts of the tree builder check if a particular element in the **stack of open elements** is in the **special** category. However, some elements (e.g., the **option** element) have their start or end tag tokens handled specifically, but are still not in the **special** category, so that they get the **ordinary** handling elsewhere.

The **stack of open elements** is said to have a **element target node in a specific scope** consisting of a list of element types list when the following algorithm terminates in a match state:

1. Initialize **node** to be the **current node** (**p1267**) (the bottommost node of the stack).
2. If **node** is the target node, terminate in a match state.
3. Otherwise, if **node** is one of the element types in list, terminate in a failure state.
4. Otherwise, set **node** to the previous entry in the **stack of open elements** and return to step 2. (This will never fail, since the loop will always terminate in the previous step if the top of the stack — an **html** element — is reached.)

The **stack of open elements** is said to have a **particular element in scope** when it **has that element in the specific scope** consisting of the following element types:

- **applet**
- **caption**
- **html**
- **table**
- **td**
- **th**
- **marquee**
- **object**
- **template**
- **MathML mi**
- **MathML mo**
The stack of open elements is said to have a particular element in list item scope when it has that element in the specific scope consisting of the following element types:

- All the element types listed above for the has an element in scope algorithm.
- ol in the HTML namespace
- ul in the HTML namespace

The stack of open elements is said to have a particular element in button scope when it has that element in the specific scope consisting of the following element types:

- All the element types listed above for the has an element in scope algorithm.
- button in the HTML namespace

The stack of open elements is said to have a particular element in table scope when it has that element in the specific scope consisting of the following element types:

- html in the HTML namespace
- table in the HTML namespace
- template in the HTML namespace

The stack of open elements is said to have a particular element in select scope when it has that element in the specific scope consisting of all element types except the following:

- optgroup in the HTML namespace
- option in the HTML namespace

Nothing happens if at any time any of the elements in the stack of open elements are moved to a new location in, or removed from, the Document tree. In particular, the stack is not changed in this situation. This can cause, amongst other strange effects, content to be appended to nodes that are no longer in the DOM.

Note

In some cases (namely, when closing misnested formatting elements), the stack is manipulated in a random-access fashion.

13.2.4.3 The list of active formatting elements

Initially, the list of active formatting elements is empty. It is used to handle mis-nested formatting element tags.

The list contains elements in the formatting category, and markers. The markers are inserted when entering applet, object, marquee, template, td, th, and caption elements, and are used to prevent formatting from “leaking” into applet, object, marquee, template, td, th, and caption elements.

In addition, each element in the list of active formatting elements is associated with the token for which it was created, so that further elements can be created for that token if necessary.

When the steps below require the UA to push onto the list of active formatting elements an element element, the UA must perform the following steps:

1. If there are already three elements in the list of active formatting elements after the last marker, if any, or anywhere in the list if there are no markers, that have the same tag name, namespace, and attributes as element, then remove the earliest such element from the list of active formatting elements. For these purposes, the attributes must be compared as they were when the elements were created by the parser; two elements have the same attributes if all their parsed attributes can be paired such that the two attributes in each pair have identical names, namespaces, and values (the order of the attributes does not matter).

Note

This is the Noah’s Ark clause. But with three per family instead of two.
2. Add element to the list of active formatting elements.

When the steps below require the UA to reconstruct the active formatting elements, the UA must perform the following steps:

1. If there are no entries in the list of active formatting elements, then there is nothing to reconstruct; stop this algorithm.
2. If the last (most recently added) entry in the list of active formatting elements is a marker, or if it is an element that is in the stack of open elements, then there is nothing to reconstruct; stop this algorithm.
3. Let entry be the last (most recently added) element in the list of active formatting elements.
4. Rewind: If there are no entries before entry in the list of active formatting elements, then jump to the step labeled create.
5. Let entry be the entry one earlier than entry in the list of active formatting elements.
6. If entry is neither a marker nor an element that is also in the stack of open elements, go to the step labeled rewind.
7. Advance: Let entry be the element one later than entry in the list of active formatting elements.
8. Create: Insert an HTML element for the token for which the element entry was created, to obtain new element.
9. Replace the entry for entry in the list with an entry for new element.
10. If the entry for new element in the list of active formatting elements is not the last entry in the list, return to the step labeled advance.

This has the effect of reopening all the formatting elements that were opened in the current body, cell, or caption (whichever is youngest) that haven’t been explicitly closed.

Note

The way this specification is written, the list of active formatting elements always consists of elements in chronological order with the least recently added element first and the most recently added element last (except for while steps 7 to 10 of the above algorithm are being executed, of course).

When the steps below require the UA to clear the list of active formatting elements up to the last marker, the UA must perform the following steps:

1. Let entry be the last (most recently added) entry in the list of active formatting elements.
2. Remove entry from the list of active formatting elements.
3. If entry was a marker, then stop the algorithm at this point. The list has been cleared up to the last marker.
4. Go to step 1.

13.2.4.4 The element pointers

Initially, the head element pointer and the form element pointer are both null.

Once a head element has been parsed (whether implicitly or explicitly) the head element pointer gets set to point to this node.

The form element pointer points to the last form element that was opened and whose end tag has not yet been seen. It is used to make form controls associate with forms in the face of dramatically bad markup, for historical reasons. It is ignored inside template elements.

13.2.4.5 Other parsing state flags

The scripting flag is set to "enabled" if scripting was enabled for the Document, with which the parser is associated when the parser was created, and "disabled" otherwise.
The **frameset-ok flag** is set to "ok" when the parser is created. It is set to "not ok" after certain tokens are seen.

### 13.2.5 Tokenization

Implementations must act as if they used the following state machine to tokenize HTML. The state machine must start in the **data state**. Most states consume a single character, which may have various side-effects, and either switches the state machine to a new state to **reconsume** the **current input character**, or switches it to a new state to consume the **next character**, or stays in the same state to consume the next character. Some states have more complicated behavior and can consume several characters before switching to another state. In some cases, the tokenizer state is also changed by the tree construction stage.

When a state says to **reconsume** a matched character in a specified state, that means to switch to that state, but when it attempts to consume the **next input character**, provide it with the **current input character** instead.

The exact behavior of certain states depends on the **insertion mode** and the **stack of open elements**. Certain states also use a **temporary buffer** to track progress, and the **character reference state** uses a **return state** to return to the state it was invoked from.

The output of the tokenization step is a series of zero or more of the following tokens: DOCTYPE, start tag, end tag, comment, character, end-of-file. DOCTYPE tokens have a name, a public identifier, a system identifier, and a **force-quirks flag**. When a DOCTYPE token is created, its name, public identifier, and system identifier must be marked as missing (which is a distinct state from the empty string), and the **force-quirks flag** must be set to **off** (its other state is on). Start and end tag tokens have a tag name, a **self-closing flag**, and a list of attributes, each of which has a name and a value. When a start or end tag token is created, its **self-closing flag** must be unset (its other state is that it be set), and its attributes list must be empty. Comment and character tokens have data.

When a token is emitted, it must immediately be handled by the **tree construction** stage. The tree construction stage can affect the state of the tokenization stage, and can insert additional characters into the stream. (For example, the **script** element can result in scripts executing and using the **dynamic markup insertion** APIs to insert characters into the stream being tokenized.)

**Note**

Creating a token and emitting it are distinct actions. It is possible for a token to be created but implicitly abandoned (never emitted), e.g. if the file ends unexpectedly while processing the characters that are being parsed into a start tag token.

When a start tag token is emitted with its **self-closing flag** set, if the flag is not **acknowledged** when it is processed by the tree construction stage, that is a **non-void-html-element-start-tag-with-trailing-solidus** **parse error**.

When an end tag token is emitted with attributes, that is an **end-tag-with-attributes** **parse error**.

When an end tag token is emitted with its **self-closing flag** set, that is an **end-tag-with-trailing-solidus** **parse error**.

An appropriate end tag token is an end tag token whose tag name matches the tag name of the last start tag to have been emitted from this tokenizer, if any. If no start tag has been emitted from this tokenizer, then no end tag token is appropriate.

A **character reference** is said to be consumed as part of an attribute if the **return state** is either **attribute value (double-quoted) state**, **attribute value (single-quoted) state**, or **attribute value (unquoted) state**.

When a state says to flush code points consumed as a character reference, it means that for each code point in the **temporary buffer** (in the order they were added to the buffer) user agent must append the code point from the buffer to the current attribute's value if the character reference was consumed as part of an attribute, or emit the code point as a character token otherwise.

Before each step of the tokenizer, the user agent must first check the **parser pause flag**. If it is true, then the tokenizer must abort the processing of any nested invocations of the tokenizer, yielding control back to the caller.

The tokenizer state machine consists of the states defined in the following subsections.
13.2.5.1 Data state

Consume the next input character:

- **U+0026 AMPERSAND (&)**
  Set the return state to the data state. Switch to the character reference state.
- **U+003C LESS-THAN SIGN (<)**
  Switch to the tag open state.
- **U+0000 NULL**
  This is an unexpected-null-character parse error. Emit the current input character as a character token.
- **EOF**
  Emit an end-of-file token.
- **Anything else**
  Emit the current input character as a character token.

13.2.5.2 CDATA state

Consume the next input character:

- **U+0026 AMPERSAND (&)**
  Set the return state to the CDATA state. Switch to the character reference state.
- **U+003C LESS-THAN SIGN (<)**
  Switch to the CDATA less-than sign state.
- **U+0000 NULL**
  This is an unexpected-null-character parse error. Emit a U+FFFD REPLACEMENT CHARACTER character token.
- **EOF**
  Emit an end-of-file token.
- **Anything else**
  Emit the current input character as a character token.

13.2.5.3 Raw text state

Consume the next input character:

- **U+003C LESS-THAN SIGN (<)**
  Switch to the Raw text less-than sign state.
- **U+0000 NULL**
  This is an unexpected-null-character parse error. Emit a U+FFFD REPLACEMENT CHARACTER character token.
- **EOF**
  Emit an end-of-file token.
- **Anything else**
  Emit the current input character as a character token.

13.2.5.4 Script data state

Consume the next input character:

- **U+003C LESS-THAN SIGN (<)**
  Switch to the script data less-than sign state.
This is an unexpected-null-character parse error. Emit a U+FFFD REPLACEMENT CHARACTER character token.

Emit an end-of-file token.

Emit the current input character as a character token.

Consume the next input character:

This is an unexpected-null-character parse error. Emit a U+FFFD REPLACEMENT CHARACTER character token.

Emit an end-of-file token.

Emit the current input character as a character token.

Consume the next input character:

This is an unexpected-null-character parse error. Emit a U+FFFD REPLACEMENT CHARACTER character token.

Emit an end-of-file token.

Emit the current input character as a character token.

Consume the next input character:

Switch to the markup declaration open state.

Switch to the end tag open state.

Create a new start tag token, set its tag name to the empty string. Reconsume in the tag name state.

This is an unexpected-question-mark-instead-of-tag-name parse error. Create a comment token whose data is the empty string. Reconsume in the bogus comment state.

This is an eof-before-tag-name parse error. Emit a U+003C LESS-THAN SIGN character token and an end-of-file token.

This is an invalid-first-character-of-tag-name parse error. Emit a U+003C LESS-THAN SIGN character token.

Reconsume in the data state.

Consume the next input character:

Create a new end tag token, set its tag name to the empty string. Reconsume in the tag name state.

This is a missing-end-tag-name parse error. Switch to the data state.

This is an eof-before-tag-name parse error. Emit a U+003C LESS-THAN SIGN character token, a U+002F SOLIDUS character token and an end-of-file token.
Anything else
This is an invalid-first-character-of-tag-name\textsuperscript{p1255} parse error\textsuperscript{p1254}. Create a comment token whose data is the empty string. Reconsume\textsuperscript{p1271} in the bogus comment state\textsuperscript{p1285}.

### 13.2.5.8 Tag name state

Consume the next input character\textsuperscript{p1266}:

- \textsuperscript{U+0009} CHARACTER TABULATION (tab)
- \textsuperscript{U+000A} LINE FEED (LF)
- \textsuperscript{U+000C} FORM FEED (FF)
- \textsuperscript{U+0020} SPACE
  - Switch to the before attribute name state\textsuperscript{p1282}.
- \textsuperscript{U+002F} SOLIDUS (/)
  - Switch to the self-closing start tag state\textsuperscript{p1285}.
- \textsuperscript{U+003E} GREATER-THAN SIGN (>)
  - Switch to the data state\textsuperscript{p1272}. Emit the current tag token.

**ASCII upper alpha**
- Append the lowercase version of the current input character\textsuperscript{p1266} (add 0x0020 to the character's code point) to the current tag token's tag name.
- \textsuperscript{U+0000} NULL
  - This is an unexpected-null-character\textsuperscript{p1258} parse error\textsuperscript{p1254}. Append a U+FFFD REPLACEMENT CHARACTER character to the current tag token's tag name.
- EOF
  - This is an eof-in-tag\textsuperscript{p1255} parse error\textsuperscript{p1254}. Emit an end-of-file token.
- Anything else
  - Append the current input character\textsuperscript{p1266} to the current tag token's tag name.

### 13.2.5.9 RCDATA less-than sign state

Consume the next input character\textsuperscript{p1266}:

- \textsuperscript{U+002F} SOLIDUS (/)
  - Set the temporary buffer\textsuperscript{p1271} to the empty string. Switch to the RCDATA end tag open state\textsuperscript{p1274}.
- Anything else
  - Emit a U+003C LESS-THAN SIGN character token. Reconsume\textsuperscript{p1271} in the RCDATA state\textsuperscript{p1272}.

### 13.2.5.10 RCDATA end tag open state

Consume the next input character\textsuperscript{p1266}:

**ASCII alpha**
- Create a new end tag token, set its tag name to the empty string. Reconsume\textsuperscript{p1271} in the RCDATA end tag name state\textsuperscript{p1275}.
- Anything else
  - Emit a U+003C LESS-THAN SIGN character token and a U+002F SOLIDUS character token. Reconsume\textsuperscript{p1271} in the RCDATA state\textsuperscript{p1272}.
13.2.5.11 RCDATA end tag name state

Consume the next input character:

- U+0009 CHARACTER TABULATION (tab)
- U+00A LINE FEED (LF)
- U+00C FORM FEED (FF)
- U+020 SPACE
  
  If the current end tag token is an appropriate end tag token, then switch to the before attribute name state. Otherwise, treat it as per the "anything else" entry below.

- U+002F SOLIDUS (/)
  
  If the current end tag token is an appropriate end tag token, then switch to the self-closing start tag state. Otherwise, treat it as per the "anything else" entry below.

- U+003E GREATER-TWAN SIGN (>)
  
  If the current end tag token is an appropriate end tag token, then switch to the data state and emit the current tag token. Otherwise, treat it as per the "anything else" entry below.

- ASCII upper alpha
  
  Append the lowercase version of the current input character (add 0x0020 to the character's code point) to the current tag token's tag name. Append the current input character to the temporary buffer.

- ASCII lower alpha
  
  Append the current input character to the current tag token's tag name. Append the current input character to the temporary buffer.

- Anything else
  
  Emit a U+003C LESS-TWAN SIGN character token, a U+002F SOLIDUS character token, and a character token for each of the characters in the temporary buffer (in the order they were added to the buffer). Reconsume in the RCDATA state.

13.2.5.12 RAWTEXT less-than sign state

Consume the next input character:

- U+002F SOLIDUS (/)
  
  Set the temporary buffer to the empty string. Switch to the RAWTEXT end tag open state.

- Anything else
  
  Emit a U+003C LESS-TWAN SIGN character token. Reconsume in the RAWTEXT state.

13.2.5.13 RAWTEXT end tag open state

Consume the next input character:

- ASCII alpha
  
  Create a new end tag token, set its tag name to the empty string. Reconsume in the RAWTEXT end tag name state.

- Anything else
  
  Emit a U+003C LESS-TWAN SIGN character token and a U+002F SOLIDUS character token. Reconsume in the RAWTEXT state.

13.2.5.14 RAWTEXT end tag name state

Consume the next input character:
13.2.5.15 Script data less-than sign state

Consume the next input character:

- **U+002F SOLIDUS (/)**
  Set the temporary buffer to the empty string. Switch to the script data end tag open state.

- **U+0021 EXCLAMATION MARK (!)**

- **Anything else**
  Emit a U+003C LESS-THE-SIGN character token. Reconsume in the script data state.

13.2.5.16 Script data end tag open state

Consume the next input character:

- **ASCII alpha**
  Create a new end tag token, set its tag name to the empty string. Reconsume in the script data end tag name state.

- **Anything else**
  Emit a U+003C LESS-THE-SIGN character token and a U+002F SOLIDUS character token. Reconsume in the script data state.

13.2.5.17 Script data end tag name state

Consume the next input character:
If the current end tag token is an appropriate end tag token\(^{p1271}\), then switch to the before attribute name state\(^{p1282}\). Otherwise, treat it as per the "anything else" entry below.

If the current end tag token is an appropriate end tag token\(^{p1271}\), then switch to the self-closing start tag state\(^{p1285}\). Otherwise, treat it as per the "anything else" entry below.

If the current end tag token is an appropriate end tag token\(^{p1271}\), then switch to the data state\(^{p1272}\) and emit the current tag token. Otherwise, treat it as per the "anything else" entry below.

Append the lowercase version of the current input character\(^{p1266}\) (add 0x0020 to the character's code point) to the current tag token's tag name. Append the current input character\(^{p1266}\) to the temporary buffer\(^{p1271}\).

Append the current input character\(^{p1266}\) to the current tag token's tag name. Append the current input character\(^{p1266}\) to the temporary buffer\(^{p1271}\).

Emit a U+003C LESS-THAN SIGN character token, a U+002F SOLIDUS character token, and a character token for each of the characters in the temporary buffer\(^{p1271}\) (in the order they were added to the buffer). Reconsume\(^{p1271}\) in the script data state\(^{p1272}\).

13.2.5.18 Script data escape start state §\(^{p12}\)

Consume the next input character\(^{p1266}\):

Switch to the script data escape start dash state\(^{p1277}\). Emit a U+002D HYPHEN-MINUS character token.

Anything else

13.2.5.19 Script data escape start dash state §\(^{p12}\)

Consume the next input character\(^{p1266}\):

Switch to the script data escaped dash dash state\(^{p1278}\). Emit a U+002D HYPHEN-MINUS character token.

Anything else

13.2.5.20 Script data escaped state §\(^{p12}\)

Consume the next input character\(^{p1266}\):

Switch to the script data escaped dash dash state\(^{p1278}\). Emit a U+002D HYPHEN-MINUS character token.

Switch to the script data escaped less-than sign state\(^{p1278}\).

This is an unexpected-null-character\(^{p1258}\) parse error\(^{p1254}\). Emit a U+FFFD REPLACEMENT CHARACTER character token.
13.2.5.21 Script data escaped dash state §p1278

Consume the next input character:p1266:

↩ U+002D HYPHEN-MINUS (-)

↩ U+003C LESS-THAN SIGN (<)
Switch to the script data escaped less-than sign state:p1278.

↩ U+0000 NULL
This is an unexpected-null-character:p1258 parse error:p1254. Switch to the script data escaped state:p1277. Emit a U+FFFD REPLACEMENT CHARACTER character token.

↩ EOF
This is an eof-in-script-html-comment-like-text:p1255 parse error:p1254. Emit an end-of-file token.

↩ Anything else
Switch to the script data escaped state:p1277. Emit the current input character:p1266 as a character token.

13.2.5.22 Script data escaped dash dash state §p1278

Consume the next input character:p1266:

↩ U+002D HYPHEN-MINUS (-)
Emit a U+002D HYPHEN-MINUS character token.

↩ U+003C LESS-THAN SIGN (<)
Switch to the script data escaped less-than sign state:p1278.

↩ U+003E GREATER-THAN SIGN (>)
Switch to the script data state:p1272. Emit a U+003E GREATER-THAN SIGN character token.

↩ U+0000 NULL
This is an unexpected-null-character:p1258 parse error:p1254. Switch to the script data escaped state:p1277. Emit a U+FFFD REPLACEMENT CHARACTER character token.

↩ EOF
This is an eof-in-script-html-comment-like-text:p1255 parse error:p1254. Emit an end-of-file token.

↩ Anything else
Switch to the script data escaped state:p1277. Emit the current input character:p1266 as a character token.

13.2.5.23 Script data escaped less-than sign state §p1278

Consume the next input character:p1266:

↩ U+002F SOLIDUS (/)
Set the temporary buffer:p1272 to the empty string. Switch to the script data escaped end tag open state:p1279.

↩ ASCII alpha
Anything else
Emit a U+003C LESS-THAN SIGN character token. Reconsume after in the script data escaped state.

13.2.5.24 Script data escaped end tag open state

Consume the next input character.

→ ASCII alpha
Create a new end tag token, set its tag name to the empty string. Reconsume in the script data escaped end tag name state.

Anything else
Emit a U+003C LESS-THAN SIGN character token and a U+002F SOLIDUS character token. Reconsume in the script data escaped state.

13.2.5.25 Script data escaped end tag state

Consume the next input character:

→ U+0009 CHARACTER TABULATION (tab)
→ U+000A LINE FEED (LF)
→ U+000C FORM FEED (FF)
→ U+0020 SPACE
If the current end tag token is an appropriate end tag token, then switch to the before attribute name state. Otherwise, treat it as per the "anything else" entry below.

→ U+002F SOLIDUS (/)
If the current end tag token is an appropriate end tag token, then switch to the self-closing start tag state. Otherwise, treat it as per the "anything else" entry below.

→ U+003E GREATER-THAN SIGN (>)
If the current end tag token is an appropriate end tag token, then switch to the data state and emit the current tag token. Otherwise, treat it as per the "anything else" entry below.

→ ASCII upper alpha
Append the lowercase version of the current input character (add 0x0020 to the character's code point) to the current tag token's tag name. Append the current input character to the temporary buffer.

→ ASCII lower alpha
Append the current input character to the current tag token's tag name. Append the current input character to the temporary buffer.

Anything else
Emit a U+003C LESS-THAN SIGN character token, a U+002F SOLIDUS character token, and a character token for each of the characters in the temporary buffer (in the order they were added to the buffer). Reconsume in the script data escaped state.

13.2.5.26 Script data double escape start state

Consume the next input character:
If the temporary buffer is the string "script", then switch to the script data double escaped state. Otherwise, switch to the script data escaped state. Emit the current input character as a character token.

ASCII upper alpha
Append the lowercase version of the current input character (add 0x0020 to the character’s code point) to the temporary buffer. Emit the current input character as a character token.

ASCII lower alpha
Append the current input character to the temporary buffer. Emit the current input character as a character token.

Anything else
Reconsume in the script data escaped state.

13.2.5.27 Script data double escaped state

Consume the next input character:

ASCII HYPHEN-MINUS (-)
Switch to the script data double escaped dash dash state. Emit a U+002D HYPHEN-MINUS character token.

ASCII LESS-THEAN SIGN (<)
Switch to the script data double escaped less-than sign state. Emit a U+003C LESS-THEAN SIGN character token.

NULL
This is an unexpected-null-character parse error. Emit a U+FFFD REPLACEMENT CHARACTER character token.

EOF
This is an eof-in-script-html-comment-like-text parse error. Emit an end-of-file token.

Anything else
Emit the current input character as a character token.

13.2.5.28 Script data double escaped dash state

Consume the next input character:

ASCII HYPHEN-MINUS (-)
Switch to the script data double escaped dash dash state. Emit a U+002D HYPHEN-MINUS character token.

ASCII LESS-THEAN SIGN (<)
Switch to the script data double escaped less-than sign state. Emit a U+003C LESS-THEAN SIGN character token.

NULL
This is an unexpected-null-character parse error. Switch to the script data double escaped state. Emit a U+FFFD REPLACEMENT CHARACTER character token.

EOF
This is an eof-in-script-html-comment-like-text parse error. Emit an end-of-file token.

Anything else
Switch to the script data double escaped state. Emit the current input character as a character token.
13.2.5.29 Script data double escaped dash dash state §p12

Consume the next input character:

↩ U+002D HYPHEN-MINUS (-)
   Emit a U+002D HYPHEN-MINUS character token.

↩ U+003C LESS-THAN SIGN (<)
   Switch to the script data double escaped less-than sign state. Emit a U+003C LESS-THAN SIGN character token.

↩ U+003E GREATER-THAN SIGN (>)
   Switch to the script data. Emit a U+003E GREATER-THAN SIGN character token.

↩ U+0000 NULL
   This is an unexpected-null-character parse error. Switch to the script data escaped state. Emit a U+FFFD REPLACEMENT CHARACTER character token.

↩ EOF
   This is an eof-in-script-html-comment-like-text parse error. Emit an end-of-file token.

↩ Anything else
   Switch to the script data double escaped state. Emit the current input character as a character token.

13.2.5.30 Script data double escaped less-than sign state §p12

Consume the next input character:

↩ U+002F SOLIDUS (/)
   Set the temporary buffer to the empty string. Switch to the script data escape end state. Emit a U+002F SOLIDUS character token.

↩ Anything else
   Reconsume in the script data double escaped state.

13.2.5.31 Script data double escape end state §p12

Consume the next input character:

↩ U+0009 CHARACTER TABULATION (tab)
↩ U+000A LINE FEED (LF)
↩ U+000C FORM FEED (FF)
↩ U+0020 SPACE
↩ U+002F SOLIDUS (/)
↩ U+003E GREATER-THAN SIGN (>)
   If the temporary buffer is the string "script", then switch to the script data escaped state. Otherwise, switch to the script data double escaped state. Emit the current input character as a character token.

↩ ASCII upper alpha
   Append the lowercase version of the current input character (add 0x0020 to the character’s code point) to the temporary buffer. Emit the current input character as a character token.

↩ ASCII lower alpha
   Append the current input character to the temporary buffer. Emit the current input character as a character token.

↩ Anything else
   Reconsume in the script data double escaped state.
13.2.5.32 Before attribute name state

Consume the next input character:\n
- U+0009 CHARACTER TABULATION (tab)
- U+000A LINE FEED (LF)
- U+000C FORM FEED (FF)
- U+0020 SPACE
  Ignore the character.
- U+002F SOLIDUS (/)
- U+003E GREATER-THEAN SIGN (>)
- EOF
  Reconsume in the after attribute name state.
- U+003D EQUALS SIGN (=)
  This is an unexpected-equals-sign-before-attribute-name parse error. Start a new attribute in the current tag token. Set that attribute's name to the current input character, and its value to the empty string. Switch to the attribute name state.
- Anything else
  Start a new attribute in the current tag token. Set that attribute name and value to the empty string. Reconsume in the attribute name state.

13.2.5.33 Attribute name state

Consume the next input character:\n
- U+0009 CHARACTER TABULATION (tab)
- U+000A LINE FEED (LF)
- U+000C FORM FEED (FF)
- U+0020 SPACE
- U+002F SOLIDUS (/)
- U+003E GREATER-THEAN SIGN (>)
- EOF
  Reconsume in the after attribute name state.
- U+003D EQUALS SIGN (=)
  Switch to the before attribute value state.
- ASCII upper alpha
  Append the lowercase version of the current input character (add 0x0020 to the character's code point) to the current attribute's name.
- U+0000 NULL
  This is an unexpected-null-character parse error. Append a U+FFFD REPLACEMENT CHARACTER character to the current attribute's name.
- U+0022 QUOTATION MARK ("")
- U+0027 APOSTROPHE (‘)
- U+003C LESS-THEAN SIGN (<)
  This is an unexpected-character-in-attribute-name parse error. Treat it as per the "anything else" entry below.
- Anything else
  Append the current input character to the current attribute's name.

When the user agent leaves the attribute name state (and before emitting the tag token, if appropriate), the complete attribute's name must be compared to the other attributes on the same token; if there is already an attribute on the token with the exact same name, then this is a duplicate-attribute parse error, and the new attribute must be removed from the token.
If an attribute is so removed from a token, it, and the value that gets associated with it, if any, are never subsequently used by the parser, and are therefore effectively discarded. Removing the attribute in this way does not change its status as the "current attribute" for the purposes of the tokenizer, however.

### 13.2.5.34 After attribute name state

Consume the next input character:

- U+0009 CHARACTER TABULATION (tab)
- U+000A LINE FEED (LF)
- U+000C FORM FEED (FF)
- U+0020 SPACE
  - Ignore the character.
- U+002F SOLIDUS (/)
  - Switch to the self-closing start tag state.
- U+003D EQUALS SIGN (=)
  - Switch to the before attribute value state.
- U+003E GREATER-THAN SIGN (>)
  - Switch to the data state. Emit the current tag token.
- EOF
  - This is an eof-in-tag parse error. Emit an end-of-file token.
- Anything else
  - Start a new attribute in the current tag token. Set that attribute name and value to the empty string. Reconsume in the attribute name state.

### 13.2.5.35 Before attribute value state

Consume the next input character:

- U+0009 CHARACTER TABULATION (tab)
- U+000A LINE FEED (LF)
- U+000C FORM FEED (FF)
- U+0020 SPACE
  - Ignore the character.
- U+0022 QUOTATION MARK ("")
  - Switch to the attribute value (double-quoted) state.
- U+0027 APOSTROPHE (’)
  - Switch to the attribute value (single-quoted) state.
- U+003E GREATER-THAN SIGN (>)
  - This is a missing-attribute-value parse error. Switch to the data state. Emit the current tag token.
- Anything else
  - Reconsume in the attribute value (unquoted) state.

### 13.2.5.36 Attribute value (double-quoted) state

Consume the next input character:

- U+0022 QUOTATION MARK ("")
  - Switch to the after attribute value (quoted) state.
Set the return state to the attribute value (double-quoted) state. Switch to the character reference state.

This is an unexpected-null-character parse error. Append a U+FFFD REPLACEMENT CHARACTER character to the current attribute's value.

This is an eof-in-tag parse error. Emit an end-of-file token.

Append the current input character to the current attribute's value.

Consume the next input character:

Switch to the after attribute value (quoted) state.

Set the return state to the attribute value (single-quoted) state. Switch to the character reference state.

This is an unexpected-null-character parse error. Append a U+FFFD REPLACEMENT CHARACTER character to the current attribute's value.

This is an eof-in-tag parse error. Emit an end-of-file token.

Append the current input character to the current attribute's value.

Consume the next input character:

Switch to the after attribute value (quoted) state.

Set the return state to the attribute value (unquoted) state. Switch to the character reference state.

This is an unexpected-null-character parse error. Append a U+FFFD REPLACEMENT CHARACTER character to the current attribute's value.

This is an eof-in-tag parse error. Emit an end-of-file token.

Append the current input character to the current attribute's value.

13.2.5.37 Attribute value (single-quoted) state

Consume the next input character:

Switch to the after attribute value (quoted) state.

Set the return state to the attribute value (single-quoted) state. Switch to the character reference state.

This is an unexpected-null-character parse error. Append a U+FFFD REPLACEMENT CHARACTER character to the current attribute's value.

This is an eof-in-tag parse error. Emit an end-of-file token.

Append the current input character to the current attribute's value.

13.2.5.38 Attribute value (unquoted) state

Consume the next input character:

Switch to the after attribute name state.

Set the return state to the attribute value (unquoted) state. Switch to the character reference state.

Switch to the data state. Emit the current tag token.

This is an unexpected-null-character parse error. Append a U+FFFD REPLACEMENT CHARACTER character to the current attribute's value.

This is an unexpected-character-in-unquoted-attribute-value parse error. Treat it as per the "anything else" entry below.
← EOF
   This is an `eof-in-tag` parse error. Emit an end-of-file token.

← Anything else
   Append the `current input character` to the current attribute's value.

13.2.5.39 After attribute value (quoted) state

Consume the next input character:

← U+0009 CHARACTER TABULATION (tab)
← U+000A LINE FEED (LF)
← U+000C FORM FEED (FF)
← U+0020 SPACE
       Switch to the before attribute name state.
← U+002F SOLIDUS (/)
       Switch to the self-closing start tag state.
← U+003E GREATER-THAN SIGN (>)
       Switch to the data state. Emit the current tag token.

← EOF
   This is an `eof-in-tag` parse error. Emit an end-of-file token.

← Anything else
   This is a `missing-whitespace-between-attributes` parse error. Reconsume in the before attribute name state.

13.2.5.40 Self-closing start tag state

Consume the next input character:

← U+003E GREATER-THAN SIGN (>)
       Set the `self-closing flag` of the current tag token. Switch to the data state. Emit the current tag token.

← EOF
   This is an `eof-in-tag` parse error. Emit an end-of-file token.

← Anything else
   This is an `unexpected-solidus-in-tag` parse error. Reconsume in the before attribute name state.

13.2.5.41 Bogus comment state

Consume the next input character:

← U+003E GREATER-THAN SIGN (>)
       Switch to the data state. Emit the current comment token.

← EOF
   Emit the comment. Emit an end-of-file token.

← U+0000 NULL
   This is an `unexpected-null-character` parse error. Append a U+FFFD REPLACEMENT CHARACTER character to the comment token's data.

← Anything else
   Append the `current input character` to the comment token's data.
13.2.5.42 Markup declaration open state

If the next few characters are:

↪ Two U+002D HYPHEN-MINUS characters (-)
  Consume those two characters, create a comment token whose data is the empty string, and switch to the comment start state.

↪ ASCII case-insensitive match for the word "DOCTYPE"
  Consume those characters and switch to the DOCTYPE state.

↪ The string "[CDATA[" (the five uppercase letters "CDATA" with a U+005B LEFT SQUARE BRACKET character before and after)
  Consume those characters. If there is an adjusted current node and it is not an element in the HTML namespace, then switch to the CDATA section state. Otherwise, this is a cdata-in-html-content parse error. Create a comment token whose data is the "[CDATA[" string. Switch to the bogus comment state.

↪ Anything else
  This is an incorrectly-opened-comment parse error. Create a comment token whose data is the empty string. Switch to the bogus comment state (don't consume anything in the current state).

13.2.5.43 Comment start state

Consume the next input character:

↪ U+002D HYPHEN-MINUS (-)
  Switch to the comment start dash state.

↪ U+003E GREATER-TAN SIGN (>)
  This is an abrupt-closing-of-empty-comment parse error. Switch to the data state. Emit the current comment token.

↪ Anything else
  Reconsume in the comment state.

13.2.5.44 Comment start dash state

Consume the next input character:

↪ U+002D HYPHEN-MINUS (-)
  Switch to the comment end state.

↪ U+003E GREATER-TAN SIGN (>)
  This is an abrupt-closing-of-empty-comment parse error. Switch to the data state. Emit the current comment token.

↪ EOF
  This is an eof-in-comment parse error. Emit the current comment token. Emit an end-of-file token.

↪ Anything else
  Append a U+002D HYPHEN-MINUS character (-) to the comment token's data. Reconsume in the comment state.

13.2.5.45 Comment state

Consume the next input character:

↪ U+003C LESS-TAN SIGN (<)
  Append the current input character to the comment token's data. Switch to the comment less-than-sign state.

↪ U+002D HYPHEN-MINUS (-)
  Switch to the comment end dash state.
This is an unexpected-null-character parse error. Append a U+FFFD REPLACEMENT CHARACTER character to the comment token's data.

This is an eof-in-comment parse error. Emit the current comment token. Emit an end-of-file token.

Append the current input character to the comment token's data.

Consumes the next input character:

- U+0021 EXCLAMATION MARK (!)
  Append the current input character to the comment token's data. Switch to the comment less-than sign bang state.

- U+003C LESS-THAN SIGN (<)
  Append the current input character to the comment token's data.

- Anything else
  Recomsume in the comment state.

Consumes the next input character:

- U+002D HYPHEN-MINUS (-)
  Switch to the comment less-than sign bang dash state.

- Anything else
  Recomsume in the comment state.

Consumes the next input character:

- U+002D HYPHEN-MINUS (-)
  Switch to the comment less-than sign bang dash dash state.

- Anything else
  Recomsume in the comment end dash state.

Consumes the next input character:

- U+003E GREATER-THAN SIGN (>)
  EOF
  Recomsume in the comment end state.

- Anything else
  This is a nested-comment parse error. Recomsume in the comment end state.
13.2.5.50 Comment end dash state

Consume the \texttt{next input character}.

- U+002D HYPHEN-MINUS (-)
  Switch to the \texttt{comment end state}.

- EOF
  This is an \texttt{eof-in-comment} \texttt{parse error}. Emit the current comment token. Emit an end-of-file token.

- Anything else
  Append a U+002D HYPHEN-MINUS character (-) to the comment token's data. \texttt{Reconsume} in the \texttt{comment state}.

13.2.5.51 Comment end state

Consume the \texttt{next input character}:

- U+003E GREATER-THAN SIGN (>)
  Switch to the \texttt{data state}. Emit the current comment token.

- U+0021 EXCLAMATION MARK (!)
  Switch to the \texttt{comment end bang state}.

- U+002D HYPHEN-MINUS (-)
  Append a U+002D HYPHEN-MINUS character (-) to the comment token's data.

- EOF
  This is an \texttt{eof-in-comment} \texttt{parse error}. Emit the current comment token. Emit an end-of-file token.

- Anything else
  Append two U+002D HYPHEN-MINUS characters (-) to the comment token's data. \texttt{Reconsume} in the \texttt{comment state}.

13.2.5.52 Comment end bang state

Consume the \texttt{next input character}:

- U+002D HYPHEN-MINUS (-)
  Append two U+002D HYPHEN-MINUS characters (-) and a U+0021 EXCLAMATION MARK character (!) to the comment token's data. Switch to the \texttt{comment end dash state}.

- U+003E GREATER-THAN SIGN (>)
  This is an \texttt{incorrectly-closed-comment} \texttt{parse error}. Switch to the \texttt{data state}. Emit the current comment token.

- EOF
  This is an \texttt{eof-in-comment} \texttt{parse error}. Emit the current comment token. Emit an end-of-file token.

- Anything else
  Append two U+002D HYPHEN-MINUS characters (-) and a U+0021 EXCLAMATION MARK character (!) to the comment token's data. \texttt{Reconsume} in the \texttt{comment state}.

13.2.5.53 DOCTYPE state

Consume the \texttt{next input character}:

- U+0009 CHARACTER TABULATION (tab)
- U+000A LINE FEED (LF)
- U+000C FORM FEED (FF)
- U+0020 SPACE
  Switch to the \texttt{before DOCTYPE name state}.
13.2.5.54 Before DOCTYPE name state

Consume the next input character:

- **U+0009 CHARACTER TABULATION (tab)**
- **U+000A LINE FEED (LF)**
- **U+000C FORM FEED (FF)**
- **U+0020 SPACE**

Ignore the character.

- **ASCII upper alpha**
  - Create a new DOCTYPE token. Set the token's name to the lowercase version of the current input character (add 0x0020 to the character's code point). Switch to the DOCTYPE name state.

- **U+0000 NULL**
  - This is an unexpected-null-character parse error. Create a new DOCTYPE token. Set the token's name to a U+FFFD REPLACEMENT CHARACTER character. Switch to the DOCTYPE name state.

- **U+003E GREATER-THAN SIGN (>)**
  - This is a missing-doctype-name parse error. Create a new DOCTYPE token. Set its force-quirks flag to on. Switch to the data state.

- **EOF**
  - This is an eof-in-doctype parse error. Create a new DOCTYPE token. Set its force-quirks flag to on. Emit the current token.

- **Anything else**
  - Create a new DOCTYPE token. Set the token's name to the current input character. Switch to the DOCTYPE name state.

13.2.5.55 DOCTYPE name state

Consume the next input character:

- **U+0009 CHARACTER TABULATION (tab)**
- **U+000A LINE FEED (LF)**
- **U+000C FORM FEED (FF)**
- **U+0020 SPACE**

Switch to the after DOCTYPE name state.

- **U+003E GREATER-THAN SIGN (>)**
  - Switch to the data state. Emit the current DOCTYPE token.

- **ASCII upper alpha**
  - Append the lowercase version of the current input character (add 0x0020 to the character's code point) to the current DOCTYPE token's name.

- **U+0000 NULL**
  - This is an unexpected-null-character parse error. Append a U+FFFD REPLACEMENT CHARACTER character to the current DOCTYPE token's name.
This is an **eof-in-doctype**\(^{1255}\) **parse error**\(^{1254}\). Set the current DOCTYPE token’s **force-quirks flag**\(^{1271}\) to on. Emit the current DOCTYPE token. Emit an end-of-file token.

**Anything else**

Append the **current input character**\(^{1266}\) to the current DOCTYPE token’s name.

### 13.2.5.56 After DOCTYPE name state

**Anything else**

Consume the **next input character**\(^{1266}\).

- **U+0009 CHARACTER TABULATION (tab)**
- **U+000A LINE FEED (LF)**
- **U+000C FORM FEED (FF)**
- **U+0020 SPACE**

Ignore the character.

- **U+003E GREATER-THAN SIGN (>)**

Switch to the **data state**\(^{1272}\). Emit the current DOCTYPE token.

- **EOF**

This is an **eof-in-doctype**\(^{1255}\) **parse error**\(^{1254}\). Set the current DOCTYPE token’s **force-quirks flag**\(^{1271}\) to on. Emit the current DOCTYPE token. Emit an end-of-file token.

- **Anything else**

If the six characters starting from the **current input character**\(^{1266}\) are an **ASCII case-insensitive** match for the word “PUBLIC”, then consume those characters and switch to the **after DOCTYPE public keyword state**\(^{1290}\).

Otherwise, if the six characters starting from the **current input character**\(^{1266}\) are an **ASCII case-insensitive** match for the word “SYSTEM”, then consume those characters and switch to the **after DOCTYPE system keyword state**\(^{1293}\).

Otherwise, this is an **invalid-character-sequence-after-doctype-name**\(^{1255}\) **parse error**\(^{1254}\). Set the current DOCTYPE token’s **force-quirks flag**\(^{1271}\) to on. **Reconsume**\(^{1271}\) in the **bogus DOCTYPE state**\(^{1295}\).

### 13.2.5.57 After DOCTYPE public keyword state

**Anything else**

Consume the **next input character**\(^{1266}\): 

- **U+0009 CHARACTER TABULATION (tab)**
- **U+000A LINE FEED (LF)**
- **U+000C FORM FEED (FF)**
- **U+0020 SPACE**

Switch to the **before DOCTYPE public identifier state**\(^{1291}\).

- **U+0022 QUOTATION MARK (")**

This is a **missing-whitespace-after-doctype-public-keyword**\(^{1256}\) **parse error**\(^{1254}\). Set the current DOCTYPE token’s public identifier to the empty string (not missing), then switch to the **DOCTYPE public identifier (double-quoted) state**\(^{1291}\).

- **U+0027 APOSTROPHE (')**

This is a **missing-whitespace-after-doctype-public-keyword**\(^{1256}\) **parse error**\(^{1254}\). Set the current DOCTYPE token's public identifier to the empty string (not missing), then switch to the **DOCTYPE public identifier (single-quoted) state**\(^{1291}\).

- **U+003E GREATER-THAN SIGN (>)**

This is a **missing-doctype-public-identifier**\(^{1295}\) **parse error**\(^{1254}\). Set the current DOCTYPE token’s **force-quirks flag**\(^{1271}\) to on. Switch to the **data state**\(^{1272}\). Emit the current DOCTYPE token.

- **EOF**

This is an **eof-in-doctype**\(^{1255}\) **parse error**\(^{1254}\). Set the current DOCTYPE token’s **force-quirks flag**\(^{1271}\) to on. Emit the current DOCTYPE token. Emit an end-of-file token.
Anything else
This is a missing-quote-before-doctype-public-identifier parse error. Set the current DOCTYPE token's force-quirks flag to on. Reconsume in the bogus DOCTYPE state.

13.2.5.58 Before DOCTYPE public identifier state

Consume the next input character:

↪ U+0009 CHARACTER TABULATION (tab)
↪ U+000A LINE FEED (LF)
↪ U+000C FORM FEED (FF)
↪ U+0020 SPACE
Ignore the character.

↪ U+0022 QUOTATION MARK ("")
Set the current DOCTYPE token's public identifier to the empty string (not missing), then switch to the DOCTYPE public identifier (double-quoted) state.

↪ U+0027 APOSTROPHE (')
Set the current DOCTYPE token's public identifier to the empty string (not missing), then switch to the DOCTYPE public identifier (single-quoted) state.

↪ U+003E GREATER-THAN SIGN (>)
This is a missing-doctype-public-identifier parse error. Set the current DOCTYPE token's force-quirks flag to on. Switch to the data state. Emit the current DOCTYPE token.

↪ EOF
This is an eof-in-doctype parse error. Set the current DOCTYPE token's force-quirks flag to on. Emit the current DOCTYPE token. Emit an end-of-file token.

↪ Anything else
This is a missing-quote-before-doctype-public-identifier parse error. Set the current DOCTYPE token's force-quirks flag to on. Reconsume in the bogus DOCTYPE state.

13.2.5.59 DOCTYPE public identifier (double-quoted) state

Consume the next input character:

↪ U+0022 QUOTATION MARK ("")
Switch to the after DOCTYPE public identifier state.

↪ U+0000 NULL
This is an unexpected-null-character parse error. Append a U+FFFD REPLACEMENT CHARACTER character to the current DOCTYPE token's public identifier.

↪ U+003E GREATER-THAN SIGN (>)
This is an abrupt-doctype-public-identifer parse error. Set the current DOCTYPE token's force-quirks flag to on. Switch to the data state. Emit the current DOCTYPE token.

↪ EOF
This is an eof-in-doctype parse error. Set the current DOCTYPE token's force-quirks flag to on. Emit the current DOCTYPE token. Emit an end-of-file token.

↪ Anything else
Append the current input character to the current DOCTYPE token's public identifier.

13.2.5.60 DOCTYPE public identifier (single-quoted) state

Consume the next input character:
U+0027 APOSTROPHE (')
Switch to the after DOCTYPE public identifier state.

U+0000 NULL
This is an unexpected-null-character parse error. Append a U+FFFD REPLACEMENT CHARACTER character to the current DOCTYPE token's public identifier.

U+003E GREATER-THAN SIGN (>)
This is an abrupt-doctype-public-identifier parse error. Set the current DOCTYPE token's force-quirks flag to on. Switch to the data state. Emit the current DOCTYPE token.

EOF
This is an eof-in-doctype parse error. Set the current DOCTYPE token's force-quirks flag to on. Emit the current DOCTYPE token. Emit an end-of-file token.

Anything else
Append the current input character to the current DOCTYPE token's public identifier.

13.2.5.61 After DOCTYPE public identifier state
Consume the next input character.

U+0009 CHARACTER TABULATION (tab)
U+00A0 LINE FEED (LF)
U+000C FORM FEED (FF)
U+0020 SPACE
Switch to the between DOCTYPE public and system identifiers state.

U+003E GREATER-THAN SIGN (>
Switch to the data state. Emit the current DOCTYPE token.

U+0022 QUOTATION MARK ("
This is a missing-whitespace-between-doctype-public-and-system-identifiers parse error. Set the current DOCTYPE token's system identifier to the empty string (not missing), then switch to the DOCTYPE system identifier (double-quoted) state.

U+0027 APOSTROPHE ('
This is a missing-whitespace-between-doctype-public-and-system-identifiers parse error. Set the current DOCTYPE token's system identifier to the empty string (not missing), then switch to the DOCTYPE system identifier (single-quoted) state.

EOF
This is an eof-in-doctype parse error. Set the current DOCTYPE token's force-quirks flag to on. Emit the current DOCTYPE token. Emit an end-of-file token.

Anything else
This is a missing-quote-before-doctype-system-identifier parse error. Set the current DOCTYPE token's force-quirks flag to on. Reconsume in the bogus DOCTYPE state.

13.2.5.62 Between DOCTYPE public and system identifiers state
Consume the next input character:

U+0009 CHARACTER TABULATION (tab)
U+000A LINE FEED (LF)
U+000C FORM FEED (FF)
U+0020 SPACE
Ignore the character.

U+003E GREATER-THAN SIGN (>
Switch to the data state. Emit the current DOCTYPE token.
13.2.5.63 After DOCTYPE system keyword state

Consume the next input character:

- U+0009 CHARACTER TABULATION (tab)
- U+000A LINE FEED (LF)
- U+000C FORM FEED (FF)
- U+0020 SPACE

Switch to the before DOCTYPE system identifier state.

- U+0022 QUOTATION MARK ("")
  This is a missing-whitespace-after-doctype-system-keyword parse error. Set the current DOCTYPE token's system identifier to the empty string (not missing), then switch to the DOCTYPE system identifier (double-quoted) state.

- U+0027 APOSTROPHE (')
  This is a missing-whitespace-after-doctype-system-keyword parse error. Set the current DOCTYPE token's system identifier to the empty string (not missing), then switch to the DOCTYPE system identifier (single-quoted) state.

- EOF
  This is an eof-in-doctype parse error. Set the current DOCTYPE token's force-quirks flag to on. Emit the current DOCTYPE token. Emit an end-of-file token.

- Anything else
  This is a missing-quote-before-doctype-system-identifier parse error. Set the current DOCTYPE token's force-quirks flag to on. Recompose in the bogus DOCTYPE state.

13.2.5.64 Before DOCTYPE system identifier state

Consume the next input character:

- U+0009 CHARACTER TABULATION (tab)
- U+000A LINE FEED (LF)
- U+000C FORM FEED (FF)
- U+0020 SPACE

Ignore the character.

- U+0022 QUOTATION MARK ("")
  Set the current DOCTYPE token's system identifier to the empty string (not missing), then switch to the DOCTYPE system identifier (double-quoted) state.
13.2.5.65 DOCTYPE system identifier (double-quoted) state

Consume the next input character:

- **U+0022 QUOTATION MARK (")**
  - Switch to the after DOCTYPE system identifier state.

- **U+0000 NULL**
  - This is an unexpected-null-character parse error. Append a U+FFFD REPLACEMENT CHARACTER character to the current DOCTYPE token's system identifier.

- **U+003E GREATER-THAN SIGN (>)**
  - This is an abrupt-doctype-system-identifier parse error. Set the current DOCTYPE token's force-quirks flag to on. Switch to the data state. Emit the current DOCTYPE token.

- **EOF**
  - This is an eof-in-doctype parse error. Set the current DOCTYPE token's force-quirks flag to on. Emit the current DOCTYPE token. Emit an end-of-file token.

- **Anything else**
  - Append the current input character to the current DOCTYPE token's system identifier.

13.2.5.66 DOCTYPE system identifier (single-quoted) state

Consume the next input character:

- **U+0027 APOSTROPHE (')**
  - Switch to the after DOCTYPE system identifier state.

- **U+0000 NULL**
  - This is an unexpected-null-character parse error. Append a U+FFFD REPLACEMENT CHARACTER character to the current DOCTYPE token's system identifier.

- **U+003E GREATER-THAN SIGN (>)**
  - This is an abrupt-doctype-system-identifier parse error. Set the current DOCTYPE token's force-quirks flag to on. Switch to the data state. Emit the current DOCTYPE token.

- **EOF**
  - This is an eof-in-doctype parse error. Set the current DOCTYPE token's force-quirks flag to on. Emit the current DOCTYPE token. Emit an end-of-file token.

- **Anything else**
  - Append the current input character to the current DOCTYPE token's system identifier.
13.2.5.67 After DOCTYPE system identifier state

Consume the next input character:

- U+0009 CHARACTER TABULATION (tab)
- U+000A LINE FEED (LF)
- U+000C FORM FEED (FF)
- U+0020 SPACE
  
  Ignore the character.

- U+003E GREATER-Than SIGN (>)
  
  Switch to the data state. Emit the current DOCTYPE token.

- EOF
  
  This is an eof-in-doctype parse error. Set the current DOCTYPE token's force-quirks flag to on. Emit the current DOCTYPE token. Emit an end-of-file token.

- Anything else
  
  This is an unexpected-character-after-doctype-system-identifier parse error. Recompose in the bogus DOCTYPE state. (This does not set the current DOCTYPE token's force-quirks flag to on.)

13.2.5.68 Bogus DOCTYPE state

Consume the next input character:

- U+003E GREATER-Than SIGN (>)
  
  Switch to the data state. Emit the DOCTYPE token.

- U+0000 NULL
  
  This is an unexpected-null-character parse error. Ignore the character.

- EOF
  
  Emit the DOCTYPE token. Emit an end-of-file token.

- Anything else
  
  Ignore the character.

13.2.5.69 CDATA section state

Consume the next input character:

- U+005D RIGHT SQUARE BRACKET (]
  
  Switch to the CDATA section bracket state.

- EOF
  
  This is an eof-in-cdata parse error. Emit an end-of-file token.

- Anything else
  
  Emit the current input character as a character token.

Note

U+0000 NULL characters are handled in the tree construction stage, as part of the in foreign content insertion mode, which is the only place where CDATA sections can appear.

13.2.5.70 CDATA section bracket state

Consume the next input character:
13.2.5.71 CDATA section end state

Consume the next input character:

- U+005D RIGHT SQUARE BRACKET
  Emit a U+005D RIGHT SQUARE BRACKET character token.
- U+0003E GREATER-THEL THAN SIGN character
  Switch to the data state.
- Anything else
  Emit two U+005D RIGHT SQUARE BRACKET character tokens.

13.2.5.72 Character reference state

Set the temporary buffer to the empty string. Append a U+0026 AMPERSAND (&) character to the temporary buffer. Consume the next input character:

- ASCII alphanumeric
  Reconsume in the named character reference state.
- U+00023 NUMBER SIGN (#)
  Append the current input character to the temporary buffer. Switch to the numeric character reference state.
- Anything else
  Flush code points consumed as a character reference. Reconsume in the return state.

13.2.5.73 Named character reference state

Consume the maximum number of characters possible, where the consumed characters are one of the identifiers in the first column of the named character references table. Append each character to the temporary buffer when it’s consumed.

- If there is a match
  If the character reference was consumed as part of an attribute, and the last character matched is not a U+003B SEMICOLON character (;), and the next input character is either a U+003D EQUALS SIGN character (=) or an ASCII alphanumeric, then, for historical reasons, flush code points consumed as a character reference and switch to the return state.

  Otherwise:
  1. If the last character matched is not a U+003B SEMICOLON character (;), then this is a missing-semicolon-after-character-reference parse error.
  2. Set the temporary buffer to the empty string. Append one or two characters corresponding to the character reference name (as given by the second column of the named character references table) to the temporary buffer.
  3. Flush code points consumed as a character reference. Switch to the return state.

- Otherwise
  Flush code points consumed as a character reference. Switch to the ambiguous ampersand state.
If the markup contains (not in an attribute) the string I'm &notit; I tell you, the character reference is parsed as "not", as in, I'm ¬it; I tell you (and this is a parse error). But if the markup was I'm &notin; I tell you, the character reference would be parsed as "notin;", resulting in I'm I tell you (and no parse error).

However, if the markup contains the string I'm &notit; I tell you in an attribute, no character reference is parsed and string remains intact (and there is no parse error).

### 13.2.5.74 Ambiguous ampersand state

Consume the next input character:

- **ASCII alphanumeric**
  - If the character reference was **consumed as part of an attribute**, then append the current input character to the current attribute's value. Otherwise, emit the current input character as a character token.

- **U+003B SEMICOLON (;)**
  - This is an **unknown-named-character-reference parse error**. Reconsume in the return state.

- **Anything else**
  - Reconsume in the return state.

### 13.2.5.75 Numeric character reference state

Set the **character reference code** to zero (0).

Consume the next input character:

- **U+0078 LATIN SMALL LETTER X**
- **U+0058 LATIN CAPITAL LETTER X**
  - Append the current input character to the temporary buffer. Switch to the hexadecimal character reference start state.

- **Anything else**
  - Reconsume in the decimal character reference start state.

### 13.2.5.76 Hexadecimal character reference start state

Consume the next input character:

- **ASCII hex digit**
  - Reconsume in the hexadecimal character reference state.

- **Anything else**
  - This is an **absence-of-digits-in-numeric-character-reference parse error**. Flush code points consumed as a character reference. Reconsume in the return state.

### 13.2.5.77 Decimal character reference start state

Consume the next input character:

- **ASCII digit**
  - Reconsume in the decimal character reference state.

- ** Anything else**
  - This is an **absence-of-digits-in-numeric-character-reference parse error**. Flush code points consumed as a character reference. Reconsume in the return state.
13.2.5.78 Hexadecimal character reference state

Consume the next input character:

- **ASCII digit**
  Multiply the character reference code by 16. Add a numeric version of the current input character (subtract 0x0030 from the character's code point) to the character reference code.

- **ASCII upper hex digit**
  Multiply the character reference code by 16. Add a numeric version of the current input character as a hexadecimal digit (subtract 0x0037 from the character's code point) to the character reference code.

- **ASCII lower hex digit**
  Multiply the character reference code by 16. Add a numeric version of the current input character as a hexadecimal digit (subtract 0x0057 from the character's code point) to the character reference code.

- **U+003B SEMICOLON**
  Switch to the numeric character reference end state.

- **Anything else**
  This is a missing-semicolon-after-character-reference parse error. Recomsume in the numeric character reference end state.

13.2.5.79 Decimal character reference state

Consume the next input character:

- **ASCII digit**
  Multiply the character reference code by 10. Add a numeric version of the current input character (subtract 0x0030 from the character's code point) to the character reference code.

- **U+003B SEMICOLON**
  Switch to the numeric character reference end state.

- **Anything else**
  This is a missing-semicolon-after-character-reference parse error. Recomsume in the numeric character reference end state.

13.2.5.80 Numeric character reference end state

Check the character reference code:

- If the number is 0x00, then this is a null-character-reference parse error. Set the character reference code to 0xFFFD.
- If the number is greater than 0x10FFFF, then this is a character-reference-outside-unicode-range parse error. Set the character reference code to 0xFFFD.
- If the number is a surrogate, then this is a surrogate-character-reference parse error. Set the character reference code to 0xFFFD.
- If the number is a noncharacter, then this is a noncharacter-character-reference parse error.
- If the number is 0x0D, or a control that's not ASCII whitespace, then this is a control-character-reference parse error. If the number is one of the numbers in the first column of the following table, then find the row with that number in the first column, and set the character reference code to the number in the second column of that row.

<table>
<thead>
<tr>
<th>Number</th>
<th>Code point</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x80</td>
<td>0x20AC</td>
</tr>
<tr>
<td>0x82</td>
<td>0x201A</td>
</tr>
<tr>
<td>0x83</td>
<td>0x0192</td>
</tr>
<tr>
<td>0x84</td>
<td>0x201E</td>
</tr>
</tbody>
</table>

If the number is one of the numbers in the first column of the following table, then find the row with that number in the first column, and set the character reference code to the number in the second column of that row.
<table>
<thead>
<tr>
<th>Number</th>
<th>Code point</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x85</td>
<td>0x2026</td>
<td>HORIZONTAL ELLIPSIS (…)</td>
</tr>
<tr>
<td>0x86</td>
<td>0x2020</td>
<td>DAGGER (†)</td>
</tr>
<tr>
<td>0x87</td>
<td>0x2021</td>
<td>DOUBLE DAGGER (‡)</td>
</tr>
<tr>
<td>0x88</td>
<td>0x2026</td>
<td>MODIFIER LETTER CIRCUMFLEX ACCENT (ˆ)</td>
</tr>
<tr>
<td>0x89</td>
<td>0x2030</td>
<td>PER MILLE SIGN (‰)</td>
</tr>
<tr>
<td>0x8A</td>
<td>0x0160</td>
<td>LATIN CAPITAL LETTER S WITH CARON (Š)</td>
</tr>
<tr>
<td>0x8B</td>
<td>0x2039</td>
<td>SINGLE LEFT-POINTING ANGLE QUOTATION MARK (‘)</td>
</tr>
<tr>
<td>0x8C</td>
<td>0x0152</td>
<td>LATIN CAPITAL LIGATURE OE (Œ)</td>
</tr>
<tr>
<td>0x8D</td>
<td>0x0170</td>
<td>LATIN CAPITAL LETTER Z WITH CARON (Ž)</td>
</tr>
<tr>
<td>0x91</td>
<td>0x2018</td>
<td>LEFT SINGLE QUOTATION MARK (‘)</td>
</tr>
<tr>
<td>0x92</td>
<td>0x2019</td>
<td>RIGHT SINGLE QUOTATION MARK (’)</td>
</tr>
<tr>
<td>0x93</td>
<td>0x201C</td>
<td>LEFT DOUBLE QUOTATION MARK (”)</td>
</tr>
<tr>
<td>0x94</td>
<td>0x201D</td>
<td>RIGHT DOUBLE QUOTATION MARK (”)</td>
</tr>
<tr>
<td>0x95</td>
<td>0x2022</td>
<td>BULLET (•)</td>
</tr>
<tr>
<td>0x96</td>
<td>0x2013</td>
<td>EN DASH (―)</td>
</tr>
<tr>
<td>0x97</td>
<td>0x2014</td>
<td>EM DASH (—)</td>
</tr>
<tr>
<td>0x98</td>
<td>0x02DC</td>
<td>SMALL TILDE (”)</td>
</tr>
<tr>
<td>0x99</td>
<td>0x2122</td>
<td>TRADE MARK SIGN (™)</td>
</tr>
<tr>
<td>0x9A</td>
<td>0x0161</td>
<td>LATIN SMALL LETTER S WITH CARON (š)</td>
</tr>
<tr>
<td>0x9B</td>
<td>0x203A</td>
<td>SINGLE RIGHT-POINTING ANGLE QUOTATION MARK (‘)</td>
</tr>
<tr>
<td>0x9C</td>
<td>0x0153</td>
<td>LATIN SMALL LIGATURE OE (œ)</td>
</tr>
<tr>
<td>0x9D</td>
<td>0x017E</td>
<td>LATIN SMALL LETTER Z WITH CARON (ž)</td>
</tr>
<tr>
<td>0x9E</td>
<td>0x0178</td>
<td>LATIN CAPITAL LETTER Y WITH DIAERESIS (Ÿ)</td>
</tr>
</tbody>
</table>

Set the `temporary buffer` to the empty string. Append a code point equal to the `character reference code` to the `temporary buffer`. Flush code points consumed as a character reference. Switch to the `return state`.

### 13.2.6 Tree construction

The input to the tree construction stage is a sequence of tokens from the tokenization stage. The tree construction stage is associated with a DOM `Document` object when a parser is created. The "output" of this stage consists of dynamically modifying or extending that document's DOM tree.

This specification does not define when an interactive user agent has to render the `Document` so that it is available to the user, or when it has to begin accepting user input.

As each token is emitted from the tokenizer, the user agent must follow the appropriate steps from the following list, known as the tree construction dispatcher:

- If the stack of open elements is empty
- If the adjusted current node is an element in the HTML namespace
- If the adjusted current node is a MathML text integration point and the token is a start tag whose tag name is neither "mglyph" nor "malignmark"
- If the adjusted current node is a MathML text integration point and the token is a character token
- If the adjusted current node is a MathML annotation-xml element and the token is a start tag whose tag name is "svg"
- If the adjusted current node is an HTML integration point and the token is a start tag
- If the adjusted current node is an HTML integration point and the token is a character token
- If the token is an end-of-file token
  - Process the token according to the rules given in the section corresponding to the current insertion mode in HTML content.
- Otherwise
  - Process the token according to the rules given in the section for parsing tokens in foreign content.

The next token is the token that is about to be processed by the tree construction dispatcher (even if the token is subsequently
A node is a **MathML text integration point** if it is one of the following elements:

- A MathML `mi` element
- A MathML `mo` element
- A MathML `mn` element
- A MathML `ms` element
- A MathML `mtext` element

A node is an **HTML integration point** if it is one of the following elements:

- A MathML `annotation-xml` element whose start tag token had an attribute with the name "encoding" whose value was an ASCII case-insensitive match for the string "text/html"
- A MathML `annotation-xml` element whose start tag token had an attribute with the name "encoding" whose value was an ASCII case-insensitive match for the string "application/xhtml+xml"
- A SVG `foreignObject` element
- An SVG `desc` element
- An SVG `title` element

13.2.6.1 Creating and inserting nodes

While the parser is processing a token, it can enable or disable **foster parenting**. This affects the following algorithm.

The **appropriate place for inserting a node**, optionally using a particular **override target**, is the position in an element returned by running the following steps:

1. If there was an **override target** specified, then let `target` be the **override target**.
   Otherwise, let `target` be the **current node**.
2. Determine the **adjusted insertion location** using the first matching steps from the following list:

   If **foster parenting** is enabled and `target` is a `table`, `tbody`, `tfoot`, `thead`, or `tr` element

   Foster parenting happens when content is misnested in tables.

   Run these substeps:

   1. Let `last template` be the last `template` element in the stack of open elements, if any.
   2. Let `last table` be the last `table` element in the stack of open elements, if any.
   3. If there is a `last template` and either there is no `last table`, or there is one, but `last template` is lower (more recently added) than `last table` in the stack of open elements, then: let **adjusted insertion location** be inside `last template`'s `template contents`, after its last child (if any), and abort these steps.
   4. If there is no `last table`, then let **adjusted insertion location** be inside the first element in the stack of open elements (the `html` element), after its last child (if any), and abort these steps. (fragment case)
5. If last table has a parent node, then let adjusted insertion location be inside last table's parent node, immediately before last table, and abort these steps.

6. Let previous element be the element immediately above last table in the stack of open elements.

7. Let adjusted insertion location be inside previous element, after its last child (if any).

Note
These steps are involved in part because it’s possible for elements, the table element in this case in particular, to have been moved by a script around in the DOM, or indeed removed from the DOM entirely, after the element was inserted by the parser.

→ Otherwise
Let adjusted insertion location be inside target, after its last child (if any).

3. If the adjusted insertion location is inside a template element, let it instead be inside the template element's template contents, after its last child (if any).

4. Return the adjusted insertion location.

When the steps below require the UA to create an element for a token in a particular given namespace and with a particular intended parent, the UA must run the following steps:

1. If the active speculative HTML parser is not null, then return the result of creating a speculative mock element given given namespace, the tag name of the given token, and the attributes of the given token.

2. Otherwise, optionally create a speculative mock element given given namespace, the tag name of the given token, and the attributes of the given token.

Note
The result is not used. This step allows for a speculative fetch to be initiated from non-speculative parsing. The fetch is still speculative at this point, because, for example, by the time the element is inserted, intended parent might have been removed from the document.

3. Let document be intended parent's node document.

4. Let local name be the tag name of the token.

5. Let is be the value of the "is" attribute in the given token, if such an attribute exists, or null otherwise.

6. Let definition be the result of looking up a custom element definition given document, given namespace, local name, and is.

7. If definition is non-null and the parser was not created as part of the HTML fragment parsing algorithm, then let will execute script be true. Otherwise, let it be false.

8. If will execute script is true, then:
   1. Increment document's throw-on-dynamic-markup-insertion counter.
   2. If the JavaScript execution context stack is empty, then perform a microtask checkpoint.
   3. Push a new element queue onto document's relevant agent's custom element reactions stack.

9. Let element be the result of creating an element given document, localName, given namespace, null, and is. If will execute script is true, set the synchronous custom elements flag; otherwise, leave it unset.

Note
This will cause custom element constructors to run, if will execute script is true. However, since we incremented the throw-on-dynamic-markup-insertion counter, this cannot cause new characters to be inserted into the tokenizer, or the document to be blown away.

10. Append each attribute in the given token to element.
11. If will execute script is true, then:
   1. Let queue be the result of popping from document's relevant agent’s custom element reactions stack. (This will be the same element queue as was pushed above.)
   2. Invoke custom element reactions in queue.
   3. Decrement document's throw-on-dynamic-markup-insertion counter.

12. If element has an xmlns attribute in the XMLNS namespace whose value is not exactly the same as the element's namespace, that is a parse error. Similarly, if element has an xmlns:xlink attribute in the XMLNS namespace whose value is not the XLink Namespace, that is a parse error.

13. If element is a resettable element, invoke its reset algorithm. (This initializes the element's value and checkedness based on the element's attributes.)

14. If element is a form-associated element and not a form-associated custom element, and not a form-associated element, the form element pointer is not null, there is no template element on the stack of open elements, element is either not listed or doesn't have a form attribute, and the intended parent is in the same tree as the element pointed to by the form element pointer, then associate element with the form element pointed to by the form element pointer and set element's parser inserted flag. (This initializes the element's value and checkedness based on the element's attributes.)

15. Return element.

To insert an element at the adjusted insertion location with an element element:

1. Let the adjusted insertion location be the appropriate place for inserting a node.
2. If it is not possible to insert element at the adjusted insertion location, abort these steps.
3. If the parser was not created as part of the HTML fragment parsing algorithm, then push a new element queue onto element's relevant agent’s custom element reactions stack.
4. Insert element at the adjusted insertion location.
5. If the parser was not created as part of the HTML fragment parsing algorithm, then pop the element queue from element's relevant agent’s custom element reactions stack, and invoke custom element reactions in that queue.

Note

If the adjusted insertion location cannot accept more elements, e.g., because it's a Document that already has an element child, then element is dropped on the floor.

When the steps below require the user agent to insert a foreign element for a token in a given namespace and with a boolean onlyAddToElementStack, the user agent must run these steps:

1. Let the adjusted insertion location be the appropriate place for inserting a node.
2. Let element be the result of creating an element for the token in the given namespace, with the intended parent being the element in which the adjusted insertion location finds itself.
3. If onlyAddToElementStack is false, then run insert an element at the adjusted insertion location with element.
4. Push element onto the stack of open elements so that it is the new current node.
5. Return element.

When the steps below require the user agent to insert an HTML element for a token, the user agent must insert a foreign

Note

This can enqueue a custom element callback reaction for the attributeChangedCallback, which might run immediately (in the next step).

Note

Even though the element attribute governs the creation of a customized built-in element, it is not present during the execution of the relevant custom element constructor; it is appended in this step, along with all other attributes.
When the steps below require the user agent to adjust MathML attributes for a token, then, if the token has an attribute named definitionurl, change its name to definitionURL (note the case difference).

When the steps below require the user agent to adjust SVG attributes for a token, then, for each attribute on the token whose attribute name is one of the ones in the first column of the following table, change the attribute's name to the name given in the corresponding cell in the second column. (This fixes the case of SVG attributes that are not all lowercase.)

<table>
<thead>
<tr>
<th>Attribute name on token</th>
<th>Attribute name on element</th>
</tr>
</thead>
<tbody>
<tr>
<td>attributename</td>
<td>attributeName</td>
</tr>
<tr>
<td>attributetype</td>
<td>attributeType</td>
</tr>
<tr>
<td>basefrequency</td>
<td>baseFrequency</td>
</tr>
<tr>
<td>basestate</td>
<td>baseProfile</td>
</tr>
<tr>
<td>calcmode</td>
<td>calcMode</td>
</tr>
<tr>
<td>clippathunits</td>
<td>clipPathUnits</td>
</tr>
<tr>
<td>diffuseconstant</td>
<td>diffuseConstant</td>
</tr>
<tr>
<td>edgemode</td>
<td>edgeMode</td>
</tr>
<tr>
<td>filterunits</td>
<td>filterUnits</td>
</tr>
<tr>
<td>glyphref</td>
<td>glyphRef</td>
</tr>
<tr>
<td>gradienttransform</td>
<td>gradientTransform</td>
</tr>
<tr>
<td>gradientunits</td>
<td>gradientUnits</td>
</tr>
<tr>
<td>kernelmatrix</td>
<td>kernelMatrix</td>
</tr>
<tr>
<td>kernelunitlength</td>
<td>kernelUnitLength</td>
</tr>
<tr>
<td>keypoints</td>
<td>keyPoints</td>
</tr>
<tr>
<td>keysplines</td>
<td>keySplines</td>
</tr>
<tr>
<td>keytimes</td>
<td>keyTimes</td>
</tr>
<tr>
<td>lengthadjust</td>
<td>lengthAdjust</td>
</tr>
<tr>
<td>limitingconeangle</td>
<td>limitingConeAngle</td>
</tr>
<tr>
<td>markerheight</td>
<td>markerHeight</td>
</tr>
<tr>
<td>markerunits</td>
<td>markerUnits</td>
</tr>
<tr>
<td>markerwidth</td>
<td>markerWidth</td>
</tr>
<tr>
<td>maskcontentunits</td>
<td>maskContentUnits</td>
</tr>
<tr>
<td>maskunits</td>
<td>maskUnits</td>
</tr>
<tr>
<td>numoctaves</td>
<td>numOctaves</td>
</tr>
<tr>
<td>pathlength</td>
<td>pathLength</td>
</tr>
<tr>
<td>patterncontentunits</td>
<td>patternContentUnits</td>
</tr>
<tr>
<td>patterntransform</td>
<td>patternTransform</td>
</tr>
<tr>
<td>patternunits</td>
<td>patternUnits</td>
</tr>
<tr>
<td>pointsatx</td>
<td>pointsAtX</td>
</tr>
<tr>
<td>pointsaty</td>
<td>pointsAtY</td>
</tr>
<tr>
<td>pointsatZ</td>
<td>pointsAtZ</td>
</tr>
<tr>
<td>preservealpha</td>
<td>preserveAlpha</td>
</tr>
<tr>
<td>preserveaspectratio</td>
<td>preserveAspectRatio</td>
</tr>
<tr>
<td>primitiveunits</td>
<td>primitiveUnits</td>
</tr>
<tr>
<td>refx</td>
<td>refX</td>
</tr>
<tr>
<td>refy</td>
<td>refY</td>
</tr>
<tr>
<td>repeatcount</td>
<td>repeatCount</td>
</tr>
<tr>
<td>repeatdur</td>
<td>repeatDur</td>
</tr>
<tr>
<td>requiredextensions</td>
<td>requiredExtensions</td>
</tr>
<tr>
<td>requiredfeatures</td>
<td>requiredFeatures</td>
</tr>
<tr>
<td>specularconstant</td>
<td>specularConstant</td>
</tr>
<tr>
<td>specularexponent</td>
<td>specularExponent</td>
</tr>
<tr>
<td>spreadmethod</td>
<td>spreadMethod</td>
</tr>
<tr>
<td>startoffset</td>
<td>startOffset</td>
</tr>
<tr>
<td>stddeviation</td>
<td>stdDeviation</td>
</tr>
<tr>
<td>stitchtiles</td>
<td>stitchTiles</td>
</tr>
</tbody>
</table>
When the steps below require the user agent to adjust foreign attributes for a token, then, if any of the attributes on the token match the strings given in the first column of the following table, let the attribute be a namespaced attribute, with the prefix being the string given in the corresponding cell in the second column, the local name being the string given in the corresponding cell in the third column, and the namespace being the namespace given in the corresponding cell in the fourth column. (This fixes the use of namespaced attributes, in particular lang attributes in the XML namespace.)

<table>
<thead>
<tr>
<th>Attribute name on token</th>
<th>Attribute name on element</th>
<th>Prefix</th>
<th>Local name</th>
<th>Namespace</th>
</tr>
</thead>
<tbody>
<tr>
<td>surfacescale</td>
<td>surfaceScale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>systemlanguage</td>
<td>systemLanguage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tablevalues</td>
<td>tableValues</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>targetx</td>
<td>targetX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>targety</td>
<td>targetY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>textlength</td>
<td>textLength</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>viewBox</td>
<td>viewBox</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>viewTarget</td>
<td>viewTarget</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>xchannelselector</td>
<td>xChannelSelector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ychannelselector</td>
<td>yChannelSelector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>zoomandpan</td>
<td>zoomAndPan</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When the steps below require the user agent to insert a character while processing a token, the user agent must run the following steps:

1. Let data be the characters passed to the algorithm, or, if no characters were explicitly specified, the character of the character token being processed.

2. Let the adjusted insertion location be the appropriate place for inserting a node.

3. If the adjusted insertion location is in a Document node, then return.

4. If there is a Text node immediately before the adjusted insertion location, then append data to that Text node's data. Otherwise, create a new Text node whose data is data and whose node document is the same as that of the element in which the adjusted insertion location finds itself, and insert the newly created node at the adjusted insertion location.

Note
The DOM will not let Document nodes have Text node children, so they are dropped on the floor.

Example
Here are some sample inputs to the parser and the corresponding number of Text nodes that they result in, assuming a user agent that executes scripts.

<table>
<thead>
<tr>
<th>Input</th>
<th>Number of Text nodes</th>
</tr>
</thead>
</table>
| A<script>
  var script = document.getElementsByTagName('script')[0];
document.body.removeChild(script); | One Text node in the document, containing "AB".|
When the steps below require the user agent to insert a comment while processing a comment token, optionally with an explicitly insertion position, the user agent must run the following steps:

1. Let data be the data given in the comment token being processed.
2. If position was specified, then let the adjusted insertion location be position. Otherwise, let adjusted insertion location be the appropriate place for inserting a node.
3. Create a Comment node whose data attribute is set to data and whose node document is the same as that of the node in which the adjusted insertion location finds itself.
4. Insert the newly created node at the adjusted insertion location.

DOM mutation events must not fire for changes caused by the UA parsing the document. This includes the parsing of any content inserted using `document.write()` and `document.writeln()` calls. However, mutation observers do fire, as required by DOM.

### 13.2.6.2 Parsing elements that contain only text

The generic raw text element parsing algorithm and the generic RCDATA element parsing algorithm consist of the following steps. These algorithms are always invoked in response to a start tag token.

1. Insert an HTML element for the token.
2. If the algorithm that was invoked is the generic raw text element parsing algorithm, switch the tokenizer to the RAWTEXT state; otherwise the algorithm invoked was the generic RCDATA element parsing algorithm, switch the tokenizer to the RCDATA state.
3. Let the original insertion mode be the current insertion mode.
4. Then, switch the insertion mode to "text".
13.2.6.3 Closing elements that have implied end tags

When the steps below require the UA to generate implied end tags, then, while the current node is a dd element, a dt element, an li element, an optgroup element, an option element, a p element, an rb element, a rtc element, or an rt element, the UA must pop the current node off the stack of open elements.

If a step requires the UA to generate implied end tags but lists an element to exclude from the process, then the UA must perform the above steps as if that element was not in the above list.

When the steps below require the UA to generate all implied end tags thoroughly, then, while the current node is a caption element, a colgroup element, a dd element, a dt element, an li element, an optgroup element, an option element, an p element, an rb element, an rtc element, a tbody element, a td element, a thead element, a th element, a tr element, or a tfoot element, the UA must pop the current node off the stack of open elements.

13.2.6.4 The rules for parsing tokens in HTML content

13.2.6.4.1 The "initial" insertion mode

A Document object has an associated parser cannot change the mode flag (a boolean). It is initially false.

When the user agent is to apply the rules for the "initial" insertion mode, the user agent must handle the token as follows:

- A character token that is one of U+0009 CHARACTER TABULATION, U+000A LINE FEED (LF), U+000C FORM FEED (FF), U+000D CARRIAGE RETURN (CR), or U+0020 SPACE
  Ignore the token.

- A comment token
  Insert a comment as the last child of the Document object.

- A DOCTYPE token
  If the DOCTYPE token's name is not "html", or the token's public identifier is not missing, or the token's system identifier is neither missing nor "about:legacy-compat", then there is a parse error.

  Append a DocumentType node to the Document node, with its name set to the name given in the DOCTYPE token, or the empty string if the name was missing; its public ID set to the public identifier given in the DOCTYPE token, or the empty string if the public identifier was missing; and its system ID set to the system identifier given in the DOCTYPE token, or the empty string if the system identifier was missing.

  
  This also ensures that the DocumentType node is returned as the value of the doctype attribute of the Document object.

  Then, if the document is not an iframe srcdoc document, and the parser cannot change the mode flag is false, and the DOCTYPE token matches one of the conditions in the following list, then set the Document to quirks mode:

  - The force-quirks flag is set to on.
  - The name is not "html".
  - The public identifier is set to: "/W3C/DTD HTML 3.2 Transitional/EN/"
  - The public identifier is set to: "/W3C/DTD HTML 4.0 Transitional/EN/"
  - The public identifier is set to: "http://www.w3.org/1998/04/impl/"
  - The system identifier is set to: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "//htmlimpl/"
  - The public identifier starts with: "//htmlimpl/"
  - The public identifier starts with: "//w3c/svg+xml/"
  - The public identifier starts with: "//w3c/svg+xml/"
  - The public identifier starts with: "//www.citeseer.illinois.edu/"
  - The public identifier starts with: "//www.citeseer.illinois.edu/"
  - The public identifier starts with: "//www.citeseer.illinois.edu/"
  - The public identifier starts with: "//www.w3.org/1998/04/impl/"
  - The public identifier starts with: "//www.w3.org/1998/04/impl/"
  - The public identifier starts with: "//www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.citeseer.illinois.edu/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
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  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
  - The public identifier starts with: "http://www.w3.org/1998/04/impl/"
• The public identifier starts with: "//IETF/DTD HTML Level 2/"
• The public identifier starts with: "//IETF/DTD HTML Level 3/"
• The public identifier starts with: "//IETF/DTD HTML Strict Level 0/"
• The public identifier starts with: "//IETF/DTD HTML Strict Level 1/"
• The public identifier starts with: "//IETF/DTD HTML Strict Level 2/"
• The public identifier starts with: "//IETF/DTD HTML Strict Level 3/"
• The public identifier starts with: "//IETF/DTD HTML Strict/
• The public identifier starts with: "//Metrius/DTD Metrius Presentation/
• The public identifier starts with: "//Microsoft/DTD Internet Explorer 2.0 HTML Strict/
• The public identifier starts with: "//Microsoft/DTD Internet Explorer 2.0 HTML/
• The public identifier starts with: "//Microsoft/DTD Internet Explorer 2.0 Tables/
• The public identifier starts with: "//Microsoft/DTD Internet Explorer 3.0 HTML Strict/
• The public identifier starts with: "//Microsoft/DTD Internet Explorer 3.0 HTML/
• The public identifier starts with: "//Microsoft/DTD Internet Explorer 3.0 Tables/
• The public identifier starts with: "//Netscape Comm. Corp./DTD HTML/
• The public identifier starts with: "//Netscape Comm. Corp./DTD Strict HTML/
• The public identifier starts with: "//O'Reilly and Associates/DTD HTML 2.0/
• The public identifier starts with: "//O'Reilly and Associates/DTD HTML Extended 1.0/
• The public identifier starts with: "//O'Reilly and Associates/DTD HTML Extended Relaxed 1.0/
• The public identifier starts with: "//SQ/DTD HTML 2.0 HoTMetaL + extensions/
• The public identifier starts with: "//SoftQuad Software/DTD HoTMetaL PRO 6.0:/19990601::extensions to HTML 4.0/
• The public identifier starts with: "//Sun Microsystems Corp./DTD HotJava HTML/
• The public identifier starts with: "//Sun Microsystems Corp./DTD HotJava Strict HTML/
• The public identifier starts with: "//W3C/DTD HTML 3 1995-03-24/"
• The public identifier starts with: "//W3C/DTD HTML 3.2 Draft/
• The public identifier starts with: "//W3C/DTD HTML 3.2 Final/
• The public identifier starts with: "//W3C/DTD HTML 3.2/
• The public identifier starts with: "//W3C/DTD HTML 3.2S Draft/
• The public identifier starts with: "//W3C/DTD HTML 4.0 Frameset/
• The public identifier starts with: "//W3C/DTD HTML 4.0 Transitional/
• The public identifier starts with: "//W3C/DTD HTML Experimental 19980712/
• The public identifier starts with: "//W3C/DTD HTML Experimental 970421/
• The public identifier starts with: "//W3C/DTD W3 HTML/
• The public identifier starts with: "//W3C/DTD W3 HTML 3.0/
• The public identifier starts with: "//WebTechs/DTD Mozilla HTML 2.0/
• The public identifier starts with: "//WebTechs/DTD Mozilla HTML/
• The system identifier is missing and the public identifier starts with: "//W3C/DTD HTML 4.01 Frameset/
• The system identifier is missing and the public identifier starts with: "//W3C/DTD HTML 4.01 Transitional/

Otherwise, if the document is not an iframe srcdoc document, and the parser cannot change the mode flag is false, and the DOCTYPE token matches one of the conditions in the following list, then set the Document to limited-quirks mode:

• The public identifier starts with: "//W3C/DTD XHTML 1.0 Frameset/
• The public identifier starts with: "//W3C/DTD XHTML 1.0 Transitional/
• The system identifier is not missing and the public identifier starts with: "//W3C/DTD HTML 4.01 Frameset/
• The system identifier is not missing and the public identifier starts with: "//W3C/DTD HTML 4.01 Transitional/

The system identifier and public identifier strings must be compared to the values given in the lists above in an ASCII case-insensitive manner. A system identifier whose value is the empty string is not considered missing for the purposes of the conditions above.

Then, switch the insertion mode to "before html".

→ Anything else

If the document is not an iframe srcdoc document, then this is a parse error; if the parser cannot change the mode flag is false, set the Document to quirks mode.

In any case, switch the insertion mode to "before html", then reprocess the token.

13.2.6.4.2 The "before html" insertion mode

When the user agent is to apply the rules for the "before html" insertion mode, the user agent must handle the token as follows:

→ A DOCTYPE token

Parse error. Ignore the token.
A comment token

Insert a comment as the last child of the Document object.

A character token that is one of U+0009 CHARACTER TABULATION, U+000A LINE FEED (LF), U+000C FORM FEED (FF), U+000D CARRIAGE RETURN (CR), or U+0020 SPACE

Ignore the token.

A start tag whose tag name is "html"

Create an element for the token in the HTML namespace, with the Document as the intended parent. Append it to the Document object. Put this element in the stack of open elements.

Switch the insertion mode to "before head".

An end tag whose tag name is one of: "head", "body", "html", "br"

Act as described in the "anything else" entry below.

Any other end tag

Parse error. Ignore the token.

Anything else


Switch the insertion mode to "before head", then reprocess the token.

The document element can end up being removed from the Document object, e.g. by scripts; nothing in particular happens in such cases, content continues being appended to the nodes as described in the next section.

13.2.6.4.3 The "before head" insertion mode

When the user agent is to apply the rules for the "before head" insertion mode, the user agent must handle the token as follows:

A character token that is one of U+0009 CHARACTER TABULATION, U+000A LINE FEED (LF), U+000C FORM FEED (FF), U+000D CARRIAGE RETURN (CR), or U+0020 SPACE

Ignore the token.

A comment token

Insert a comment.

A DOCTYPE token

Parse error. Ignore the token.

A start tag whose tag name is "html"

Process the token using the rules for the "in body" insertion mode.

A start tag whose tag name is "head"

Insert an HTML element for the token.

Set the head element pointer to the newly created head element.

Switch the insertion mode to "in head".

An end tag whose tag name is one of: "head", "body", "html", "br"

Act as described in the "anything else" entry below.

Any other end tag

Parse error. Ignore the token.

Anything else

Insert an HTML element for a "head" start tag token with no attributes.
Set the head element pointer to the newly created head element.

Switch the insertion mode to “in head”.

Reprocess the current token.

13.2.6.4.4 The “in head” insertion mode

When the user agent is to apply the rules for the “in head” insertion mode, the user agent must handle the token as follows:

- A character token that is one of U+0009 CHARACTER TABULATION, U+000A LINE FEED (LF), U+000C FORM FEED (FF), U+000D CARRIAGE RETURN (CR), or U+0020 SPACE
  Insert the character.

- A comment token
  Insert a comment.

- A DOCTYPE token
  Parse error. Ignore the token.

- A start tag whose tag name is “html”
  Process the token using the rules for the “in body” insertion mode.

- A start tag whose tag name is one of: ”base”, ”basefont”, ”bgsound”, ”link”
  Insert an HTML element for the token. Immediately pop the current node off the stack of open elements.
  Acknowledge the token’s self-closing flag, if it is set.

- A start tag whose tag name is “meta”
  Insert an HTML element for the token. Immediately pop the current node off the stack of open elements.
  Acknowledge the token’s self-closing flag, if it is set.

  If the active speculative HTML parser is null, then:
  
  1. If the element has a charset attribute, and getting an encoding from its value results in an encoding, and the confidence is currently tentative, then change the encoding to the resulting encoding.
  2. Otherwise, if the element has an http-equiv attribute whose value is an ASCII case-insensitive match for the string ”Content-Type”, and the element has a content attribute, and applying the algorithm for extracting a character encoding from a meta element to that attribute’s value returns an encoding, and the confidence is currently tentative, then change the encoding to the extracted encoding.

Note: The speculative HTML parser doesn’t speculatively apply character encoding declarations in order to reduce implementation complexity.

- A start tag whose tag name is “title”
  Follow the generic RCDATA element parsing algorithm.

- A start tag whose tag name is ”noscript”, if the scripting flag is enabled

- A start tag whose tag name is one of: ”noframes”, ”style”
  Follow the generic raw text element parsing algorithm.

- A start tag whose tag name is ”noscript”, if the scripting flag is disabled
  Insert an HTML element for the token.

  Switch the insertion mode to “in head noscript”.

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Run these steps:

1. Let the adjusted insertion location be the appropriate place for inserting a node.
2. Create an element for the token in the HTML namespace, with the intended parent being the element in which the adjusted insertion location finds itself.
3. Set the element's parser document to the Document, and set the element's force async to false.

Note

This ensures that, if the script is external, any document.write() calls in the script will execute in-line, instead of blowing the document away, as would happen in most other cases. It also prevents the script from executing until the end tag is seen.

4. If the parser was created as part of the HTML fragment parsing algorithm, then set the script element's already started to true. (fragment case)
5. If the parser was invoked via the document.write() or document.writeln() methods, then optionally set the script element's already started to true. (For example, the user agent might use this clause to prevent execution of cross-origin scripts inserted via document.write() under slow network conditions, or when the page has already taken a long time to load.)
6. Insert the newly created element at the adjusted insertion location.
7. Push the element onto the stack of open elements so that it is the new current node.
8. Switch the tokenizer to the script data state.
9. Let the original insertion mode be the current insertion mode.
10. Switch the insertion mode to "text".

An end tag whose tag name is "head"

Pop the current node (which will be the head element) off the stack of open elements.

Switch the insertion mode to "after head".

An end tag whose tag name is one of: "body", "html", "br"

Act as described in the "anything else" entry below.

A start tag whose tag name is "template"

Let template start tag be the start tag.

Insert a marker at the end of the list of active formatting elements.

Set the frameset-ok flag to "not ok".

Switch the insertion mode to "in template".

Push "in template" onto the stack of template insertion modes so that it is the new current template insertion mode.

Let the adjusted insertion location be the appropriate place for inserting a node.

Let intended parent be the element in which the adjusted insertion location finds itself.

Let document be intended parent's node document.

If any of the following are false:

- template start tag's shadowrootmode is not in the none state;
- Document's allow declarative shadow roots is true; or
- the adjusted current node is not the topmost element in the stack of open elements,
then insert an HTML element for the token.

Otherwise:

1. Let declarative shadow host element be adjusted current node.
2. Let template be the result of insert a foreign element for template start tag, with HTML namespace and true.
3. Let mode be template start tag's shadowrootmode attribute's value.
4. Let clonable be true if template start tag has a shadowrootclonable attribute; otherwise false.
5. Let serializable be true if template start tag has a shadowrootserializable attribute; otherwise false.
6. Let delegatesFocus be true if template start tag has a shadowrootdelegatesfocus attribute; otherwise false.
7. If declarative shadow host element is a shadow host, then insert an element at the adjusted insertion location with template.
8. Otherwise:
   1. Attach a shadow root with declarative shadow host element, mode, clonable, serializable, delegatesFocus, and "named". If an exception is thrown, then catch it, report the exception, insert an element at the adjusted insertion location with template, and return.
   2. Let shadow be declarative shadow host element's shadow root.
   3. Set shadow's declarative to true.
   4. Set template's template contents property to shadow.
   5. Set shadow's available to element internals to true.

↪ An end tag whose tag name is "template"

If there is no template element on the stack of open elements, then this is a parse error; ignore the token.

Otherwise, run these steps:

1. Generate all implied end tags thoroughly.
2. If the current node is not a template element, then this is a parse error.
3. Pop elements from the stack of open elements until a template element has been popped from the stack.
4. Clear the list of active formatting elements up to the last marker.
5. Pop the current template insertion mode off the stack of template insertion modes.
6. Reset the insertion mode appropriately.

↪ A start tag whose tag name is "head"

↪ Any other end tag
 Parse error. Ignore the token.

↪ Anything else

Pop the current node (which will be the head element) off the stack of open elements.

Switch the insertion mode to "after head".

Reprocess the token.

13.2.6.4.5 The "in head noscript" insertion mode

When the user agent is to apply the rules for the "in head noscript" insertion mode, the user agent must handle the token as follows:
A DOCTYPE token

Parse error. Ignore the token.

A start tag whose tag name is "html"

Process the token using the rules for the "in body" insertion mode.

An end tag whose tag name is "noscript"

Pop the current node (which will be a noscript element) from the stack of open elements; the new current node will be a head element.

Switch the insertion mode to "in head".

A character token that is one of U+0009 CHARACTER TABULATION, U+000A LINE FEED (LF), U+000C FORM FEED (FF), U+000D CARRIAGE RETURN (CR), or U+0020 SPACE

A comment token

A start tag whose tag name is one of: "basefont", "bgsound", "link", "meta", "noframes", "style"

Process the token using the rules for the "in head" insertion mode.

An end tag whose tag name is "br"

Act as described in the "anything else" entry below.

A start tag whose tag name is one of: "head", "noscript"

Any other end tag

Parse error. Ignore the token.

Anything else

Parse error. Ignore the token.

13.2.6.4.6 The "after head" insertion mode

When the user agent is to apply the rules for the "after head" insertion mode, the user agent must handle the token as follows:

A character token that is one of U+0009 CHARACTER TABULATION, U+000A LINE FEED (LF), U+000C FORM FEED (FF), U+000D CARRIAGE RETURN (CR), or U+0020 SPACE

Insert the character.

A comment token

Insert a comment.

A DOCTYPE token

Parse error. Ignore the token.

A start tag whose tag name is "html"

Process the token using the rules for the "in body" insertion mode.

A start tag whose tag name is "body"

Insert an HTML element for the token.

Set the frameset-ok flag to "not ok".

Switch the insertion mode to "in body".
A start tag whose tag name is "frameset"

Insert an HTML element for the token.

Switch the insertion mode to "in frameset".

A start tag whose tag name is one of: "base", "basefont", "bgsound", "link", "meta", "noframes", "script", "style", "template", "title"

Parse error.

Push the node pointed to by the head element pointer onto the stack of open elements.

Process the token using the rules for the "in head" insertion mode.

Remove the node pointed to by the head element pointer from the stack of open elements. (It might not be the current node at this point.)

Note

The head element pointer cannot be null at this point.

An end tag whose tag name is "template"

Process the token using the rules for the "in head" insertion mode.

An end tag whose tag name is one of: "body", "html", "br"

Act as described in the "anything else" entry below.

A start tag whose tag name is "head"

Any other end tag

Parse error. Ignore the token.

Anything else

Insert an HTML element for a "body" start tag token with no attributes.

Switch the insertion mode to "in body".

Reprocess the current token.

13.2.6.4.7 The "in body" insertion mode

When the user agent is to apply the rules for the "in body" insertion mode, the user agent must handle the token as follows:

A character token that is U+0000 NULL

Parse error. Ignore the token.

A character token that is one of U+0009 CHARACTER TABULATION, U+000A LINE FEED (LF), U+000C FORM FEED (FF), U+000D CARRIAGE RETURN (CR), or U+0020 SPACE

Reconstruct the active formatting elements, if any.

Insert the token's character.

Set the frameset-ok flag to "not ok".

A comment token

Insert a comment.
A DOCTYPE token

Parse error\(^{\text{p1254}}\). Ignore the token.

A start tag whose tag name is "html"

Parse error\(^{\text{p1254}}\).

If there is a template\(^{\text{p666}}\) element on the stack of open elements\(^{\text{p1267}}\), then ignore the token.

Otherwise, for each attribute on the token, check to see if the attribute is already present on the top element of the stack of open elements\(^{\text{p1267}}\). If it is not, add the attribute and its corresponding value to that element.

A start tag whose tag name is one of: "base", "basefont", "bgsound", "link", "meta", "noframes", "script", "style", "template", "title"

An end tag whose tag name is "template"

Process the token using the rules for the "in head\(^{\text{p1309}}\)" insertion mode\(^{\text{p1266}}\).

A start tag whose tag name is "body"

Parse error\(^{\text{p1254}}\).

If the stack of open elements\(^{\text{p1267}}\) has only one node on it, if the second element on the stack of open elements\(^{\text{p1267}}\) is not a body\(^{\text{p202}}\) element, or if there is a template\(^{\text{p666}}\) element on the stack of open elements\(^{\text{p1267}}\), then ignore the token. (fragment case\(^{\text{p1354}}\) or there is a template\(^{\text{p666}}\) element on the stack)

Otherwise, set the frameset-ok flag\(^{\text{p1271}}\) to "not ok"; then, for each attribute on the token, check to see if the attribute is already present on the body\(^{\text{p202}}\) element (the second element) on the stack of open elements\(^{\text{p1267}}\), and if it is not, add the attribute and its corresponding value to that element.

A start tag whose tag name is "frameset"

Parse error\(^{\text{p1254}}\).

If the stack of open elements\(^{\text{p1267}}\) has only one node on it, or if the second element on the stack of open elements\(^{\text{p1267}}\) is not a body\(^{\text{p202}}\) element, then ignore the token. (fragment case\(^{\text{p1354}}\) or there is a template\(^{\text{p666}}\) element on the stack)

If the frameset-ok flag\(^{\text{p1271}}\) is set to "not ok", ignore the token.

Otherwise, run the following steps:

1. Remove the second element on the stack of open elements\(^{\text{p1267}}\) from its parent node, if it has one.
2. Pop all the nodes from the bottom of the stack of open elements\(^{\text{p1267}}\), from the current node\(^{\text{p1267}}\) up to, but not including, the root html\(^{\text{p169}}\) element.
3. Insert an HTML element\(^{\text{p1302}}\) for the token.
4. Switch the insertion mode\(^{\text{p1266}}\) to "in frameset\(^{\text{p1335}}\)".

An end-of-file token

If the stack of template insertion modes\(^{\text{p1266}}\) is not empty, then process the token using the rules for the "in template\(^{\text{p1333}}\)" insertion mode\(^{\text{p1266}}\).

Otherwise, follow these steps:

1. If there is a node in the stack of open elements\(^{\text{p1267}}\) that is not either a dd\(^{\text{p245}}\) element, a dt\(^{\text{p244}}\) element, an li\(^{\text{p238}}\) element, an optgroup\(^{\text{p571}}\) element, an option\(^{\text{p572}}\) element, a p\(^{\text{p226}}\) element, an rb\(^{\text{p1407}}\) element, an rp\(^{\text{p274}}\) element, an rt\(^{\text{p273}}\) element, an rtc\(^{\text{p1407}}\) element, a tbody\(^{\text{p485}}\) element, a td\(^{\text{p490}}\) element, atfoot\(^{\text{p487}}\) element, a th\(^{\text{p491}}\) element, a thead\(^{\text{p486}}\) element, a tr\(^{\text{p498}}\) element, the body\(^{\text{p202}}\) element, or the html\(^{\text{p169}}\) element, then this is a parse error\(^{\text{p1254}}\).
2. Stop parsing\(^{\text{p1339}}\).

An end tag whose tag name is "body"

If the stack of open elements\(^{\text{p1267}}\) does not have a body element in scope\(^{\text{p1268}}\), this is a parse error\(^{\text{p1254}}\); ignore the token.

Otherwise, if there is a node in the stack of open elements\(^{\text{p1267}}\) that is not either a dd\(^{\text{p245}}\) element, a dt\(^{\text{p244}}\) element, an li\(^{\text{p238}}\) element, an optgroup\(^{\text{p571}}\) element, an option\(^{\text{p572}}\) element, a p\(^{\text{p226}}\) element, an rb\(^{\text{p1407}}\) element, an rp\(^{\text{p274}}\) element, an rt\(^{\text{p273}}\) element, an rtc\(^{\text{p1407}}\) element, a tbody\(^{\text{p485}}\) element, a td\(^{\text{p490}}\) element, a tfoot\(^{\text{p487}}\) element, a th\(^{\text{p491}}\) element, a thead\(^{\text{p486}}\) element,
a `<tr>` element, the `<body>` element, or the `<html>` element, then this is a parse error.

Switch the insertion mode to “after body”.

↪

An end tag whose tag name is “html”

If the stack of open elements does not have a `<body>` element in scope, this is a parse error; ignore the token.

Otherwise, if there is a node in the stack of open elements that is not either a `<dd>` element, a `<dt>` element, an `<option>` element, an `<a>` element, an `<tt>` element, a `<ruby>` element, an `<rt>` element, a `<tbody>` element, a `<td>` element, an `<tfoot>` element, a `<th>` element, an `<thead>` element, or the `<html>` element, then this is a parse error.

Switch the insertion mode to “after body”.

Reprocess the token.

↪

A start tag whose tag name is one of: "address", "article", "aside", "blockquote", "center", "details", "dialog", "dir", "div", "dl", "fieldset", "figcaption", "figure", "footer", "header", "hgroup", "main", "menu", "nav", "ol", "p", "search", "section", "summary", "ul"

If the stack of open elements has a `<p>` element in button scope, then close a `<p>` element.

Insert an HTML element for the token.

↪

A start tag whose tag name is one of: "h1", "h2", "h3", "h4", "h5", "h6"

If the stack of open elements has a `<p>` element in button scope, then close a `<p>` element.

If the current node is an `<HTML>` element whose tag name is one of "h1", "h2", "h3", "h4", "h5", or "h6", then this is a parse error; pop the current node off the stack of open elements.

Insert an HTML element for the token.

↪

A start tag whose tag name is one of: "pre", "listing"

If the stack of open elements has a `<p>` element in button scope, then close a `<p>` element.

Insert an HTML element for the token.

If the next token is a U+000A LINE FEED (LF) character token, then ignore that token and move on to the next one.

(Newlines at the start of `<pre>` blocks are ignored as an authoring convenience.)

Set the frameset-ok flag to "not ok".

↪

A start tag whose tag name is "form"

If the form element pointer is not null, and there is no template element on the stack of open elements, then this is a parse error; ignore the token.

Otherwise:

If the stack of open elements has a `<p>` element in button scope, then close a `<p>` element.

Insert an HTML element for the token, and, if there is no template element on the stack of open elements, set the form element pointer to point to the element created.

↪

A start tag whose tag name is "li"

Run these steps:

1. Set the frameset-ok flag to "not ok".
2. Initialize node to be the current node (the bottommost node of the stack).
3. Loop: If node is an `<li>` element, then run these substeps:
   1. Generate implied end tags, except for `<li>` elements.
   2. If the current node is not an `<li>` element, then this is a parse error.
3. Pop elements from the stack of open elements until an li element has been popped from the stack.

4. Jump to the step labeled done below.

4. If node is in the special category, but is not an address, div, or p element, then jump to the step labeled done below.

5. Otherwise, set node to the previous entry in the stack of open elements and return to the step labeled loop.

6. Done: If the stack of open elements has a p element in button scope, then close a p element.

7. Finally, insert an HTML element for the token.

↪ A start tag whose tag name is one of: "dd", "dt"

Run these steps:

1. Set the frameset-ok flag to "not ok".

2. Initialize node to be the current node (the bottommost node of the stack).

3. Loop: If node is a dd element, then run these substeps:
   
   1. Generate implied end tags, except for dd elements.
   
   2. If the current node is not a dd element, then this is a parse error.
   
   3. Pop elements from the stack of open elements until a dd element has been popped from the stack.
   
   4. Jump to the step labeled done below.

4. If node is a dt element, then run these substeps:
   
   1. Generate implied end tags, except for dt elements.
   
   2. If the current node is not a dt element, then this is a parse error.
   
   3. Pop elements from the stack of open elements until a dt element has been popped from the stack.
   
   4. Jump to the step labeled done below.

5. If node is in the special category, but is not an address, div, or p element, then jump to the step labeled done below.

6. Otherwise, set node to the previous entry in the stack of open elements and return to the step labeled loop.

7. Done: If the stack of open elements has a p element in button scope, then close a p element.

8. Finally, insert an HTML element for the token.

↪ A start tag whose tag name is "plaintext"

If the stack of open elements has a p element in button scope, then close a p element.

Insert an HTML element for the token.

Switch the tokenizer to the PLAINTEXT state.

Note

Once a start tag with the tag name "plaintext" has been seen, that will be the last token ever seen other than character tokens (and the end-of-file token), because there is no way to switch out of the PLAINTEXT state.

↪ A start tag whose tag name is "button"

1. If the stack of open elements has a button element in scope, then run these substeps:
   
   1. Parse error.
   
   2. Generate implied end tags.
   
   3. Pop elements from the stack of open elements until a button element has been popped from the stack.
2. Reconstruct the active formatting elements\textsuperscript{1270}, if any.
3. Insert an HTML element\textsuperscript{1302} for the token.
4. Set the frameset-ok flag\textsuperscript{1271} to "not ok".

\textbf{An end tag whose tag name is one of:} "address", "article", "aside", "blockquote", "button", "center", "details", "dialog", "dir", "div", "dl", "fieldset", "figcaption", "figure", "footer", "header", "hgroup", "listing", "main", "menu", "nav", "ol", "pre", "search", "section", "summary", "ul"

If the \textit{stack of open elements}\textsuperscript{1267} does not have an element in scope\textsuperscript{1268} that is an HTML element\textsuperscript{45} with the same tag name as that of the token, then this is a parse error\textsuperscript{1254}; ignore the token.

Otherwise, run these steps:

1. Generate implied end tags\textsuperscript{1306}.
2. If the \textit{current node}\textsuperscript{1267} is not an HTML element\textsuperscript{45} with the same tag name as that of the token, then this is a parse error\textsuperscript{1254}.
3. Pop elements from the \textit{stack of open elements}\textsuperscript{1267} until an HTML element\textsuperscript{45} with the same tag name as the token has been popped from the stack.

\textbf{An end tag whose tag name is "form"}

If there is no template\textsuperscript{686} element on the \textit{stack of open elements}\textsuperscript{1267}, then run these substeps:

1. Let \textit{node} be the element that the form element pointer\textsuperscript{1270} is set to, or null if it is not set to an element.
2. Set the form element pointer\textsuperscript{1270} to null.
3. If \textit{node} is null or if the \textit{stack of open elements}\textsuperscript{1267} does not have node in scope\textsuperscript{1268}, then this is a parse error\textsuperscript{1254}; return and ignore the token.
4. Generate implied end tags\textsuperscript{1306}.
5. If the \textit{current node}\textsuperscript{1267} is not node, then this is a parse error\textsuperscript{1254}.
6. Remove node from the \textit{stack of open elements}\textsuperscript{1267}.

If there is a template\textsuperscript{686} element on the \textit{stack of open elements}\textsuperscript{1267}, then run these substeps instead:

1. If the \textit{stack of open elements}\textsuperscript{1267} does not have a form element in scope\textsuperscript{1268}, then this is a parse error\textsuperscript{1254}; return and ignore the token.
2. Generate implied end tags\textsuperscript{1306}.
3. If the \textit{current node}\textsuperscript{1267} is not a form\textsuperscript{510} element, then this is a parse error\textsuperscript{1254}.
4. Pop elements from the \textit{stack of open elements}\textsuperscript{1267} until a form\textsuperscript{510} element has been popped from the stack.

\textbf{An end tag whose tag name is "p"}

If the \textit{stack of open elements}\textsuperscript{1267} does not have a p element in button scope\textsuperscript{1269}, then this is a parse error\textsuperscript{1254}; insert an HTML element\textsuperscript{45} for a "p" start tag token with no attributes.

Close a p element\textsuperscript{1322}.

\textbf{An end tag whose tag name is "li"}

If the \textit{stack of open elements}\textsuperscript{1267} does not have an li element in list item scope\textsuperscript{1269}, then this is a parse error\textsuperscript{1254}; ignore the token.

Otherwise, run these steps:

1. Generate implied end tags\textsuperscript{1306}, except for li\textsuperscript{1238} elements.
2. If the \textit{current node}\textsuperscript{1267} is not an li\textsuperscript{1238} element, then this is a parse error\textsuperscript{1254}.
3. Pop elements from the \textit{stack of open elements}\textsuperscript{1267} until an li\textsuperscript{1238} element has been popped from the stack.
An end tag whose tag name is one of: "dd", "dt"

If the stack of open elements does not have an element in scope that is an HTML element with the same tag name as that of the token, then this is a parse error; ignore the token.

Otherwise, run these steps:

1. Generate implied end tags, except for HTML elements with the same tag name as the token.
2. If the current node is not an HTML element with the same tag name as that of the token, then this is a parse error.
3. Pop elements from the stack of open elements until an HTML element with the same tag name as the token has been popped from the stack.

An end tag whose tag name is one of: "h1", "h2", "h3", "h4", "h5", "h6"

If the stack of open elements does not have an element in scope that is an HTML element and whose tag name is one of "h1", "h2", "h3", "h4", "h5", or "h6", then this is a parse error; ignore the token.

Otherwise, run these steps:

1. Generate implied end tags.
2. If the current node is not an HTML element with the same tag name as that of the token, then this is a parse error.
3. Pop elements from the stack of open elements until an HTML element whose tag name is one of "h1", "h2", "h3", "h4", "h5", or "h6" has been popped from the stack.

An end tag whose tag name is "sarcasm"

Take a deep breath, then act as described in the "any other end tag" entry below.

A start tag whose tag name is "a"

If the list of active formatting elements contains an element between the end of the list and the last marker on the list (or the start of the list if there is no marker on the list), then this is a parse error; run the adoption agency algorithm for the token, then remove that element from the list of active formatting elements and the stack of open elements if the adoption agency algorithm didn't already remove it (it might not have if the element is not in table scope).

Reconstruct the active formatting elements, if any.

Insert an HTML element for the token. Push onto the list of active formatting elements that element.

A start tag whose tag name is one of: "b", "big", "code", "em", "font", "i", "s", "small", "strike", "strong", "tt", "u"

Reconstruct the active formatting elements, if any.

Insert an HTML element for the token. Push onto the list of active formatting elements that element.

A start tag whose tag name is "nobr"

Reconstruct the active formatting elements, if any.

If the stack of open elements has a nobr element in scope, then this is a parse error; run the adoption agency algorithm for the token, then once again reconstruct the active formatting elements, if any.

Insert an HTML element for the token. Push onto the list of active formatting elements that element.

An end tag whose tag name is one of: "a", "b", "big", "code", "em", "font", "i", "nobr", "s", "small", "strike", "strong", "tt", "u"

In the non-conforming stream `<a href="a">a</a><table><a href="b">b</a>`x`, the first `a` element would be closed upon seeing the second one, and the "x" character would be inside a link to "b", not to "a". This is despite the fact that the outer `a` element is not in table scope (meaning that a regular end tag at the start of the table wouldn't close the outer `a` element). The result is that the two `a` elements are indirectly nested inside each other — non-conforming markup will often result in non-conforming DOMs when parsed.

Reconstruct the active formatting elements, if any.

Insert an HTML element for the token. Push onto the list of active formatting elements that element.
Run the adoption agency algorithm for the token.

- A start tag whose tag name is one of: "applet", "marquee", "object"
  Reconstruct the active formatting elements, if any.
  Insert an HTML element for the token.
  Insert a marker at the end of the list of active formatting elements.
  Set the frameset-ok flag to "not ok".

- An end tag token whose tag name is one of: "applet", "marquee", "object"
  If the stack of open elements does not have an element in scope that is an HTML element with the same tag name as that of the token, then this is a parse error: ignore the token.
  Otherwise, run these steps:
    1. Generate implied end tags.
    2. If the current node is not an HTML element with the same tag name as that of the token, then this is a parse error.
    3. Pop elements from the stack of open elements until an HTML element with the same tag name as the token has been popped from the stack.
    4. Clear the list of active formatting elements up to the last marker.

- A start tag whose tag name is "table"
  If the Document is not set to quirks mode, and the stack of open elements has a p element in button scope, then close a p element.
  Insert an HTML element for the token.
  Set the frameset-ok flag to "not ok".
  Switch the insertion mode to "in table".

- An end tag whose tag name is "br"
  Parse error. Drop the attributes from the token, and act as described in the next entry: i.e. act as if this was a "br" start tag token with no attributes, rather than the end tag token that it actually is.

- A start tag whose tag name is one of: "area", "br", "embed", "img", "keygen", "wbr"
  Reconstruct the active formatting elements, if any.
  Insert an HTML element for the token. Immediately pop the current node off the stack of open elements.
  Acknowledge the token's self-closing flag, if it is set.
  Set the frameset-ok flag to "not ok".

- A start tag whose tag name is "input"
  Reconstruct the active formatting elements, if any.
  Insert an HTML element for the token. Immediately pop the current node off the stack of open elements.
  Acknowledge the token's self-closing flag, if it is set.
  If the token does not have an attribute with the name "type", or if it does, but that attribute's value is not an ASCII case-insensitive match for the string "hidden", then: set the frameset-ok flag to "not ok".

- A start tag whose tag name is one of: "param", "source", "track"
  Insert an HTML element for the token. Immediately pop the current node off the stack of open elements.
  Acknowledge the token's self-closing flag, if it is set.
A start tag whose tag name is "hr"
If the stack of open elements has a p element in button scope, then close a p element.

Insert an HTML element for the token. Immediately pop the current node off the stack of open elements.

Acknowledge the token's self-closing flag, if it is set.
Set the frameset-ok flag to "not ok".

A start tag whose tag name is "image"
Parse error. Change the token's tag name to "img" and reprocess it. (Don't ask.)

A start tag whose tag name is "textarea"
Run these steps:

1. Insert an HTML element for the token.
2. If the next token is a U+000A LINE FEED (LF) character token, then ignore that token and move on to the next one. (Newlines at the start of textarea elements are ignored as an authoring convenience.)
3. Switch the tokenizer to the RCDATA state.
4. Let the original insertion mode be the current insertion mode.
5. Set the frameset-ok flag to "not ok".
6. Switch the insertion mode to "text".

A start tag whose tag name is "xmp"
If the stack of open elements has a p element in button scope, then close a p element.

Reconstruct the active formatting elements, if any.
Set the frameset-ok flag to "not ok".
Follow the generic raw text element parsing algorithm.

A start tag whose tag name is "iframe"
Set the frameset-ok flag to "not ok".

Follow the generic raw text element parsing algorithm.

A start tag whose tag name is "noembed"
A start tag whose tag name is "noscript", if the scripting flag is enabled
Follow the generic raw text element parsing algorithm.

A start tag whose tag name is "select"
Reconstruct the active formatting elements, if any.
Insert an HTML element for the token.
Set the frameset-ok flag to "not ok".
If the insertion mode is one of "in table", "in caption", "in table body", "in row", or "in cell", then switch the insertion mode to "in select in table". Otherwise, switch the insertion mode to "in select".

A start tag whose tag name is one of: "optgroup", "option"
If the current node is an option element, then pop the current node off the stack of open elements.
Reconstruct the active formatting elements, if any.
Insert an HTML element for the token.

A start tag whose tag name is one of: "rb", "rtc"
If the stack of open elements has a ruby element in scope, then generate implied end tags. If the current node
is not now a ruby element, this is a parse error.

Insert an HTML element for the token.

↪ A start tag whose tag name is one of: "rp", "rt"

If the stack of open elements has a ruby element in scope, then generate implied end tags, except for rtc elements. If the current node is not now a rtc element or a ruby element, this is a parse error.

Insert an HTML element for the token.

↪ A start tag whose tag name is "math"

Reconstruct the active formatting elements, if any.

Adjust MathML attributes for the token. (This fixes the case of MathML attributes that are not all lowercase.)

Adjust foreign attributes for the token. (This fixes the use of namespaced attributes, in particular XLink.)

Insert a foreign element for the token, with MathML namespace and false.

If the token has its self-closing flag set, pop the current node off the stack of open elements and acknowledge the token's self-closing flag.

↪ A start tag whose tag name is "svg"

Reconstruct the active formatting elements, if any.

Adjust SVG attributes for the token. (This fixes the case of SVG attributes that are not all lowercase.)

Adjust foreign attributes for the token. (This fixes the use of namespaced attributes, in particular XLink in SVG.)

Insert a foreign element for the token, with SVG namespace and false.

If the token has its self-closing flag set, pop the current node off the stack of open elements and acknowledge the token's self-closing flag.

↪ A start tag whose tag name is one of: "caption", "col", "colgroup", "frame", "head", "tbody", "td", "tfoot", "th", "thead", "tr"

Parse error. Ignore the token.

↪ Any other start tag

Reconstruct the active formatting elements, if any.

Insert an HTML element for the token.

Note

This element will be an ordinary element. With one exception: if the scripting flag is disabled, it can also be a noscript element.

↪ Any other end tag

Run these steps:

1. Initialize node to be the current node (the bottommost node of the stack).

2. Loop: If node is an HTML element with the same tag name as the token, then:
   1. Generate implied end tags, except for HTML elements with the same tag name as the token.
   2. If node is not the current node, then this is a parse error.
   3. Pop all the nodes from the current node up to node, including node, then stop these steps.

3. Otherwise, if node is in the special category, then this is a parse error; ignore the token, and return.

4. Set node to the previous entry in the stack of open elements.

5. Return to the step labeled loop.
When the steps above say the user agent is to close a `p` element, it means that the user agent must run the following steps:

1. Generate implied end tags[^1306], except for `p` elements.
2. If the current node[^1267] is not a `p` element, then this is a parse error[^1254].
3. Pop elements from the stack of open elements[^1267] until a `p` element has been popped from the stack.

The adoption agency algorithm, which takes as its only argument a token `token` for which the algorithm is being run, consists of the following steps:

1. Let subject be `token`'s tag name.
2. If the current node[^1267] is an HTML element[^45] whose tag name is subject, and the current node[^1267] is not in the list of active formatting elements[^1269], then pop the current node[^1267] off the stack of open elements[^1267] and return.
3. Let outerLoopCounter be 0.
4. While true:
   1. If outerLoopCounter is greater than or equal to 8, then return.
   2. Increment outerLoopCounter by 1.
   3. Let formattingElement be the last element in the list of active formatting elements[^1269] that:
      - is between the end of the list and the last marker[^1269] in the list, if any, or the start of the list otherwise, and
      - has the tag name subject.
      
      If there is no such element, then return and instead act as described in the "any other end tag" entry above.
   4. If formattingElement is not in the stack of open elements[^1267], then this is a parse error[^1254]; remove the element from the list, and return.
   5. If formattingElement is in the stack of open elements[^1267], but the element is not in scope[^1268], then this is a parse error[^1254]; return.
   6. If formattingElement is not the current node[^1267], this is a parse error[^1254]. (But do not return.)
   7. Let furthestBlock be the topmost node in the stack of open elements[^1267] that is lower in the stack than formattingElement, and is an element in the special[^1268] category. There might not be one.
   8. If there is no furthestBlock, then the UA must first pop all the nodes from the bottom of the stack of open elements[^1267], from the current node[^1267] up to and including formattingElement, then remove formattingElement from the list of active formatting elements[^1269], and finally return.
   9. Let commonAncestor be the element immediately above formattingElement in the stack of open elements[^1267].
10. Let a bookmark note the position of formattingElement in the list of active formatting elements[^1269] relative to the elements on either side of it in the list.
11. Let node and lastNode be furthestBlock.
12. Let innerLoopCounter be 0.
13. While true:
   1. Increment innerLoopCounter by 1.
   2. Let node be the element immediately above node in the stack of open elements[^1267], or if node is no longer in the stack of open elements[^1267] (e.g. because it got removed by this algorithm), the element that was immediately above node in the stack of open elements[^1267] before node was removed.
   3. If node is formattingElement, then break.
   4. If innerLoopCounter is greater than 3 and node is in the list of active formatting elements[^1269], then remove node from the list of active formatting elements[^1269].
   5. If node is not in the list of active formatting elements[^1269], then remove node from the stack of open...
6. Create an element for the token for which the element node was created, in the HTML namespace, with commonAncestor as the intended parent; replace the entry for node in the list of active formatting elements with an entry for the new element, replace the entry for node in the stack of open elements with an entry for the new element, and let node be the new element.

7. If last node is furthestBlock, then move the aforementioned bookmark to be immediately after the new node in the list of active formatting elements.

8. Append lastNode to node.

9. Set lastNode to node.

14. Insert whatever lastNode ended up being in the previous step at the appropriate place for inserting a node, but using commonAncestor as the override target.

15. Create an element for the token for which formattingElement was created, in the HTML namespace, with furthestBlock as the intended parent.

16. Take all of the child nodes of furthestBlock and append them to the element created in the last step.

17. Append that new element to furthestBlock.

18. Remove formattingElement from the list of active formatting elements, and insert the new element into the list of active formatting elements at the position of the aforementioned bookmark.

19. Remove formattingElement from the stack of open elements, and insert the new element into the stack of open elements immediately below the position of furthestBlock in that stack.

---

**Note**

This algorithm's name, the "adoption agency algorithm", comes from the way it causes elements to change parents, and is in contrast with other possible algorithms for dealing with misnested content.

### 13.2.6.4.8 The "text" insertion mode

When the user agent is to apply the rules for the "text insertion mode", the user agent must handle the token as follows:

- **A character token**
  
  Insert the token's character.

- **An end-of-file token**
  
  Parse error.

  If the current node is a script element, then set its already started to true.

  Pop the current node off the stack of open elements.

  Switch the insertion mode to the original insertion mode and reprocess the token.

- **An end tag whose tag name is "script"**
  
  If the active speculative HTML parser is null and the JavaScript execution context stack is empty, then perform a microtask checkpoint.

  Let script be the current node (which will be a script element).

  Pop the current node off the stack of open elements.

  Switch the insertion mode to the original insertion mode.

---

This can never be a U+0000 NULL character; the tokenizer converts those to U+FFFD REPLACEMENT CHARACTER characters.
Let the old insertion point have the same value as the current insertion point. Let the insertion point be just before the next input character.

Increment the parser's script nesting level by one.

If the active speculative HTML parser is null, then prepare the script element script. This might cause some script to execute, which might cause new characters to be inserted into the tokenizer, and might cause the tokenizer to output more tokens, resulting in a reentrant invocation of the parser.

Decrement the parser's script nesting level by one. If the parser's script nesting level is zero, then set the parser pause flag to false.

Let the insertion point have the value of the old insertion point. (In other words, restore the insertion point to its previous value. This value might be the "undefined" value.)

At this stage, if the pending parsing-blocking script is not null, then:

1. If the script nesting level is not zero:
   Set the parser pause flag to true, and abort the processing of any nested invocations of the tokenizer, yielding control back to the caller. (Tokenization will resume when the caller returns to the "outer" tree construction stage.)

   Note
   
   The tree construction stage of this particular parser is being called reentrantly, say from a call to document.write().

2. Otherwise:
   While the pending parsing-blocking script is not null:
   
   1. Let the script be the pending parsing-blocking script.
   2. Set the pending parsing-blocking script to null.
   3. Start the speculative HTML parser for this instance of the HTML parser.
   4. Block the tokenizer such that the event loop will not run tasks that invoke the tokenizer.
   5. If the parser's Document has a style sheet that is blocking scripts or the script's ready to be parser-executed is false: spin the event loop until the parser's Document has no style sheet that is blocking scripts and the script's ready to be parser-executed becomes true.
   6. If this parser has been aborted in the meantime, return.

   Note
   
   This could happen if, e.g., while the spin the event loop algorithm is running, the Document gets destroyed, or the document.open() method gets invoked on the Document.

1. Stop the speculative HTML parser for this instance of the HTML parser.
2. Unblock the tokenizer for this instance of the HTML parser, such that tasks can again be run.
3. Let the insertion point be just before the next input character.
4. Increment the parser's script nesting level by one (it should be zero before this step, so this sets it to one).
5. Execute the script element the script.
6. Decrement the parser's script nesting level by one. If the parser's script nesting level is zero (which it always should be at this point), then set the parser pause flag to false.
7. Let the insertion point be undefined again.

Any other end tag

Pop the current node off the stack of open elements.
Switch the insertion mode to the original insertion mode.

13.2.6.9 The "in table" insertion mode

When the user agent is to apply the rules for the "in table" insertion mode, the user agent must handle the token as follows:

↓ A character token, if the current node is table, tbody, template, tfoot, thead, or tr element

Let the pending table character tokens be an empty list of tokens.

Let the original insertion mode be the current insertion mode.

Switch the insertion mode to "in table text" and reprocess the token.

↓ A comment token

Insert a comment.

↓ A DOCTYPE token

Parse error. Ignore the token.

↓ A start tag whose tag name is "caption"

Clear the stack back to a table context. (See below.)

Insert a marker at the end of the list of active formatting elements.

Insert an HTML element for the token, then switch the insertion mode to "in caption".

↓ A start tag whose tag name is "colgroup"

Clear the stack back to a table context. (See below.)

Insert an HTML element for the token, then switch the insertion mode to "in column group".

↓ A start tag whose tag name is "col"

Clear the stack back to a table context. (See below.)

Insert an HTML element for a "colgroup" start tag token with no attributes, then switch the insertion mode to "in column group".

Reprocess the current token.

↓ A start tag whose tag name is one of: "tbody", "tfoot", "thead"

Clear the stack back to a table context. (See below.)

Insert an HTML element for the token, then switch the insertion mode to "in table body".

↓ A start tag whose tag name is one of: "td", "th", "tr"

Clear the stack back to a table context. (See below.)

Insert an HTML element for a “tbody” start tag token with no attributes, then switch the insertion mode to "in table body".

Reprocess the current token.

↓ A start tag whose tag name is "table"

Parse error.

If the stack of open elements does not have a table element in table scope, ignore the token.

Otherwise:

Pop elements from this stack until a table element has been popped from the stack.

Reset the insertion mode appropriately.
Reprocess the token.

- An end tag whose tag name is “table”
  If the stack of open elements does not have a table element in table scope, this is a parse error. Ignore the token.

  Otherwise:

  Pop elements from this stack until a table element has been popped from the stack.

  Reset the insertion mode appropriately.

- An end tag whose tag name is one of: "body", "caption", "col", "colgroup", "html", "tbody", "td", "tfoot", "th", "thead", "tr"

  Parse error. Ignore the token.

- A start tag whose tag name is one of: "style", "script", "template"

- An end tag whose tag name is “template”

  Process the token using the rules for the “in head” insertion mode.

- A start tag whose tag name is “input”

  If the token does not have an attribute with the name "type", or if it does, but that attribute's value is not an ASCII case-insensitive match for the string "hidden", then: act as described in the “anything else” entry below.

  Otherwise:

  Parse error. Insert an HTML element for the token.

  Pop that input element off the stack of open elements.

  Acknowledge the token’s self-closing flag, if it is set.

- A start tag whose tag name is “form”

  Parse error. If there is a template element on the stack of open elements, or if the form element pointer is not null, ignore the token.

  Otherwise:

  Insert an HTML element for the token, and set the form element pointer to point to the element created.

  Pop that form element off the stack of open elements.

- An end-of-file token

  Process the token using the rules for the “in body” insertion mode.

- Anything else

  Parse error. Enable foster parenting, process the token using the rules for the “in body” insertion mode, and then disable foster parenting.

When the steps above require the UA to clear the stack back to a table context, it means that the UA must, while the current node is not a table, template, or html element, pop elements from the stack of open elements.

Note

This is the same list of elements as used in the has an element in table scope steps.

Note

The current node being an html element after this process is a fragment case.
13.2.6.4.10 The "in table text" insertion mode

When the user agent is to apply the rules for the "in table text" insertion mode, the user agent must handle the token as follows:

↪ A character token that is U+0000 NULL
   Parse error. Ignore the token.

↪ Any other character token
   Append the character token to the pending table character tokens list.

↪ Anything else
   If any of the tokens in the pending table character tokens list are character tokens that are not ASCII whitespace, then this is a parse error: reprocess the character tokens in the pending table character tokens list using the rules given in the "anything else" entry in the "in table" insertion mode.

   Otherwise, insert the characters given by the pending table character tokens list.

   Switch the insertion mode to the original insertion mode and reprocess the token.

13.2.6.4.11 The "in caption" insertion mode

When the user agent is to apply the rules for the "in caption" insertion mode, the user agent must handle the token as follows:

↪ An end tag whose tag name is "caption"
   If the stack of open elements does not have a caption element in table scope, this is a parse error; ignore the token. (fragment case)

   Otherwise:
   Generate implied end tags.

   Now, if the current node is not a caption element, then this is a parse error.

   Pop elements from this stack until a caption element has been popped from the stack.

   Clear the list of active formatting elements up to the last marker.

   Switch the insertion mode to "in table".

↪ A start tag whose tag name is one of: "caption", "col", "colgroup", "tbody", "td", "tfoot", "th", "thead", "tr"

↪ An end tag whose tag name is "table"
   If the stack of open elements does not have a caption element in table scope, this is a parse error; ignore the token. (fragment case)

   Otherwise:
   Generate implied end tags.

   Now, if the current node is not a caption element, then this is a parse error.

   Pop elements from this stack until a caption element has been popped from the stack.

   Clear the list of active formatting elements up to the last marker.

   Switch the insertion mode to "in table".

   Reprocess the token.

↪ An end tag whose tag name is one of: "body", "col", "colgroup", "html", "tbody", "td", "tfoot", "th", "thead", "tr" Parse error. Ignore the token.
Anything else

Process the token using the rules for the "in body" insertion mode.

13.2.6.4.12 The "in column group" insertion mode

When the user agent is to apply the rules for the "in column group" insertion mode, the user agent must handle the token as follows:

- A character token that is one of U+0009 CHARACTER TABULATION, U+000A LINE FEED (LF), U+000C FORM FEED (FF), U+000D CARRIAGE RETURN (CR), or U+0020 SPACE
  
  Insert the character.

- A comment token
  
  Insert a comment.

- A DOCTYPE token
  
  Parse error. Ignore the token.

- A start tag whose tag name is "html"
  
  Process the token using the rules for the "in body" insertion mode.

- A start tag whose tag name is "col"
  
  Insert an HTML element for the token. Immediately pop the current node off the stack of open elements.

  Acknowledge the token's self-closing flag, if it is set.

- An end tag whose tag name is "colgroup"
  
  If the current node is not a colgroup element, then this is a parse error; ignore the token.

  Otherwise, pop the current node from the stack of open elements. Switch the insertion mode to "in table".

- An end tag whose tag name is "col"
  
  Parse error. Ignore the token.

- A start tag whose tag name is "template"

- An end tag whose tag name is "template"
  
  Process the token using the rules for the "in head" insertion mode.

- An end-of-file token
  
  Process the token using the rules for the "in body" insertion mode.

- Anything else
  
  If the current node is not a colgroup element, then this is a parse error; ignore the token.

  Otherwise, pop the current node from the stack of open elements.

  Switch the insertion mode to "in table".

  Reprocess the token.

13.2.6.4.13 The "in table body" insertion mode

When the user agent is to apply the rules for the "in table body" insertion mode, the user agent must handle the token as follows:

- A start tag whose tag name is "tr"
  
  Clear the stack back to a table body context. (See below.)

  Insert an HTML element for the token, then switch the insertion mode to "in row".
A start tag whose tag name is one of: "th", "td"

Parse error

Clear the stack back to a table body context (See below.)

Insert an HTML element for a "tr" start tag token with no attributes, then switch the insertion mode to "in row".

Reprocess the current token.

An end tag whose tag name is one of: "tbody", "tfoot", "thead"

If the stack of open elements does not have an element in table scope that is an HTML element with the same tag name as the token, this is a parse error; ignore the token.

Otherwise:

Clear the stack back to a table body context. (See below.)

Pop the current node from the stack of open elements. Switch the insertion mode to "in table".

Reprocess the token.

An end tag whose tag name is one of: "caption", "col", "colgroup", "tbody", "tfoot", "thead"

An end tag whose tag name is "table"

If the stack of open elements does not have a tbody, thead, or tfoot element in table scope, this is a parse error; ignore the token.

Otherwise:

Clear the stack back to a table body context. (See below.)

Pop the current node from the stack of open elements. Switch the insertion mode to "in table".

Reprocess the token.

A start tag whose tag name is one of: "body", "caption", "col", "colgroup", "html", "td", "th", "tr"

Parse error. Ignore the token.

Anything else

Process the token using the rules for the "in table" insertion mode.

When the steps above require the UA to clear the stack back to a table body context, it means that the UA must, while the current node is not a tbody, tfoot, thead, template, or html element, pop elements from the stack of open elements.

The current node being an html element after this process is a fragment case.

13.2.6.4.14 The "in row" insertion mode

When the user agent is to apply the rules for the "in row" insertion mode, the user agent must handle the token as follows:

A start tag whose tag name is one of: "th", "td"

Clear the stack back to a table row context. (See below.)

Insert an HTML element for the token, then switch the insertion mode to "in cell".

Insert a marker at the end of the list of active formatting elements.

An end tag whose tag name is "tr"

If the stack of open elements does not have a tr element in table scope, this is a parse error; ignore the token.

Otherwise:
Clear the stack back to a table row context. (See below.)

Pop the current node (which will be a tr element) from the stack of open elements. Switch the insertion mode to "in table body".

→ A start tag whose tag name is one of: "caption", "col", "colgroup", "tbody", "tfoot", "thead", "tr"

→ An end tag whose tag name is "table"

If the stack of open elements does not have a tr element in table scope, this is a parse error; ignore the token.

Otherwise:

Clear the stack back to a table row context. (See below.)

Pop the current node (which will be a tr element) from the stack of open elements. Switch the insertion mode to "in table body".

Reprocess the token.

→ An end tag whose tag name is one of: "tbody", "tfoot", "thead"

If the stack of open elements does not have an element in table scope that is an HTML element with the same tag name as the token, this is a parse error; ignore the token.

If the stack of open elements does not have a tr element in table scope, ignore the token.

Otherwise:

Clear the stack back to a table row context. (See below.)

Pop the current node (which will be a tr element) from the stack of open elements. Switch the insertion mode to "in table body".

Reprocess the token.

→ An end tag whose tag name is one of: "body", "caption", "col", "colgroup", "html", "td", "th"

Parse error. Ignore the token.

→ Anything else

Process the token using the rules for the "in table" insertion mode.

When the steps above require the UA to clear the stack back to a table row context, it means that the UA must, while the current node is not a tr, template, or html element, pop elements from the stack of open elements.

The current node being an html element after this process is a fragment case.

13.2.6.4.15 The "in cell" insertion mode

When the user agent is to apply the rules for the "in cell" insertion mode, the user agent must handle the token as follows:

→ An end tag whose tag name is one of: "td", "th"

If the stack of open elements does not have an element in table scope that is an HTML element with the same tag name as that of the token, then this is a parse error; ignore the token.

Otherwise:

Generate implied end tags.

Now, if the current node is not an HTML element with the same tag name as the token, then this is a parse error.

Pop elements from the stack of open elements stack until an HTML element with the same tag name as the token has been popped from the stack.
Clear the list of active formatting elements up to the last marker.  

Switch the insertion mode to “in row”.

- A start tag whose tag name is one of: "caption", "col", "colgroup", "tbody", "td", "tfoot", "th", "thead", "tr" 
  Assert: The stack of open elements has a td or th element in table scope.

  Close the cell (see below) and reprocess the token.

- An end tag whose tag name is one of: "body", "caption", "col", "colgroup", "html"
  Parse error. Ignore the token.

- An end tag whose tag name is one of: "table", "tbody", "tfoot", "thead", "tr" 
  If the stack of open elements does not have an element in table scope that is an HTML element with the same tag name as that of the token, then this is a parse error; ignore the token.

  Otherwise, close the cell (see below) and reprocess the token.

- Anything else 
  Process the token using the rules for the "in body" insertion mode.

Where the steps above say to close the cell, they mean to run the following algorithm:

1. Generate implied end tags.
2. If the current node is not now a td element or a th element, then this is a parse error.
3. Pop elements from the stack of open elements stack until a td element or a th element has been popped from the stack.
4. Clear the list of active formatting elements up to the last marker.
5. Switch the insertion mode to “in row”.

Note: The stack of open elements cannot have both a td and a th element in table scope at the same time, nor can it have neither when the close the cell algorithm is invoked.

13.2.6.4.16 The "in select" insertion mode

When the user agent is to apply the rules for the "in select" insertion mode, the user agent must handle the token as follows:

- A character token that is U+0000 NULL 
  Parse error. Ignore the token.

- Any other character token 
  Insert the token's character.

- A comment token 
  Insert a comment.

- A DOCTYPE token 
  Parse error. Ignore the token.

- A start tag whose tag name is "html" 
  Process the token using the rules for the "in body" insertion mode.

- A start tag whose tag name is "option" 
  If the current node is an option element, pop that node from the stack of open elements.

  Insert an HTML element for the token.
A start tag whose tag name is "optgroup"
If the current node is an option element, pop that node from the stack of open elements.
If the current node is an optgroup element, pop that node from the stack of open elements.
Insert an HTML element for the token.

A start tag whose tag name is "hr"
If the current node is an option element, pop that node from the stack of open elements.
If the current node is an optgroup element, pop that node from the stack of open elements.
Insert an HTML element for the token. Immediately pop the current node off the stack of open elements.
Acknowledge the token's self-closing flag, if it is set.

A end tag whose tag name is "optgroup"
First, if the current node is an option element, and the node immediately before it in the stack of open elements is an optgroup element, then pop the current node from the stack of open elements.
If the current node is an optgroup element, then pop that node from the stack of open elements. Otherwise, this is a parse error; ignore the token.

A end tag whose tag name is "option"
If the current node is an option element, then pop that node from the stack of open elements. Otherwise, this is a parse error; ignore the token.

A end tag whose tag name is "select"
If the stack of open elements does not have a select element in select scope, this is a parse error; ignore the token. (fragment case)
Otherwise:
Pop elements from the stack of open elements until a select element has been popped from the stack.
Reset the insertion mode appropriately.

A start tag whose tag name is "select"
Parse error.
If the stack of open elements does not have a select element in select scope, ignore the token. (fragment case)
Otherwise:
Pop elements from the stack of open elements until a select element has been popped from the stack.
Reset the insertion mode appropriately.

Note: It just gets treated like an end tag.

A start tag whose tag name is one of: "input", "keygen", "textarea"
Parse error.
If the stack of open elements does not have a select element in select scope, ignore the token. (fragment case)
Otherwise:
Pop elements from the stack of open elements until a select element has been popped from the stack.
Reset the insertion mode appropriately.

Reprocess the token.
A start tag whose tag name is one of: "script", "template"

An end tag whose tag name is "template"

Process the token using the rules for the "in head" insertion mode.

An end-of-file token

Process the token using the rules for the "in body" insertion mode.

Anything else

Parse error. Ignore the token.

13.2.6.4.17 The "in select in table" insertion mode

When the user agent is to apply the rules for the "in select in table" insertion mode, the user agent must handle the token as follows:

A start tag whose tag name is one of: "caption", "table", "tbody", "tfoot", "thead", "tr", "td", "th"

Parse error.

Pop elements from the stack of open elements until a select element has been popped from the stack.

Reset the insertion mode appropriately.

Reprocess the token.

An end tag whose tag name is one of: "caption", "table", "tbody", "tfoot", "thead", "tr", "td", "th"

Parse error.

If the stack of open elements does not have an element in table scope that is an HTML element with the same tag name as that of the token, then ignore the token.

Otherwise:

Pop elements from the stack of open elements until a select element has been popped from the stack.

Reset the insertion mode appropriately.

Reprocess the token.

Anything else

Process the token using the rules for the "in select" insertion mode.

13.2.6.4.18 The "in template" insertion mode

When the user agent is to apply the rules for the "in template" insertion mode, the user agent must handle the token as follows:

A character token

A comment token

A DOCTYPE token

Process the token using the rules for the "in body" insertion mode.

A start tag whose tag name is one of: "base", "basefont", "bgsound", "link", "meta", "noframes", "script", "style", "template", "title"

An end tag whose tag name is "template"

Process the token using the rules for the "in head" insertion mode.

A start tag whose tag name is one of: "caption", "colgroup", "tbody", "tfoot", "thead"

Pop the current template insertion mode off the stack of template insertion modes.
Push "in table" onto the stack of template insertion modes so that it is the new current template insertion mode.

Switch the insertion mode to "in table", and reprocess the token.

↪ A start tag whose tag name is "col"

Pop the current template insertion mode off the stack of template insertion modes.

Push "in column group" onto the stack of template insertion modes so that it is the new current template insertion mode.

Switch the insertion mode to "in column group", and reprocess the token.

↪ A start tag whose tag name is "tr"

Pop the current template insertion mode off the stack of template insertion modes.

Push "in table body" onto the stack of template insertion modes so that it is the new current template insertion mode.

Switch the insertion mode to "in table body", and reprocess the token.

↪ A start tag whose tag name is one of: "td", "th"

Pop the current template insertion mode off the stack of template insertion modes.

Push "in row" onto the stack of template insertion modes so that it is the new current template insertion mode.

Switch the insertion mode to "in row", and reprocess the token.

↪ Any other start tag

Pop the current template insertion mode off the stack of template insertion modes.

Push "in body" onto the stack of template insertion modes so that it is the new current template insertion mode.

Switch the insertion mode to "in body", and reprocess the token.

↪ Any other end tag

Parse error. Ignore the token.

↪ An end-of-file token

If there is no template element on the stack of open elements, then stop parsing. (Fragment case)

Otherwise, this is a parse error.

Pop elements from the stack of open elements until a template element has been popped from the stack.

Clear the list of active formatting elements up to the last marker.

Pop the current template insertion mode off the stack of template insertion modes.

Reset the insertion mode appropriately.

Reprocess the token.

13.2.6.4.19 The "after body" insertion mode

When the user agent is to apply the rules for the "after body" insertion mode, the user agent must handle the token as follows:

↪ A character token that is one of U+0009 CHARACTER TABULATION, U+000A LINE FEED (LF), U+000C FORM FEED (FF), U+000D CARRIAGE RETURN (CR), or U+0020 SPACE

Process the token using the rules for the "in body" insertion mode.

↪ A comment token

Insert a comment as the last child of the first element in the stack of open elements (the html element).
A DOCTYPE token
   Parse error. Ignore the token.

A start tag whose tag name is "html"
   Process the token using the rules for the "in body" insertion mode.

An end tag whose tag name is "html"
   If the parser was created as part of the HTML fragment parsing algorithm, this is a parse error; ignore the token.
   Otherwise, switch the insertion mode to "after after body".

An end-of-file token
   Stop parsing.

Anything else
   Parse error. Switch the insertion mode to "in body" and reprocess the token.

13.2.6.4.20 The "in frameset" insertion mode

When the user agent is to apply the rules for the "in frameset" insertion mode, the user agent must handle the token as follows:

A character token that is one of U+0009 CHARACTER TABULATION, U+000A LINE FEED (LF), U+000C FORM FEED (FF), U+000D CARRIAGE RETURN (CR), or U+0020 SPACE
   Insert the character.

A comment token
   Insert a comment.

A DOCTYPE token
   Parse error. Ignore the token.

A start tag whose tag name is "html"
   Process the token using the rules for the "in body" insertion mode.

A start tag whose tag name is "frameset"
   Insert an HTML element for the token.

An end tag whose tag name is "frameset"
   If the current node is the root html element, then this is a parse error; ignore the token.
   Otherwise, pop the current node from the stack of open elements.
   If the parser was not created as part of the HTML fragment parsing algorithm (fragment case), and the current node is no longer a frameset element, then switch the insertion mode to "after frameset".

A start tag whose tag name is "frame"
   Insert an HTML element for the token. Immediately pop the current node off the stack of open elements.
   Acknowledge the token's self-closing flag, if it is set.

A start tag whose tag name is "noframes"
   Process the token using the rules for the "in head" insertion mode.

An end-of-file token
   If the current node is not the root html element, then this is a parse error.

Note
   The current node can only be the root html element in the fragment case.
When the user agent is to apply the rules for the "after frameset" insertion mode, the user agent must handle the token as follows:

↪ A character token that is one of U+0009 CHARACTER TABULATION, U+000A LINE FEED (LF), U+000C FORM FEED (FF), U+000D CARRIAGE RETURN (CR), or U+0020 SPACE
  Insert the character.

↪ A comment token
  Insert a comment.

↪ A DOCTYPE token
  Parse error. Ignore the token.

↪ A start tag whose tag name is "html"
  Process the token using the rules for the "in body" insertion mode.

↪ An end tag whose tag name is "html"
  Switch the insertion mode to "after after frameset".

↪ A start tag whose tag name is "noframes"
  Process the token using the rules for the "in head" insertion mode.

↪ An end-of-file token
  Stop parsing.

↪ Anything else
  Parse error. Ignore the token.

When the user agent is to apply the rules for the "after after body" insertion mode, the user agent must handle the token as follows:

↪ A comment token
  Insert a comment as the last child of the Document object.

↪ A DOCTYPE token
  A character token that is one of U+0009 CHARACTER TABULATION, U+000A LINE FEED (LF), U+000C FORM FEED (FF), U+000D CARRIAGE RETURN (CR), or U+0020 SPACE
  Process the token using the rules for the "in body" insertion mode.

↪ A start tag whose tag name is "html"
  Process the token using the rules for the "in body" insertion mode.

↪ An end-of-file token
  Stop parsing.

↪ Anything else
  Parse error. Switch the insertion mode to "in body" and reprocess the token.
13.2.6.4.23 The "after after frameset" insertion mode

When the user agent is to apply the rules for the "after after frameset" insertion mode, the user agent must handle the token as follows:

↪ A comment token
   Insert a comment as the last child of the Document object.

↪ A DOCTYPE token
   A character token that is one of U+0009 CHARACTER TABULATION, U+000A LINE FEED (LF), U+000C FORM FEED (FF), U+000D CARRIAGE RETURN (CR), or U+0020 SPACE
   A start tag whose tag name is "html"
      Process the token using the rules for the "in body" insertion mode.
   An end-of-file token
      Stop parsing.
   A start tag whose tag name is "noframes"
      Process the token using the rules for the "in head" insertion mode.
   Anything else
      Parse error. Ignore the token.

13.2.6.5 The rules for parsing tokens in foreign content

When the user agent is to apply the rules for parsing tokens in foreign content, the user agent must handle the token as follows:

↪ A character token that is U+0000 NULL
   Parse error. Insert a U+FFFD REPLACEMENT CHARACTER character.

↪ A character token that is one of U+0009 CHARACTER TABULATION, U+000A LINE FEED (LF), U+000C FORM FEED (FF), U+000D CARRIAGE RETURN (CR), or U+0020 SPACE
   Insert the token's character.
↪ Any other character token
   Insert the token's character.
↪ Any other start tag
   If the adjusted current node is an element in the MathML namespace, adjust MathML attributes for the token. (This fixes 13.2.6.4.23 The "after after frameset" insertion mode §137 137 §p13
13.2.6.5 The rules for parsing tokens in foreign content §137 §p13
37
1337
If the **adjusted current node**\(^{1268}\) is an element in the **SVG namespace**, and the token's tag name is one of the ones in the first column of the following table, change the tag name to the name given in the corresponding cell in the second column. (This fixes the case of SVG elements that are not all lowercase.)

<table>
<thead>
<tr>
<th>Tag name</th>
<th>Element name</th>
</tr>
</thead>
<tbody>
<tr>
<td>altglyph</td>
<td>altGlyph</td>
</tr>
<tr>
<td>altglyphdef</td>
<td>altGlyphDef</td>
</tr>
<tr>
<td>altglyphitem</td>
<td>altGlyphItem</td>
</tr>
<tr>
<td>animatecolor</td>
<td>animateColor</td>
</tr>
<tr>
<td>animatemotion</td>
<td>animateMotion</td>
</tr>
<tr>
<td>animatetransform</td>
<td>animateTransform</td>
</tr>
<tr>
<td>clippath</td>
<td>clipPath</td>
</tr>
<tr>
<td>teblend</td>
<td>feBlend</td>
</tr>
<tr>
<td>fecolormatrix</td>
<td>feColorMatrix</td>
</tr>
<tr>
<td>fecomponenttransfer</td>
<td>feComponentTransfer</td>
</tr>
<tr>
<td>fecomposite</td>
<td>feComposite</td>
</tr>
<tr>
<td>feconvolvematrix</td>
<td>feConvolveMatrix</td>
</tr>
<tr>
<td>fediffuselighting</td>
<td>feDiffuseLighting</td>
</tr>
<tr>
<td>fedisplacementmap</td>
<td>feDisplacementMap</td>
</tr>
<tr>
<td>fedistantlight</td>
<td>feDistantLight</td>
</tr>
<tr>
<td>fedropshadow</td>
<td>feDropShadow</td>
</tr>
<tr>
<td>reflood</td>
<td>feFlood</td>
</tr>
<tr>
<td>efunca</td>
<td>feFuncA</td>
</tr>
<tr>
<td>efuncb</td>
<td>feFuncB</td>
</tr>
<tr>
<td>efuncg</td>
<td>feFuncG</td>
</tr>
<tr>
<td>efunrc</td>
<td>feFuncR</td>
</tr>
<tr>
<td>fegaussianblur</td>
<td>feGaussianBlur</td>
</tr>
<tr>
<td>featimage</td>
<td>feImage</td>
</tr>
<tr>
<td>femerge</td>
<td>feMerge</td>
</tr>
<tr>
<td>femergenode</td>
<td>feMergeNode</td>
</tr>
<tr>
<td>femorphology</td>
<td>feMorphology</td>
</tr>
<tr>
<td>feoffset</td>
<td>feOffset</td>
</tr>
<tr>
<td>fepointlight</td>
<td>fePointLight</td>
</tr>
<tr>
<td>fespecularlighting</td>
<td>feSpecularLighting</td>
</tr>
<tr>
<td>fespotlight</td>
<td>feSpotLight</td>
</tr>
<tr>
<td>fetile</td>
<td>feTile</td>
</tr>
<tr>
<td>feturbulence</td>
<td>feTurbulence</td>
</tr>
<tr>
<td>foreignobject</td>
<td>foreignObject</td>
</tr>
<tr>
<td>linGradient</td>
<td>linearGradient</td>
</tr>
<tr>
<td>radialGradient</td>
<td>radialGradient</td>
</tr>
<tr>
<td>textpath</td>
<td>textPath</td>
</tr>
</tbody>
</table>

If the **adjusted current node**\(^{1268}\) is an element in the **SVG namespace**, **adjust SVG attributes**\(^{1303}\) for the token. (This fixes the case of SVG attributes that are not all lowercase.)

**Adjust foreign attributes**\(^{1304}\) for the token. (This fixes the use of namespaced attributes, in particular XLink in SVG.)

**Insert a foreign element**\(^{1302}\) for the token, with **adjusted current node**\(^{1268}\) is namespace and false.

If the token has its **self-closing flag**\(^{1271}\) set, then run the appropriate steps from the following list:

1. **If the token’s tag name is "script", and the new current node is in the SVG namespace**
   
   Acknowledge the token’s **self-closing flag**\(^{1271}\), and then act as described in the steps for a "script" end tag below.

2. **Otherwise**
   
   Pop the **current node**\(^{1267}\) off the **stack of open elements**\(^{1267}\) and **acknowledge the token’s self-closing flag**\(^{1271}\).
An end tag whose tag name is “script”, if the current node is an SVG script element
Pop the current node off the stack of open elements.

Let the old insertion point have the same value as the current insertion point. Let the insertion point be just before the next input character.

Increment the parser's script nesting level by one. Set the parser pause flag to true.

If the active speculative HTML parser is null and the user agent supports SVG, then Process the SVG script element according to the SVG rules.

[SVG]

Decrement the parser's script nesting level by one. If the parser's script nesting level is zero, then set the parser pause flag to false.

Let the insertion point have the value of the old insertion point. (In other words, restore the insertion point to its previous value. This value might be the "undefined" value.)

Any other end tag
Run these steps:

1. Initialize node to be the current node (the bottommost node of the stack).
2. If node’s tag name, converted to ASCII lowercase, is not the same as the tag name of the token, then this is a parse error.
3. Loop: If node is the topmost element in the stack of open elements, then return. (fragment case)
4. If node’s tag name, converted to ASCII lowercase, is the same as the tag name of the token, pop elements from the stack of open elements until node has been popped from the stack, and then return.
5. Set node to the previous entry in the stack of open elements.
6. If node is not an element in the HTML namespace, return to the step labeled loop.
7. Otherwise, process the token according to the rules given in the section corresponding to the current insertion mode in HTML content.

13.2.7 The end
Once the user agent stops parsing the document, the user agent must run the following steps:

1. If the active speculative HTML parser is not null, then stop the speculative HTML parser and return.
2. Set the insertion point to undefined.
3. Update the current document readiness to "interactive".
4. Pop all the nodes off the stack of open elements.
5. While the list of scripts that will execute when the document has finished parsing is not empty:
   1. Spin the event loop until the first script in the list of scripts that will execute when the document has finished parsing has its ready to be parser-executed set to true and the parser's Document has no style sheet that is blocking scripts.
   2. Execute the script element given by the first script in the list of scripts that will execute when the document has finished parsing.
   3. Remove the first script element from the list of scripts that will execute when the document has finished parsing.
6. **Queue a global task**\(^{(659)}\) on the **DOM manipulation task source**\(^{(1115)}\) given the **Document**\(^{(1128)}\)'s **relevant global object**\(^{(1071)}\) to run the following substeps:

   1. **Set the Document**\(^{(1128)}\)'s **load timing info**\(^{(1132)}\)'s **DOM content loaded event start time**\(^{(1132)}\) to the **current high resolution time** given the **Document**\(^{(1128)}\)'s **relevant global object**\(^{(1071)}\).
   2. **Fire an event** named **DOMContentLoaded**\(^{(1145)}\) at the **Document**\(^{(1128)}\) object, with its **bubbles** attribute initialized to true.
   3. **Set the Document**\(^{(1128)}\)'s **load timing info**\(^{(1132)}\)'s **DOM content loaded event end time**\(^{(1132)}\) to the **current high resolution time** given the **Document**\(^{(1128)}\)'s **relevant global object**\(^{(1071)}\).
   4. **Enable the client message queue** of the **ServiceWorkerContainer** object whose associated **service worker client** is the **Document**\(^{(1128)}\)'s **relevant settings object**\(^{(1071)}\).
   5. **Invoke WebDriver BiDi DOM content loaded** with the **Document**\(^{(1128)}\)'s **browsing context**\(^{(988)}\), and a new **WebDriver BiDi navigation status** whose **id** is the **Document**\(^{(1128)}\) object's **during-loading navigation ID for WebDriver BiDi**\(^{(1129)}\), **status** is "pending", and **url** is the **Document**\(^{(1128)}\) object's **URL**.

7. **Spin the event loop**\(^{(1111)}\) until the **set of scripts that will execute as soon as possible**\(^{(659)}\) and the **list of scripts that will execute in order as soon as possible**\(^{(659)}\) are empty.

8. **Spin the event loop**\(^{(1111)}\) until there is nothing that **delays the load event** in the **Document**\(^{(1128)}\).

9. **Queue a global task**\(^{(659)}\) on the **DOM manipulation task source**\(^{(1115)}\) given the **Document**\(^{(1128)}\)'s **relevant global object**\(^{(1071)}\) to run the following steps:

   1. **Update the current document readiness**\(^{(1132)}\) to "complete".
   2. If the **Document**\(^{(1128)}\) object's **browsing context**\(^{(988)}\) is null, then abort these steps.
   3. Let **window** be the **Document**\(^{(1128)}\)'s **relevant global object**\(^{(1071)}\).
   4. **Set the Document**\(^{(1128)}\)'s **load timing info**\(^{(1132)}\)'s **load event start time**\(^{(1132)}\) to the **current high resolution time** given **window**.
   5. **Fire an event** named **load**\(^{(1145)}\) at **window**, with legacy target override flag set.
   6. **Invoke WebDriver BiDi load complete** with the **Document**\(^{(1128)}\)'s **browsing context**\(^{(988)}\), and a new **WebDriver BiDi navigation status** whose **id** is the **Document**\(^{(1128)}\) object's **during-loading navigation ID for WebDriver BiDi**\(^{(1129)}\), **status** is "complete", and **url** is the **Document**\(^{(1128)}\) object's **URL**.
   7. **Set the Document**\(^{(1128)}\) object's **during-loading navigation ID for WebDriver BiDi**\(^{(1129)}\) to null.
   8. **Set the Document**\(^{(1128)}\)'s **load timing info**\(^{(1132)}\)'s **load event end time**\(^{(1132)}\) to the **current high resolution time** given **window**.
   9. **Assert**: **Document**\(^{(1128)}\)'s **page showing**\(^{(1052)}\) is false.
   10. **Set the Document**\(^{(1128)}\)'s **page showing**\(^{(1052)}\) flag to true.
   11. **Fire a page transition event**\(^{(974)}\) named **pageshow**\(^{(1145)}\) at **window** with false.
   12. **Completely finish loading**\(^{(1052)}\) the **Document**\(^{(1128)}\).
   13. **Queue the navigation timing entry** for the **Document**\(^{(1128)}\).

10. If the **Document**\(^{(1128)}\)'s **print when loaded**\(^{(1150)}\) flag is set, then run the **printing steps**\(^{(1150)}\).

11. The **Document**\(^{(1128)}\) is now ready for post-load tasks.

When the user agent is to **abort a parser**, it must run the following steps:

1. Throw away any pending content in the **input stream**\(^{(1126)}\), and discard any future content that would have been added to it.
2. **Stop the speculative HTML parser**\(^{(1132)}\) for this HTML parser.
3. Update the current document readiness to "interactive".
4. Pop all the nodes off the stack of open elements.
5. Update the current document readiness to "complete".

13.2.8 Speculative HTML parsing

User agents may implement an optimization, as described in this section, to speculatively fetch resources that are declared in the HTML markup while the HTML parser is waiting for a pending parsing-blocking script to be fetched and executed, or during normal parsing, at the time an element is created for a token. While this optimization is not defined in precise detail, there are some rules to consider for interoperability.

Each HTML parser can have an active speculative HTML parser. It is initially null.

The speculative HTML parser must act like the normal HTML parser (e.g., the tree builder rules apply), with some exceptions:

- The state of the normal HTML parser and the document itself must not be affected.

A speculative fetch for a speculative mock element element must follow these rules:

- If the speculative HTML parser encounters one of the following elements, then act as if that element is processed for the purpose of its effect of subsequent speculative fetches.
  - A base element.
  - A meta element whose http-equiv attribute is in the Content security policy state.
  - A meta element whose name attribute is an ASCII case-insensitive match for "referrer".
  - A meta element whose name attribute is an ASCII case-insensitive match for "viewport". (This can affect whether a media query list matches the environment.)

- Let url be the URL that element would fetch if it was processed normally. If there is no such URL or if it is the empty string, then do nothing. Otherwise, if url is already in the list of speculative fetch URLs, then do nothing. Otherwise, fetch url as if the element was processed normally, and add url to the list of speculative fetch URLs.

Each Document has a list of speculative fetch URLs, which is a list of URLs, initially empty.

To start the speculative HTML parser for an instance of an HTML parser:

1. Optionally, return.

2. If parser's active speculative HTML parser is not null, then stop the speculative HTML parser for parser.

Note: This step allows user agents to opt out of speculative HTML parsing.
3. Let `speculativeParser` be a new speculative HTML parser\(^{1341}\), with the same state as `parser`.

4. Let `speculativeDoc` be a new isomorphic representation of `parser`'s Document\(^{128}\), where all elements are instead speculative mock elements\(^{1342}\). Let `speculativeParser` parse into `speculativeDoc`.

5. Set `parser`'s active speculative HTML parser\(^{1341}\) to `speculativeParser`.

6. In parallel\(^{44}\), run `speculativeParser` until it is stopped or until it reaches the end of its input stream\(^{1265}\).

To stop the speculative HTML parser for an instance of an HTML parser `parser`:

1. Let `speculativeParser` be `parser`'s active speculative HTML parser\(^{1341}\).

2. If `speculativeParser` is null, then return.

3. Throw away any pending content in `speculativeParser`'s input stream\(^{1265}\), and discard any future content that would have been added to it.

4. Set `parser`'s active speculative HTML parser\(^{1341}\) to null.

The speculative HTML parser\(^{1341}\) will create speculative mock elements\(^{1342}\) instead of normal elements. DOM operations that the tree builder normally does on elements are expected to work appropriately on speculative mock elements.

A speculative mock element is a struct with the following items:

- A string namespace, corresponding to an element's namespace.
- A string local name, corresponding to an element's local name.
- A list attribute list, corresponding to an element's attribute list.
- A list children, corresponding to an element's children.

To create a speculative mock element given a namespace, tagName, and attributes:

1. Let `element` be a new speculative mock element\(^{1342}\).

2. Set `element`'s namespace\(^{1342}\) to namespace.

3. Set `element`'s local name\(^{1342}\) to tagName.

4. Set `element`'s attribute list\(^{1342}\) to attributes.

5. Set `element`'s children\(^{1342}\) to a new empty list.

6. Optionally, perform a speculative fetch\(^{1341}\) for `element`.

7. Return `element`.

When the tree builder says to insert an element into a template element's template contents, if that is a speculative mock element\(^{1342}\), and the template element's template contents is not a ShadowRoot node, instead do nothing. URLs found speculatively inside non-declarative-shadow-root template elements might themselves be templates, and must not be speculatively fetched.

### 13.2.9 Coercing an HTML DOM into an infoset

When an application uses an HTML parser\(^{1252}\) in conjunction with an XML pipeline, it is possible that the constructed DOM is not compatible with the XML tool chain in certain subtle ways. For example, an XML toolchain might not be able to represent attributes with the name xmlns, since they conflict with the Namespaces in XML syntax. There is also some data that the HTML parser\(^{1252}\) generates that isn't included in the DOM itself. This section specifies some rules for handling these issues.
If the XML API being used doesn't support DOCTYPEs, the tool may drop DOCTYPEs altogether.

If the XML API doesn't support attributes in no namespace that are named "xmlns", attributes whose names start with "xmlns:", or attributes in the XMLNS namespace, then the tool may drop such attributes.

The tool may annotate the output with any namespace declarations required for proper operation.

If the XML API being used restricts the allowable characters in the local names of elements and attributes, then the tool may map all element and attribute local names that the API wouldn't support to a set of names that are allowed, by replacing any character that isn't supported with the uppercase letter U and the six digits of the character's code point when expressed in hexadecimal, using digits 0-9 and capital letters A-F as the symbols, in increasing numeric order.

Example
For example, the element name foo<bar, which can be output by the HTML parser, though it is neither a legal HTML element name nor a well-formed XML element name, would be converted into fooU00003Cbar, which is a well-formed XML element name (though it's still not legal in HTML by any means).

Example
As another example, consider the attribute xlink:href. Used on a MathML element, it becomes, after being adjusted, an attribute with a prefix "xlink" and a local name "href". However, used on an HTML element, it becomes an attribute with no prefix and the local name "xlink:href", which is not a valid NCName, and thus might not be accepted by an XML API. It could thus get converted, becoming "xlinkU00003Ahref".

Note
The resulting names from this conversion conveniently can't clash with any attribute generated by the HTML parser, since those are all either lowercase or those listed in the adjust foreign attributes algorithm's table.

If the XML API restricts comments from having two consecutive U+002D HYPHEN-MINUS characters (--), the tool may insert a single U+0020 SPACE character between any such offending characters.

If the XML API restricts comments from ending in a U+002D HYPHEN-MINUS character (-), the tool may insert a single U+0020 SPACE character at the end of such comments.

If the XML API restricts allowed characters in character data, attribute values, or comments, the tool may replace any U+000C FORM FEED (FF) character with a U+0020 SPACE character, and any other literal non-XML character with a U+FFFF REPLACEMENT CHARACTER.

If the tool has no way to convey out-of-band information, then the tool may drop the following information:

- Whether the document is set to no-quirks mode, limited-quirks mode, or quirks mode
- The association between form controls and forms that aren't their nearest form element ancestor (use of the form element pointer in the parser)
- The template contents of any template elements.

Note
The mutations allowed by this section apply after the HTML parser's rules have been applied. For example, a <a::> start tag will be closed by a </a::> end tag, and never by a </aU00003AU00003A> end tag, even if the user agent is using the rules above to then generate an actual element in the DOM with the name aU00003AU00003A for that start tag.

13.2.10 An introduction to error handling and strange cases in the parser

This section is non-normative.

This section examines some erroneous markup and discusses how the HTML parser handles these cases.
13.2.10.1 Misnested tags: `<b><i></b></i>`

This section is non-normative.

The most-often discussed example of erroneous markup is as follows:

```
<p>1<b>2</i>3</b>4</p>
```

The parsing of this markup is straightforward up to the "3". At this point, the DOM looks like this:

```
<html>
<head></head>
<body>
<p>1<b>2</i>3</b>4</p>
</body>
</html>
```

Here, the stack of open elements has five elements on it: `html`, `body`, `p`, `b`, and `i`. The list of active formatting elements just has two: `b` and `i`. The insertion mode is "in body".

Upon receiving the end tag token with the tag name "b", the adoption agency algorithm is invoked. This is a simple case, in that the formatting element is the `b` element, and there is no furthest block. Thus, the stack of open elements ends up with just three elements: `html`, `body`, and `p`, while the list of active formatting elements has just one: `i`. The DOM tree is unmodified at this point.

The next token is a character ("4"), triggers the reconstruction of the active formatting elements, in this case just the `i` element. A new `i` element is thus created for the "4" text node. After the end tag token for the "i" is also received, and the "5" text node is inserted, the DOM looks as follows:

```
<html>
<head></head>
<body>
<p>1<b>2</i>3</b>4</p>
</body>
</html>
```

13.2.10.2 Misnested tags: `<b><p></b></p>`

This section is non-normative.

A case similar to the previous one is the following:

```
<b>1<p>2</b>3</p></b>
```

Up to the "2" the parsing here is straightforward:
The interesting part is when the end tag token with the tag name "b" is parsed.

Before that token is seen, the stack of open elements has four elements on it: \texttt{html}, \texttt{body}, \texttt{b}, and \texttt{p}. The list of active formatting elements just has the one: \texttt{b}. The insertion mode is "in body".

Upon receiving the end tag token with the tag name "b", the adoption agency algorithm is invoked, as in the previous example. However, in this case, there is a furthest block, namely the \texttt{p} element. Thus, this time the adoption agency algorithm isn't skipped over.

The common ancestor is the \texttt{body} element. A conceptual "bookmark" marks the position of the \texttt{b} in the list of active formatting elements, but since that list has only one element in it, the bookmark won't have much effect.

As the algorithm progresses, node ends up set to the formatting element (\texttt{b}), and last node ends up set to the furthest block (\texttt{p}).

The last node gets appended (moved) to the common ancestor, so that the DOM looks like:

```
html
  head
    body
      b
        #text: 1
      p
        #text: 2
```

A new \texttt{b} element is created, and the children of the \texttt{p} element are moved to it:

```
html
  head
    body
      b
        #text: 1
      p
      \texttt{b}
        #text: 2
```

Finally, the new \texttt{b} element is appended to the \texttt{p} element, so that the DOM looks like:

```
html
  head
    body
      b
        #text: 1
      p
      b
        #text: 2
```

The \texttt{b} element is removed from the list of active formatting elements and the stack of open elements, so that when the "3" is parsed, it is appended to the \texttt{p} element:

```
html
  head
    body
      b
        #text: 1
      p
      b
        #text: 2
      \texttt{b}
        #text: 3
```
This section is non-normative.

Error handling in tables is, for historical reasons, especially strange. For example, consider the following markup:

```html
<table><b><tr><td>aaa</td></tr><bbb></tbody></table>ccc
```

The highlighted `b` element start tag is not allowed directly inside a table like that, and the parser handles this case by placing the element before the table. (This is called foster parenting.) This can be seen by examining the DOM tree as it stands just after the `table` element's start tag has been seen:

```
<html>  
<head>  
<body>  
<table>
```

...and then immediately after the `b` element start tag has been seen:

```
<html>  
<head>  
<body>  
 b  
<table>
```

At this point, the stack of open elements has on it the elements `html`, `body`, `table`, and `b` (in that order, despite the resulting DOM tree); the list of active formatting elements just has the `b` element in it; and the insertion mode is "in table".

The `tr` start tag causes the `b` element to be popped off the stack and a `tbody` start tag to be implied; the `tbody` and `tr` elements are then handled in a rather straight-forward manner, taking the parser through the "in table body" and "in row" insertion modes, after which the DOM looks as follows:

```
<html>  
<head>  
<body>  
<table>  
<tbody>  
<tr>
```

Here, the stack of open elements has on it the elements `html`, `body`, `tbody`, `table`, and `tr`; the list of active formatting elements still has the `b` element in it; and the insertion mode is "in row".

The `td` element start tag token, after putting a `td` element on the tree, puts a marker on the list of active formatting elements (it also switches to the "in cell" insertion mode).

```
html  
head  
body  
 b  
<table>
```

The marker means that when the "aaa" character tokens are seen, no `b` element is created to hold the resulting Text node:

```
html  
head  
body  
 b  
<table>
```

13.2.10.3 Unexpected markup in tables
The end tags are handled in a straight-forward manner; after handling them, the stack of open elements has on it the elements \texttt{html}, \texttt{body}, \texttt{table}, and \texttt{tbody}, the list of active formatting elements still has the \texttt{b} element in it (the marker having been removed by the "td" end tag token); and the insertion mode is "in table body".

Thus it is that the "bbb" character tokens are found. These trigger the "in table text" insertion mode to be used (with the original insertion mode set to "in table body"). The character tokens are collected, and when the next token (the \texttt{table} element end tag) is seen, they are processed as a group. Since they are not all spaces, they are handled as per the "anything else" rules in the "in table" insertion mode, which defer to the "in body" insertion mode but with foster parenting.

When the active formatting elements are reconstructed, a \texttt{b} element is created and foster parented, and then the "bbb" Text node is appended to it:

```
    html
     head
     body
      b
      b
      #text: bbb
     table
      tbody
      tr
       td
        #text: aaa
``` 

The stack of open elements has on it the elements \texttt{html}, \texttt{body}, \texttt{table}, \texttt{tbody}, and the new \texttt{b} (again, note that this doesn't match the resulting tree!); the list of active formatting elements has the new \texttt{b} element in it; and the insertion mode is still "in table body".

Had the character tokens been only ASCII whitespace instead of "bbb", then that ASCII whitespace would just be appended to the \texttt{tbody} element.

Finally, the \texttt{table} is closed by a "table" end tag. This pops all the nodes from the stack of open elements up to and including the \texttt{table} element, but it doesn't affect the list of active formatting elements, so the "ccc" character tokens after the table result in yet another \texttt{b} element being created, this time after the table:

```
    html
     head
     body
      b
      b
      #text: bbb
     table
      tbody
      tr
       td
        #text: aaa
       td
        #text: ccc
``` 

This section is non-normative.

Consider the following markup, which for this example we will assume is the document with URL https://example.com/inner, being rendered as the content of an \texttt{iframe} in another document with the URL https://example.com/outer:
Up to the first "script" end tag, before the script is parsed, the result is relatively straightforward:

```html
<html>
  <head></head>
  <body>
    <div id="a">
      <script>
        var div = document.getElementById('a');
        parent.document.body.appendChild(div);
      </script>
      <script>
        alert(document.URL);
      </script>
    </div>
  </body>
</html>
```

After the script is parsed, though, the `div` element and its child `script` element are gone:

```html
<html>
  <head></head>
  <body>
    <script>
      alert(document.URL);
    </script>
  </body>
</html>
```

They are, at this point, in the `Document` of the aforementioned outer `browsing context`. However, the `stack of open elements` still contains the `div` element.

Thus, when the second `script` element is parsed, it is inserted into the outer `Document` object.

Those parsed into different `Document` s than the one the parser was created for do not execute, so the first alert does not show.

Once the `div` element's end tag is parsed, the `div` element is popped off the stack, and so the next `script` element is in the inner `Document`:

```html
<html>
  <head></head>
  <body>
    <script>
      alert(document.URL);
    </script>
  </body>
</html>
```

This script does execute, resulting in an alert that says "https://example.com/inner".

### 13.2.10.5 The execution of scripts that are moving across multiple documents

This section is non-normative.

Elaborating on the example in the previous section, consider the case where the second `script` element is an external script (i.e. one with a `src` attribute). Since the element was not in the parser's `Document` when it was created, that external script is not even downloaded.

In a case where a `script` element with a `src` attribute is parsed normally into its parser's `Document`, but while the external script is being downloaded, the element is moved to another document, the script continues to download, but does not execute.

**Note**

In general, moving `script` elements between `Document` s is considered a bad practice.
13.2.10.6 Unclosed formatting elements §113

This section is non-normative.

The following markup shows how nested formatting elements (such as \texttt{b}) get collected and continue to be applied even as the elements they are contained in are closed, but that excessive duplicates are thrown away.

```html
<!DOCTYPE html>
<p><b class="x"><b class="x"><b class="x"><b class="x"><b class="x">X
</b></b></b></p>
</p>

The resulting DOM tree is as follows:

```
DOCTYPE: html
html
  head
  body
    p
      b class="x" class="x" class="x" class="x" class="x">
        X
    </b>
  p
    b class="x" class="x" class="x" class="x" class="x">
      X
    </b>
  p
    b class="x" class="x" class="x" class="x" class="x">
      X
    </b>
  p
    #text: X
```

Note how the second \texttt{p} element in the markup has no explicit \texttt{b} elements, but in the resulting DOM, up to three of each kind of formatting element (in this case three \texttt{b} elements with the class attribute, and two unadorned \texttt{b} elements) get reconstructed before the element's "X".

Also note how this means that in the final paragraph only six \texttt{b} end tags are needed to completely clear the list of active formatting elements, even though nine \texttt{b} start tags have been seen up to this point.

13.3 Serializing HTML fragments §113

For the purposes of the following algorithm, an element \texttt{serializes as void} if its element type is one of the \texttt{void elements}, or is \texttt{basefont}, \texttt{bgsound}, \texttt{frame}, \texttt{keygen}, or \texttt{param}.

The following steps form the HTML fragment serialization algorithm. The algorithm takes as input a DOM Element, Document.
or DocumentFragment referred to as the node, a boolean serializableShadowRoots, and a sequence<ShadowRoot> shadowRoots, and returns a string.

Note

This algorithm serializes the children of the node being serialized, not the node itself.

1. If the node serializes as void, then return the empty string.
2. Let s be a string, and initialize it to the empty string.
3. If the node is a template element, then let the node instead be the template element's template contents (a DocumentFragment node).
4. If current node is a shadow host, then:
   1. Let shadow be current node's shadow root.
   2. If one of the following is true:
      ■ serializableShadowRoots is true and shadow's serializable is true; or
      ■ shadowRoots contains shadow,
      then:
         1. Append "<template shadowrootmode="".
         2. If shadow's mode is "open", then append "open". Otherwise, append "closed".
         3. Append ".
         4. If shadow's delegates focus is set, then append " shadowrootdelegatesfocus="".
         5. If shadow's serializable is set, then append " shadowrootserializable="".
         6. If shadow's clonable is set, then append " shadowrootclonable="".
         7. Append ">".
         8. Append the value of running the HTML fragment serialization algorithm with shadow, serializableShadowRoots, and shadowRoots (thus recursing into this algorithm for that element).
         9. Append "</template>".
5. For each child node of the node, in tree order, run the following steps:
   1. Let current node be the child node being processed.
   2. Append the appropriate string from the following list to s:
      → If current node is an Element
         If current node is an element in the HTML namespace, the MathML namespace, or the SVG namespace, then let tagname be current node's local name. Otherwise, let tagname be current node's qualified name.
         Append a U+003C LESS-THAN SIGN character (<), followed by tagname.
         Note
         For HTML elements created by the HTML parser or createElement(), tagname will be lowercase.
         If current node's is value is not null, and the element does not have an is attribute in its attribute list, then append the string " is="", followed by current node's is value escaped as described below in attribute mode, followed by a U+0022 QUOTATION MARK character (").
         For each attribute that the element has, append a U+0020 SPACE character, the attribute's serialized name as described below, a U+003D EQUALS SIGN character (=), a U+0022 QUOTATION MARK character ("), the attribute's value, escaped as described below in attribute mode, and a second U+0022 QUOTATION MARK character (").
An attribute's serialized name for the purposes of the previous paragraph must be determined as follows:

voie If the attribute has no namespace
The attribute's serialized name is the attribute's local name.

Note
For attributes on HTML elements set by the HTML parser or by setAttribute(), the local name will be lowercase.

voie If the attribute is in the XML namespace
The attribute's serialized name is the string "xml:" followed by the attribute's local name.

voie If the attribute is in the XMLNS namespace and the attribute's local name is xmlns
The attribute's serialized name is the string "xmlns:"

voie If the attribute is in the XMLNS namespace and the attribute's local name is not xmlns
The attribute's serialized name is the string "xmlns:" followed by the attribute's local name.

voie If the attribute is in the XLink namespace
The attribute's serialized name is the string "xlink:" followed by the attribute's local name.

voie If the attribute is in some other namespace
The attribute's serialized name is the attribute's qualified name.

While the exact order of attributes is implementation-defined, and may depend on factors such as the order that the attributes were given in the original markup, the sort order must be stable, such that consecutive invocations of this algorithm serialize an element's attributes in the same order.

Append a U+003E GREATER-THAN SIGN character (>).

If current node serializes as void, then continue on to the next child node at this point.

Append the value of running the HTML fragment serialization algorithm with current node, serializableShadowRoots, and shadowRoots (thus recursing into this algorithm for that node), followed by a U+003C LESS-THAN SIGN character (<), a U+002F SOLIDUS character (/), tagname again, and finally a U+003E GREATER-THAN SIGN character (>).

voie If current node is a Text node
If the parent of current node is a style, script, xmp, iframe, noembed, noframes, or plaintext element, or if the parent of current node is a noscript element and scripting is enabled for the node, then append the value of current node's data literally.

Otherwise, append the value of current node's data, escaped as described below.

voie If current node is a Comment
Append "<!-- " (U+003C LESS-THAN SIGN, U+0021 EXCLAMATION MARK, U+002D HYPHEN-MINUS, U+002D HYPHEN-MINUS, U+0020 SPACE), followed by the value of current node's data, followed by the literal string "--> " (U+002D HYPHEN-MINUS, U+002D HYPHEN-MINUS, U+003E GREATER-THAN SIGN).

voie If current node is a ProcessingInstruction
Append "<? " (U+003C LESS-THAN SIGN, U+0003F QUESTION MARK), followed by the value of current node's target IDL attribute, followed by a single U+0020 SPACE character, followed by the value of current node's data, followed by a single U+003E GREATER-THAN SIGN character (>).

voie If current node is a DocumentType
Append "<!DOCTYPE " (U+003C LESS-THAN SIGN, U+00021 EXCLAMATION MARK, U+00026 LATIN CAPITAL LETTER D, U+00004 LATIN CAPITAL LETTER T, U+00005 LATIN CAPITAL LETTER T, U+00009 LATIN CAPITAL LETTER Y, U+00005 LATIN CAPITAL LETTER P, U+00004 LATIN CAPITAL LETTER E), followed by a space (U+0020 SPACE), followed by the value of current node's name, followed by ">") (U+003E GREATER-THAN SIGN).

6. Return s.
It is possible that the output of this algorithm, if parsed with an HTML parser, will not return the original tree structure. Tree structures that do not roundtrip a serialize and reparse step can also be produced by the HTML parser itself, although such cases are typically non-conforming.

Example
For instance, if a textarea element to which a Comment node has been appended is serialized and the output is then reparsed, the comment will end up being displayed in the text control. Similarly, if, as a result of DOM manipulation, an element contains a comment that contains "-->", then when the result of serializing the element is parsed, the comment will be truncated at that point and the rest of the comment will be interpreted as markup. More examples would be making a script element contain a Text node with the text string "</script>", or having a p element that contains a ul element (as the ul element's start tag would imply the end tag for the p).

This can enable cross-site scripting attacks. An example of this would be a page that lets the user enter some font family names that are then inserted into a CSS style block via the DOM and which then uses the innerHTML IDL attribute to get the HTML serialization of that style element: if the user enters "</style><script>attack</script>" as a font family name, innerHTML will return markup that, if parsed in a different context, would contain a script node, even though no script node existed in the original DOM.

Example
For example, consider the following markup:

```html
<form id="outer"><div></form><form id="inner"><input>
```

This will be parsed into:

```html
<html><head></head><body><form id="outer"><div></form><form id="inner"><input></form></body></html>
```

Example
For another example, consider the following markup:

```html
<a><table><a>
```

This will be parsed into:

```html
<html><head></head><body><a><table><a></table></a></body></html>
```
That is, the `p` element is foster parented. After a serialize-reparse roundtrip, the `p` and the `table` element would all be siblings, because the second `<a>` start tag implicitly closes the first `p` element.

For example, consider the following markup:

```html
<pre>Hello.</pre>
```

When this document is first parsed, the `pre` element's child text content starts with a single newline character. After a serialize-reparse roundtrip, the `pre` element's child text content is simply "Hello.".

Because of the special role of the `is` attribute in signaling the creation of customized built-in elements, in that it provides a mechanism for parsed HTML to set the element's `is` value, we special-case its handling during serialization. This ensures that an element's `is` value is preserved through serialize-parse roundtrips.

Example

When creating a customized built-in element via the parser, a developer uses the `is` attribute directly; in such cases serialize-parse roundtrips work fine.

```javascript
window.SuperP = class extends HTMLParagraphElement {};
customElements.define("super-p", SuperP, { extends: "p" });
</script>

<div id="container"><p is="super-p">Superb!</p></div>

But when creating a customized built-in element via its `constructor` or via `createElement()`, the `is` attribute is not added. Instead, the `is` value (which is what the custom elements machinery uses) is set without intermediating through an attribute.

```javascript
container.innerHTML = "";
const p = document.createElement("p", { is: "super-p" });
```
To ensure that serialize-parse roundtrips still work, the serialization process explicitly writes out the element’s `is` value as an `is` attribute:

```javascript
<p is="super-p">...
</p>
```

### Escaping a string

(for the purposes of the algorithm above) consists of running the following steps:

1. Replace any occurrence of the "&" character by the string "&amp;".
2. Replace any occurrences of the U+00A0 NO-BREAK SPACE character by the string "\&nbsp;".
3. If the algorithm was invoked in the attribute mode, replace any occurrences of the "\" character by the string "\".
4. If the algorithm was not invoked in the attribute mode, replace any occurrences of the "<" character by the string "&lt;", and any occurrences of the ">" character by the string "&gt;".

### 13.4 Parsing HTML fragments

The following steps form the HTML fragment parsing algorithm. The algorithm takes as input an `Element` node, referred to as the `context` element, which gives the context for the parser, `input`, a string to parse, and an optional boolean `allowDeclarativeShadowRoots` (default false). It returns a list of zero or more nodes.

**Note**

Parts marked fragment case in algorithms in the parser section are parts that only occur if the parser was created for the purposes of this algorithm. The algorithms have been annotated with such markings for informational purposes only; such markings have no normative weight. If it is possible for a condition described as a fragment case to occur even when the parser wasn’t created for the purposes of handling this algorithm, then that is an error in the specification.

1. Create a new `Document` node, and mark it as being an HTML document.
2. If the node document of the `context` element is in quirks mode, then let the `Document` be in quirks mode. Otherwise, the node document of the `context` element is in limited-quirks mode, then let the `Document` be in limited-quirks mode. Otherwise, leave the `Document` in no-quirks mode.
3. If `allowDeclarativeShadowRoots` is true, then set the `Document`’s `allow declarative shadow roots` to true.
4. Create a new `HTML parser`, and associate it with the just created `Document` node.
5. Set the state of the `HTML parser`’s `tokenization` stage as follows, switching on the `context` element:
   - `title`
   - `textarea`

   Switch the tokenizer to the `RCDATA state`. 
6. Let root be a new html element with no attributes.

7. Append the element root to the Document node created above.

8. Set up the parser’s stack of open elements so that it contains just the single element root.

9. If the context element is a template element, push “in template” onto the stack of template insertion modes so that it is the new current template insertion mode.

10. Create a start tag token whose name is the local name of context and whose attributes are the attributes of context.

11. Reset the parser’s insertion mode appropriately.

12. Set the parser’s form element pointer to the nearest node to the context element that is a form element (going straight up the ancestor chain, and including the element itself, if it is a form element), if any. (If there is no such form element, the form element pointer keeps its initial value, null.)

13. Place the input into the input stream for the HTML parser just created. The encoding confidence is irrelevant.

14. Start the parser and let it run until it has consumed all the characters just inserted into the input stream.

15. Return the child nodes of root, in tree order.

### 13.5 Named character references

This table lists the character reference names that are supported by HTML, and the code points to which they refer. It is referenced by the previous sections.

**Note**

It is intentional, for legacy compatibility, that many code points have multiple character reference names. For example, some
<table>
<thead>
<tr>
<th>Name</th>
<th>Character(s)</th>
<th>Glyph</th>
<th>Name</th>
<th>Character(s)</th>
<th>Glyph</th>
<th>Name</th>
<th>Character(s)</th>
<th>Glyph</th>
</tr>
</thead>
</table>
The glyphs displayed above are non-normative. Refer to Unicode for formal definitions of the characters listed above.

Note
The character reference names originate from XML Entity Definitions for Characters, though only the above is considered normative. [XMLENTITY][2464]

Note
This list is static and will not be expanded or changed in the future.
14 The XML syntax

Note
This section only describes the rules for XML resources. Rules for text/html resources are discussed in the section above entitled "The HTML syntax".

⚠ Warning!
Using the XML syntax is not recommended, for reasons which include the fact that there is no specification which defines the rules for how an XML parser must map a string of bytes or characters into a Document object, as well as the fact that the XML syntax is essentially unmaintained — in that, it’s not expected that any further features will ever be added to the XML syntax (even when such features have been added to the HTML syntax).

14.1 Writing documents in the XML syntax

Note
The XML syntax for HTML was formerly referred to as "XHTML", but this specification does not use that term (among other reasons, because no such term is used for the HTML syntaxes of MathML and SVG).

The syntax for XML is defined in XML and Namespaces in XML. [XML][1] [XMLNS][1]

This specification does not define any syntax-level requirements beyond those defined for XML proper.

XML documents may contain a DOCTYPE if desired, but this is not required to conform to this specification. This specification does not define a public or system identifier, nor provide a formal DTD.

Note
According to XML, XML processors are not guaranteed to process the external DTD subset referenced in the DOCTYPE. This means, for example, that using entity references for characters in XML documents is unsafe if they are defined in an external file (except for &lt;, &gt;, &amp;, &quot;, and &apos;).

14.2 Parsing XML documents

This section describes the relationship between XML and the DOM, with a particular emphasis on how this interacts with HTML.

An XML parser, for the purposes of this specification, is a construct that follows the rules given in XML to map a string of bytes or characters into a Document object.

Note
At the time of writing, no such rules actually exist.

An XML parser is either associated with a Document object when it is created, or creates one implicitly.

This Document must then be populated with DOM nodes that represent the tree structure of the input passed to the parser, as defined by XML, Namespaces in XML, and DOM. When creating DOM nodes representing elements, the create an element for a token algorithm or some equivalent that operates on appropriate XML data structures must be used, to ensure the proper element interfaces are created and that custom elements are set up correctly.

DOM mutation events must not fire for the operations that the XML parser performs on the Document's tree, but the user agent must act as if elements and attributes were individually appended and set respectively so as to trigger rules in this specification regarding what happens when an element is inserted into a document or has its attributes set, and DOM's requirements regarding
mutation observers mean that mutation observers are fired (unlike mutation events). 

Between the time an element's start tag is parsed and the time either the element's end tag is parsed or the parser detects a well-formedness error, the user agent must act as if the element was in a stack of open elements.

This specification provides the following additional information that user agents should use when retrieving an external entity: the public identifiers given in the following list all correspond to the URL given by this link. (This URL is a DTD containing the entity declarations for the names listed in the named character references section.)

```
• -//W3C//DTD XHTML 1.0 Transitional//EN
• -//W3C//DTD XHTML 1.1//EN
• -//W3C//DTD XHTML 1.0 Strict//EN
• -//W3C//DTD XHTML Basic 1.0//EN
• -//W3C//DTD XHTML 1.1 plus MathML 2.0//EN
• -//W3C//DTD XHTML 1.1 plus MathML 2.0 plus SVG 1.1//EN
• -//W3C//DTD MathML 2.0//EN
• -//WAPFORUM//DTD XHTML Mobile 1.0//EN
```

Furthermore, user agents should attempt to retrieve the above external entity's content when one of the above public identifiers is used, and should not attempt to retrieve any other external entity's content.

XML parsers can be invoked with XML scripting support enabled or XML scripting support disabled. Except where otherwise specified, XML parsers are invoked with XML scripting support enabled.

When an XML parser with XML scripting support enabled creates a script element, it must have its parser document set and its force async set to false. If the parser was created as part of the XML fragment parsing algorithm, then the element's already started must be set to true. When the element's end tag is subsequently parsed, the user agent must perform a microtask checkpoint, and then prepare the script element. If this causes there to be a pending parsing-blocking script, then the user agent must run the following steps:

1. Block this instance of the XML parser, such that the event loop will not run tasks that invoke it.
2. Spin the event loop until the parser's Document has no style sheet that is blocking scripts and the pending parsing-blocking script's ready to be parser-executed is true.
3. Unblock this instance of the XML parser, such that tasks that invoke it can again be run.
4. Execute the script element given by the pending parsing-blocking script.
5. Set the pending parsing-blocking script to null.

Note Since the `document.write()` API is not available for XML documents, much of the complexity in the HTML parser is not needed in the XML parser.

Note When the `XML parser` has XML scripting support disabled, none of this happens.

When an XML parser would append a node to a template element, it must instead append it to the template element's template contents (a `DocumentFragment` node).

Note This is a willful violation of XML; unfortunately, XML is not formally extensible in the manner that is needed for template.
When an XML parser creates a Node object, its node document must be set to the node document of the node into which the newly created node is to be inserted.

Certain algorithms in this specification spoon-feed the parser characters one string at a time. In such cases, the XML parser must act as it would have if faced with a single string consisting of the concatenation of all those characters.

When an XML parser reaches the end of its input, it must stop parsing, following the same rules as the HTML parser. An XML parser can also be aborted, which must again be done in the same way as for an HTML parser.

For the purposes of conformance checkers, if a resource is determined to be in the XML syntax, then it is an XML document.

14.3 Serializing XML fragments

The XML fragment serialization algorithm for a Document or Element node either returns a fragment of XML that represents that node or throws an exception.

For Document's, the algorithm must return a string in the form of a document entity, if none of the error cases below apply.

For Element's, the algorithm must return a string in the form of an internal general parsed entity, if none of the error cases below apply.

In both cases, the string returned must be XML namespace-well-formed and must be an isomorphic serialization of all of that node's relevant child nodes, in tree order. User agents may adjust prefixes and namespace declarations in the serialization (and indeed might be forced to do so in some cases to obtain namespace-well-formed XML). User agents may use a combination of regular text and character references to represent Text nodes in the DOM.

A node's relevant child nodes are those that apply given the following rules:

For template elements

The relevant child nodes are the child nodes of the template element's template contents, if any.

For all other nodes

The relevant child nodes are the child nodes of node itself, if any.

For Elements, if any of the elements in the serialization are in no namespace, the default namespace in scope for those elements must be explicitly declared as the empty string. (This doesn't apply in the Document case.) [XML] [XMLNS]

For the purposes of this section, an internal general parsed entity is considered XML namespace-well-formed if a document consisting of an element with no namespace declarations whose contents are the internal general parsed entity would itself be XML namespace-well-formed.

If any of the following error cases are found in the DOM subtree being serialized, then the algorithm must throw an "InvalidStateError" DOMException instead of returning a string:

- A Document node with no child element nodes.
- A DocumentType node that has an external subset public identifier that contains characters that are not matched by the XML PubidChar production. [XML]
- A DocumentType node that has an external subset system identifier that contains both a U+0022 QUOTATION MARK ("') and a U+0027 APOSTROPHE (') or that contains characters that are not matched by the XML Char production. [XML]
- A node with a local name containing a U+003A COLON (:).
- A node with a local name that does not match the XML Name production. [XML]
- An Attr node with no namespace whose local name is the lowercase string "xmlns". [XMLNS]
- An Element node with two or more attributes with the same local name and namespace.
- An Attr node, Text node, Comment node, or ProcessingInstruction node whose data contains characters that are not...
matched by the XML Char production. [XML]

- A Comment node whose data contains two adjacent U+002D HYPHEN-MINUS characters (-) or ends with such a character.
- A ProcessingInstruction node whose target name is an ASCII case-insensitive match for the string "xml".
- A ProcessingInstruction node whose target name contains a U+003A COLON (:).
- A ProcessingInstruction node whose data contains the string "?>".

These are the only ways to make a DOM unserialisable. The DOM enforces all the other XML constraints; for example, trying to append two elements to a Document node will throw a "HierarchyRequestError" DOMException.

### 14.4 Parsing XML fragments

The XML fragment parsing algorithm either returns a Document or throws a "SyntaxError" DOMException. Given a string input and a context element, the algorithm is as follows:

1. Create a new XML parser.
2. Feed the parser just created the string corresponding to the start tag of the context element, declaring all the namespace prefixes that are in scope on that element in the DOM, as well as declaring the default namespace (if any) that is in scope on that element in the DOM.
   
   A namespace prefix is in scope if the DOM lookupNamespaceURI() method on the element would return a non-null value for that prefix.
   
   The default namespace is the namespace for which the DOM isDefaultNamespace() method on the element would return true.

   **Note**

   No DOCTYPE is passed to the parser, and therefore no external subset is referenced, and therefore no entities will be recognized.

3. Feed the parser just created the string input.
4. Feed the parser just created the string corresponding to the end tag of the context element.
5. If there is an XML well-formedness or XML namespace well-formedness error, then throw a "SyntaxError" DOMException.
6. If the document element of the resulting Document has any sibling nodes, then throw a "SyntaxError" DOMException.
7. Return the child nodes of the document element of the resulting Document, in tree order.
15 Rendering

User agents are not required to present HTML documents in any particular way. However, this section provides a set of suggestions for rendering HTML documents that, if followed, are likely to lead to a user experience that closely resembles the experience intended by the documents' authors. So as to avoid confusion regarding the normativity of this section, "must" has not been used. Instead, the term "expected" is used to indicate behavior that will lead to this experience. For the purposes of conformance for user agents designated as supporting the suggested default rendering, the term "expected" in this section has the same conformance implications as "must".

15.1 Introduction

The suggestions in this section are generally expressed in CSS terms. User agents are expected to either support CSS, or translate from the CSS rules given in this section to approximations for other presentation mechanisms.

In the absence of style-layer rules to the contrary (e.g. author style sheets), user agents are expected to render an element so that it conveys to the user the meaning that the element represents, as described by this specification.

The suggestions in this section generally assume a visual output medium with a resolution of 96dpi or greater, but HTML is intended to apply to multiple media (it is a media-independent language). User agent implementers are encouraged to adapt the suggestions in this section to their target media.

An element is being rendered if it has any associated CSS layout boxes, SVG layout boxes, or some equivalent in other styling languages.

Note

Just being off-screen does not mean the element is not being rendered. The presence of the hidden attribute normally means the element is not being rendered, though this might be overridden by the style sheets.

Note

The fully active state does not affect whether an element is being rendered or not. Even if a document is not fully active and not shown at all to the user, elements within it can still qualify as "being rendered".

An element is said to intersect the viewport when it is being rendered and its associated CSS layout box intersects the viewport.

Note

Similar to the being rendered state, elements in non-fully active documents can still intersect the viewport. The viewport is not shared between documents and might not always be shown to the user, so an element in a non-fully active document can still intersect the viewport associated with its document.

Note

This specification does not define the precise timing for when the intersection is tested, but it is suggested that the timing match that of the Intersection Observer API.

An element is delegating its rendering to its children if it is not being rendered, but its children (if any) could be rendered, as a result of CSS 'display: contents', or some equivalent in other styling languages.

User agents that do not honor author-level CSS style sheets are nonetheless expected to act as if they applied the CSS rules given in these sections in a manner consistent with this specification and the relevant CSS and Unicode specifications.
15.2 The CSS user agent style sheet and presentational hints

The CSS rules given in these subsections are, except where otherwise specified, expected to be used as part of the user-agent level style sheet defaults for all documents that contain HTML elements.

Some rules are intended for the author-level zero-specificity presentational hints part of the CSS cascade; these are explicitly called out as presentational hints.

When the text below says that an attribute attribute on an element element maps to the pixel length property (or properties), it means that if element has an attribute attribute set, and parsing that attribute's value using the rules for parsing non-negative integers doesn't generate an error, then the user agent is expected to use the parsed value as a pixel length for a presentational hint for properties.

When the text below says that an attribute attribute on an element element maps to the dimension property (or properties), it means that if element has an attribute attribute set, and parsing that attribute's value using the rules for parsing dimension values doesn't generate an error, then the user agent is expected to use the parsed dimension as the value for a presentational hint for properties, with the value given as a pixel length if the dimension was a length, and with the value given as a percentage if the dimension was a percentage.

When the text below says that an attribute attribute on an element element maps to the dimension property (ignoring zero) (or properties) properties, it means that if element has an attribute attribute set, and parsing that attribute’s value using the rules for parsing nonzero dimension values doesn't generate an error, then the user agent is expected to use the parsed dimension as the value for a presentational hint for properties, with the value given as a pixel length if the dimension was a length, and with the value given as a percentage if the dimension was a percentage.

When the text below says that a pair of attributes w and h on an element element map to the aspect-ratio property, it means that if element has both attributes w and h, and parsing those attributes’ values using the rules for parsing non-negative integers doesn't generate an error for either, then the user agent is expected to use the parsed integers as a presentational hint for the 'aspect-ratio' property of the form auto w / h.

When the text below says that a pair of attributes w and h on an element element map to the aspect-ratio property (using dimension rules), it means that if element has both attributes w and h, and parsing those attributes' values using the rules for parsing dimension values doesn't generate an error or return a percentage for either, then the user agent is expected to use the parsed dimensions as a presentational hint for the 'aspect-ratio' property of the form auto w / h.

When a user agent is to align descendants of a node, the user agent is expected to align only those descendants that have both their 'margin-inline-start' and 'margin-inline-end' properties computing to a value other than 'auto', that are over-constrained and that have one of those two margins with a used value forced to a greater value, and that do not themselves have an applicable align attribute. When multiple elements are to align a particular descendant, the most deeply nested such element is expected to override the others. Aligned elements are expected to be aligned by having the used values of their margins on the line-left and line-right sides be set accordingly. [CSSLOGICAL][CSSWM]
15.3.2 The page

For each property in the table below, given a `body` element, the first attribute that exists maps to the pixel length property on the `body` element. If none of the attributes for a property are found, or if the value of the attribute that was found cannot be parsed successfully, then a default value of 8px is expected to be used for that property instead.

<table>
<thead>
<tr>
<th>Property</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>margin-top</code></td>
<td>The <code>body</code> element's <code>marginheight</code> attribute</td>
</tr>
<tr>
<td></td>
<td>The <code>body</code> element's <code>topmargin</code> attribute</td>
</tr>
<tr>
<td></td>
<td>The <code>body</code> element's <code>container frame element</code>'s <code>marginheight</code> attribute</td>
</tr>
<tr>
<td><code>margin-right</code></td>
<td>The <code>body</code> element's <code>marginwidth</code> attribute</td>
</tr>
<tr>
<td></td>
<td>The <code>body</code> element's <code>rightmargin</code> attribute</td>
</tr>
<tr>
<td></td>
<td>The <code>body</code> element's <code>container frame element</code>'s <code>marginwidth</code> attribute</td>
</tr>
<tr>
<td><code>margin-bottom</code></td>
<td>The <code>body</code> element's <code>marginheight</code> attribute</td>
</tr>
<tr>
<td></td>
<td>The <code>body</code> element's <code>bottommargin</code> attribute</td>
</tr>
<tr>
<td></td>
<td>The <code>body</code> element's <code>container frame element</code>'s <code>marginheight</code> attribute</td>
</tr>
<tr>
<td><code>margin-left</code></td>
<td>The <code>body</code> element's <code>marginwidth</code> attribute</td>
</tr>
<tr>
<td></td>
<td>The <code>body</code> element's <code>leftmargin</code> attribute</td>
</tr>
<tr>
<td></td>
<td>The <code>body</code> element's <code>container frame element</code>'s <code>marginwidth</code> attribute</td>
</tr>
</tbody>
</table>

If the `body` element's `node document`'s `node navigable` is a `child navigable`, and the `container` of that `navigable` is a `frame` or `iframe` element, then the `container frame element` of the `body` element is that `frame` or `iframe` element. Otherwise, there is no `container frame element`.

⚠️ **Warning!**

The above requirements imply that a page can change the margins of another page (including one from another origin) using, for example, an `iframe`. This is potentially a security risk, as it might in some cases allow an attack to contrive a situation in which a page is rendered not as the author intended, possibly for the purposes of phishing or otherwise misleading the user.
“noscroll”, or “no”, then the user agent is expected to prevent any scrollbars from being shown for the viewport of the Document's node navigable, regardless of the `overflow` property that applies to that viewport.

When a body element has a `background` attribute set to a non-empty value, the new value is expected to be encoding-parsed-and-serialized relative to the element's node document, and if that does not return failure, the user agent is expected to treat the attribute as a presentational hint setting the element's 'background-image' property to the return value.

When a body element has a `bgcolor` attribute set, the new value is expected to be parsed using the rules for parsing a legacy color value, and if that does not return an error, the user agent is expected to treat the attribute as a presentational hint setting the element's 'background-color' property to the resulting color.

When a body element has a `text` attribute, its value is expected to be parsed using the rules for parsing a legacy color value, and if that does not return an error, the user agent is expected to treat the attribute as a presentational hint setting the element's 'color' property to the resulting color.

When a body element has a `link` attribute, its value is expected to be parsed using the rules for parsing a legacy color value, and if that does not return an error, the user agent is expected to treat the attribute as a presentational hint setting the 'color' property of any element in the Document matching the :link pseudo-class to the resulting color.

When a body element has a `vlink` attribute, its value is expected to be parsed using the rules for parsing a legacy color value, and if that does not return an error, the user agent is expected to treat the attribute as a presentational hint setting the 'color' property of any element in the Document matching the :visited pseudo-class to the resulting color.

When a body element has an `alink` attribute, its value is expected to be parsed using the rules for parsing a legacy color value, and if that does not return an error, the user agent is expected to treat the attribute as a presentational hint setting the 'color' property of any element in the Document matching the :active pseudo-class and either the :link pseudo-class or the :visited pseudo-class to the resulting color.

```css
@namespace "http://www.w3.org/1999/xhtml";

address, blockquote, center, dialog, div, figure, figcaption, footer, form, header, hr, legend, listing, main, p, plaintext, pre, search, xmp {
  display: block;
}

blockquote, figure, listing, p, plaintext, pre, xmp {
  margin-block: 1em;
}

blockquote, figure {
  margin-inline: 40px;
}

address {
  font-style: italic;
}
listing, plaintext, pre, xmp {
  font-family: monospace;
  white-space: pre;
}

dialog:not([open]) {
  display: none;
}
dialog {
  position: absolute;
  inset-inline-start: 0;
  inset-inline-end: 0;
  width: fit-content;
  height: fit-content;
  margin: auto;
  border: solid;
  padding: 1em;
  background-color: Canvas;
  color: CanvasText;
```
The following rules are also expected to apply, as presentational hints:

```css
@namespace "http://www.w3.org/1999/xhtml";
pre[wrap] { white-space: pre-wrap; }
```

In quirks mode, the following rules are also expected to apply:

```css
@namespace "http://www.w3.org/1999/xhtml";
form { margin-block-end: 1em; }
```

The `center` element, and the `div` element when it has an `align` attribute whose value is an ASCII case-insensitive match for either the string "center" or the string "middle", are expected to center text within themselves, as if they had their `text-align` property set to 'center' in a presentational hint, and to align descendants to the center.
The `div` element, when it has an `align` attribute whose value is an ASCII case-insensitive match for the string "left", is expected to left-align text within itself, as if it had its `text-align` property set to 'left' in a presentational hint, and to align descendants to the left.

The `div` element, when it has an `align` attribute whose value is an ASCII case-insensitive match for the string "right", is expected to right-align text within itself, as if it had its `text-align` property set to 'right' in a presentational hint, and to align descendants to the right.

The `div` element, when it has an `align` attribute whose value is an ASCII case-insensitive match for the string "justify", is expected to full-justify text within itself, as if it had its `text-align` property set to 'justify' in a presentational hint, and to align descendants to the left.

---

**15.3.4 Phrasing content**

```css
@namespace "http://www.w3.org/1999/xhtml";

cite, dfn, em, i, var { font-style: italic; }
b, strong { font-weight: bolder; }
code, kbd, samp, tt { font-family: monospace; }
big { font-size: larger; }
small { font-size: smaller; }

sub { vertical-align: sub; }
sup { vertical-align: super; }
sub, sup { line-height: normal; font-size: smaller; }

ruby { display: ruby; }
rt { display: ruby-text; }

:link { color: #0000EE; }
:visited { color: #551A8B; }
:link:active, :visited:active { color: #FF0000; }
:link, :visited { text-decoration: underline; cursor: pointer; }
:focus-visible { outline: auto; }

mark { background: yellow; color: black; } /* this color is just a suggestion and can be changed based on implementation feedback */

abbr[title], acronym[title] { text-decoration: dotted underline; }
ins, u { text-decoration: underline; }
del, s, strike { text-decoration: line-through; }

q::before { content: open-quote; }
q::after { content: close-quote; }

br { display-outside: newline; } /* this also has bidi implications */
nobr { white-space: nowrap; }
wbr { display-outside: break-opportunity; } /* this also has bidi implications */
nobr wbr { white-space: normal; }
```

The following rules are also expected to apply, as presentational hints:

```css
@namespace "http://www.w3.org/1999/xhtml";

br[clear=left i] { clear: left; }
br[clear=right i] { clear: right; }
br[clear=all i], br[clear=both i] { clear: both; }
```

For the purposes of the CSS ruby model, runs of children of `ruby` elements that are not `rt` or `rp` elements are expected to be
When a particular part of a ruby has more than one annotation, the annotations should be distributed on both sides of the base text so as to minimize the stacking of ruby annotations on one side.

User agents that do not support correct ruby rendering are expected to render parentheses around the text of `<rt>` elements in the absence of `<rp>` elements.

User agents are expected to support the `clear` property on inline elements (in order to render `<br>` elements with the `clear` attribute) in the manner described in the non-normative note to this effect in CSS.

The initial value for the `color` property is expected to be black. The initial value for the `background-color` property is expected to be 'transparent'. The canvas's background is expected to be white.

When a `<font>` element has a `color` attribute, its value is expected to be parsed using the rules for parsing a legacy color value, and if that does not return an error, the user agent is expected to treat the attribute as a presentational hint setting the element's `color` property to the resulting color.

When a `<font>` element has a `face` attribute, the user agent is expected to treat the attribute as a presentational hint setting the element's `font-family` property to the attribute's value.

When a `<font>` element has a `size` attribute, the user agent is expected to use the following steps, known as the rules for parsing a legacy font size, to treat the attribute as a presentational hint setting the element's `font-size` property:

1. Let `input` be the attribute's value.
2. Let `position` be a pointer into `input`, initially pointing at the start of the string.
3. Skip ASCII whitespace within `input` given `position`.
4. If `position` is past the end of `input`, there is no presentational hint. Return.
5. If the character at `position` is a U+002B PLUS SIGN character (+), then let `mode` be `relative-plus`, and advance `position` to the next character. Otherwise, if the character at `position` is a U+002D HYPHEN-MINUS character (-), then let `mode` be `relative-minus`, and advance `position` to the next character. Otherwise, let `mode` be `absolute`.
6. Collect a sequence of code points that are ASCII digits from `input` given `position`, and let the resulting sequence be `digits`.
7. If `digits` is the empty string, there is no presentational hint. Return.
8. Interpret `digits` as a base-ten integer. Let `value` be the resulting number.
9. If `mode` is `relative-plus`, then increment `value` by 3. If `mode` is `relative-minus`, then let `value` be the result of subtracting `value` from 3.
10. If `value` is greater than 7, let it be 7.
11. If `value` is less than 1, let it be 1.
12. Set `font-size` to the keyword corresponding to the value of `value` according to the following table:

<table>
<thead>
<tr>
<th>value</th>
<th><code>font-size</code> keyword</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>'x-small'</td>
</tr>
<tr>
<td>2</td>
<td>'small'</td>
</tr>
<tr>
<td>3</td>
<td>'medium'</td>
</tr>
<tr>
<td>4</td>
<td>'large'</td>
</tr>
<tr>
<td>5</td>
<td>'x-large'</td>
</tr>
<tr>
<td>6</td>
<td>'xx-large'</td>
</tr>
</tbody>
</table>
15.3.5 Bidirectional text

When an `input` element's `dir` attribute is in the `auto` state and its `type` attribute is in the `Text`, `Search`, `Telephone`, `URL`, or `Email` state, then the user agent is expected to act as if it had a user-agent-level style sheet rule setting the `unicode-bidi` property to `plaintext`.

Input fields (i.e. `textarea` elements, and `input` elements when their `type` attribute is in the `Text`, `Search`, `Telephone`, `URL`, or `Email` state) are expected to present an editing user interface with a directionality that matches the element's `direction` property.

When the document's character encoding is ISO-8859-8, the following rules are additionally expected to apply, following those above: [ENCODING]

15.3.6 Sections and headings

article, aside, h1, h2, h3, h4, h5, h6, hgroup, nav, section, 

In the following CSS block, `x` is shorthand for the following selector: `:is(article, aside, nav, section)`

```css
@namespace "http://www.w3.org/1999/xhtml";

x h1 { margin-block: 0.83em; font-size: 1.50em; }
x x h1 { margin-block: 1.00em; font-size: 1.17em; }
x x x h1 { margin-block: 1.33em; font-size: 1.00em; }
x x x x h1 { margin-block: 1.67em; font-size: 0.83em; }
x x x x x h1 { margin-block: 2.33em; font-size: 0.67em; }
```

**Note**
The shorthand is used to keep this block at least mildly readable.

### 15.3.7 Lists

```css
@namespace "http://www.w3.org/1999/xhtml";

dir, dd, dl, dt, menu, ol, ul { display: block; }
li { display: list-item; text-align: match-parent; }
dir, dl, menu, ol, ul { margin-block: 1em; }
:is(dir, dl, menu, ol, ul) :is(dir, dl, menu, ol, ul) {
  margin-block: 0;
}

dd { margin-inline-start: 40px; }
dir, menu, ol, ul { padding-inline-start: 40px; }
ol, menu { counter-reset: list-item; }
ol { list-style-type: decimal; }
dir, menu, ul {
  list-style-type: disc;
}
:is(dir, menu, ol, ul) :is(dir, menu, ul) {
  list-style-type: circle;
}
:is(dir, menu, ol, ul) :is(dir, menu, ol, ul) :is(dir, menu, ul) {
  list-style-type: square;
}
```

The following rules are also expected to apply, as presentational hints.

```css
@namespace "http://www.w3.org/1999/xhtml";

ol[type="1"], li[type="1"] { list-style-type: decimal; }
```
When rendering `li` elements, non-CSS user agents are expected to use the ordinal value of the `li` element to render the counter in the list item marker.

For CSS user agents, some aspects of rendering list items are defined by the CSS Lists specification. Additionally, the following attribute mappings are expected to apply: [CSSLISTS][1]

When an `li` element has a `value` attribute, and parsing that attribute’s value using the rules for parsing integers doesn’t generate an error, the user agent is expected to use the parsed value value as a presentational hint for the ‘counter-set’ property of the form list-item value.

When an `ol` element has a `start` attribute or a `reversed` attribute, or both, the user agent is expected to use the following steps to treat the attributes as a presentational hint for the ‘counter-reset’ property:

1. Let `value` be null.
2. If the element has a `start` attribute, then set `value` to the result of parsing the attribute’s value using the rules for parsing integers.
3. If the element has a `reversed` attribute, then:
   1. If `value` is an integer, then increment `value` by 1 and return reversed(list-item) value.
   2. Otherwise, return reversed(list-item).
   
   **Note:** Either the `start` attribute was absent, or parsing its value resulted in an error.
4. Otherwise:
   1. If `value` is an integer, then decrement `value` by 1 and return list-item value.
   2. Otherwise, there is no presentational hint.

15.3.8 Tables

```css
@namespace "http://www.w3.org/1999/xhtml"

table { display: table; }
caption { display: table-caption; }
colgroup, colgroup[hidden] { display: table-column-group; }
col, col[hidden] { display: table-column; }
thead, thead[hidden] { display: table-header-group; }
tbody, tbody[hidden] { display: table-row-group; }
tfoot, tfoot[hidden] { display: table-footer-group; }
tr, tr[hidden] { display: table-row; }
td, th { display: table-cell; }

colgroup[hidden], col[hidden], thead[hidden], tbody[hidden],
tfoot[hidden], tr[hidden] {
  visibility: collapse;
}
```
The following rules are also expected to apply, as presentational hints:

```css
table {
  box-sizing: border-box;
  border-spacing: 2px;
  border-collapse: separate;
  text-indent: initial;
}
td, th { padding: 1px; }
th { font-weight: bold; }
caption { text-align: center; }
thead, tbody, tfoot, table > tr { vertical-align: middle; }
tr, td, th { vertical-align: inherit; }
thead, tbody, tfoot, tr { border-color: inherit; }
table[rules=none i], table[rules=groups i], table[rules=rows i],
table[rules=cols i], table[rules=all i], table[frame=void i],
table[frame=above i], table[frame=below i], table[frame=hsides i],
table[frame=lhs i], table[frame=rhs i], table[frame=vsides i],
table[frame=box i], table[frame=border i],
table[rules=none i] > tr > td, table[rules=none i] > tr > th,
table[rules=groups i] > tr > td, table[rules=groups i] > tr > th,
table[rules=rows i] > tr > td, table[rules=rows i] > tr > th,
table[rules=cols i] > tr > td, table[rules=cols i] > tr > th,
table[rules=all i] > tr > td, table[rules=all i] > tr > th,
table[rules=none i] > thead > tr > td, table[rules=none i] > thead > tr > th,
table[rules=groups i] > thead > tr > td, table[rules=groups i] > thead > tr > th,
table[rules=rows i] > thead > tr > td, table[rules=rows i] > thead > tr > th,
table[rules=cols i] > thead > tr > td, table[rules=cols i] > thead > tr > th,
table[rules=all i] > thead > tr > td, table[rules=all i] > thead > tr > th,
table[rules=none i] > tbody > tr > td, table[rules=none i] > tbody > tr > th,
table[rules=groups i] > tbody > tr > td, table[rules=groups i] > tbody > tr > th,
table[rules=rows i] > tbody > tr > td, table[rules=rows i] > tbody > tr > th,
table[rules=cols i] > tbody > tr > td, table[rules=cols i] > tbody > tr > th,
table[rules=all i] > tbody > tr > td, table[rules=all i] > tbody > tr > th,
table[rules=none i] > tfoot > tr > td, table[rules=none i] > tfoot > tr > th,
table[rules=groups i] > tfoot > tr > td, table[rules=groups i] > tfoot > tr > th,
table[rules=rows i] > tfoot > tr > td, table[rules=rows i] > tfoot > tr > th,
table[rules=cols i] > tfoot > tr > td, table[rules=cols i] > tfoot > tr > th,
table[rules=all i] > tfoot > tr > td, table[rules=all i] > tfoot > tr > th,
  border-color: black;
}
```

```css
@media "http://www.w3.org/1999/xhtml";


table[align=left i] { float: left; }
table[align=right i] { float: right; }
table[align=center i] { margin-inline: auto; }
thead[align=absmiddle i], tbody[align=absmiddle i], tfoot[align=absmiddle i],
tr[align=absmiddle i], td[align=absmiddle i], th[align=absmiddle i] {
  text-align: center;
}
caption[align=bottom i] { caption-side: bottom; }
p[align=left i], h1[align=left i], h2[align=left i], h3[align=left i],
h4[align=left i], h5[align=left i], h6[align=left i] {
  text-align: left;
}
p[align=right i], h1[align=right i], h2[align=right i], h3[align=right i],
h4[align=right i], h5[align=right i], h6[align=right i] {
  text-align: right;
}
```
In quirks mode, the following rules are also expected to apply:

```css
@namespace "http://www.w3.org/1999/xhtml";

table {
  font-weight: initial;
  font-style: initial;
  font-variant: initial;
  font-size: initial;
  line-height: initial;
  white-space: initial;
  text-align: initial;
}
```

For the purposes of the CSS table model, the `col` element is expected to be treated as if it was present as many times as its `span` attribute specifies.

For the purposes of the CSS table model, the `colgroup` element, if it contains no `col` element, is expected to be treated as if it had as many such children as its `span` attribute specifies.

For the purposes of the CSS table model, the `colspan` and `rowspan` attributes on `td` and `th` elements are expected to provide the special knowledge regarding cells spanning rows and columns.

In HTML documents, the following rules are also expected to apply:
The `table` element's `cellspacing` attribute maps to the pixel length property `border-spacing` on the element.

The `table` element's `cellpadding` attribute maps to the pixel length properties `padding-top`, `padding-right`, `padding-bottom`, and `padding-left` of any `td` and `th` elements that have corresponding `cellpadding` in the `table` corresponding to the `table` element.

The `table` element's `height` attribute maps to the dimension property `height` on the `table` element.

The `table` element's `width` attribute maps to the dimension property `width` on the `table` element.

The `col` element's `width` attribute maps to the dimension property `width` on the `table` element.

The `thead`, `tbody`, and `tfoot` elements' `height` attribute maps to the dimension property `height` on the `table` element.

The `tr` element's `height` attribute maps to the dimension property `height` on the `table` element.

The `td` and `th` elements' `height` attributes map to the dimension property `height` on the `table` element.

The `th` element's `align` attribute, when they have an align attribute whose value is an ASCII case-insensitive match for the string "center", are expected to center text within themselves, as if they had their `text-align` property set to 'center' in a presentational hint, and to `align descendants` to the center.

The `th` element's `align` attribute, when they have an align attribute whose value is an ASCII case-insensitive match for the string "left", are expected to left-align text within themselves, as if they had their `text-align` property set to 'left' in a presentational hint, and to `align descendants` to the left.

The `th` element's `align` attribute, when they have an align attribute whose value is an ASCII case-insensitive match for the string "right", are expected to right-align text within themselves, as if they had their `text-align` property set to 'right' in a presentational hint, and to `align descendants` to the right.

User agents are expected to have a rule in their user agent style sheet that matches `th` elements that have a parent node whose computed value for the `text-align` property is its initial value, whose declaration block consists of just a single declaration that sets the `text-align` property to the value 'center'.

When a `table` element has a `background` attribute set to a non-empty value, the new value is expected to be encoding-parsed-and-serialized relative to the element's node document, and if that does not return failure, the user agent is expected to treat the attribute as a presentational hint setting the element's `background-image` property to the return value.

When a `table` element has a `bgcolor` attribute set, the new value is expected to be parsed using the rules for parsing a legacy color value, and if that does not return an error, the user agent is expected to treat the attribute as a presentational hint setting the element's `background-color` property to the resulting color.

The `table` element's `border` attribute maps to the pixel length properties `border-top-width`, `border-right-width`, `border-bottom-width`, and `border-left-width` on the element. If the attribute is present but parsing the attribute's value using the rules for parsing...
non-negative integers\textsuperscript{75} generates an error, a default value of 1px is expected to be used for that property instead.

Rules marked "only if border is not equivalent to zero" in the CSS block above is expected to only be applied if the border\textsuperscript{1411} attribute mentioned in the selectors for the rule is not only present but, when parsed using the rules for parsing non-negative integers\textsuperscript{75}, is also found to have a value other than zero or to generate an error.

In quirks mode, a td\textsuperscript{490} element or a th\textsuperscript{491} element that has a nowrap\textsuperscript{1411} attribute but also has a width\textsuperscript{1411} attribute whose value, when parsed using the rules for parsing nonzero dimension values\textsuperscript{78}, is found to be a length (not an error or a number classified as a percentage), is expected to have a presentational hint\textsuperscript{1370} setting the element's 'white-space' property to 'normal', overriding the rule in the CSS block above that sets it to 'nowrap'.

### 15.3.9 Margin collapsing quirks \textsuperscript{83}

A node is substantial if it is a text node that is not inter-element whitespace\textsuperscript{6145}, or if it is an element node.

A node is blank if it is an element that contains no substantial\textsuperscript{1383} nodes.

The elements with default margins are the following elements: blockquote\textsuperscript{232}, dir\textsuperscript{2406}, dl\textsuperscript{241}, h1\textsuperscript{213}, h2\textsuperscript{213}, h3\textsuperscript{213}, h4\textsuperscript{213}, h5\textsuperscript{213}, h6\textsuperscript{213}, listing\textsuperscript{1406}, menu\textsuperscript{1237}, ol\textsuperscript{223}, p\textsuperscript{226}, plaintext\textsuperscript{1406}, pre\textsuperscript{228}, ul\textsuperscript{226}, xmp\textsuperscript{1407}.

In quirks mode, any element with default margins\textsuperscript{1383} that is the child of a body\textsuperscript{202}, td\textsuperscript{490}, or th\textsuperscript{491} element and has no substantial\textsuperscript{1383} previous siblings is expected to have a user-agent level style sheet rule that sets its 'margin-block-start' property to zero.

In quirks mode, any element with default margins\textsuperscript{1383} that is the child of a body\textsuperscript{202}, td\textsuperscript{490}, or th\textsuperscript{491} element, has no substantial\textsuperscript{1383} previous siblings, and is blank\textsuperscript{1383}, is expected to have a user-agent level style sheet rule that sets its 'margin-block-end' property to zero also.

In quirks mode, any element with default margins\textsuperscript{1383} that is the child of a td\textsuperscript{490} or th\textsuperscript{491} element, has no substantial\textsuperscript{1383} following siblings, and is blank\textsuperscript{1383}, is expected to have a user-agent level style sheet rule that sets its 'margin-block-start' property to zero.

In quirks mode, any p\textsuperscript{226} element that is the child of a td\textsuperscript{490} or th\textsuperscript{491} element and has no substantial\textsuperscript{1383} following siblings, is expected to have a user-agent level style sheet rule that sets its 'margin-block-end' property to zero.

### 15.3.10 Form controls \textsuperscript{83}

CSS\textsuperscript{15.3.10}

```
@namespace "http://www.w3.org/1999/xhtml";

input, select, button, textarea {
    letter-spacing: initial;
    word-spacing: initial;
    line-height: initial;
    text-transform: initial;
    text-indent: initial;
    text-shadow: initial;
    appearance: auto;
}

input: not([type=image i], [type=range i], [type=checkbox i], [type=radio i]) {
    overflow: clip !important;
    overflow-clip-margin: 0 !important;
}

input, select, textarea {
    text-align: initial;
}
```
In *quirks mode*, the following rules are also expected to apply:

```css
@namespace "http://www.w3.org/1999/xhtml";
input:not([type=image]), textarea { box-sizing: border-box; }
```

Each kind of form control is also described in the *Widgets* section, which describes the look and feel of the control.

For `input` elements where the `type` attribute is not in the *Hidden* state or the *Image Button* state, and that are being rendered, are expected to act as follows:

- The inner display type is always 'flow-root'.

### 15.3.11 The hr element

```css
@namespace "http://www.w3.org/1999/xhtml";
hr {
  color: gray;
  border-style: inset;
  border-width: 1px;
  margin-block: 0.5em;
  margin-inline: auto;
  overflow: hidden;
}
```

The following rules are also expected to apply, as *presentational hints*:

```css
@namespace "http://www.w3.org/1999/xhtml";
hr[align=left] { margin-left: 0; margin-right: auto; }
hr[align=right] { margin-left: auto; margin-right: 0; }
hr[align=center] { margin-left: auto; margin-right: auto; }
hr[color], hr[noshade] { border-style: solid; }
```

If an hr element has either a `color` attribute or a `noshade` attribute, and furthermore also has a `size` attribute, and
parsing that attribute's value using the rules for parsing non-negative integers doesn't generate an error, then the user agent is expected to use the parsed value divided by two as a pixel length for presentational hints for the properties 'border-top-width', 'border-right-width', 'border-bottom-width', and 'border-left-width' on the element.

Otherwise, if an hr element has neither a color attribute nor a noshade attribute, but does have a size attribute, and parsing that attribute's value using the rules for parsing non-negative integers doesn't generate an error, then: if the parsed value is one, then the user agent is expected to use the attribute as a presentational hint setting the element's 'border-bottom-width' to 0; otherwise, if the parsed value is greater than one, then the user agent is expected to use the parsed value minus two as a pixel length for presentational hints for the 'height' property on the element.

The width attribute on an hr element maps to the dimension property 'width' on the element.

When an hr element has a color attribute, its value is expected to be parsed using the rules for parsing a legacy color value, and if that does not return an error, the user agent is expected to treat the attribute as a presentational hint setting the element's 'color' property to the resulting color.

### 15.3.12 The fieldset and legend elements

```css
@namespace "http://www.w3.org/1999/xhtml";

fieldset {
  display: block;
  margin-inline: 2px;
  border: groove 2px ThreeDFace;
  padding-block: 0.35em 0.625em;
  padding-inline: 0.75em;
  min-inline-size: min-content;
}

legend {
  padding-inline: 2px;
}

legend[align=left i] {
  justify-self: left;
}

legend[align=center i] {
  justify-self: center;
}

legend[align=right i] {
  justify-self: right;
}
```

The fieldset element, when it generates a CSS box, is expected to act as follows:

- The element is expected to establish a new block formatting context.
- The 'display' property is expected to act as follows:
  - If the computed value of 'display' is a value such that the outer display type is 'inline', then behave as 'inline-block'.
  - Otherwise, behave as 'flow-root.'

  **Note:** This does not change the computed value.

- If the element’s box has a child box that matches the conditions in the list below, then the first such child box is the ‘fieldset’ element’s rendered legend:
The child is a `legend` element.
- The child's used value of `float` is 'none'.
- The child's used value of `position` is not 'absolute' or 'fixed'.

- If the element has a `rendered legend`, then the border is expected to not be painted behind the rectangle defined as follows, using the writing mode of the fieldset:
  1. The block-start edge of the rectangle is the smaller of the block-start edge of the `rendered legend`'s margin rectangle at its static position (ignoring transforms), and the block-start outer edge of the `fieldset`'s border.
  2. The block-end edge of the rectangle is the larger of the block-end edge of the `rendered legend`'s margin rectangle at its static position (ignoring transforms), and the block-end outer edge of the `fieldset`'s border.
  3. The inline-start edge of the rectangle is the smaller of the inline-start edge of the `rendered legend`'s border rectangle at its static position (ignoring transforms), and the inline-start outer edge of the `fieldset`'s border.
  4. The inline-end edge of the rectangle is the larger of the inline-end edge of the `rendered legend`'s border rectangle at its static position (ignoring transforms), and the inline-end outer edge of the `fieldset`'s border.

- The space allocated for the element's border on the block-start side is expected to be the element's `border-block-start-width` or the `rendered legend`'s margin box size in the `fieldset`'s block-flow direction, whichever is greater.

- For the purpose of calculating the used `block-size`, if the computed `block-size` is not 'auto', the space allocated for the `rendered legend`'s margin box that spills out past the border, if any, is expected to be subtracted from the `block-size`. If the content box's block-size would be negative, then let the content box's block-size be zero instead.

- If the element has a `rendered legend`, then that element is expected to be the first child box.

- The `anonymous fieldset content box` is expected to appear after the `rendered legend` and is expected to contain the content (including the `:before` and `:after` pseudo-elements) of the `fieldset` element except for the `rendered legend`, if there is one.

- The used value of the `padding-top`, `padding-right`, `padding-bottom`, and `padding-left` properties are expected to be zero.

- For the purpose of calculating the min-content inline size, use the greater of the min-content inline size of the `rendered legend` and the min-content inline size of the `anonymous fieldset content box`.

- For the purpose of calculating the max-content inline size, use the greater of the max-content inline size of the `rendered legend` and the max-content inline size of the `anonymous fieldset content box`.

A `fieldset` element's `rendered legend`, if any, is expected to act as follows:

- The element is expected to establish a new formatting context for its contents. The type of this formatting context is determined by its `display` value, as usual.

- The `display` property is expected to behave as if its computed value was blockified.

  **Note**

  *This does not change the computed value.*

- If the computed value of `inline-size` is 'auto', then the used value is the `fit-content inline size`.

- The element is expected to be positioned in the inline direction as is normal for blocks (e.g., taking into account margins and the `justify-self` property).

- The element's box is expected to be constrained in the inline direction by the inline content size of the `fieldset` as if it had used its computed inline padding.

**Example**

For example, if the `fieldset` has a specified padding of 50px, then the `rendered legend` will be positioned 50px in from the `fieldset`'s border. The padding will further apply to the `anonymous fieldset content box` instead of the `fieldset` element itself.

- The element is expected to be positioned in the block-flow direction such that its border box is centered over the border on the block-start side of the `fieldset` element.

A `fieldset` element's `anonymous fieldset content box` is expected to act as follows:
• The 'display' property is expected to act as follows:
  ◦ If the computed value of 'display' on the fieldset element is 'grid' or 'inline-grid', then set the used value to 'grid'.
  ◦ If the computed value of 'display' on the fieldset element is 'flex' or 'inline-flex', then set the used value to 'flex'.
  ◦ Otherwise, set the used value to 'flow-root'.

• The following properties are expected to inherit from the fieldset element:
  ◦ 'align-content'
  ◦ 'align-items'
  ◦ 'border-radius'
  ◦ 'column-count'
  ◦ 'column-fill'
  ◦ 'column-gap'
  ◦ 'column-rule'
  ◦ 'column-width'
  ◦ 'flex-direction'
  ◦ 'flex-wrap'
  ◦ 'grid-auto-columns'
  ◦ 'grid-auto-flow'
  ◦ 'grid-auto-rows'
  ◦ 'grid-auto-columns-gap'
  ◦ 'grid-template-areas'
  ◦ 'grid-template-columns'
  ◦ 'grid-template-rows'
  ◦ 'justify-content'
  ◦ 'justify-items'
  ◦ 'justify-self'
  ◦ 'overflow'
  ◦ 'padding-bottom'
  ◦ 'padding-left'
  ◦ 'padding-right'
  ◦ 'padding-top'
  ◦ 'text-overflow'
  ◦ 'unicode-bidi'

• The 'block-size' property is expected to be set to '100%'.

• For the purpose of calculating percentage padding, act as if the padding was calculated for the fieldset element.

Note

The legend is rendered over the top border, and the top border area reserves vertical space for the legend. The fieldset's top margin starts at the top margin edge of the legend. The legend's horizontal margins, or the 'justify-self' property, gives its horizontal position. The anonymous fieldset content box appears below the legend.
15.4 Replaced elements

The following elements can be replaced elements: audio, canvas, embed, iframe, img, input, object, and video.

15.4.1 Embedded content

The embed, iframe, and video elements are expected to be treated as replaced elements.

A canvas element that represents embedded content is expected to be treated as a replaced element; the contents of such elements are the element's bitmap, if any, or else a transparent black bitmap with the same natural dimensions as the element. Other canvas elements are expected to be treated as ordinary elements in the rendering model.

An object element that represents an image, plugin, or its content navigable is expected to be treated as a replaced element. Other object elements are expected to be treated as ordinary elements in the rendering model.

The audio element, when it is exposing a user interface, is expected to be treated as a replaced element about one line high, as wide as is necessary to expose the user agent's user interface features. When an audio element is not exposing a user interface, the user agent is expected to force its 'display' property to compute to 'none', irrespective of CSS rules.

Whether a video element is exposing a user interface is not expected to affect the size of the rendering; controls are expected to be overlaid above the page content without causing any layout changes, and are expected to disappear when the user does not need them.

When a video element represents a poster frame or frame of video, the poster frame or frame of video is expected to be rendered at the largest size that maintains the aspect ratio of that poster frame or frame of video without being taller or wider than the video element itself, and is expected to be centered in the video element.

Any subtitles or captions are expected to be overlaid directly on top of their video element, as defined by the relevant rendering rules; for WebVTT, those are the rules for updating the display of WebVTT text tracks.

When the user agent starts exposing a user interface for a video element, the user agent should run the rules for updating the text track rendering of each of the text tracks in the video element's list of text tracks that are showing and whose text track kind is one of subtitles or captions (e.g., for text tracks based on WebVTT, the rules for updating the display of WebVTT text tracks).

Note

Resizing video and canvas elements does not interrupt video playback or clear the canvas.

The following CSS rules are expected to apply:

```css
@namespace "http://www.w3.org/1999/xhtml";

iframe { border: 2px inset; }
video { object-fit: contain; }
```

15.4.2 Images

User agents are expected to render img and input elements whose type attributes are in the Image Button state, according to the first applicable rules from the following list:

- If the element represents an image
  The user agent is expected to treat the element as a replaced element and render the image according to the rules for doing so defined in CSS.
If the element does not represent an image and either:

- the user agent has reason to believe that the image will become available and be rendered in due course, or
- the element has no alt attribute, or
- the Document is in quirks mode, and the element already has natural dimensions (e.g., from the dimension attributes or CSS rules)

The user agent is expected to treat the element as a replaced element whose content is the text that the element represents, if any, optionally alongside an icon indicating that the image is being obtained (if applicable). For input elements, the element is expected to appear button-like to indicate that the element is a button.

If the element is an img element that represents some text and the user agent does not expect this to change

The user agent is expected to treat the element as a non-replaced phrasing element whose content is the text, optionally with an icon indicating that an image is missing, so that the user can request the image be displayed or investigate why it is not rendering. In non-graphical contexts, such an icon should be omitted.

If the element is an img element that represents nothing and the user agent does not expect this to change

The user agent is expected to treat the element as a replaced element whose natural dimensions are 0. (In the absence of further styles, this will cause the element to essentially not be rendered.)

If the element is an input element that does not represent an image and the user agent does not expect this to change

The user agent is expected to treat the element as a replaced element consisting of a button whose content is the element's alternative text. The natural dimensions of the button are expected to be about one line in height and whatever width is necessary to render the text on one line.

The icons mentioned above are expected to be relatively small so as not to disrupt most text but be easily clickable. In a visual environment, for instance, icons could be 16 pixels by 16 pixels square, or 1em by 1em if the images are scalable. In an audio environment, the icon could be a short bleep. The icons are intended to indicate to the user that they can be used to get to whatever options the UA provides for images, and, where appropriate, are expected to provide access to the context menu that would have come up if the user interacted with the actual image.

All animated images with the same absolute URL and the same image data are expected to be rendered synchronized to the same timeline as a group, with the timeline starting at the time of the least recent addition to the group.

Note

In other words, when a second image with the same absolute URL and animated image data is inserted into a document, it jumps to the point in the animation cycle that is currently being displayed by the first image.

When a user agent is to restart the animation for an img element showing an animated image, all animated images with the same absolute URL and the same image data in that img element's node document are expected to restart their animation from the beginning.

The following CSS rules are expected to apply:

```css
@namespace "http://www.w3.org/1999/xhtml";

img:is([sizes="auto" i], [sizes="auto," i]) {
  contain: size !important;
  contain-intrinsic-size: 300px 150px;
}
```

The following CSS rules are expected to apply when the Document is in quirks mode:

```css
@namespace "http://www.w3.org/1999/xhtml";

img[align=left] { margin-right: 3px; }
img[align=right] { margin-left: 3px; }
```
The following CSS rules are expected to apply as presentational hints:

```css
@namespace "http://www.w3.org/1999/xhtml";

iframe[frameborder='0'], iframe[frameborder=no i] {
  border: none;
}
embed[align=left i], iframe[align=left i], img[align=left i], input[type=image i][align=left i], object[align=left i] {
  float: left;
}
embed[align=right i], iframe[align=right i], img[align=right i], input[type=image i][align=right i], object[align=right i] {
  float: right;
}
embed[align=top i], iframe[align=top i], img[align=top i], input[type=image i][align=top i], object[align=top i] {
  vertical-align: top;
}
embed[align=baseline i], iframe[align=baseline i], img[align=baseline i], input[type=image i][align=baseline i], object[align=baseline i] {
  vertical-align: baseline;
}
embed[align=texttop i], iframe[align=texttop i], img[align=texttop i], input[type=image i][align=texttop i], object[align=texttop i] {
  vertical-align: text-top;
}
embed[align=absmiddle i], iframe[align=absmiddle i], img[align=absmiddle i], input[type=image i][align=absmiddle i], object[align=absmiddle i], embed[align=abscenter i], iframe[align=abscenter i], img[align=abscenter i], input[type=image i][align=abscenter i], object[align=abscenter i] {
  vertical-align: middle;
}
embed[align=bottom i], iframe[align=bottom i], img[align=bottom i], input[type=image i][align=bottom i], object[align=bottom i] {
  vertical-align: bottom;
}
```

When an `embed`, `iframe`, `img`, or `object` element, or an `input` element whose `type` attribute is in the Image Button state, has an align attribute whose value is an ASCII case-insensitive match for the string "center" or the string "middle", the user agent is expected to act as if the element's `vertical-align` property was set to a value that aligns the vertical middle of the element with the parent element's baseline.

The `hspace` attribute of `embed`, `img`, or `object` elements, and `input` elements with a `type` attribute in the Image Button state, maps to the dimension properties 'margin-left' and 'margin-right' on the element.

The `vspace` attribute of `embed`, `img`, or `object` elements, and `input` elements with a `type` attribute in the Image Button state, maps to the dimension properties 'margin-top' and 'margin-bottom' on the element.

When an `img` element, `object` element, or `input` element with a `type` attribute in the Image Button state has a border attribute whose value, when parsed using the rules for parsing non-negative integers, is found to be a number greater than zero, the user agent is expected to use the parsed value for eight presentational hints: four setting the parsed value as a pixel length for the element's 'border-top-width', 'border-right-width', 'border-bottom-width', and 'border-left-width' properties, and four setting the element's 'border-top-style', 'border-right-style', 'border-bottom-style', and 'border-left-style' properties to the value 'solid'.

The `width` and `height` attributes on an `img` element's dimension attribute source map to the dimension properties.
The `width` and `height` on the `img` element respectively. They similarly map to the aspect-ratio property (using dimension rules) of the `img` element.

The `width` and `height` attributes on `embed`, `iframe`, `object`, and `video` elements, and `input` elements with a `type` attribute in the `Image Button` state and that either represents an image or that the user expects will eventually represent an image, map to the dimension properties `width` and `height` on the element respectively.

The `width` and `height` attributes map to the aspect-ratio property (using dimension rules) of `img` and `video` elements, and `input` elements with a `type` attribute in the `Image Button` state.

The `width` and `height` attributes map to the aspect-ratio property on `canvas` elements.

Shapes on an `image map` are expected to act, for the purpose of the CSS cascade, as elements independent of the original `area` element that happen to match the same style rules but inherit from the `img` or `object` element.

For the purposes of the rendering, only the `cursor` property is expected to have any effect on the shape.

Example

Thus, for example, if an `area` element has a `style` attribute that sets the `cursor` property to 'help', then when the user designates that shape, the cursor would change to a Help cursor.

Example

Similarly, if an `area` element had a CSS rule that set its `cursor` property to 'inherit' (or if no rule setting the `cursor` property matched the element at all), the shape's cursor would be inherited from the `img` or `object` element of the `image map`, not from the parent of the `area` element.

15.5 Widgets

15.5.1 Native appearance

The CSS Basic User Interface specification calls elements that can have a native appearance widgets, and defines whether to use that native appearance depending on the `appearance` property. That logic, in turn, depends on whether on whether each the element is classified as a devolvable widget or non-devolvable widget. This section defines which elements match these concepts for HTML, what their native appearance is, and any particularity of their `devolved` state or `primitive appearance`. [CSSUI]

The following elements can have a native appearance for the purpose of the CSS `appearance` property.

- `button`
- `input`
- `meter`
- `progress`
- `select`
- `textarea`

15.5.2 Writing mode

Several widgets have their rendering controlled by the `writing-mode` CSS property. For the purposes of those widgets, we have the following definitions.

A horizontal writing mode is when resolving the `writing-mode` property of the control results in a computed value of 'horizontal-tb'.

A vertical writing mode is when resolving the `writing-mode` property of the control results in a computed value of either 'vertical-rl', 'vertical-lr', 'sideways-rl' or 'sideways-lr'.
15.5.3 Button layout

When an element uses button layout, it is a devolvable widget, and its native appearance is that of a button.

Button layout is as follows:

- If the element is a button element, then the `display` property is expected to act as follows:
  - If the computed value of `display` is 'inline-grid', 'grid', 'inline-flex', 'flex', 'none', or 'contents', then behave as the computed value.
  - Otherwise, if the computed value of `display` is a value such that the outer display type is 'inline', then behave as 'inline-block'.
  - Otherwise, behave as 'flow-root'.
- The element is expected to establish a new formatting context for its contents. The type of this formatting context is determined by its `display` value, as usual.
- If the element is absolutely-positioned, then for the purpose of the CSS visual formatting model, act as if the element is a replaced element. [CSS]
- If the computed value of 'inline-size' is 'auto', then the used value is the fit-content inline size.
- For the purpose of the 'normal' keyword of the `align-self` property, act as if the element is a replaced element.
- If the element is an input element, or if it is a button element and its computed value for `display` is not 'inline-grid', 'grid', 'inline-flex', or 'flex', then the element's box has a child anonymous button content box with the following behaviors:
  - The box is a block-level block container that establishes a new block formatting context (i.e., `display` is 'flow-root').
  - If the box does not overflow in the horizontal axis, then it is centered horizontally.
  - If the box does not overflow in the vertical axis, then it is centered vertically.
- Otherwise, there is no anonymous button content box.

Need to define the expected primitive appearance.

15.5.4 The button element

The button element, when it generates a CSS box, is expected to depict a button and to use button layout whose anonymous button content box's contents (if there is an anonymous button content box) are the child boxes the element's box would otherwise have.

15.5.5 The details and summary elements

```css
@namespace "http://www.w3.org/1999/xhtml";

details > summary:first-of-type {
  display: list-item;
  counter-increment: list-item 0;
  list-style: disclosure-closed inside;
}
details[open] > summary:first-of-type {
  list-style-type: disclosure-open;
}
```

The details element is expected to render as a block box. The element is also expected to have an internal shadow tree with two slots. The first slot is expected to take the details element's first summary element child, if any. The second slot is expected to
take the details\textsuperscript{p632} element's remaining descendants, if any.

The details\textsuperscript{p632} element's first summary\textsuperscript{p639} element child, if any, is expected to allow the user to request the details be shown or hidden.

The details\textsuperscript{p632} element's second slot is expected to have its style\textsuperscript{p161} attribute set to "display: block; content-visibility: hidden;" when the details\textsuperscript{p632} element does not have an open\textsuperscript{p633} attribute. When it does have the open\textsuperscript{p633} attribute, the style\textsuperscript{p161} attribute is expected to be removed from the second slot.

Note
Because the slots are hidden inside a shadow tree, this style\textsuperscript{p161} attribute is not directly visible to author code. Its impacts, however, are visible. Notably, the choice of content-visibility: hidden instead of, e.g., display: none, impacts the results of various APIs that query layout information.

15.5.6 The input\textsuperscript{p517} element as a text entry widget \textsuperscript{p913}\textsuperscript{93}

An input\textsuperscript{p517} element whose type\textsuperscript{p519} attribute is in the Text\textsuperscript{p524}, Telephone\textsuperscript{p524}, URL\textsuperscript{p525}, or Email\textsuperscript{p526} state is a devolvable widget. Its expected native appearance is to render as an 'inline-block' box depicting a one-line text control.

An input\textsuperscript{p517} element whose type\textsuperscript{p519} attribute is in the Search\textsuperscript{p524} state is a devolvable widget. Its expected native appearance is to render as an 'inline-block' box depicting a one-line text control. If the computed value of the element's 'appearance' property is not 'textfield', it may have a distinct style indicating that it is a search field.

An input\textsuperscript{p517} element whose type\textsuperscript{p519} attribute is in the Password\textsuperscript{p528} state is a devolvable widget. Its expected native appearance is to render as an 'inline-block' box depicting a one-line text control that obscures data entry.

For input\textsuperscript{p517} elements whose type\textsuperscript{p519} attribute is in one of the above states, the used value of the 'line-height' property must be a length value that is no smaller than what the used value would be for 'line-height: normal'.

Note
The used value will not be the actual keyword 'normal'. Also, this rule does not affect the computed value.

If these text controls provide a text selection, then, when the user changes the current selection, the user agent is expected to queue an element task\textsuperscript{p1107} on the user interaction task source\textsuperscript{p1115} given the input\textsuperscript{p517} element to fire an event named select\textsuperscript{p1452} at the element, with the bubbles attribute initialized to true.

An input\textsuperscript{p517} element whose type\textsuperscript{p519} attribute is in one of the above states is an element with default preferred size, and user agents are expected to apply the 'field-sizing' CSS property to the element. User agents are expected to determine the inline size of its intrinsic size by the following steps:

1. If the 'field-sizing' property on the element has a computed value of 'content', the inline size is determined by the text which the element shows. The text is either a value\textsuperscript{p593} or a short hint specified by the placeholder\textsuperscript{p555} attribute. User agents may take the text caret size into account in the inline size.

2. If the element has a size\textsuperscript{p547} attribute, and parsing that attribute's value using the rules for parsing non-negative integers\textsuperscript{p75} doesn't generate an error, return the value obtained from applying the converting a character width to pixels\textsuperscript{p1393} algorithm to the value of the attribute.

3. Otherwise, return the value obtained from applying the converting a character width to pixels\textsuperscript{p1393} algorithm to the number 20.

The converting a character width to pixels algorithm returns (size-1)\times\text{avg} + \text{max}, where size is the character width to convert, \text{avg} is the average character width of the primary font for the element for which the algorithm is being run, in pixels, and \text{max} is the maximum character width of that same font, also in pixels. (The element's 'letter-spacing' property does not affect the result.)

These text controls are expected to be scroll containers and support scrolling in the inline axis, but not the block axis.

Need to detail the expected native appearance and primitive appearance.
15.5.7 The `input` element as domain-specific widgets

An `input` element whose `type` attribute is in the `Date` state is a devolvable widget expected to render as an 'inline-block' box depicting a date control.

An `input` element whose `type` attribute is in the `Month` state is a devolvable widget expected to render as an 'inline-block' box depicting a month control.

An `input` element whose `type` attribute is in the `Week` state is a devolvable widget expected to render as an 'inline-block' box depicting a week control.

An `input` element whose `type` attribute is in the `Time` state is a devolvable widget expected to render as an 'inline-block' box depicting a time control.

An `input` element whose `type` attribute is in the `Local Date and Time` state is a devolvable widget expected to render as an 'inline-block' box depicting a local date and time control.

An `input` element whose `type` attribute is in the `Number` state is a devolvable widget expected to render as an 'inline-block' box depicting a number control.

An `input` element whose `type` attribute is in the `Number` state is an element with default preferred size, and user agents are expected to apply the 'field-sizing' CSS property to the element. The block size of the intrinsic size is about one line high. If the 'field-sizing' property on the element has a computed value of 'content', the inline size of the intrinsic size is expected to be about as wide as necessary to show the current value. Otherwise, the inline size of the intrinsic size is expected to be about as wide as necessary to show the widest possible value.

An `input` element whose `type` attribute is in the `Date`, `Month`, `Week`, `Time`, or `Local Date and Time` state is expected to be about one line high, and about as wide as necessary to show the widest possible value.

Need to detail the expected native appearance and primitive appearance.

15.5.8 The `input` element as a range control

An `input` element whose `type` attribute is in the `Range` state is a non-devolvable widget. Its expected native appearance is to render as an 'inline-block' box depicting a slider control.

When this control has a horizontal writing mode, the control is expected to be a horizontal slider. Its lowest value is on the right if the 'direction' property has a computed value of 'rtl', and on the left otherwise. When this control has a vertical writing mode, it is expected to be a vertical slider. Its lowest value is on the bottom if the 'direction' property has a computed value of 'rtl', and on the top otherwise.

Predefined suggested values (provided by the `list` attribute) are expected to be shown as tick marks on the slider, which the slider can snap to.

Need to detail the expected primitive appearance.

15.5.9 The `input` element as a color well

An `input` element whose `type` attribute is in the `Color` state is expected to depict a color well, which, when activated, provides the user with a color picker (e.g. a color wheel or color palette) from which the color can be changed. The element, when it generates a CSS box, is expected to use button layout, that has no child boxes of the anonymous button content box. The anonymous button content box is expected to have a presentational hint setting the 'background-color' property to the element's value.

Predefined suggested values (provided by the `list` attribute) are expected to be shown in the color picker interface, not on the color well itself.
15.5.10 The `input` element as a checkbox and radio button widgets

An `input` element whose `type` attribute is in the `Checkbox` state is a non-devolvable widget expected to render as an ‘inline-block’ box containing a single checkbox control, with no label.

An `input` element whose `type` attribute is in the `Radio Button` state is a non-devolvable widget expected to render as an ‘inline-block’ box containing a single radio button control, with no label.

15.5.11 The `input` element as a file upload control

An `input` element whose `type` attribute is in the `File Upload` state, when it generates a CSS box, is expected to render as an ‘inline-block’ box containing a span of text giving the filename(s) of the selected files, if any, followed by a button that, when activated, provides the user with a file picker from which the selection can be changed. The button is expected to use `button layout` and match the `::file-selector-button` pseudo-element. The contents of its anonymous button content box are expected to be implementation-defined (and possibly locale-specific) text, for example “Choose file”.

User agents may handle an `input` element whose `type` attribute is in the `File Upload` state as an element with default preferred size, and user agents may apply the `field-sizing` CSS property to the element. If the `field-sizing` property on the element has a computed value of ‘content’, the intrinsic size of the element is expected to depend on its content such as the `::file-selector-button` pseudo-element and chosen file names.

15.5.12 The `input` element as a button

An `input` element whose `type` attribute is in the `Submit Button`, `Reset Button`, or `Button` state, when it generates a CSS box, is expected to depict a button and use `button layout` and the contents of the anonymous button content box are expected to be the text of the element’s `value` attribute, if any, or text derived from the element’s `type` attribute in an implementation-defined (and probably locale-specific) fashion, if not.

15.5.13 The `marquee` element

CSS

```css
@namespace "http://www.w3.org/1999/xhtml";

marquee {
  display: inline-block;
  text-align: initial;
  overflow: hidden !important;
}
```

The `marquee` element, while turned on, is expected to render in an animated fashion according to its attributes as follows:

If the element’s `behavior` attribute is in the `scroll` state

Slide the contents of the element in the direction described by the `direction` attribute as defined below, such that it begins off the start side of the `marquee`, and ends flush with the inner end side.
Example
For example, if the `direction` attribute is `left` (the default), then the contents would start such that their left edge are off the side of the right edge of the `marquee`'s content area, and the contents would then slide up to the point where the left edge of the contents are flush with the left inner edge of the `marquee`'s content area.

Once the animation has ended, the user agent is expected to increment the marquee current loop index. If the element is still turned on, after this, then the user agent is expected to restart the animation.

If the element's `behavior` attribute is in the `slide` state
Slide the contents of the element in the direction described by the `direction` attribute as defined below, such that it begins off the start side of the `marquee`, and ends off the end side of the `marquee`.

Example
For example, if the `direction` attribute is `left` (the default), then the contents would start such that their left edge are off the side of the right edge of the `marquee`'s content area, and the contents would then slide up to the point where the right edge of the contents are flush with the left inner edge of the `marquee`'s content area.

Once the animation has ended, the user agent is expected to increment the marquee current loop index. If the element is still turned on, after this, then the user agent is expected to restart the animation.

If the element's `behavior` attribute is in the `alternate` state
When the `marquee current loop index` is even (or zero), slide the contents of the element in the direction described by the `direction` attribute as defined below, such that it begins flush with the start side of the `marquee`, and ends flush with the end side of the `marquee`.

When the `marquee current loop index` is odd, slide the contents of the element in the opposite direction than that described by the `direction` attribute as defined below, such that it begins flush with the end side of the `marquee`, and ends flush with the start side of the `marquee`.

Example
For example, if the `direction` attribute is `left` (the default), then the contents would with their right edge flush with the right inner edge of the `marquee`'s content area, and the contents would then slide up to the point where the left edge of the contents are flush with the left inner edge of the `marquee`'s content area.

Once the animation has ended, the user agent is expected to increment the marquee current loop index. If the element is still turned on, after this, then the user agent is expected to continue the animation.

The `direction` attribute has the meanings described in the following table:

<table>
<thead>
<tr>
<th>direction attribute</th>
<th>Direction of animation</th>
<th>Start edge</th>
<th>End edge</th>
<th>Opposite direction</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>left</code></td>
<td>← Right to left</td>
<td>Right</td>
<td>Left</td>
<td>→ Left to Right</td>
</tr>
<tr>
<td><code>right</code></td>
<td>→ Left to Right</td>
<td>Left</td>
<td>Right</td>
<td>← Right to left</td>
</tr>
<tr>
<td><code>up</code></td>
<td>↑ Up (Bottom to Top)</td>
<td>Bottom</td>
<td>Top</td>
<td>↓ Down (Top to Bottom)</td>
</tr>
<tr>
<td><code>down</code></td>
<td>↓ Down (Bottom to Top)</td>
<td>Top</td>
<td>Bottom</td>
<td>↑ Up (Bottom to Top)</td>
</tr>
</tbody>
</table>

In any case, the animation should proceed such that there is a delay given by the `marquee scroll interval` between each frame, and such that the content moves at most the distance given by the `marquee scroll distance` with each frame.

When a `marquee` element has a `bgcolor` attribute set, the value is expected to be parsed using the rules for parsing a legacy color value, and if that does not return an error, the user agent is expected to treat the attribute as a `presentational hint` setting the element's `background-color` property to the resulting color.

The `width` and `height` attributes on a `marquee` element map to the dimension properties `width` and `height` on the element respectively.

The `natural height` of a `marquee` element with its `direction` attribute in the `up` or `down` states is 200 CSS pixels.

The `vspace` attribute of a `marquee` element maps to the dimension properties `margin-top` and `margin-bottom` on the element. The `hspace` attribute of a `marquee` element maps to the dimension properties `margin-left` and `margin-right` on the element.
The `meter` element is a devolvable widget. Its expected native appearance is to render as an `inline-block` box with a `block-size` of '1em' and a `inline-size` of '5em', and with its contents depicting a gauge.

When this element has a horizontal writing mode, the depiction is expected to be of a horizontal gauge. Its minimum value is on the right if the `direction` property has a computed value of 'rtl', and on the left otherwise. When this element has a vertical writing mode, it is expected to depict a vertical gauge. Its minimum value is on the bottom if the `direction` property has a computed value of 'rtl', and on the top otherwise.

User agents are expected to use a presentation consistent with platform conventions for gauges, if any.

**Note**

Requirements for what must be depicted in the gauge are included in the definition of the `meter` element.

Need to detail the expected primitive appearance.

The `progress` element is a devolvable widget. Its expected native appearance is to render as an `inline-block` box with a `block-size` of '1em' and a `inline-size` of '10em', and a `vertical-align` of '-0.2em'.

When the this element has a horizontal writing mode, the element is expected to be depicted as a horizontal progress bar. The start is on the right and the end is on the left if the `direction` property on this element has a computed value of 'rtl', and with the start on the left and the end on the right otherwise. When this element has a vertical writing mode, it is expected to be depicted as a vertical progress bar. The start is on the bottom and the end is on the top if the `direction` property on this element has a computed value of 'rtl', and with the start on the top and the end on the bottom otherwise.

User agents are expected to use a presentation consistent with platform conventions for progress bars. In particular, user agents are expected to use different presentations for determinate and indeterminate progress bars. User agents are also expected to vary the presentation based on the dimensions of the element.

**Note**

Requirements for how to determine if the progress bar is determinate or indeterminate, and what progress a determinate progress bar is to show, are included in the definition of the `progress` element.

Need to detail the expected primitive appearance.
15.5.16 The `select` element

The `select` element is an element with default preferred size, and user agents are expected to apply the 'field-sizing' CSS property to `select` elements.

A `select` element is either a list box or a drop-down box, depending on its attributes.

A `select` element whose `multiple` attribute is present is expected to render as a multi-select list box.

A `select` element whose `multiple` attribute is absent, and whose `display size` is greater than 1, is expected to render as a single-select list box.

When the element renders as a list box, it is a devolvable widget expected to render as an 'inline-block' box. The inline size of its intrinsic size is the width of the `select`'s labels plus the width of a scrollbar. The block size of its intrinsic size is determined by the following steps:

1. If the 'field-sizing' property on the element has a computed value of 'content', return the height necessary to contain all rows for items.
2. If the size attribute is absent or it has no valid value, return the height necessary to contain four rows.
3. Otherwise, return the height necessary to contain as many rows for items as given by the element's display size.

A `select` element whose `multiple` attribute is absent, and whose `display size` is 1, is expected to render as an 'inline-block' one-line drop-down box. The inline size of its intrinsic size is the width of the `select`'s labels. If the 'field-sizing' property on the element has a computed value of 'content', the inline size of the intrinsic size depends on the shown text. The shown text is typically the label of an option of which selectedness is set to true.

When the element renders as a drop-down box, it is a devolvable widget. Its appearance in the devolved state, as well as its appearance when the computed value of the element's appearance property is 'menu-list-button', is that of a drop-down box, including a "drop-down button", but not necessarily rendered using a native control of the host operating system. In such a state, CSS properties such as 'color', 'background-color', and 'border' should not be disregarded (as is generally permissible when rendering an element according to its native appearance).

In either case (list box or drop-down box), the element's items are expected to be the element's list of options, with the element's optgroup element children providing headers for groups of options where applicable.

An optgroup element is expected to be rendered by displaying the element's label attribute.

An option element is expected to be rendered by displaying the element's label, indented under its optgroup element if it has one.

Each sequence of one or more child element siblings may be rendered as a single separator.

The width of the `select`'s labels is the wider of the width necessary to render the widest optgroup, and the width necessary to render the widest option element in the element's list of options (including its indent, if any).

If a `select` element contains a placeholder label option, the user agent is expected to render that option in a manner that conveys that it is a label, rather than a valid option of the control. This can include preventing the placeholder label option from being explicitly selected by the user. When the placeholder label option's selectedness is true, the control is expected to be displayed in a fashion that indicates that no valid option is currently selected.

User agents are expected to render the labels in a `select` in such a manner that any alignment remains consistent whether the label is being displayed as part of the page or in a menu control.

Need to detail the expected native appearance and primitive appearance.

15.5.17 The `textarea` element

The `textarea` element is a devolvable widget expected to render as an 'inline-block' box depicting a multiline text control. If this multiline text control provides a selection, then, when the user changes the current selection, the user agent is expected to queue an element task on the user interaction task source given the `textarea` element to fire an event named select at the
element, with the `bubbles` attribute initialized to true.

The `textarea` element is an element with default preferred size, and user agents are expected to apply the `field-sizing` CSS property to `textarea` elements.

If the `field-sizing` property on the element has a computed value of `content`, the intrinsic size is determined from the text which the element shows. The text is either a raw value or a hint specified by the `placeholder` attribute. User agents may take the text caret size into account in the intrinsic size. Otherwise, its intrinsic size is computed from `textarea effective width` and `textarea effective height` (as defined below).

The `textarea effective width` of a `textarea` element is `size×avg + sbw`, where `size` is the element's character width, `avg` is the average character width of the primary font of the element, in CSS pixels, and `sbw` is the width of a scrollbar, in CSS pixels. (The element's `letter-spacing` property does not affect the result.)

The `textarea effective height` of a `textarea` element is the height in CSS pixels of the number of lines specified the element's character height, plus the height of a scrollbar in CSS pixels.

User agents are expected to apply the `white-space` CSS property to `textarea` elements. For historical reasons, if the element has a `wrap` attribute whose value is an ASCII case-insensitive match for the string "off", then the user agent is expected to treat the attribute as a presentational hint setting the element's `white-space` property to 'pre'.

**15.6 Frames and framesets**

User agent are expected to render `frameset` elements as a box with the height and width of the `viewport`, with a surface rendered according to the following layout algorithm:

1. The `cols` and `rows` variables are lists of zero or more pairs consisting of a number and a unit, the unit being one of `percentage`, `relative`, and `absolute`.

   Use the rules for parsing a list of dimensions to parse the value of the element's `cols` attribute, if there is one. Let `cols` be the result, or an empty list if there is no such attribute.

   Use the rules for parsing a list of dimensions to parse the value of the element's `rows` attribute, if there is one. Let `rows` be the result, or an empty list if there is no such attribute.

2. For any of the entries in `cols` or `rows` that have the number zero and the unit `relative`, change the entry's number to one.

3. If `cols` has no entries, then add a single entry consisting of the value 1 and the unit `relative` to `cols`.

   If `rows` has no entries, then add a single entry consisting of the value 1 and the unit `relative` to `rows`.

4. Invoke the algorithm defined below to convert a list of dimensions to a list of pixel values using `cols` as the input list, and the width of the surface that the `frameset` is being rendered into, in CSS pixels, as the input dimension. Let sized `cols` be the resulting list.

   Invoke the algorithm defined below to convert a list of dimensions to a list of pixel values using `rows` as the input list, and the height of the surface that the `frameset` is being rendered into, in CSS pixels, as the input dimension. Let sized `rows` be the resulting list.

5. Split the surface into a grid of `w×h` rectangles, where `w` is the number of entries in sized `cols` and `h` is the number of entries in sized `rows`.

   Size the columns so that each column in the grid is as many CSS pixels wide as the corresponding entry in the sized `cols` list.

   Size the rows so that each row in the grid is as many CSS pixels high as the corresponding entry in the sized `rows` list.

6. Let `children` be the list of `frame` and `frameset` elements that are `children` of the `frameset` element for which the algorithm was invoked.

7. For each row of the grid of rectangles created in the previous step, from top to bottom, run these substeps:

   1. For each rectangle in the row, from left to right, run these substeps:
1. If there are any elements left in children, take the first element in the list, and assign it to the rectangle.

If this is a frameset element, then recurse the entire frameset layout algorithm for that frameset element, with the rectangle as the surface.

Otherwise, it is a frame element; render its content navigable, positioned and sized to fit the rectangle.

2. If there are any elements left in children, remove the first element from children.

8. If the frameset element has a border, draw an outer set of borders around the rectangles, using the element's frame border color.

For each rectangle, if there is an element assigned to that rectangle, and that element has a border, draw an inner set of borders around that rectangle, using the element's frame border color.

For each (visible) border that does not abut a rectangle that is assigned a frame element with a noresize attribute (including rectangles in further nested frameset elements), the user agent is expected to allow the user to move the border, resizing the rectangles within, keeping the proportions of any nested frameset grids.

A frameset or frame element has a border if the following algorithm returns true:

1. If the element has a frameborder attribute whose value is not the empty string and whose first character is either a U+0031 DIGIT ONE (1) character, a U+0079 LATIN SMALL LETTER Y character (y), or a U+0059 LATIN CAPITAL LETTER Y character (Y), then return true.

2. Otherwise, if the element has a frameborder attribute, return false.

3. Otherwise, if the element has a parent element that is a frameset element, then return true if that element has a border, and false if it does not.

4. Otherwise, return true.

The frame border color of a frameset or frame element is the color obtained from the following algorithm:

1. If the element has a bordercolor attribute, and applying the rules for parsing a legacy color value to that attribute's value does not result in an error, then return the color so obtained.

2. Otherwise, if the element has a parent element that is a frameset element, then return the frame border color of that element.

3. Otherwise, return gray.

The algorithm to convert a list of dimensions to a list of pixel values consists of the following steps:

1. Let input list be the list of numbers and units passed to the algorithm.

   Let output list be a list of numbers the same length as input list, all zero.

   Entries in output list correspond to the entries in input list that have the same position.

2. Let input dimension be the size passed to the algorithm.

3. Let count percentage be the number of entries in input list whose unit is percentage.

   Let total percentage be the sum of all the numbers in input list whose unit is percentage.

   Let count relative be the number of entries in input list whose unit is relative.

   Let total relative be the sum of all the numbers in input list whose unit is relative.

   Let count absolute be the number of entries in input list whose unit is absolute.

   Let total absolute be the sum of all the numbers in input list whose unit is absolute.

   Let remaining space be the value of input dimension.

4. If total absolute is greater than remaining space, then for each entry in input list whose unit is absolute, set the corresponding value in output list to the number of the entry in input list multiplied by remaining space and divided by total absolute. Then, set remaining space to zero.
Otherwise, for each entry in input list whose unit is absolute, set the corresponding value in output list to the number of the entry in input list. Then, decrement remaining space by total absolute.

5. If total percentage multiplied by the input dimension and divided by 100 is greater than remaining space, then for each entry in input list whose unit is percentage, set the corresponding value in output list to the number of the entry in input list multiplied by remaining space and divided by total percentage. Then, set remaining space to zero.

Otherwise, for each entry in input list whose unit is percentage, set the corresponding value in output list to the number of the entry in input list multiplied by the input dimension and divided by 100. Then, decrement remaining space by total percentage multiplied by the input dimension and divided by 100.

6. For each entry in input list whose unit is relative, set the corresponding value in output list to the number of the entry in input list multiplied by remaining space and divided by total relative.

7. Return output list.

User agents working with integer values for frame widths (as opposed to user agents that can lay frames out with subpixel accuracy) are expected to distribute the remainder first to the last entry whose unit is relative, then equally (not proportionally) to each entry whose unit is percentage, then equally (not proportionally) to each entry whose unit is absolute, and finally, failing all else, to the last entry.

The contents of a frame element that does not have a frameset parent are expected to be rendered as transparent black; the user agent is expected to not render its content navigable in this case, and its content navigable is expected to have a viewport with zero width and zero height.

15.7 Interactive media

15.7.1 Links, forms, and navigation

User agents are expected to allow the user to control aspects of hyperlink activation and form submission, such as which navigable is to be used for the subsequent navigation.

User agents are expected to allow users to discover the destination of hyperlinks and of forms before triggering their navigation.

User agents may allow users to navigate to the URLs indicated by the cite attributes on q, blackquote, ins, and del elements.

User agents may surface created by link elements in their user interface, as discussed previously.

15.7.2 The title attribute

User agents are expected to expose the advisory information of elements upon user request, and to make the user aware of the presence of such information.

On interactive graphical systems where the user can use a pointing device, this could take the form of a tooltip. When the user is unable to use a pointing device, then the user agent is expected to make the content available in some other fashion, e.g. by making the element a focusable area and always displaying the advisory information of the currently focused element, or by showing the advisory information of the elements under the user’s finger on a touch device as the user pans around the screen.

U+000A LINE FEED (LF) characters are expected to cause line breaks in the tooltip; U+0009 CHARACTER TABULATION (tab) characters are expected to render as a nonzero horizontal shift that lines up the next glyph with the next tab stop, with tab stops occurring at points that are multiples of 8 times the width of a U+0020 SPACE character.
For example, a visual user agent could make elements with a `title` attribute focusable, and could make any focused element with a `title` attribute show its tooltip under the element while the element has focus. This would allow a user to tab around the document to find all the advisory text.

**Example**
As another example, a screen reader could provide an audio cue when reading an element with a tooltip, with an associated key to read the last tooltip for which a cue was played.

### 15.7.3 Editing hosts
The current text editing caret (i.e. the active range, if it is empty and in an editing host), if any, is expected to act like an inline replaced element with the vertical dimensions of the caret and with zero width for the purposes of the CSS rendering model.

**Note**
*This means that even an empty block can have the caret inside it, and that when the caret is in such an element, it prevents margins from collapsing through the element.*

### 15.7.4 Text rendered in native user interfaces
User agents are expected to honor the Unicode semantics of text that is exposed in user interfaces, for example supporting the bidirectional algorithm in text shown in dialogs, title bars, popup menus, and tooltips. Text from the contents of elements is expected to be rendered in a manner that honors the directionality of the element from which the text was obtained. Text from attributes is expected to be rendered in a manner that honours the directionality of the attribute.

**Example**
Consider the following markup, which has Hebrew text asking for a programming language, the languages being text for which a left-to-right direction is important given the punctuation in some of their names:

```html
<p dir="rtl" lang="he">
  <label>בחר שפת תכנות:</label>
  <select>
    <option dir="ltr">C++</option>
    <option dir="ltr">C#</option>
    <option dir="ltr">FreePascal</option>
    <option dir="ltr">F#</option>
  </select>
</p>
```

If the `select` element was rendered as a drop down box, a correct rendering would ensure that the punctuation was the same both in the drop down, and in the box showing the current selection.

**Example**
The directionality of attributes depends on the attribute and on the element's `dir` attribute, as the following example
A string provided by a script (e.g. the argument to `window.alert()` is expected to be treated as an independent set of one or more bidirectional algorithm paragraphs when displayed, as defined by the bidirectional algorithm, including, for instance, supporting the paragraph-breaking behavior of U+000A LINE FEED (LF) characters. For the purposes of determining the paragraph level of such text in the bidirectional algorithm, this specification does not provide a higher-level override of rules P2 and P3.

When necessary, authors can enforce a particular direction for a given paragraph by starting it with the Unicode U+200E LEFT-TO-RIGHT MARK or U+200F RIGHT-TO-LEFT MARK characters.

Example

Thus, the following script:

```javascript
alert('"לא אفهم HTML!" (not "אני HTML!"), regardless of the language of the user agent interface or the direction of the page or any of its elements.

Example

For a more complex example, consider the following script:

```javascript
/* Warning: this script does not handle right-to-left scripts correctly */
var s;
if (s = prompt('What is your name?')) {
  alert(s + '! Ok, Fred, ' + s + ', and Wilma will get the car.');
}
```
15.8 Print media

User agents are expected to allow the user to request the opportunity to **obtain a physical form** (or a representation of a physical form) of a `Document`. For example, selecting the option to print a page or convert it to PDF format. [PDF]

When the user actually **obtains a physical form** (or a representation of a physical form) of a `Document`, the user agent is expected to create a new rendering of the `Document` for the print media.

15.9 Unstyled XML documents

HTML user agents may, in certain circumstances, find themselves rendering non-HTML documents that use vocabularies for which they lack any built-in knowledge. This section provides for a way for user agents to handle such documents in a somewhat useful manner.

While a `Document` is an **unstyled document**, the user agent is expected to render an **unstyled document view**.

A `Document` is an **unstyled document** while it matches the following conditions:

- The `Document` has no author style sheets (whether referenced by HTTP headers, processing instructions, elements like `link`, inline elements like `style`, or any other mechanism).
- None of the elements in the `Document` have any `presentation hints`.
- None of the elements in the `Document` have any `style attributes`.
- None of the elements in the `Document` are in any of the following namespaces: HTML namespace, SVG namespace, MathML namespace.
- The `Document` has no `focusable area` (e.g. from XLink) other than the `viewport`.
- The `Document` has no `hyperlinks` (e.g. from XLink).
- There exists no `script` whose `settings object` is `global object` or `Window` object with this `Document` as its `associated Document`.
- None of the elements in the `Document` have any registered event listeners.

**An unstyled document view** is one where the DOM is not rendered according to CSS (which would, since there are no applicable styles in this context, just result in a wall of text), but is instead rendered in a manner that is useful for a developer. This could consist of just showing the `Document` object's source, maybe with syntax highlighting, or it could consist of displaying just the DOM tree, or simply a message saying that the page is not a styled document.

**Note**

If a `Document` stops being an **unstyled document**, then the conditions above stop applying, and thus a user agent following these requirements will switch to using the regular CSS rendering.
16 Obsolete features

16.1 Obsolete but conforming features

Features listed in this section will trigger warnings in conformance checkers.

Authors should not specify a `border` attribute on an `img` element. If the attribute is present, its value must be the string "0". CSS should be used instead.

Authors should not specify a `charset` attribute on a `script` element. If the attribute is present, its value must be an ASCII case-insensitive match for "utf-8". (This has no effect in a document that conforms to the requirements elsewhere in this standard of being encoded as UTF-8.)

Authors should not specify a `language` attribute on a `script` element. If the attribute is present, its value must be an ASCII case-insensitive match for the string "JavaScript" and either the `type` attribute must be omitted or its value must be an ASCII case-insensitive match for the string "text/javascript". The attribute should be entirely omitted instead (with the value "JavaScript", it has no effect), or replaced with use of the `type` attribute.

Authors should not specify a value for the `type` attribute on `script` elements that is the empty string or a JavaScript MIME type essence match. Instead, they should omit the attribute, which has the same effect.

Authors should not specify a `type` attribute on a `style` element. If the attribute is present, its value must be an ASCII case-insensitive match for "text/css".

Authors should not specify the `name` attribute on a `a` element. If the attribute is present, its value must not be the empty string and must neither be equal to the value of any of the `ids` in the element's tree other than the element's own `id`, if any, nor be equal to the value of any of the other `name` attributes on `a` elements in the element's tree. If this attribute is present and the element has an `id`, then the attribute's value must be equal to the element's `id`. In earlier versions of the language, this attribute was intended as a way to specify possible targets for fragments in URLs. The `id` attribute should be used instead.

Authors should not, but may despite requirements to the contrary elsewhere in this specification, specify the `maxlength` and `size` attributes on `input` elements whose `type` attributes are in the Number state. One valid reason for using these attributes regardless is to help legacy user agents that do not support `input` elements with `type="number"` to still render the text control with a useful width.

16.1.1 Warnings for obsolete but conforming features

To ease the transition from HTML4 Transitional documents to the language defined in this specification, and to discourage certain features that are only allowed in very few circumstances, conformance checkers must warn the user when the following features are used in a document. These are generally old obsolete features that have no effect, and are allowed only to distinguish between likely mistakes (regular conformance errors) and mere vestigial markup or unusual and discouraged practices (these warnings).

The following features must be categorized as described above:

- The presence of a `border` attribute on an `img` element if its value is the string "0".
- The presence of a `charset` attribute on a `script` element if its value is an ASCII case-insensitive match for "utf-8".
- The presence of a `language` attribute on a `script` element if its value is an ASCII case-insensitive match for the string "JavaScript" and if there is no `type` attribute or there is and its value is an ASCII case-insensitive match for the string "text/javascript".
- The presence of a `type` attribute on a `script` element if its value is a JavaScript MIME type essence match.
- The presence of a `type` attribute on a `style` element if its value is an ASCII case-insensitive match for "text/css".
- The presence of a `name` attribute on an `a` element, if its value is not the empty string.
- The presence of a `maxlength` attribute on an `input` element whose `type` attribute is in the Number state.
• The presence of a `size` attribute on an `input` element whose `type` attribute is in the `Number` state.

Conformance checkers must distinguish between pages that have no conformance errors and have none of these obsolete features, and pages that have no conformance errors but do have some of these obsolete features.

**Example**

For example, a validator could report some pages as "Valid HTML" and others as "Valid HTML with warnings".

### 16.2 Non-conforming features

Elements in the following list are entirely obsolete, and must not be used by authors:

- **applet**
  - Use `embed` or `object` instead.

- **acronym**
  - Use `abbr` instead.

- **bgsound**
  - Use `audio` instead.

- **dir**
  - Use `ul` instead.

- **frame**
  - **frameset**
  - **noframes**
    - Either use `iframe` and CSS instead, or use server-side includes to generate complete pages with the various invariant parts merged in.

- **isindex**
  - Use an explicit `form` and `text control` combination instead.

- **keygen**
  - For enterprise device management use cases, use native on-device management capabilities.
  - For certificate enrollment use cases, use the Web Cryptography API to generate a keypair for the certificate, and then export the certificate and key to allow the user to install them manually. `[WEBCRYPTO]`

- **listing**
  - Use `pre` and `code` instead.

- **menuitem**
  - To implement a custom context menu, use script to handle the `contextmenu` event.

- **nextid**
  - Use GUIDs instead.

- **noembed**
  - Use `object` instead of `embed` when fallback is necessary.

- **param**
  - Use the `data` attribute of the `object` element to set the URL of the external resource.

- **plaintext**
  - Use the "text/plain" MIME type instead.
Providing the ruby base directly inside the `<ruby>` element or using nested `<ruby>` elements is sufficient.

**strike**

Use `<del>` instead if the element is marking an edit, otherwise use `<s>` instead.

**xmp**

Use `<pre>` and `<code>` instead, and escape `<` and `&` characters as `&lt;` and `&amp;` respectively.

**basefont**

**big**

**blink**

**center**

**font**

**marquee**

**multicol**

**nobr**

**spacer**

**tt**

Use appropriate elements or CSS instead.

Where the `<tt>` element would have been used for marking up keyboard input, consider the `<kbd>` element; for variables, consider the `<var>` element; for computer code, consider the `<code>` element; and for computer output, consider the `<samp>` element.

Similarly, if the `<big>` element is being used to denote a heading, consider using the `<h1>` element; if it is being used for marking up important passages, consider the `<strong>` element; and if it is being used for highlighting text for reference purposes, consider the `<mark>` element.

See also the text-level semantics usage summary for more suggestions with examples.

The following attributes are obsolete (though the elements are still part of the language), and must not be used by authors:

**charset** on `<a>` elements

**charset** on `<link>` elements

Use an HTTP `Content-Type` header on the linked resource instead.

**charset** on `<script>` elements (except as noted in the previous section)

Omit the attribute. Both documents and scripts are required to use UTF-8, so it is redundant to specify it on the `<script>` element since it inherits from the document.

**coords** on `<a>` elements

**shape** on `<a>` elements

Use `<area>` instead of `<a>` for image maps.

**methods** on `<a>` elements

**methods** on `<link>` elements

Use the HTTP OPTIONS feature instead.

**name** on `<a>` elements (except as noted in the previous section)

**name** on `<embed>` elements

**name** on `<img>` elements

**name** on `<option>` elements

Use the `id` attribute instead.
Use the `rel` attribute instead, with an opposite term. (For example, instead of `rev="made"`, use `rel="author"`.)

Specify the preferred persistent identifier using the `href` attribute instead.

These attributes do not do anything useful, and for historical reasons there are no corresponding IDL attributes on `area` elements. Omit them altogether.

Omitting the `href` attribute is sufficient; the `noreferrer` attribute is unnecessary. Omit it altogether.

Unnecessary. Omit it altogether.

Use service workers instead. [SW](#)

Unnecessary. Omit it altogether.

Unnecessary. Omit it altogether. All `input` elements with a `type` attribute in the `ImageButton` state are processed as server-side image maps.

Use the `img` element for image maps.

Use a regular `a` element to link to the description, or (in the case of images) use an image map to provide a link from the image to the image's description.

Use a progressive JPEG image (given in the `src` attribute), instead of using two separate images.

Unnecessary. Omit it altogether.

To implement a custom context menu, use script to handle the `contextmenu` event. For toolbar menus, omit the attribute.

To implement a custom context menu, use script to handle the `contextmenu` event.

Use only one scheme per field, or make the scheme declaration part of the value.
Use the data and type attributes to invoke plugins.

Repeat the object element completely each time the resource is to be reused.

Optimize the linked resource so that it loads quickly or, at least, incrementally.

Avoid using object elements with untrusted resources.

Omit the attribute for JavaScript; for data blocks, use the type attribute instead.

Use DOM events mechanisms to register event listeners. [DOM]

Omit the attribute for CSS; for data blocks, use script as the container instead of style.

Unnecessary. Omit it altogether.

Use one of the techniques for describing tables given in the table section instead.

Use text that begins in an unambiguous and terse manner, and include any more elaborate text after that. The title attribute can also be useful in including more detailed text, so that the cell’s contents can be made terse. If it’s a heading, use th (which has an abbr attribute).

Use script and a mechanism such as XMLHttpRequest to populate the page dynamically. [XHR]

Use script to handle the dragenter and dragover events instead.
alink on body elements
bgcolor on body elements
bottommargin on body elements
leftmargin on body elements
link on body elements
marginheight on body elements
marginwidth on body elements
rightmargin on body elements
text on body elements
topmargin on body elements
vlink on body elements
clear on br elements
align on caption elements
align on col elements
char on col elements
charoff on col elements
valign on col elements
width on col elements
align on div elements
compact on dl elements
align on embed elements
hspace on embed elements
vspace on embed elements
align on hr elements
color on hr elements
noshade on hr elements
size on hr elements
width on hr elements
align on h1—h6 elements
align on iframe elements
allowtransparency on iframe elements
frameborder on iframe elements
framespacing on iframe elements
hspace on iframe elements
marginheight on iframe elements
marginwidth on iframe elements
scrolling on iframe elements
vspace on iframe elements
align on input elements
border on input elements
hspace on input elements
vspace on input elements
align on img elements
border on img elements (except as noted in the previous section)
hspace on img elements
vspace on img elements
align on legend elements
type on li elements
compact on menu elements
align on object elements
border on object elements
hspace on object elements
vspace on object elements
The `marquee` element must implement the `HTMLMarqueeElement` interface.

```idl
[Exposed=Window]
interface HTMLMarqueeElement : HTMLElement {
    [HTMLConstructor] constructor();

    [CEReactions] attribute DOMString behavior;
    [CEReactions] attribute DOMString bgColor;
    [CEReactions] attribute DOMString direction;
    ...
```
A `marquee` element can be **turned on** or **turned off**. When it is created, it is **turned on**.

When the `start()` method is called, the `marquee` element must be **turned on**.

When the `stop()` method is called, the `marquee` element must be **turned off**.

The `behavior` content attribute on `marquee` elements is an **enumerated attribute** with the following keywords and states (all non-conforming):

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>scroll</td>
<td>scroll</td>
</tr>
<tr>
<td>slide</td>
<td>slide</td>
</tr>
<tr>
<td>alternate</td>
<td>alternate</td>
</tr>
</tbody>
</table>

The attribute’s **missing value default** and **invalid value default** are both the `scroll` state.

The `direction` content attribute on `marquee` elements is an **enumerated attribute** with the following keywords and states (all non-conforming):

<table>
<thead>
<tr>
<th>Keyword</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>left</td>
<td>left</td>
</tr>
<tr>
<td>right</td>
<td>right</td>
</tr>
<tr>
<td>up</td>
<td>up</td>
</tr>
<tr>
<td>down</td>
<td>down</td>
</tr>
</tbody>
</table>

The attribute’s **missing value default** and **invalid value default** are both the `left` state.

The `truespeed` content attribute on `marquee` elements is a **boolean attribute**.

A `marquee` element has a **marquee scroll interval**, which is obtained as follows:

1. If the element has a `scrolldelay` attribute, and parsing its value using the [rules for parsing non-negative integers](#) does not return an error, then let `delay` be the parsed value. Otherwise, let `delay` be 85.
2. If the element does not have a `truespeed` attribute, and the `delay` value is less than 60, then let `delay` be 60 instead.
3. The **marquee scroll interval** is `delay`, interpreted in milliseconds.

A `marquee` element has a **marquee scroll distance**, which, if the element has a `scrollamount` attribute, and parsing its value using the [rules for parsing non-negative integers](#) does not return an error, is the parsed value interpreted in **CSS pixels**, and otherwise is 6 **CSS pixels**.
A `marquee` element has a **marquee loop count**, which, if the element has a `loop` attribute, and parsing its value using the rules for parsing integers does not return an error or a number less than 1, is the parsed value, and otherwise is −1.

The `loop` IDL attribute, on getting, must return the element's **marquee loop count** and on setting, if the new value is different than the element's **marquee loop count** and either greater than zero or equal to −1, must set the element's `loop` content attribute (adding it if necessary) to the **valid integer** that represents the new value. (Other values are ignored.)

A `marquee` element also has a **marquee current loop index**, which is zero when the element is created.

The rendering layer will occasionally increment the **marquee current loop index**, which must cause the following steps to be run:

1. If the **marquee loop count** is −1, then return.
2. Increment the **marquee current loop index** by one.
3. If the **marquee current loop index** is now greater than or equal to the element's **marquee loop count**, turn off the `marquee` element.

The **behavior**, **direction**, **height**, **hspace**, **vspace**, and **width** IDL attributes must **reflect** the respective content attributes of the same name.

The **bgColor** IDL attribute must **reflect** the `bgcolor` content attribute.

The **scrollAmount** IDL attribute must **reflect** the `scrollamount` content attribute. The **default value** is 6.

The **scrollDelay** IDL attribute must **reflect** the `scrolldelay` content attribute. The **default value** is 85.

The **trueSpeed** IDL attribute must **reflect** the `truespeed` content attribute.

### 16.3.2 Frames

The `frameset` element acts as the **body element** in documents that use frames.

The `frameset` element must implement the [HTMLFrameSetElement](https://html.spec.whatwg.org/multipage/semantics.html#interface-htmlframesetelement) interface.

```idl
[Exposed=Window]
interface HTMLFrameSetElement : HTMLElement {
  [HTMLConstructor] constructor();
  [CEReactions] attribute DOMString cols;
  [CEReactions] attribute DOMString rows;
};
```

The **cols** and **rows** IDL attributes of the `frameset` element must **reflect** the respective content attributes of the same name.

The `frameset` element exposes as **event handler content attributes** a number of the **event handlers** of the `Window` object. It also mirrors their **event handler IDL attributes**.

The **event handlers** of the `Window` object named by the `Window-reflecting body element event handler set`, exposed on the `frameset` element, replace the generic **event handlers** with the same names normally supported by HTML elements.

The `frame` element has a **content navigable** similar to the `iframe` element, but rendered within a `frameset` element.

The `frame` [HTML element insertion steps](https://html.spec.whatwg.org/multipage/dom.html#html-element-insertion-steps), given `insertedNode`, are:

1. If `insertedNode`'s is not in a document tree, then return.
2. If `insertedNode`'s root's **browsing context** is null, then return.
3. Create a new child navigable for insertedNode.

4. Process the frame attributes for insertedNode, with initialInsertion set to true.

The frame HTML element removing steps, given removedNode, are to destroy a child navigable given removedNode.

Whenever a frame element with a non-null content has its src attribute set, changed, or removed, the user agent must process the frame attributes.

To process the frame attributes for an element, with an optional boolean initialInsertion:

1. Let url be the result of running the shared attribute processing steps for iframe and frame elements given element and initialInsertion.

2. If url is null, then return.

3. If url matches about:blank and initialInsertion is true, then:
   1. Fire an event named load at element.
   2. Return.

4. Navigate an iframe or frame given element, url, and the empty string.

The frame element potentially delays the load event.

The frame element must implement the HTMLFrameElement interface.

```idl
[Exposed=Window]
interface HTMLFrameElement : HTMLElement {
    [HTMLConstructor] constructor();

    [CEReactions] attribute DOMString name;
    [CEReactions] attribute DOMString scrolling;
    [CEReactions] attribute USVString src;
    [CEReactions] attribute DOMString frameBorder;
    [CEReactions] attribute USVString longDesc;
    [CEReactions] attribute boolean noResize;
    readonly attribute Document? contentDocument;
    readonly attribute WindowProxy? contentWindow;

    [CEReactions] attribute [LegacyNullToEmptyString] DOMString marginHeight;
    [CEReactions] attribute [LegacyNullToEmptyString] DOMString marginWidth;
};
```

The name, scrolling, and src IDL attributes of the frame element must reflect the respective content attributes of the same name. For the purposes of reflection, the frame element’s src content attribute is defined as containing a URL.

The frameBorder IDL attribute of the frame element must reflect the element’s frameborder content attribute.

The longDesc IDL attribute of the frame element must reflect the element’s longdesc content attribute, which for the purposes of reflection is defined as containing a URL.

The noResize IDL attribute of the frame element must reflect the element’s noresize content attribute.

The marginHeight IDL attribute of the frame element must reflect the element’s marginheight content attribute.

The marginWidth IDL attribute of the frame element must reflect the element’s marginwidth content attribute.

The contentDocument getter steps are to return this’s content document.

The contentWindow getter steps are to return this’s content window.
User agents must treat `acronym` elements in a manner equivalent to `abbr` elements in terms of semantics and for purposes of rendering.

```idl
partial interface HTMLAnchorElement {
    [CEReactions] attribute DOMString coords;
    [CEReactions] attribute DOMString charset;
    [CEReactions] attribute DOMString name;
    [CEReactions] attribute DOMString rev;
    [CEReactions] attribute DOMString shape;
};
```

The `coords`, `charset`, `name`, `rev`, and `shape` IDL attributes of the `a` element must reflect the respective content attributes of the same name.

```idl
partial interface HTMLAreaElement {
    [CEReactions] attribute boolean noHref;
};
```

The `noHref` IDL attribute of the `area` element must reflect the element's `nohref` content attribute.

```idl
partial interface HTMLBodyElement {
    [CEReactions] attribute [LegacyNullToEmptyString] DOMString text;
    [CEReactions] attribute [LegacyNullToEmptyString] DOMString link;
    [CEReactions] attribute [LegacyNullToEmptyString] DOMString vLink;
    [CEReactions] attribute [LegacyNullToEmptyString] DOMString aLink;
    [CEReactions] attribute [LegacyNullToEmptyString] DOMString bgColor;
    [CEReactions] attribute DOMString background;
};
```

The `text` IDL attribute of the `body` element must reflect the element's `text` content attribute.

The `link` IDL attribute of the `body` element must reflect the element's `link` content attribute.

The `aLink` IDL attribute of the `body` element must reflect the element's `alink` content attribute.

The `vLink` IDL attribute of the `body` element must reflect the element's `vlink` content attribute.

The `bgColor` IDL attribute of the `body` element must reflect the element's `bgcolor` content attribute. (The `background` content is not defined to contain a `URL`, despite rules regarding its handling in the Rendering section above.)

```idl
partial interface HTMLBRElement {
    [CEReactions] attribute DOMString clear;
};
```

The `clear` IDL attribute of the `br` element must reflect the content attribute of the same name.

```idl
partial interface HTMLTableCaptionElement {
    [CEReactions] attribute DOMString align;
};
```

The `align` IDL attribute of the `caption` element must reflect the content attribute of the same name.
The `align` and `width` IDL attributes of the `col` element must reflect the respective content attributes of the same name.

The `ch` IDL attribute of the `col` element must reflect the element's `char` content attribute.

The `chOff` IDL attribute of the `col` element must reflect the element's `charOff` content attribute.

The `vAlign` IDL attribute of the `col` element must reflect the element's `valign` content attribute.

User agents must treat `dir` elements in a manner equivalent to `ul` elements in terms of semantics and for purposes of rendering.

The `dir` element must implement the `HTMLDirectoryElement` interface.

The `compact` IDL attribute of the `dir` element must reflect the content attribute of the same name.

The `align` IDL attribute of the `div` element must reflect the content attribute of the same name.

The `compact` IDL attribute of the `dl` element must reflect the content attribute of the same name.

The `name` and `align` IDL attributes of the `embed` element must reflect the respective content attributes of the same name.

The `font` element must implement the `HTMLFontElement` interface.
The `color`, `face`, and `size` IDL attributes of the `font` element must reflect the respective content attributes of the same name.

```
partial interface HTMLHeadingElement {
  [CEReactions] attribute DOMString align;
}
```

The `align` IDL attribute of the `h1`–`h6` elements must reflect the content attribute of the same name.

```
partial interface HTMLHRElement {
  [CEReactions] attribute DOMString align;
  [CEReactions] attribute DOMString color;
  [CEReactions] attribute boolean noShade;
  [CEReactions] attribute DOMString size;
  [CEReactions] attribute DOMString width;
}
```

The `align`, `color`, `size`, and `width` IDL attributes of the `hr` element must reflect the respective content attributes of the same name.

The `noShade` IDL attribute of the `hr` element must reflect the element's `noshade` content attribute.

```
partial interface HTMLHtmlElement {
  [CEReactions] attribute DOMString version;
}
```

The `version` IDL attribute of the `html` element must reflect the content attribute of the same name.

```
partial interface HTMLIFrameElement {
  [CEReactions] attribute DOMString align;
  [CEReactions] attribute DOMString scrolling;
  [CEReactions] attribute DOMString frameBorder;
  [CEReactions] attribute USVString longDesc;

  [CEReactions] attribute [LegacyNullToEmptyString] DOMString marginHeight;
  [CEReactions] attribute [LegacyNullToEmptyString] DOMString marginWidth;
}
```

The `align` and `scrolling` IDL attributes of the `iframe` element must reflect the respective content attributes of the same name.

The `frameBorder` IDL attribute of the `iframe` element must reflect the element's `frameborder` content attribute.

The `longDesc` IDL attribute of the `iframe` element must reflect the element's `longdesc` content attribute, which for the purposes of reflection is defined as containing a URL.
The `marginHeight` IDL attribute of the `iframe` element must reflect the element's `marginheight` content attribute.

The `marginWidth` IDL attribute of the `iframe` element must reflect the element's `marginwidth` content attribute.

```
IDL partial interface HTMLImageElement {
  [CEReactions] attribute DOMString name;
  [CEReactions] attribute USVString lowsrc;
  [CEReactions] attribute DOMString align;
  [CEReactions] attribute unsigned long hspace;
  [CEReactions] attribute unsigned long vspace;
  [CEReactions] attribute USVString longDesc;

  [CEReactions] attribute [LegacyNullToEmptyString] DOMString border;
};
```

The `name`, `align`, `border`, `hspace`, and `vspace` IDL attributes of the `img` element must reflect the respective content attributes of the same name.

The `longDesc` IDL attribute of the `img` element must reflect the element's `longdesc` content attribute, which for the purposes of reflection is defined as containing a URL.

The `lowsrc` IDL attribute of the `img` element must reflect the element's `lowsrc` content attribute, which for the purposes of reflection is defined as containing a URL.

```
IDL partial interface HTMLInputElement {
  [CEReactions] attribute DOMString align;
  [CEReactions] attribute DOMString useMap;
};
```

The `align` IDL attribute of the `input` element must reflect the content attribute of the same name.

The `useMap` IDL attribute of the `input` element must reflect the element's `usemap` content attribute.

```
IDL partial interface HTMLLegendElement {
  [CEReactions] attribute DOMString align;
};
```

The `align` IDL attribute of the `legend` element must reflect the content attribute of the same name.

```
IDL partial interface HTMLLIElement {
  [CEReactions] attribute DOMString type;
};
```

The `type` IDL attribute of the `li` element must reflect the content attribute of the same name.

```
IDL partial interface HTMLLinkElement {
  [CEReactions] attribute DOMString charset;
  [CEReactions] attribute DOMString rev;
  [CEReactions] attribute DOMString target;
};
```

The `charset`, `rev`, and `target` IDL attributes of the `link` element must reflect the respective content attributes of the same name.
User agents must treat listing elements in a manner equivalent to pre elements in terms of semantics and for purposes of rendering.

```idl
definition partial interface HTMLMenuElement {
    [CEReactions] attribute boolean compact;
};
```

The `compact` IDL attribute of the `menu` element must reflect the content attribute of the same name.

```idl
definition partial interface HTMLMetaElement {
    [CEReactions] attribute DOMString scheme;
};
```

User agents may treat the `scheme` content attribute on the `meta` element as an extension of the element’s `name` content attribute when processing a `meta` element with a `name` attribute whose value is one that the user agent recognizes as supporting the `scheme` attribute.

User agents are encouraged to ignore the `scheme` attribute and instead process the value given to the metadata name as if it had been specified for each expected value of the `scheme` attribute.

**Example**

For example, if the user agent acts on `meta` elements with `name` attributes having the value "eGMS.subject.keyword", and knows that the `scheme` attribute is used with this metadata name, then it could take the `scheme` attribute into account, acting as if it was an extension of the `name` attribute. Thus the following two `meta` elements could be treated as two elements giving values for two different metadata names, one consisting of a combination of "eGMS.subject.keyword" and "LGCL", and the other consisting of a combination of "eGMS.subject.keyword" and "ORLY":

```
<!-- this markup is invalid -->
<meta name="eGMS.subject.keyword" scheme="LGCL" content="Abandoned vehicles">
<meta name="eGMS.subject.keyword" scheme="ORLY" content="Mah car: kthxbye">
```

The suggested processing of this markup, however, would be equivalent to the following:

```
<meta name="eGMS.subject.keyword" content="Abandoned vehicles">
<meta name="eGMS.subject.keyword" content="Mah car: kthxbye">
```

The `scheme` IDL attribute of the `meta` element must reflect the content attribute of the same name.

```idl
definition partial interface HTMLObjectElement {
    [CEReactions] attribute DOMString align;
    [CEReactions] attribute DOMString archive;
    [CEReactions] attribute DOMString code;
    [CEReactions] attribute boolean declare;
    [CEReactions] attribute unsigned long hspace;
    [CEReactions] attribute DOMString standby;
    [CEReactions] attribute unsigned long vspace;
    [CEReactions] attribute DOMString codeBase;
    [CEReactions] attribute DOMString codeType;
    [CEReactions] attribute DOMString useMap;
    [CEReactions] attribute [LegacyNullToEmptyString] DOMString border;
};
```

The `align`, `archive`, `border`, `code`, `declare`, `hspace`, `standby`, and `vspace` IDL attributes of the `object` element must reflect the respective content attributes of the same name.
The `codeBase` IDL attribute of the `object` element must `reflect` the element's `codebase` content attribute, which for the purposes of reflection is defined as containing a URL.

The `codeType` IDL attribute of the `object` element must `reflect` the element's `codetype` content attribute.

The `useMap` IDL attribute must `reflect` the `usemap` content attribute.

```idl
partial interface HTMLOListElement {
  [CEReactions] attribute boolean compact;
};
```

The `compact` IDL attribute of the `ol` element must `reflect` the content attribute of the same name.

```idl
partial interface HTMLParagraphElement {
  [CEReactions] attribute DOMString align;
};
```

The `align` IDL attribute of the `p` element must `reflect` the content attribute of the same name.

The `param` element must implement the `HTMLParamElement` interface.

```idl
[Exposed=Window]
interface HTMLParamElement : HTMLElement {
  [HTMLConstructor] constructor();

  [CEReactions] attribute DOMString name;
  [CEReactions] attribute DOMString value;
  [CEReactions] attribute DOMString type;
  [CEReactions] attribute DOMString valueType;
};
```

The `name`, `value`, and `type` IDL attributes of the `param` element must `reflect` the respective content attributes of the same name.

The `valueType` IDL attribute of the `param` element must `reflect` the element's `valuetype` content attribute.

User agents must treat `plaintext` elements in a manner equivalent to `pre` elements in terms of semantics and for purposes of rendering. (The parser has special behavior for this element, though.)

```idl
partial interface HTMLPreElement {
  [CEReactions] attribute long width;
};
```

The `width` IDL attribute of the `pre` element must `reflect` the content attribute of the same name.

```idl
partial interface HTMLStyleElement {
  [CEReactions] attribute DOMString type;
};
```

The `type` IDL attribute of the `style` element must `reflect` the element's `type` content attribute.
The `charset` and `event` IDL attributes of the `<script>` element must `reflect` the respective content attributes of the same name.

The `htmlFor` IDL attribute of the `<script>` element must `reflect` the element's `for` content attribute.

The `align`, `border`, `frame`, `summary`, `rules`, and `width`, IDL attributes of the `<table>` element must `reflect` the respective content attributes of the same name.

The `bgColor` IDL attribute of the `<table>` element must `reflect` the element's `bgcolor` content attribute.

The `cellPadding` IDL attribute of the `<table>` element must `reflect` the element's `cellpadding` content attribute.

The `cellSpacing` IDL attribute of the `<table>` element must `reflect` the element's `cellspacing` content attribute.

The `align` IDL attribute of the `<tbody>`, `<thead>`, and `<tfoot>` elements must `reflect` the content attribute of the same name.

The `ch` IDL attribute of the `<tbody>`, `<thead>`, and `<tfoot>` elements must `reflect` the elements' `char` content attributes.

The `chOff` IDL attribute of the `<tbody>`, `<thead>`, and `<tfoot>` elements must `reflect` the elements' `charoff` content attributes.

The `vAlign` IDL attribute of the `<tbody>`, `<thead>`, and `<tfoot>` element must `reflect` the elements' `valign` content attributes.
The `align`, `axis`, `height`, and `width` IDL attributes of the `td` and `th` elements must `reflect` the respective content attributes of the same name.

The `ch` IDL attribute of the `td` and `th` elements must `reflect` the elements' `char` content attributes.

The `chOff` IDL attribute of the `td` and `th` elements must `reflect` the elements' `charoff` content attributes.

The `noWrap` IDL attribute of the `td` and `th` elements must `reflect` the elements' `nowrap` content attributes.

The `vAlign` IDL attribute of the `td` and `th` elements must `reflect` the elements' `valign` content attributes.

The `bgColor` IDL attribute of the `td` and `th` elements must `reflect` the elements' `bgcolor` content attributes.

---

```idl
partial interface HTMLTableRowElement { 

  [CEReactions] attribute DOMString align;
  [CEReactions] attribute DOMString ch;
  [CEReactions] attribute DOMString chOff;
  [CEReactions] attribute DOMString vAlign;

  [CEReactions] attribute [LegacyNullToEmptyString] DOMString bgColor;
};
```

The `align` IDL attribute of the `tr` element must `reflect` the content attribute of the same name.

The `ch` IDL attribute of the `tr` element must `reflect` the element's `char` content attribute.

The `chOff` IDL attribute of the `tr` element must `reflect` the element's `charoff` content attribute.

The `vAlign` IDL attribute of the `tr` element must `reflect` the element's `valign` content attribute.

The `bgColor` IDL attribute of the `tr` element must `reflect` the element's `bgcolor` content attribute.

---

```idl
partial interface HTMLUListElement { 

  [CEReactions] attribute boolean compact;
  [CEReactions] attribute DOMString type;
};
```

The `compact` and `type` IDL attributes of the `ul` element must `reflect` the respective content attributes of the same name.

User agents must treat `xmp` elements in a manner equivalent to `pre` elements in terms of semantics and for purposes of rendering. (The parser has special behavior for this element though.)

---

```idl
partial interface Document { 

  [CEReactions] attribute [LegacyNullToEmptyString] DOMString fgColor;
  [CEReactions] attribute [LegacyNullToEmptyString] DOMString linkColor;
  [CEReactions] attribute [LegacyNullToEmptyString] DOMString vlinkColor;
  [CEReactions] attribute [LegacyNullToEmptyString] DOMString alinkColor;
  [CEReactions] attribute [LegacyNullToEmptyString] DOMString bgColor;

  [SameObject] readonly attribute HTMLCollection anchors;
};
```
The attributes of the `Document` object listed in the first column of the following table must reflect the content attribute on the `body` element with the name given in the corresponding cell in the second column on the same row, if the `body` element is a `body` element (as opposed to a `frameset` element). When there is no `body` element or if it is a `frameset` element, the attributes must instead return the empty string on getting and do nothing on setting.

<table>
<thead>
<tr>
<th>IDL attribute</th>
<th>Content attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>fgColor</td>
<td>text</td>
</tr>
<tr>
<td>linkColor</td>
<td>link</td>
</tr>
<tr>
<td>vlinkColor</td>
<td>vlink</td>
</tr>
<tr>
<td>alinkColor</td>
<td>alink</td>
</tr>
<tr>
<td>bgColor</td>
<td>bgcolor</td>
</tr>
</tbody>
</table>

The `anchors` attribute must return an `HTMLCollection` rooted at the `Document` node, whose filter matches only `a` elements with `name` attributes.

The `applets` attribute must return an `HTMLCollection` rooted at the `Document` node, whose filter matches nothing. (It exists for historical reasons.)

The `clear()`, `captureEvents()`, and `releaseEvents()` methods must do nothing.

The `all` attribute must return an `HTMLAllCollection` rooted at the `Document` node, whose filter matches all elements.

```idl
partial interface Window {

    undefined captureEvents();
    undefined releaseEvents();

    [Replaceable, SameObject] readonly attribute External external;
}
```

The `captureEvents()` and `releaseEvents()` methods must do nothing.

The `external` attribute of the `Window` interface must return an instance of the `External` interface:

```idl
[Exposed=Window]
interface External {
    undefined AddSearchProvider();
    undefined IsSearchProviderInstalled();
}
```

The `AddSearchProvider()` and `IsSearchProviderInstalled()` methods must do nothing.
17 IANA considerations

17.1 text/html

This registration is for community review and will be submitted to the IESG for review, approval, and registration with IANA.

Type name:
  text

_subtype name:
  html

Required parameters:
  No required parameters

Optional parameters:
  charset

The _charset_ parameter may be provided to specify the document's character encoding, overriding any character encoding declarations in the document other than a Byte Order Mark (BOM). The parameter's value must be an ASCII case-insensitive match for the string "utf-8".

Encoding considerations:
  8bit (see the section on character encoding declarations)

Security considerations:

Entire novels have been written about the security considerations that apply to HTML documents. Many are listed in this document, to which the reader is referred for more details. Some general concerns bear mentioning here, however:

HTML is a scripted language, and has a large number of APIs (some of which are described in this document). Script can expose the user to potential risks of information leakage, credential leakage, cross-site scripting attacks, cross-site request forgeries, and a host of other problems. While the designs in this specification are intended to be safe if implemented correctly, a full implementation is a massive undertaking and, as with any software, user agents are likely to have security bugs.

Even without scripting, there are specific features in HTML which, for historical reasons, are required for broad compatibility with legacy content but that expose the user to unfortunate security problems. In particular, the _img_ element can be used in conjunction with some other features as a way to effect a port scan from the user's location on the Internet. This can expose local network topologies that the attacker would otherwise not be able to determine.

HTML relies on a compartmentalization scheme sometimes known as the _same-origin policy_. An _origin_ in most cases consists of all the pages served from the same host, on the same port, using the same protocol.

It is critical, therefore, to ensure that any untrusted content that forms part of a site be hosted on a different _origin_ than any sensitive content on that site. Untrusted content can easily spoof any other page on the same origin, read data from that origin, cause scripts in that origin to execute, submit forms to and from that origin even if they are protected from cross-site request forgeries by unique tokens, and make use of any third-party resources exposed to or rights granted to that origin.

Interoperability considerations:

Rules for processing both conforming and non-conforming content are defined in this specification.

Published specification:

This document is the relevant specification. Labeling a resource with the _text/html_ type asserts that the resource is an HTML document using the HTML syntax.

Applications that use this media type:

Web browsers, tools for processing web content, HTML authoring tools, search engines, validators.

Additional information:

Magic number(s):

No sequence of bytes can uniquely identify an HTML document. More information on detecting HTML documents is available in _MIME Sniffing_.

File extension(s):

"html" and "htm" are commonly, but certainly not exclusively, used as the extension for HTML documents.
Macintosh file type code(s):
   TEXT

Person & email address to contact for further information:
   Ian Hickson <ian@hixie.ch>

Intended usage:
   Common

Restrictions on usage:
   No restrictions apply.

Author:
   Ian Hickson <ian@hixie.ch>

Change controller:
   W3C

Fragments used with text/html resources either refer to the indicated part of the corresponding Document, or provide state information for in-page scripts.

17.2 multipart/x-mixed-replace

This registration is for community review and will be submitted to the IESG for review, approval, and registration with IANA.

Type name:
   multipart

Subtype name:
   x-mixed-replace

Required parameters:
   • boundary (defined in RFC2046) [RFC2046]

Optional parameters:
   No optional parameters.

Encoding considerations:
   binary

Security considerations:
   Subresources of a multipart/x-mixed-replace resource can be of any type, including types with non-trivial security implications such as text/html.

Interoperability considerations:
   None.

Published specification:
   This specification describes processing rules for web browsers. Conformance requirements for generating resources with this type are the same as for multipart/mixed. [RFC2046]

Applications that use this media type:
   This type is intended to be used in resources generated by web servers, for consumption by web browsers.

Additional information:
   Magic number(s):
      No sequence of bytes can uniquely identify a multipart/x-mixed-replace resource.

   File extension(s):
      No specific file extensions are recommended for this type.

   Macintosh file type code(s):
      No specific Macintosh file type codes are recommended for this type.

Person & email address to contact for further information:
   Ian Hickson <ian@hixie.ch>
Intended usage:
Common

Restrictions on usage:
No restrictions apply.

Author:
Ian Hickson <ian@hixie.ch>

Change controller:
W3C

Fragments used with multipart/x-mixed-replace resources apply to each body part as defined by the type used by that body part.

17.3 application/xhtml+xml

This registration is for community review and will be submitted to the IESG for review, approval, and registration with IANA.

Type name:
application

Subtype name:
xhtml+xml

Required parameters:
Same as for application/xml [RFC7303]

Optional parameters:
Same as for application/xml [RFC7303]

Encoding considerations:
Same as for application/xml [RFC7303]

Security considerations:
Same as for application/xml [RFC7303]

Interoperability considerations:
Same as for application/xml [RFC7303]

Published specification:
Labeling a resource with the application/xhtml+xml type asserts that the resource is an XML document that likely has a document element from the HTML namespace. Thus, the relevant specifications are XML, Namespaces in XML, and this specification. [XML] [XMLNS]

Applications that use this media type:
Same as for application/xml [RFC7303]

Additional information:
Magic number(s):
Same as for application/xml [RFC7303]

File extension(s):
"xhtml" and "xht" are sometimes used as extensions for XML resources that have a document element from the HTML namespace.

Macintosh file type code(s):
TEXT

Person & email address to contact for further information:
Ian Hickson <ian@hixie.ch>

Intended usage:
Common
Restrictions on usage:
No restrictions apply.

Author:
Ian Hickson <ian@hixie.ch>

Change controller:
W3C

Fragments used with application/xhtml+xml resources have the same semantics as with any XML MIME type. [RFC7303]

17.4 text/ping

This registration is for community review and will be submitted to the IESG for review, approval, and registration with IANA.

Type name:
text

Subtype name:
ping

Required parameters:
No parameters

Optional parameters:
charset
The charset parameter may be provided. The parameter's value must be "utf-8". This parameter serves no purpose; it is only allowed for compatibility with legacy servers.

Encoding considerations:
Not applicable.

Security considerations:
If used exclusively in the fashion described in the context of hyperlink auditing, this type introduces no new security concerns.

Interoperability considerations:
Rules applicable to this type are defined in this specification.

Published specification:
This document is the relevant specification.

Applications that use this media type:
Web browsers.

Additional information:
Magic number(s):
text/ping resources always consist of the four bytes 0x50 0x49 0x4E 0x47 (‘PING’).

File extension(s):
No specific file extension is recommended for this type.

Macintosh file type code(s):
No specific Macintosh file type codes are recommended for this type.

Person & email address to contact for further information:
Ian Hickson <ian@hixie.ch>

Intended usage:
Common

Restrictions on usage:
Only intended for use with HTTP POST requests generated as part of a web browser's processing of the ping attribute.

Author:
Ian Hickson <ian@hixie.ch>
Change controller:
W3C

Fragments have no meaning with text/ping resources.

17.5 application/microdata+json

This registration is for community review and will be submitted to the IESG for review, approval, and registration with IANA.

Type name:
application

Subtype name:
microdata+json

Required parameters:
Same as for application/json

Optional parameters:
Same as for application/json

Encoding considerations:
8bit (always UTF-8)

Security considerations:
Same as for application/json

Interoperability considerations:
Same as for application/json

Published specification:
Labeling a resource with the application/microdata+json type asserts that the resource is a JSON text that consists of an object with a single entry called "items" consisting of an array of entries, each of which consists of an object with an entry called "id" whose value is a string, an entry called "type" whose value is another string, and an entry called "properties" whose value is an object whose entries each have a value consisting of an array of either objects or strings, the objects being of the same form as the objects in the aforementioned "items" entry. Thus, the relevant specifications are JSON and this specification.

Applications that use this media type:
Applications that transfer data intended for use with HTML’s microdata feature, especially in the context of drag-and-drop, are the primary application class for this type.

Additional information:

Magic number(s):
Same as for application/json

File extension(s):
Same as for application/json

Macintosh file type code(s):
Same as for application/json

Person & email address to contact for further information:
Ian Hickson <ian@hixie.ch>

Intended usage:
Common

Restrictions on usage:
No restrictions apply.

Author:
Ian Hickson <ian@hixie.ch>

Change controller:
W3C
17.6 text/event-stream

This registration is for community review and will be submitted to the IESG for review, approval, and registration with IANA.

Type name:

text

Subtype name:

event-stream

Required parameters:

No parameters

Optional parameters:

charset

The charset parameter may be provided. The parameter's value must be "utf-8". This parameter serves no purpose; it is only allowed for compatibility with legacy servers.

Encoding considerations:

8bit (always UTF-8)

Security considerations:

An event stream from an origin distinct from the origin of the content consuming the event stream can result in information leakage. To avoid this, user agents are required to apply CORS semantics. [FETCH]

Event streams can overwhelm a user agent; a user agent is expected to apply suitable restrictions to avoid depleting local resources because of an overabundance of information from an event stream.

Servers can be overwhelmed if a situation develops in which the server is causing clients to reconnect rapidly. Servers should use a 5xx status code to indicate capacity problems, as this will prevent conforming clients from reconnecting automatically.

Interoperability considerations:

Rules for processing both conforming and non-conforming content are defined in this specification.

Published specification:

This document is the relevant specification.

Applications that use this media type:

Web browsers and tools using web services.

Additional information:

Magic number(s):

No sequence of bytes can uniquely identify an event stream.

File extension(s):

No specific file extensions are recommended for this type.

Macintosh file type code(s):

No specific Macintosh file type codes are recommended for this type.

Person & email address to contact for further information:

Ian Hickson <ian@hixie.ch>

Intended usage:

Common

Restrictions on usage:

This format is only expected to be used by dynamic open-ended streams served using HTTP or a similar protocol. Finite resources are not expected to be labeled with this type.

Author:

Ian Hickson <ian@hixie.ch>
Fragments have no meaning with `text/event-stream` resources.

17.7 web+ scheme prefix

This section describes a convention for use with the IANA URI scheme registry. It does not itself register a specific scheme.

[RFC7595]

**Scheme name:**

Schemes starting with the four characters "web+" followed by one or more letters in the range a-z.

**Status:**

Permanent

**Scheme syntax:**

Scheme-specific.

**Scheme semantics:**

Scheme-specific.

**Encoding considerations:**

All "web+" schemes should use UTF-8 encodings where relevant.

**Applications/protocols that use this scheme name:**

Scheme-specific.

**Interoperability considerations:**

The scheme is expected to be used in the context of web applications.

**Security considerations:**

Any web page is able to register a handler for all "web+" schemes. As such, these schemes must not be used for features intended to be core platform features (e.g., HTTP). Similarly, such schemes must not store confidential information in their URLs, such as usernames, passwords, personal information, or confidential project names.

**Contact:**

Ian Hickson <ian@hixie.ch>

**Change controller:**

Ian Hickson <ian@hixie.ch>

**References:**

Custom scheme handlers, HTML Living Standard: https://html.spec.whatwg.org/#custom-handlers
## Elements

This section is non-normative.

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
<th>Categories</th>
<th>Parents†</th>
<th>Children</th>
<th>Attributes</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Hyperlink</td>
<td>flow; phrasing; interactive; palpable</td>
<td>phrasing</td>
<td>·</td>
<td>globals; href; target; download; ping; rel; hreflang; type; referrerpolicy</td>
<td>HTMLAnchorElement</td>
</tr>
<tr>
<td>abbr</td>
<td>Abbreviation</td>
<td>flow; phrasing; palpable</td>
<td>phrasing</td>
<td>·</td>
<td>globals</td>
<td>HTMLElement</td>
</tr>
<tr>
<td>address</td>
<td>Contact information for a page or article element</td>
<td>flow; phrasing</td>
<td>flow</td>
<td>·</td>
<td>globals</td>
<td>HTMLElement</td>
</tr>
<tr>
<td>area</td>
<td>Hyperlink or dead area on an image map</td>
<td>flow; phrasing</td>
<td>empty</td>
<td>·</td>
<td>globals; alt; coords; shape; href; target; download; ping; referrerpolicy</td>
<td>HTMLAreaElement</td>
</tr>
<tr>
<td>article</td>
<td>Self-contained syndicatable or reusable composition</td>
<td>flow; sectioning; palpable</td>
<td>flow</td>
<td>·</td>
<td>globals</td>
<td>HTMLElement</td>
</tr>
<tr>
<td>aside</td>
<td>Sidebar for tangentially related content</td>
<td>flow; sectioning; palpable</td>
<td>flow</td>
<td>·</td>
<td>globals</td>
<td>HTMLElement</td>
</tr>
<tr>
<td>audio</td>
<td>Audio player</td>
<td>flow; phrasing; embedded; interactive; palpable</td>
<td>phrasing</td>
<td>·</td>
<td>source; src; track; preload; autoplay; loop; muted; controls</td>
<td>HTMLAudioElement</td>
</tr>
<tr>
<td>b</td>
<td>Keywords</td>
<td>flow; phrasing; palpable</td>
<td>phrasing</td>
<td>·</td>
<td>globals</td>
<td>HTMLElement</td>
</tr>
<tr>
<td>base</td>
<td>Base URL and default target navigable for hyperlinks and forms</td>
<td>metadata</td>
<td>head</td>
<td>empty</td>
<td>globals; href; target</td>
<td>HTMLBaseElement</td>
</tr>
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<td>bdi</td>
<td>Text directionality isolation</td>
<td>flow; phrasing; palpable</td>
<td>phrasing</td>
<td>·</td>
<td>globals</td>
<td>HTMLElement</td>
</tr>
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<td>Text directionality formatting</td>
<td>flow; phrasing; palpable</td>
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<tr>
<td>blockquote</td>
<td>A section quoted from another source</td>
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<td>flow</td>
<td>·</td>
<td>globals; cite</td>
<td>HTMLQuoteElement</td>
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<td>html</td>
<td>flow</td>
<td>globals; onafterprint; onbeforeprint; onbeforeunload</td>
<td>HTMLBodyElement</td>
</tr>
<tr>
<td>Element</td>
<td>Description</td>
<td>Categories</td>
<td>Parents†</td>
<td>Children</td>
<td>Attributes</td>
<td>Interface</td>
</tr>
<tr>
<td>---------</td>
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</tr>
<tr>
<td>br</td>
<td>Line break, e.g. in poem or postal address</td>
<td>flow, phrasing</td>
<td>empty</td>
<td>globals</td>
<td>onhashchange, onlanguagechange, onmessage, onmessageerror, offline, ononline, onpageswap, onpagehide, onpagereveal, onpageshow, onpopstate, onrejectionhandled, onstorage, onunhandledrejection, onunload</td>
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</tr>
<tr>
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<td>Button control</td>
<td>flow, phrasing, interactive, listed, labelable, submittable, form, associated, palpable</td>
<td>globals</td>
<td>globals, disabled, form, formaction, formmethod, formnovalidate, formtarget, name, popoptarget, popoptargetaction, type, value</td>
<td>HTMLButtonElement</td>
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<td>Scriptable bitmap canvas</td>
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<td>transparent</td>
<td>globals</td>
<td>width, height</td>
<td>HTMLCanvasElement</td>
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<td>globals</td>
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<td>Computer code</td>
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<td>globals, span</td>
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<td>globals, value</td>
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<td>A removal from the document</td>
<td>flow, phrasing, palpable</td>
<td></td>
<td>globals, cite, datetime</td>
<td>HTMLModElement</td>
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</tr>
<tr>
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<td>Disclosure control for hiding details</td>
<td>flow, interactive, palpable</td>
<td></td>
<td>summary, flow</td>
<td>HTMLDetailsElement</td>
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<td>Defining instance</td>
<td>flow, phrasing, palpable</td>
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<td>flow</td>
<td></td>
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<td>HTMLDialogElement</td>
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<td>Generic flow container, or container for name-value groups in dt elements</td>
<td>flow, palpable</td>
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<td>HTMLDivElement</td>
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<tr>
<td>Element</td>
<td>Description</td>
<td>Categories</td>
<td>Parents†</td>
<td>Children</td>
<td>Attributes</td>
<td>Interface</td>
</tr>
<tr>
<td>---------</td>
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</tr>
<tr>
<td>embed[^296]</td>
<td>Plugin[^46]</td>
<td>flow[^287]; phrasing[^246]; embed[^256]; interactive[^256]; palpable[^256]</td>
<td>phrasing[^246] empty</td>
<td>globals[^252]; src[^238]; type[^238]; width[^238]; height[^238]; any[^*]</td>
<td>HTML Embed Element[^306]</td>
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</tr>
<tr>
<td>figure[^216]</td>
<td>Figure with optional caption</td>
<td>flow[^287]; palpable[^256]</td>
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<td>figcaption[^216]; flow[^287]</td>
<td>globals[^252]</td>
<td>HTML Element[^210]</td>
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<tr>
<td>form[^118]</td>
<td>User-submittable form</td>
<td>flow[^287]; palpable[^256]</td>
<td>flow[^287]</td>
<td>globals[^252]; accept-charset[^238]; action[^238]; autocomplete[^238]; enctype[^238]; method[^238]; name[^238]; novalidate[^238]; rel[^238]; target[^238]</td>
<td>HTML Form Element[^211]</td>
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<tr>
<td>h1[^213], h2[^213], h3[^213], h4[^213], h5[^213], h6[^213]</td>
<td>Heading</td>
<td>flow[^287]; heading[^217]; summary[^219]; flow[^217]</td>
<td>legend[^282]; summary[^219]; flow[^217]</td>
<td>phrasing[^246]; globals[^252]</td>
<td>HTML Heading Element[^214]</td>
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<td>iframe[^297]</td>
<td>Child navigable[^98]</td>
<td>flow[^287]; phrasing[^246]; embed[^256]; interactive[^256]; palpable[^256]</td>
<td>phrasing[^246] empty</td>
<td>globals[^252]; src[^238]; srcdoc[^238]; name[^232]; sandbox[^238]; allow[^238]; allowfullscreen[^238]; width[^238]; height[^238]; referrerpolicy[^239]; loading[^238]</td>
<td>HTML IFrame Element[^258]</td>
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<tr>
<td>img[^393]</td>
<td>Image</td>
<td>flow[^287]; phrasing[^246]; embed[^256]; interactive[^256]; palpable[^256]; form- associated[^255]</td>
<td>phrasing[^246]; picture[^339] empty</td>
<td>globals[^252]; alt[^238]; src[^238]; srcset[^238]; sizes[^238]; crossorigin[^238]; usemap[^239]; ismap[^239]; width[^238]; height[^238]; referrerpolicy[^239]; decoding[^238]; loading[^238]; fetchpriority[^238]</td>
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</tr>
<tr>
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<td>Description</td>
<td>Categories</td>
<td>Parents†</td>
<td>Children</td>
<td>Attributes</td>
<td>Interface</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------------</td>
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</tr>
<tr>
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<td>Form control</td>
<td>flow, phrasing</td>
<td>empty</td>
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<td>flow, phrasing</td>
<td>transparent</td>
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<td>globals, cite, datetime</td>
<td>HTMLModElement</td>
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<td>kbd</td>
<td>User input</td>
<td>flow, phrasing</td>
<td>globals</td>
<td></td>
<td>global</td>
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<tr>
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<td>Caption for a form control</td>
<td>flow, phrasing</td>
<td>globals</td>
<td>for</td>
<td>global</td>
<td>HTMLLabelElement</td>
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<td>legend</td>
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<td>fieldset</td>
<td>phrasing, heading, content</td>
<td>global</td>
<td>HTMLLegendElement</td>
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<td>List item</td>
<td>none</td>
<td>al, il, menu</td>
<td>flow</td>
<td>global</td>
<td>HTMLLIElement</td>
</tr>
<tr>
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<td>head, nocontent, phrasing</td>
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<td>globals, href, crossorigin, rel, as, media, hreflang, type, sizes, imagesrcset, imagesizes, referrerpolicy, integrity, blocking, color, disabled, setheight</td>
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</tr>
<tr>
<td>main</td>
<td>Container for the dominant contents of the document</td>
<td>flow, phrasing</td>
<td>global</td>
<td></td>
<td>global</td>
<td>HTMLElement</td>
</tr>
<tr>
<td>map</td>
<td>Image map</td>
<td>flow, phrasing</td>
<td>transparent, area</td>
<td></td>
<td>global</td>
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<td>Highlight</td>
<td>flow, phrasing</td>
<td>phrasing</td>
<td>global</td>
<td>global</td>
<td>HTMLElement</td>
</tr>
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<td>MathML math</td>
<td>MathML root</td>
<td>flow, phrasing</td>
<td>per MathML</td>
<td>per MathML</td>
<td>global</td>
<td>Element</td>
</tr>
<tr>
<td>menu</td>
<td>Menu of commands</td>
<td>flow</td>
<td>li; script</td>
<td>supporting elements</td>
<td>global</td>
<td>HTMLMenuElement</td>
</tr>
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<td>Text metadata</td>
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<td>head, nocontent</td>
<td>empty</td>
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<td>Gauge</td>
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<td>phrasing</td>
<td>global</td>
<td>value, min, max, low, high, optimum</td>
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<td>flow</td>
<td>global</td>
<td>global</td>
<td>HTMLNavigationElement</td>
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<td>head, nocontent</td>
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<td>HTMLElement</td>
</tr>
<tr>
<td>object</td>
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<td>flow, phrasing</td>
<td>transparent</td>
<td>global</td>
<td>data, type, name, form, width, height</td>
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</tr>
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<td>Element</td>
<td>Description</td>
<td>Categories</td>
<td>Parents†</td>
<td>Children</td>
<td>Attributes</td>
<td>Interface</td>
</tr>
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<td>----------</td>
<td>------------</td>
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</tr>
<tr>
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<td>Ordered list</td>
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<td>flow</td>
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<td></td>
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<td>text, globals</td>
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<td>globals</td>
<td>for, form, name</td>
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<td>Paragraph</td>
<td>flow, palbable</td>
<td>flow</td>
<td>phrasing</td>
<td>globals</td>
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<td>Image</td>
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<td>phrasing</td>
<td>source</td>
<td>one</td>
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<td>pre228</td>
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<td>phrasing</td>
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<td>Parenthesis for ruby annotation text</td>
<td>none</td>
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<td>text</td>
<td>globals</td>
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<td>globals</td>
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<td>Ruby annotation(s)</td>
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<td>globals</td>
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<td>globals</td>
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<tr>
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<td>Embedded script</td>
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<td>head, phrasing, script, supporting</td>
<td>script, data, or script documentation</td>
<td>src, type, nomodule, async, defer, crossorigin, integrity, referrerpolicy, blocking, fetchpriority</td>
<td>HTMLScriptElement268</td>
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<td>Container for search controls</td>
<td>flow, palicable</td>
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<td>flow</td>
<td>globals</td>
<td>HTMLElement251</td>
</tr>
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<td>globals</td>
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<td>Categories</td>
<td>Parents†</td>
<td>Children</td>
<td>Attributes</td>
<td>Interface</td>
</tr>
<tr>
<td>-----------</td>
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<td>---------------------------</td>
<td>-----------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>select</td>
<td>List box control</td>
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<td>phrasing</td>
<td>option, optgroup, script, supporting elements</td>
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<td>Shadow tree slot</td>
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<td>HTMLSlotElement</td>
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<tr>
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<td>Side comment</td>
<td>flow, phrasing</td>
<td>phrasing, globals</td>
<td>globals</td>
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<td>flow, phrasing</td>
<td>phrasing, globals</td>
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<td>HTMLSpanElement</td>
</tr>
<tr>
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<td>Importance</td>
<td>flow, phrasing</td>
<td>phrasing, globals</td>
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<td>globals: <code>media</code>, <code>blocking</code></td>
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<td>HTMLSpanElement</td>
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<td>globals</td>
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<td>Superscript</td>
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<td>caption, colgroup, thead, tbody, tr, script, supporting elements</td>
<td>globals</td>
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<tr>
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<td>tr, script, supporting elements</td>
<td>globals</td>
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<td>phrasing</td>
<td>text</td>
<td>globals: <code>autocomplete</code>, <code>cols</code>, <code>dirname</code>, <code>disabled</code>, <code>form</code>, <code>maxlength</code>, <code>minlength</code>, <code>name</code>, <code>placeholder</code>, <code>rows</code>, <code>wrap</code></td>
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<tr>
<td>Element</td>
<td>Description</td>
<td>Categories</td>
<td>Parents†</td>
<td>Children</td>
<td>Attributes</td>
<td>Interface</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>------------</td>
<td>----------</td>
<td>----------</td>
<td>------------</td>
<td>-----------</td>
</tr>
<tr>
<td>tfoot</td>
<td>Group of footer rows in a table</td>
<td>none</td>
<td>table, tr</td>
<td>tr</td>
<td>globals</td>
<td>HTMLTableSectionElement</td>
</tr>
<tr>
<td>th</td>
<td>Table header cell</td>
<td>interactive</td>
<td>tr</td>
<td>flow</td>
<td>globals: colspan, rowspan, headers, scope, abbr</td>
<td>HTMLTableCellElement</td>
</tr>
<tr>
<td>thead</td>
<td>Group of heading rows in a table</td>
<td>none</td>
<td>table, tr</td>
<td>tr</td>
<td>globals</td>
<td>HTMLTableSectionElement</td>
</tr>
<tr>
<td>time</td>
<td>Machine-readable equivalent of date- or time-related data</td>
<td>flow, phrasing, palpable</td>
<td>tr</td>
<td>globals, datetime</td>
<td>HTMLTimeElement</td>
<td></td>
</tr>
<tr>
<td>title</td>
<td>Document title</td>
<td>metadata</td>
<td>head</td>
<td>text</td>
<td>globals</td>
<td>HTMLTitleElement</td>
</tr>
<tr>
<td>tr</td>
<td>Table row</td>
<td>none</td>
<td>table, th, thead, tfoot</td>
<td>th</td>
<td>globals</td>
<td>HTMLTableRowElement</td>
</tr>
<tr>
<td>track</td>
<td>Timed text track</td>
<td>none</td>
<td>audio, video</td>
<td>empty</td>
<td>globals: default, kind, label, src, srclang</td>
<td>HTMLTrackElement</td>
</tr>
<tr>
<td>s</td>
<td>Unarticulated annotation</td>
<td>flow, phrasing, palpable</td>
<td>tr</td>
<td>globals</td>
<td>HTMLAnnotationElement</td>
<td></td>
</tr>
<tr>
<td>ul</td>
<td>List</td>
<td>flow, palpable</td>
<td>li</td>
<td>globals</td>
<td>HTMLULListElement</td>
<td></td>
</tr>
<tr>
<td>var</td>
<td>Variable</td>
<td>flow, palpable</td>
<td>tr</td>
<td>globals</td>
<td>HTMLVarElement</td>
<td></td>
</tr>
<tr>
<td>video</td>
<td>Video player</td>
<td>flow, phrasing, embedded, interactive, palpable</td>
<td>tr</td>
<td>globals: src, crossorigin, poster, preload, autoplay, playsinline, loop, muted, controls, width, height</td>
<td>HTMLVideoElement</td>
<td></td>
</tr>
<tr>
<td>wbr</td>
<td>Line breaking opportunity</td>
<td>flow, phrasing</td>
<td>empty</td>
<td>globals</td>
<td>HTMLWbrElement</td>
<td></td>
</tr>
</tbody>
</table>

An asterisk (*) in a cell indicates that the actual rules are more complicated than indicated in the table above.

† Categories in the "Parents" column refer to parents that list the given categories in their content model, not to elements that themselves are in those categories. For example, the s element’s "Parents" column says "phrasing", so any element whose content model contains the "phrasing" category could be a parent of an s element. Since the "flow" category includes all the "phrasing" elements, that means the th element could be a parent to an s element.

**Element content categories**

This section is non-normative.

<table>
<thead>
<tr>
<th>Category</th>
<th>Elements</th>
<th>Elements with exceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metadata content</td>
<td>base, link, meta, noscript, script, style, template, title</td>
<td>—</td>
</tr>
<tr>
<td>Flow content</td>
<td>a, abbr, address, article, aside, audio, bdi, bdo, blockquote, br, button, canvas, cite, code, data, datalist, del, details, dfn, dialog, div, dl, em, embed, fieldset, figure, footer, form, h1, h2, h3, h4, h5, header, legend, map, menu, nav, ol, p, pre, section, summary, time, track, video, wbr</td>
<td>area (if it is a descendant of a map element); link (if it is allowed in the body); main (if it is a hierarchically correct main element); meta (if the itemprop attribute)</td>
</tr>
<tr>
<td>Category</td>
<td>Elements</td>
<td>Elements with exceptions</td>
</tr>
<tr>
<td>----------</td>
<td>----------</td>
<td>--------------------------</td>
</tr>
<tr>
<td><strong>Form-associated elements</strong></td>
<td>button[93], fieldset[94], input[95], label[96], object[97], output[98], select[99], textarea[100], img[101], form-associated custom elements[102]</td>
<td></td>
</tr>
<tr>
<td><strong>Listed elements</strong></td>
<td>button[93], fieldset[94], input[95], object[96], output[97], select[98], textarea[99], form-associated custom elements[100]</td>
<td></td>
</tr>
<tr>
<td><strong>Submittable elements</strong></td>
<td>button[93], input[94], select[95], textarea[96], form-associated custom elements[97]</td>
<td></td>
</tr>
<tr>
<td><strong>Resettable elements</strong></td>
<td>input[94], output[95], select[96], textarea[97], form-associated custom elements[98]</td>
<td></td>
</tr>
<tr>
<td><strong>Autocapitalize-inheriting elements</strong></td>
<td>button[93], fieldset[94], input[95], object[96], output[97], select[98], textarea[99], form-associated custom elements[100]</td>
<td></td>
</tr>
<tr>
<td><strong>Labelable elements</strong></td>
<td>button[93], input[94], meter[95], output[96], progress[97], select[98], textarea[99], form-associated custom elements[100]</td>
<td></td>
</tr>
<tr>
<td><strong>Printable content</strong></td>
<td>a[92], abbr[93], address[94], article[95], aside[96], p[97], h1[98], h2[99], h3[100], h4[101], h5[102], h6[103], header[104], hr[105], iframe[95], img[96], ins[106], del[107], cite[97], code[98], data[99], details[100], dfn[101], em[102], embed[103], fieldset[104], figure[105], footer[106], form[107], b[108], bdi[109], big[110], bd[111], small[112], span[113], strong[114], sub[115], sup[116], small[117], span[118], strong[119], sub[120], sup[121], SVG svg:table[122], textarea[123], time[124], u[125], var[126], video[127], wbr[128], autonomous custom elements[129], Text[130]</td>
<td></td>
</tr>
<tr>
<td><strong>Script supporting elements</strong></td>
<td>script[131], template[132]</td>
<td></td>
</tr>
</tbody>
</table>

## Attributes

This section is non-normative.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Element(s)</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>abbr</td>
<td>th[133]</td>
<td>Alternative label to use for the header cell when referencing the cell in other contexts</td>
<td>Text[134]</td>
</tr>
<tr>
<td>accept</td>
<td>input[135]</td>
<td>Hint for expected file type in file</td>
<td>Set of comma-separated tokens consisting of valid MIME types</td>
</tr>
<tr>
<td>Attribute</td>
<td>Element(s)</td>
<td>Description</td>
<td>Value</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>accept-charset</td>
<td>form HTML</td>
<td>Character encodings to use for form submission[^423]</td>
<td>Ordered case-insensitive match for &quot;UTF-8&quot;</td>
</tr>
<tr>
<td>accesskey</td>
<td>HTML elements[^486]</td>
<td>Keyboard shortcut to activate or focus element</td>
<td>Ordered set of unique space-separated tokens[^69], none of which are identical to another, each consisting of one code point in length</td>
</tr>
<tr>
<td>action</td>
<td>form HTML</td>
<td>URL to use for form submission[^423]</td>
<td>Valid non-empty URL potentially surrounded by spaces[^95]</td>
</tr>
<tr>
<td>allow</td>
<td>iframe HTML</td>
<td>Permissions policy to be applied to the iframe[^486]'s contents</td>
<td>Serialized permissions policy</td>
</tr>
<tr>
<td>allowfullscreen</td>
<td>iframe HTML</td>
<td>Whether to allow the iframe[^486]'s contents to use requestFullscreen()</td>
<td>Boolean attribute[^73]</td>
</tr>
<tr>
<td>alt</td>
<td>area HTML, img HTML, input HTML</td>
<td>Replacement text for use when images are not available</td>
<td>Text[^413]</td>
</tr>
<tr>
<td>as</td>
<td>link HTML</td>
<td>Potential destination for a preload request (for rel[^413]=&quot;preload[^413]&quot; and rel[^413]=&quot;modulepreload[^413]&quot; and rel[^413]=&quot;anonymous[^413]&quot;)</td>
<td>Potential destination, for rel[^413]=&quot;preload[^413]&quot;; script-like destination, for rel[^413]=&quot;modulepreload[^413]&quot;</td>
</tr>
<tr>
<td>async</td>
<td>script HTML</td>
<td>Execute script when available, without blocking while fetching</td>
<td>Boolean attribute[^73]</td>
</tr>
<tr>
<td>autocapitalize</td>
<td>HTML elements[^486]</td>
<td>Recommended autocapitalization behavior (for supported input methods)</td>
<td>&quot;on[^73]&quot;, &quot;off[^73]&quot;, &quot;none[^73]&quot;, &quot;sentences[^73]&quot;, &quot;words[^73]&quot;, &quot;characters[^73]&quot;</td>
</tr>
<tr>
<td>autocomplete</td>
<td>form HTML</td>
<td>Default setting for autofill feature for controls in the form</td>
<td>&quot;on&quot;; &quot;off&quot;</td>
</tr>
<tr>
<td>autocomplete</td>
<td>input HTML, select HTML, textarea HTML</td>
<td>Hint for form autofill feature</td>
<td>Autocomplete[^462] name and related tokens*</td>
</tr>
<tr>
<td>autofocus</td>
<td>HTML elements[^486]</td>
<td>Automatically focus the element when the page is loaded</td>
<td>Boolean attribute[^73]</td>
</tr>
<tr>
<td>autoplay</td>
<td>audio HTML, video HTML</td>
<td>Hint that the media resource[^412] can be started automatically when the page is loaded</td>
<td>Boolean attribute[^73]</td>
</tr>
<tr>
<td>blocking</td>
<td>link HTML, script HTML, style HTML</td>
<td>Whether the element is potentially render-blocking[^412]</td>
<td>Unordered set of unique space-separated tokens[^74]</td>
</tr>
<tr>
<td>charset</td>
<td>meta HTML</td>
<td>Character encoding declaration[^488]</td>
<td>&quot;utf-8&quot;</td>
</tr>
<tr>
<td>checked</td>
<td>input HTML</td>
<td>Whether the control is checked</td>
<td>Boolean attribute[^73]</td>
</tr>
<tr>
<td>cite</td>
<td>blockquote[^322], del[^319], ins[^319], strike[^319]</td>
<td>Link to the source of the quotation or more information about the edit</td>
<td>Valid URL potentially surrounded by spaces[^95]</td>
</tr>
<tr>
<td>class</td>
<td>HTML elements[^522]</td>
<td>Classes to which the element belongs</td>
<td>Set of space-separated tokens[^49]</td>
</tr>
<tr>
<td>color</td>
<td>link HTML</td>
<td>Color to use when customizing a site's icon (for rel[^413]=&quot;mask-icon[^413]&quot;)</td>
<td>CSS <code>&lt;color&gt;</code></td>
</tr>
<tr>
<td>cols</td>
<td>textarea HTML</td>
<td>Maximum number of characters per line</td>
<td>Valid non-negative integer[^97] greater than zero</td>
</tr>
<tr>
<td>colspan</td>
<td>td[^411], th[^411]</td>
<td>Number of columns that the cell is to span</td>
<td>Valid non-negative integer[^97] greater than zero</td>
</tr>
<tr>
<td>content</td>
<td>meta HTML</td>
<td>Value of the element</td>
<td>Text[^413]</td>
</tr>
<tr>
<td>contenteditable</td>
<td>HTML elements[^486]</td>
<td>Whether the element is editable</td>
<td>&quot;true&quot;; &quot;plaintext-only&quot;; &quot;false&quot;</td>
</tr>
<tr>
<td>controls</td>
<td>audio HTML, video HTML</td>
<td>Show user agent controls</td>
<td>Boolean attribute[^73]</td>
</tr>
<tr>
<td>coords</td>
<td>area HTML, img HTML, link HTML, script HTML, video HTML</td>
<td>Coordinates for the shape to be created in an image map[^430]</td>
<td>Valid list of floating-point numbers[^78]</td>
</tr>
<tr>
<td>crossorigin</td>
<td>audio HTML, img HTML, link HTML, script HTML, video HTML</td>
<td>How the element handles crossorigin requests</td>
<td>&quot;anonymous[^98]&quot;, &quot;use-credentials[^98]&quot;</td>
</tr>
<tr>
<td>data</td>
<td>object[c3]</td>
<td>Address of the resource</td>
<td>Valid non-empty URL potentially surrounded by spaces[^95]</td>
</tr>
<tr>
<td>datetime</td>
<td>del[^418], ins[^419]</td>
<td>Date and (optionally) time of the change</td>
<td>Valid date string with optional time[^435]</td>
</tr>
<tr>
<td>datetime</td>
<td>time[^427]</td>
<td>Machine-readable value</td>
<td>Valid month string[^439], valid date string[^439], valid yearless date string[^439], valid time string[^439], valid local date and time string[^439], valid time-zone offset string[^439], valid global date and time string[^439], valid week string[^443], valid non-negative integer[^443], or valid duration string[^443]</td>
</tr>
<tr>
<td>decoding</td>
<td>img[^411]</td>
<td>Decoding hint to use when processing this image for</td>
<td>&quot;sync[^101]&quot;, &quot;async[^101]&quot;, &quot;auto[^101]&quot;</td>
</tr>
</tbody>
</table>

[^413]: [HTML](https://html.spec.whatwg.org/multipage/index.html)  
[^423]: [HTML](https://html.spec.whatwg.org/multipage/index.html)  
[^430]: [HTML](https://html.spec.whatwg.org/multipage/index.html)  
[^439]: [HTML](https://html.spec.whatwg.org/multipage/index.html)  
[^443]: [HTML](https://html.spec.whatwg.org/multipage/index.html)  
[^450]: [HTML](https://html.spec.whatwg.org/multipage/index.html)
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Element(s)</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>default</td>
<td>track[^110]</td>
<td>Enable the track if no other text track[^110] is more suitable</td>
<td>Boolean attribute[^112]</td>
</tr>
<tr>
<td>defer</td>
<td>script[^119]</td>
<td>Defer script execution</td>
<td>Boolean attribute[^112]</td>
</tr>
<tr>
<td>dirname</td>
<td>input[^398], textarea[^398]</td>
<td>Name of form control to use for sending the element's directionality[^119] in form submission[^123]</td>
<td>Text[^119]</td>
</tr>
<tr>
<td>disabled</td>
<td>button[^209], input[^209], optgroup[^209]: option[^211], select[^209], textarea[^209], form-associated custom elements[^209]</td>
<td>Whether the form control is disabled</td>
<td>Boolean attribute[^112]</td>
</tr>
<tr>
<td>disabled</td>
<td>fieldset[^209]</td>
<td>Whether the descendant form controls, except any inside legend[^210], are disabled</td>
<td>Boolean attribute[^112]</td>
</tr>
<tr>
<td>download</td>
<td>a[^199], area[^199]</td>
<td>Whether to download the resource instead of navigating to it, and its filename if so</td>
<td>Text</td>
</tr>
<tr>
<td>draggable</td>
<td>HTML elements[^127]</td>
<td>Whether the element is draggable</td>
<td>&quot;true&quot;, &quot;false&quot;</td>
</tr>
<tr>
<td>enctype</td>
<td>form[^159]</td>
<td>Entry list[^162], encoding type to use for form submission[^123]</td>
<td>&quot;application/x-www-form-urlencoded&quot;, &quot;multipart/form-data&quot;, &quot;text/plain&quot;</td>
</tr>
<tr>
<td>enterkeyhint</td>
<td>HTML elements[^154]</td>
<td>Hint for selecting an enter key action</td>
<td>&quot;enter&quot;, &quot;done&quot;, &quot;go&quot;, &quot;next&quot;, &quot;previous&quot;, &quot;search&quot;, &quot;send&quot;</td>
</tr>
<tr>
<td>fetchpriority</td>
<td>img[^191], link[^192], script[^161]</td>
<td>Sets the priority for fetches initiated by the element</td>
<td>&quot;auto&quot;, &quot;high&quot;, &quot;low&quot;</td>
</tr>
<tr>
<td>for</td>
<td>label[^113]</td>
<td>Associate the label with form control</td>
<td>ID*</td>
</tr>
<tr>
<td>for</td>
<td>output[^101]</td>
<td>Specifies controls from which the output was calculated</td>
<td>Unordered set of unique space-separated tokens[^105] consisting of IDs*</td>
</tr>
<tr>
<td>form</td>
<td>button[^109], fieldset[^109], input[^109], object[^109], output[^109], select[^109], textarea[^109], form-associated custom elements[^109]</td>
<td>Associates the element with a form[^110] element</td>
<td>ID*</td>
</tr>
<tr>
<td>formaction</td>
<td>button[^109], input[^109]</td>
<td>URL to use for form submission[^123]</td>
<td>Valid non-empty URL potentially surrounded by spaces[^109]</td>
</tr>
<tr>
<td>formenctype</td>
<td>button[^109], input[^109]</td>
<td>Entry list[^162], encoding type to use for form submission[^123]</td>
<td>&quot;application/x-www-form-urlencoded&quot;, &quot;multipart/form-data&quot;, &quot;text/plain&quot;</td>
</tr>
<tr>
<td>formmethod</td>
<td>button[^109], input[^109]</td>
<td>Variant to use for form output[^123]</td>
<td>&quot;GET&quot;, &quot;POST&quot;, &quot;dialog&quot;</td>
</tr>
<tr>
<td>formnovalidate</td>
<td>button[^109], input[^109]</td>
<td>Bypass form control validation for form submission[^123]</td>
<td>Boolean attribute[^113]</td>
</tr>
<tr>
<td>formtarget</td>
<td>button[^109], input[^109]</td>
<td>Navigable[^108] for form submission[^123]</td>
<td>Valid navigable target name or keyword[^105]</td>
</tr>
<tr>
<td>headers</td>
<td>header[^101], td[^101]</td>
<td>The header cells for this cell</td>
<td>Unordered set of unique space-separated tokens[^105] consisting of IDs*</td>
</tr>
<tr>
<td>height</td>
<td>canvas[^201], embed[^141], iframe[^141], img[^141], input[^201], object[^141], source[^141] (in picture[^339]), video[^141]</td>
<td>Vertical dimension</td>
<td>Valid non-negative integer[^125]</td>
</tr>
<tr>
<td>hidden</td>
<td>HTML elements[^122]</td>
<td>Whether the element is relevant</td>
<td>&quot;until-found&quot;, &quot;hidden&quot;, the empty string</td>
</tr>
<tr>
<td>high</td>
<td>meter[^159]</td>
<td>Low limit of high range</td>
<td>Valid floating-point number[^109]</td>
</tr>
<tr>
<td>href</td>
<td>a[^199], area[^199]</td>
<td>Address of the hyperlink[^298]</td>
<td>Valid URL potentially surrounded by spaces[^105]</td>
</tr>
<tr>
<td>href</td>
<td>link[^115]</td>
<td>Address of the hyperlink[^298]</td>
<td>Valid non-empty URL potentially surrounded by spaces[^105]</td>
</tr>
<tr>
<td>hreflang</td>
<td>a[^199], link[^118]</td>
<td>Language of the linked resource</td>
<td>Valid BCP 47 language tag</td>
</tr>
<tr>
<td>http-equiv</td>
<td>meta[^152]</td>
<td>Pragma directive</td>
<td>&quot;content-type&quot;, &quot;default-style&quot;, &quot;refresh&quot;, &quot;x-&quot;</td>
</tr>
<tr>
<td>Attribute</td>
<td>Element(s)</td>
<td>Description</td>
<td>Value</td>
</tr>
<tr>
<td>-----------</td>
<td>------------</td>
<td>-------------</td>
<td>-------</td>
</tr>
<tr>
<td>id</td>
<td>HTML elements</td>
<td>The element's ID</td>
<td>TEXT</td>
</tr>
<tr>
<td>imagesizes</td>
<td>link</td>
<td>Image sizes for different page layouts (for <code>rel</code> = &quot;preload&quot;)</td>
<td>Valid source size list</td>
</tr>
<tr>
<td>imagesrcset</td>
<td>link</td>
<td>Images to use in different situations, e.g., high-resolution displays, small monitors, etc. (for <code>rel</code> = &quot;preconnect&quot;)</td>
<td>Comma-separated list of image candidate strings</td>
</tr>
<tr>
<td>inert</td>
<td>HTML elements</td>
<td>Whether the element is inert</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>inputmode</td>
<td>HTML elements</td>
<td>Hint for selecting an input modality</td>
<td>&quot;none&quot;, &quot;text&quot;, &quot;email&quot;, &quot;url&quot;, &quot;numeric&quot;, &quot;decimal&quot;, &quot;search&quot;</td>
</tr>
<tr>
<td>integrity</td>
<td>link, script</td>
<td>Integrity metadata used in Subresource Integrity checks</td>
<td>TEXT</td>
</tr>
<tr>
<td>is</td>
<td>HTML elements</td>
<td>Creates a customized built-in element</td>
<td>Valid custom element name of a defined customized built-in element</td>
</tr>
<tr>
<td>ismap</td>
<td>img</td>
<td>Whether the image is a server-side image map</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>itemid</td>
<td>HTML elements</td>
<td>Global identifier for a microdata item</td>
<td>Valid URL potentially surrounded by spaces</td>
</tr>
<tr>
<td>itemprop</td>
<td>HTML elements</td>
<td>Property names of a microdata item</td>
<td>Unordered set of unique space-separated tokens consisting of valid absolute URLs, defined property names, or text</td>
</tr>
<tr>
<td>itemref</td>
<td>HTML elements</td>
<td>Referenced elements</td>
<td>Unordered set of unique space-separated tokens consisting of IDs</td>
</tr>
<tr>
<td>itemscope</td>
<td>HTML elements</td>
<td>Introduces a microdata item</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>itemtype</td>
<td>HTML elements</td>
<td>Item types of a microdata item</td>
<td>Unordered set of unique space-separated tokens consisting of valid absolute URLs</td>
</tr>
<tr>
<td>kind</td>
<td>track</td>
<td>The type of text track</td>
<td>&quot;subtitles&quot;, &quot;captions&quot;, &quot;descriptions&quot;, &quot;chapters&quot;, &quot;metadata&quot;</td>
</tr>
<tr>
<td>label</td>
<td>optgroup, option, track</td>
<td>User-visible label</td>
<td>TEXT</td>
</tr>
<tr>
<td>lang</td>
<td>HTML elements</td>
<td>Language of the element</td>
<td>BCP 47 language tag or the empty string</td>
</tr>
<tr>
<td>list</td>
<td>input</td>
<td>List of autocomplete options</td>
<td>ID</td>
</tr>
<tr>
<td>loading</td>
<td>iframe, img</td>
<td>Used when determining loading deferral</td>
<td>&quot;lazy&quot;, &quot;eager&quot;</td>
</tr>
<tr>
<td>loop</td>
<td>audio, video</td>
<td>Whether to loop the media resource</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>low</td>
<td>meter</td>
<td>High limit of low range</td>
<td>Valid floating-point number</td>
</tr>
<tr>
<td>max</td>
<td>input</td>
<td>Maximum value</td>
<td>Varies</td>
</tr>
<tr>
<td>max</td>
<td>meter, progress</td>
<td>Upper bound of range</td>
<td>Valid floating-point number</td>
</tr>
<tr>
<td>maxlength</td>
<td>input, textarea</td>
<td>Maximum length of value</td>
<td>Valid non-negative integer</td>
</tr>
<tr>
<td>media</td>
<td>link, meta, source, style</td>
<td>Applicable media</td>
<td>Valid media query list</td>
</tr>
<tr>
<td>method</td>
<td>form</td>
<td>Variant to use for form submission</td>
<td>&quot;GET&quot;, &quot;POST&quot;, &quot;dialog&quot;</td>
</tr>
<tr>
<td>min</td>
<td>input</td>
<td>Minimum value</td>
<td>Varies</td>
</tr>
<tr>
<td>min</td>
<td>meter, textarea</td>
<td>Lower bound of range</td>
<td>Valid floating-point number</td>
</tr>
<tr>
<td>minlength</td>
<td>input, textarea</td>
<td>Minimum length of value</td>
<td>Valid non-negative integer</td>
</tr>
<tr>
<td>multiple</td>
<td>input, select</td>
<td>Whether to allow multiple values</td>
<td>Boolean attribute</td>
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<td>muted</td>
<td>audio, video</td>
<td>Whether to mute the media resource, by default</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>name</td>
<td>button, fieldset, input, output, select, textarea, form-associated custom elements</td>
<td>Name of the element to use for form submission and in the form.elements API</td>
<td>TEXT</td>
</tr>
<tr>
<td>name</td>
<td>details</td>
<td>Name of group of mutually-exclusive details elements</td>
<td>TEXT</td>
</tr>
<tr>
<td>name</td>
<td>form</td>
<td>Name of form to use in the document.forms API</td>
<td>TEXT</td>
</tr>
<tr>
<td>name</td>
<td>iframe, object</td>
<td>Name of content navigable target name or keyword</td>
<td>Valid navigable target name or keyword</td>
</tr>
<tr>
<td>Attribute</td>
<td>Element(s)</td>
<td>Description</td>
<td>Value</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>name</td>
<td><code>map</code>[^147]</td>
<td>Name of <code>image-map</code>[^147] to reference[^147] from the <code>usemap</code>[^147] attribute</td>
<td>Text</td>
</tr>
<tr>
<td>name</td>
<td><code>meta</code>[^147]</td>
<td>Metadata name</td>
<td>Text</td>
</tr>
<tr>
<td>name</td>
<td><code>slot</code>[^147]</td>
<td>Name of shadow tree slot</td>
<td>Text</td>
</tr>
<tr>
<td>nomodule</td>
<td><code>script</code>[^147]</td>
<td>Prevents execution in user agents that support <code>module-scripts</code>[^147]</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>nonce</td>
<td>HTML elements[^208]</td>
<td>Cryptographic nonce used in Content Security Policy checks (CSP)[^208]</td>
<td>Text</td>
</tr>
<tr>
<td>novalidate</td>
<td><code>form</code>[^110]</td>
<td>Bypass form control validation for <code>form submission</code>[^110]</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>open</td>
<td><code>details</code>[^113]</td>
<td>Whether the details are visible</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>open</td>
<td><code>dialog</code>[^144]</td>
<td>Whether the dialog box is showing</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>optimum</td>
<td><code>meter</code>[^106]</td>
<td>Optimum value in gauge</td>
<td>Valid floating-point number[^203]</td>
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<tr>
<td>pattern</td>
<td><code>input</code>[^149]</td>
<td>Pattern to be matched by the form control's value</td>
<td>Regular expression matching the JavaScript Pattern production</td>
</tr>
<tr>
<td>ping</td>
<td><code>a</code>[^205]; <code>area</code>[^208]</td>
<td>URLs to ping</td>
<td>Set of space-separated tokens[^203] consisting of valid non-empty URLs[^204]</td>
</tr>
<tr>
<td>placeholder</td>
<td><code>input</code>[^177]; <code>textarea</code>[^179]</td>
<td>User-visible label to be placed within the form control</td>
<td>Text[^177]</td>
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<tr>
<td>playsinline</td>
<td><code>video</code>[^160]</td>
<td>Encourage the user agent to display video content within the element's playback area</td>
<td>Boolean attribute</td>
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<tr>
<td>popover</td>
<td>HTML elements[^208]</td>
<td>Makes the element a <code>popover</code>[^208] element</td>
<td><code>auto</code>[^208]; <code>manual</code>[^208];</td>
</tr>
<tr>
<td>popovertarget</td>
<td><code>input</code>[^182]; <code>button</code>[^148]</td>
<td>Targets a popover element to toggle, show, or hide</td>
<td>ID^*</td>
</tr>
<tr>
<td>popovertargetaction</td>
<td><code>input</code>[^182]; <code>button</code>[^148]</td>
<td>Indicates whether a targeted popover element is to be toggled, shown, or hidden</td>
<td><code>toggle</code>[^148]; <code>show</code>[^148]; <code>hide</code>[^148]</td>
</tr>
<tr>
<td>poster</td>
<td><code>video</code>[^248]</td>
<td>Poster frame to show prior to video playback</td>
<td>Valid non-empty URL potentially surrounded by spaces[^248]</td>
</tr>
<tr>
<td>preload</td>
<td><code>audio</code>[^240]; <code>video</code>[^148]</td>
<td>Hints how much buffering the media resource[^240] will likely need</td>
<td><code>none</code>[^240]; <code>metadata</code>[^240]; <code>auto</code>[^240]</td>
</tr>
<tr>
<td>readonly</td>
<td><code>input</code>[^189]; <code>textarea</code>[^179]</td>
<td>Whether to allow the value to be edited by the user</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>readonly</td>
<td><code>form-associated custom elements</code>[^147]</td>
<td>Affects <code>willValidate</code>[^147], plus any behavior added by the custom element author</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>referrerpolicy</td>
<td><code>a</code>[^208]; <code>area</code>[^208]; <code>iframe</code>[^393]; <code>img</code>[^134]; <code>link</code>[^135]; <code>script</code>[^150]</td>
<td>Referrer policy for fetches initiated by the element</td>
<td>Referrer policy</td>
</tr>
<tr>
<td>rel</td>
<td><code>a</code>[^208]; <code>area</code>[^208]</td>
<td>Relationship between the location in the document containing the <code>hyperlink</code>[^208] and the destination resource</td>
<td>Unordered set of unique space-separated tokens[^208]</td>
</tr>
<tr>
<td>rel</td>
<td><code>link</code>[^135]</td>
<td>Relationship between the document containing the <code>hyperlink</code>[^208] and the destination resource</td>
<td>Unordered set of unique space-separated tokens[^135]</td>
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<tr>
<td>required</td>
<td><code>input</code>[^165]; <code>select</code>[^146]; <code>textarea</code>[^113]</td>
<td>Whether the control is required for <code>form submission</code>[^113]</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>reversed</td>
<td><code>gl</code>[^173]</td>
<td>Number the list backwards</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>rows</td>
<td><code>textarea</code>[^179]</td>
<td>Number of lines to show</td>
<td>Valid non-negative integer[^179] greater than zero</td>
</tr>
<tr>
<td>rowspan</td>
<td><code>td</code>[^145]; <code>th</code>[^145]</td>
<td>Number of rows that the cell is to span</td>
<td>Valid non-negative integer[^145]</td>
</tr>
<tr>
<td>sandbox</td>
<td><code>iframe</code>[^102]</td>
<td>Security rules for nested content</td>
<td>Unordered set of unique space-separated tokens[^102], ASCII case-insensitive, consisting of</td>
</tr>
</tbody>
</table>

[^147]: consisting of space-separated tokens
[^208]: consisting of valid non-empty URL potentially surrounded by spaces
[^110]: Boolean attribute
[^177]: Text
[^120]: Set of space-separated tokens
[^148]: Valid non-empty URL
[^135]: Valid non-negative integer
[^139]: Unordered set of unique space-separated tokens
[^144]: Valid non-empty URL
[^147]: ID
[^149]: Regular expression matching the JavaScript Pattern production
[^150]: Boolean attribute
[^155]: Unordered set of unique space-separated tokens
[^203]: Valid floating-point number
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Element(s)</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>scope</td>
<td>th</td>
<td>Specifies which cells the header cell applies to</td>
<td>&quot;row&quot;, &quot;col&quot;, &quot;rowgroup&quot;, &quot;colgroup&quot;</td>
</tr>
<tr>
<td>selected</td>
<td>option</td>
<td>Whether the option is selected by default</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>shadowrootmode</td>
<td>template</td>
<td>Enables streaming declarative shadow roots</td>
<td>&quot;open&quot;, &quot;closed&quot;</td>
</tr>
<tr>
<td>shadowrootdelegatesfocus</td>
<td>template</td>
<td>Sets delegates focus on a declarative shadow root</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>shadowrootcloneable</td>
<td>template</td>
<td>Sets cloneable on a declarative shadow root</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>shadowrootserializable</td>
<td>template</td>
<td>Sets serializable on a declarative shadow root</td>
<td>Boolean attribute</td>
</tr>
<tr>
<td>shape</td>
<td>area</td>
<td>The kind of shape to be created in an image map</td>
<td>&quot;circle&quot;, &quot;default&quot;, &quot;poly&quot;, &quot;rect&quot;</td>
</tr>
<tr>
<td>size</td>
<td>input; select</td>
<td>Size of the control</td>
<td>Valid non-negative integer greater than zero</td>
</tr>
<tr>
<td>sizes</td>
<td>link</td>
<td>Sizes of the icons (for rel=icon)</td>
<td>Unordered set of unique space-separated tokens, ASCII case-insensitive, consisting of sizes*</td>
</tr>
<tr>
<td>sizes</td>
<td>img; source</td>
<td>Image sizes for different page layouts</td>
<td>Valid source size list</td>
</tr>
<tr>
<td>slot</td>
<td>HTML elements</td>
<td>The element's desired slot</td>
<td>Text</td>
</tr>
<tr>
<td>span</td>
<td>col; colgroup</td>
<td>Number of columns spanned by the element</td>
<td>Valid non-negative integer greater than zero</td>
</tr>
<tr>
<td>spellcheck</td>
<td>HTML elements</td>
<td>Whether the element is to have its spelling and grammar checked</td>
<td>&quot;true&quot;, &quot;false&quot;, the empty string</td>
</tr>
<tr>
<td>src</td>
<td>audio; embed; iframe; img; input; script; source (in video or audio); track; video</td>
<td>Address of the resource</td>
<td>Valid non-empty URL potentially surrounded by spaces</td>
</tr>
<tr>
<td>srcdoc</td>
<td>iframe</td>
<td>A document to render in the iframe</td>
<td>The source of an iframe srcdoc document</td>
</tr>
<tr>
<td>srclang</td>
<td>track</td>
<td>Language of the text track</td>
<td>Valid BCP 47 language tag</td>
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<tr>
<td>srcset</td>
<td>img; source</td>
<td>Images to use in different situations, e.g., high-resolution displays, small monitors, etc.</td>
<td>Comma-separated list of image candidate strings</td>
</tr>
<tr>
<td>start</td>
<td>ol</td>
<td>Starting value of the list</td>
<td>Valid integer</td>
</tr>
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<td>step</td>
<td>input</td>
<td>Granularity to be matched by the form control’s value</td>
<td>Valid floating-point number greater than zero, or &quot;any&quot;</td>
</tr>
<tr>
<td>style</td>
<td>HTML elements</td>
<td>Presentational and formatting instructions</td>
<td>CSS declarations</td>
</tr>
<tr>
<td>tabindex</td>
<td>HTML elements</td>
<td>Whether the element is focusable and sequentially focusable, and the relative order of the element for the purposes of sequential focus navigation</td>
<td>Valid integer</td>
</tr>
<tr>
<td>target</td>
<td>a; area</td>
<td>Navigable for hyperlink navigation and form submission</td>
<td>Valid navigable target name or keyword</td>
</tr>
<tr>
<td>target</td>
<td>base</td>
<td>Default navigable for hyperlink navigation and form submission</td>
<td>Valid navigable target name or keyword</td>
</tr>
<tr>
<td>target</td>
<td>form</td>
<td>Navigable for form submission</td>
<td>Valid navigable target name or keyword</td>
</tr>
<tr>
<td>title</td>
<td>HTML elements</td>
<td>Advisory information for the element</td>
<td>Text</td>
</tr>
<tr>
<td>title</td>
<td>abbr; dfn</td>
<td>Full term or expansion of abbreviation</td>
<td>Text</td>
</tr>
</tbody>
</table>
An asterisk (*) in a cell indicates that the actual rules are more complicated than indicated in the table above.
<table>
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<tr>
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<th>Element(s)</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ondrag</td>
<td>HTML elements</td>
<td>drag event handler</td>
<td>Event handler content attribute</td>
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<tr>
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<td>dragend event handler</td>
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<td>onstorage</td>
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<td>storage event handler for Window object</td>
<td>Event handler content attribute</td>
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<td>onsubmit</td>
<td>HTML elements</td>
<td>submit event handler</td>
<td>Event handler content attribute</td>
</tr>
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<td>HTML elements</td>
<td>suspend event handler</td>
<td>Event handler content attribute</td>
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<td>Event handler content attribute</td>
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<td>onunload</td>
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<td>unload event handler</td>
<td>Event handler content attribute</td>
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<td>onvolumechange</td>
<td>HTML elements</td>
<td>volumechange event handler</td>
<td>Event handler content attribute</td>
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<tr>
<td>onwheel</td>
<td>HTML elements</td>
<td>wheel event handler</td>
<td>Event handler content attribute</td>
</tr>
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</table>

**Element interfaces**

This section is non-normative.

<table>
<thead>
<tr>
<th>Element(s)</th>
<th>Interface(s)</th>
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<tbody>
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</table>
This section is non-normative.

- AudioTrack
- AudioTrackList
- BarProp
- BeforeUnloadEvent
- BroadcastChannel
- CanvasGradient
- CanvasPattern
- CanvasRenderingContext2D
- CloseWatcher
- CustomElementRegistry
- CustomStateSet
- DOMParser
- DOMStringList
- DOMStringMap
- DataTransfer
- DataTransferItem
- DataTransferItemList
- DedicatedWorkerGlobalScope
- Document
- DragEvent
- Element
- ElementPartial
- ElementInternals
- ErrorEvent
- EventSource
- External
- FormDataEvent
- HTMLAllCollection
- HTMLAnchorElement
- HTMLAreaElement
- HTMLAudioElement
- HTMLVideoElement
- CustomElement

Supplied by the element's author (inherits from HTMLElement)
## Events

This section is non-normative.


<table>
<thead>
<tr>
<th>Event</th>
<th>Interface</th>
<th>List of events</th>
<th>Description</th>
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<tbody>
<tr>
<td>DOMContentLoaded</td>
<td>Event</td>
<td><code>Document</code></td>
<td>Fired at the <code>Document</code> once the parser has finished</td>
</tr>
<tr>
<td>afterprint</td>
<td>Event</td>
<td><code>Window</code></td>
<td>Fired at the <code>Window</code> after printing</td>
</tr>
<tr>
<td>beforeprint</td>
<td>Event</td>
<td><code>Window</code></td>
<td>Fired at the <code>Window</code> before printing</td>
</tr>
<tr>
<td>beforematch</td>
<td>Event</td>
<td>Elements</td>
<td>Fired on elements with the <code>hiddenuntil-found</code></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Event</th>
<th>Interface</th>
<th>Interesting targets</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>beforetoggle</td>
<td>ToggleEvent(^{1451})</td>
<td>Elements</td>
<td>Fired on elements with the :overflow(^{168}) attribute when they are transitioning between showing and hidden.</td>
</tr>
<tr>
<td>beforeunload</td>
<td>BeforeUnloadEvent(^{168})</td>
<td>Window(^{1169}) elements</td>
<td>Fired at the Window(^{1169}) when the page is about to be unloaded, in case the page would like to show a warning prompt.</td>
</tr>
<tr>
<td>blur</td>
<td>Event</td>
<td>Window(^{1169}) elements</td>
<td>Fired at nodes when they stop being focused(^{168}).</td>
</tr>
<tr>
<td>cancel</td>
<td>Event</td>
<td>CloseWatcher(^{168}), dialog(^{168}) elements, input(^{110}) elements</td>
<td>Fired at CloseWatcher(^{168}) objects or dialog(^{168}) elements when they receive a close request(^{168}), or at input(^{110}) elements in the File(^{160}) state when the user does not change their selection.</td>
</tr>
<tr>
<td>change</td>
<td>Event</td>
<td>Form controls</td>
<td>Fired at controls when the user commits a value change (see also the input event).</td>
</tr>
<tr>
<td>click</td>
<td>PointerEvent</td>
<td>Elements</td>
<td>Normally a mouse event; also synthetically fired at an element before its activation behavior(^{18}) is run, when an element is activated from a non-pointer input device (e.g. a keyboard).</td>
</tr>
<tr>
<td>close</td>
<td>Event</td>
<td>CloseWatcher(^{168}), dialog(^{168}) elements, MessagePort(^{110})</td>
<td>Fired at CloseWatcher(^{168}) objects or dialog(^{168}) elements when they are closed via a close request(^{168}) or via web developer code, or at MessagePort(^{110}) objects when disentangled(^{118}).</td>
</tr>
<tr>
<td>connect</td>
<td>MessageEvent(^{110})</td>
<td>SharedWorkerGlobalScope(^{118})</td>
<td>Fired at a shared worker's global scope when a new client connects.</td>
</tr>
<tr>
<td>contextlost</td>
<td>Event</td>
<td>canvas(^{18}) elements, OffscreenCanvas(^{18}) objects</td>
<td>Fired when the corresponding CanvasRenderingContext(^{20}), or OffscreenCanvasRenderingContext(^{20}) is lost.</td>
</tr>
<tr>
<td>contextrestored</td>
<td>Event</td>
<td>canvas(^{18}) elements, OffscreenCanvas(^{18}) objects</td>
<td>Fired when the corresponding CanvasRenderingContext(^{20}), or OffscreenCanvasRenderingContext(^{20}) is restored after being lost.</td>
</tr>
<tr>
<td>currententrychange</td>
<td>NavigationCurrentEntryChangeEvent(^{127})</td>
<td>Navigation(^{110})</td>
<td>Fired when navigation.currentEntry(^{110}) changes</td>
</tr>
<tr>
<td>dispose</td>
<td>Event</td>
<td>NavigationHistoryEntry(^{108})</td>
<td>Fired when the session history entry(^{108}) corresponding to the NavigationHistoryEntry(^{108}) has been permanently evicted from session history and can no longer be traversed.</td>
</tr>
<tr>
<td>error</td>
<td>Event or ErrorEvent(^{18})</td>
<td>Global scope objects, Worker(^{116}) objects, elements, networking-related objects</td>
<td>Fired when unexpected errors occur (e.g. networking errors, script errors, decoding errors).</td>
</tr>
<tr>
<td>focus</td>
<td>Event</td>
<td>Window(^{1169}) elements</td>
<td>Fired at nodes gaining focus(^{168})</td>
</tr>
<tr>
<td>formdata</td>
<td>FormDataEvent(^{131})</td>
<td>form(^{131}) elements</td>
<td>Fired at a form(^{131}) element when it is constructing the entry list(^{131})</td>
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<tr>
<td>hashchange</td>
<td>HashChangeEvent(^{1451})</td>
<td>Window(^{1169})</td>
<td>Fired at the Window(^{1169}) when the fragment part of the document's URL changes.</td>
</tr>
<tr>
<td>input</td>
<td>Event</td>
<td>Elements</td>
<td>Fired when the user changes the contenteditable(^{164}) element's content, or the form control's value. See also the change(^{161}) event for form controls.</td>
</tr>
<tr>
<td>invalid</td>
<td>Event</td>
<td>Form controls</td>
<td>Fired at controls during form validation if they do not satisfy their constraints.</td>
</tr>
<tr>
<td>languagechange</td>
<td>Event</td>
<td>Global scope objects</td>
<td>Fired at the global scope object when the user's preferred languages change.</td>
</tr>
<tr>
<td>load</td>
<td>Event</td>
<td>Window(^{1169}) elements</td>
<td>Fired at the Window(^{1169}) when the document has finished loading; fired at an element containing a resource (e.g. img(^{141}), embed(^{168})) when its resource has finished loading.</td>
</tr>
<tr>
<td>message</td>
<td>MessageEvent(^{110})</td>
<td>Window(^{1169}), EventSource(^{110}), MessagePort(^{110}), BroadcastChannel(^{110}), DedicatedWorkerGlobalScope(^{116}), Worker(^{116}), ServiceWorkerContainer</td>
<td>Fired at an object when it receives a message.</td>
</tr>
<tr>
<td>messageerror</td>
<td>MessageEvent(^{110})</td>
<td>Window(^{1169}), MessagePort(^{110}), BroadcastChannel(^{110}), DedicatedWorkerGlobalScope(^{116}), Worker(^{116}), ServiceWorkerContainer</td>
<td>Fired at an object when it receives a message that cannot be deserialized.</td>
</tr>
<tr>
<td>Event</td>
<td>Interface</td>
<td>Interesting targets</td>
<td>Description</td>
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<td>-----------------</td>
<td>---------------------</td>
<td>-----------------------------------------------------------------------------</td>
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<tr>
<td>navigate</td>
<td>NavigateEvent</td>
<td>Navigation</td>
<td>Fired before the navigable reloads, traverses, or otherwise changes its URL</td>
</tr>
<tr>
<td>navigateerror</td>
<td>ErrorEvent</td>
<td>Navigation</td>
<td>Fired when a navigation does not complete successfully</td>
</tr>
<tr>
<td>navigatesuccess</td>
<td>Event</td>
<td>Navigation</td>
<td>Fired when a navigation completes successfully</td>
</tr>
<tr>
<td>offline</td>
<td>Event</td>
<td>Global scope objects</td>
<td>Fired at the global scope object when the network connections fails</td>
</tr>
<tr>
<td>online</td>
<td>Event</td>
<td>Global scope objects</td>
<td>Fired at the global scope object when the network connections returns</td>
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<tr>
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<td>Event</td>
<td>EventSource</td>
<td>Fired at EventSource objects when a connection is established</td>
</tr>
<tr>
<td>pageswap</td>
<td>PageSwapEvent</td>
<td>Window</td>
<td>Fired at the Window right before a document is unloaded as a result of a navigation.</td>
</tr>
<tr>
<td>pagehide</td>
<td>PageTransitionEvent</td>
<td>Window</td>
<td>Fired at the Window when the page's session history entry stops being the active entry.</td>
</tr>
<tr>
<td>pagereveal</td>
<td>PageRevealEvent</td>
<td>Window</td>
<td>Fired at the Window when the page begins to render for the first time after it has been initialized or reactivated.</td>
</tr>
<tr>
<td>pageshow</td>
<td>PageTransitionEvent</td>
<td>Window</td>
<td>Fired at the Window when the page's session history entry becomes the active entry.</td>
</tr>
<tr>
<td>pointercancel</td>
<td>PointerEvent</td>
<td>Elements and Text</td>
<td>Fired at the source node when the user attempts to initiate a drag-and-drop operation.</td>
</tr>
<tr>
<td>popstate</td>
<td>PopStateEvent</td>
<td>Window</td>
<td>Fired at the Window when in some cases of session history traversal.</td>
</tr>
<tr>
<td>readystatechange</td>
<td>Event</td>
<td>document</td>
<td>Fired at the Document when it finishes parsing and again when all its subresources have finished loading.</td>
</tr>
<tr>
<td>rejectionhandled</td>
<td>PromiseRejectionEvent</td>
<td>Global scope objects</td>
<td>Fired at global scope objects when a previously-unhandled promise rejection becomes handled.</td>
</tr>
<tr>
<td>reset</td>
<td>Event</td>
<td>form</td>
<td>Fired at a form element when it is reset.</td>
</tr>
<tr>
<td>select</td>
<td>Event</td>
<td>Form controls</td>
<td>Fired at form controls when their text selection is adjusted (whether by an API or by the user).</td>
</tr>
<tr>
<td>storage</td>
<td>StorageEvent</td>
<td>Window</td>
<td>Fired at Window event when the corresponding localStorage or sessionStorage storage areas change.</td>
</tr>
<tr>
<td>submit</td>
<td>SubmitEvent</td>
<td>form</td>
<td>Fired at a form element when it is submitted.</td>
</tr>
<tr>
<td>toggle</td>
<td>ToggleEvent</td>
<td>details and popover</td>
<td>Fired at details elements when they open or close; fired on elements with the popover attribute when they are transitioning between showing and hidden.</td>
</tr>
<tr>
<td>unhandledrejection</td>
<td>PromiseRejectionEvent</td>
<td>Global scope objects</td>
<td>Fired at global scope objects when a promise rejection goes unhandled.</td>
</tr>
<tr>
<td>unload</td>
<td>Event</td>
<td>Window</td>
<td>Fired at the Window object when the page is going away.</td>
</tr>
<tr>
<td>visibilitychange</td>
<td>Event</td>
<td>Document</td>
<td>Fired at the Document object when the page becomes visible or hidden to the user.</td>
</tr>
</tbody>
</table>

**HTTP headers**  

This section is non-normative.

The following HTTP request headers are defined by this specification:

- `Last-Event-ID`
- `Ping-From`
- `Ping-To`

The following HTTP response headers are defined by this specification:
MIME types

This section is non-normative.

The following MIME types are mentioned in this specification:

- application/atom+xml
  - Atom [ATOM]
- application/json
  - JSON [JSON]
- application/octet-stream
  - Generic binary data [RFC2046]
- application/microdata+json
  - Microdata as JSON
- application/rss+xml
  - RSS
- application/x-www-form-urlencoded
  - Form submission
- application/xhtml+xml
  - HTML
- application/xml
  - XML [XML] [RFC7303]
- image/gif
  - GIF images [GIF]
- image/jpeg
  - JPEG images [JPEG]
- image/png
  - PNG images [PNG]
- image/svg+xml
  - SVG images [SVG]
- multipart/form-data
  - Form submission [RFC7578]
- multipart/mixed
  - Generic mixed content [RFC2046]
- multipart/x-mixed-replace
  - Streaming server push
text/css
  CSS [CSS]\(\text{[CSS]}\)\(^{1456}\)

**text/event-stream**\(^{1429}\)
  Server-sent event streams

**text/javascript**
  JavaScript [JAVASCRIPT]\(\text{[JAVASCRIPT]}\)\(^{1459}\) [RFC9239]\(^{1461}\)

**text/json**
  JSON (legacy type)

**text/plain**
  Generic plain text [RFC2046]\(^{1461}\) [RFC3676]\(^{1461}\)

**text/html**\(^{1424}\)
  HTML

**text/ping**\(^{1427}\)
  Hyperlink auditing

**text/uri-list**
  List of URLs [RFC2483]\(^{1461}\)

**text/vcard**
  vCard [RFC6350]\(^{1461}\)

**text/vtt**
  WebVTT [WEBVTT]\(^{1464}\)

**text/xml**
  XML [XML]\(^{1464}\) [RFC7303]\(^{1461}\)

**video/mp4**
  MPEG-4 video [RFC4337]\(^{1461}\)

**video/mpeg**
  MPEG video [RFC2046]\(^{1461}\)
References

All references are normative unless marked "Non-normative".

[ABNF]
Augmented BNF for Syntax Specifications: ABNF, D. Crocker, P. Overell. IETF.

[ABOUT]
The ‘about’ URI scheme, S. Moonesamy. IETF.

[APNG]

[ARIA]

[ARIAHTML]
ARIA in HTML, S. Faulkner, S. O'Hara. W3C.

[ATAG]

[ATOM]
(Non-normative) The Atom Syndication Format, M. Nottingham, R. Sayre. IETF.

[BATTERY]
(Non-normative) Battery Status API, A. Kostiainen, M. Lamouri. W3C.

[BCP47]
Tags for Identifying Languages; Matching of Language Tags, A. Phillips, M. Davis. IETF.

[BEZIER]
Courbes à poles, P. de Casteljau. INPI, 1959.

[BIDI]

[BOCU1]

[CESU8]
(Non-normative) UTR #26: Compatibility Encoding Scheme For UTF-16: 8-BIT (CESU-8), T. Phipps. Unicode Consortium.

[CHARMOD]

[CHARMODNORM]

[CLIPBOARD-APIS]
Clipboard API and events, G. Kacmarcik, A. Snigdha. W3C.

[COMPOSITE]
Compositing and Blending, R. Cabanier, N. Andronikos. W3C.

[COMPUTABLE]

[COMPUTEPRESSURE]
(Non-normative) Compute Pressure, K. Christiansen, A. Mandy. W3C.

[CONSOLE]
Console, T. Stock, R. Kowalski, D. Farolino. WHATWG.
[COOKIES]
  HTTP State Management Mechanism, A. Barth. IETF.

[CREDMAN]
  Credential Management, N. Satragno, J. Hodges, M. West. W3C.

[CSP]
  Content Security Policy, M. West, D. Veditz. W3C.

[CSS]
  Cascading Style Sheets Level 2 Revision 2, B. Bos, T. Çelik, I. Hickson, H. Lie. W3C.

[CSSALIGN]
  CSS Box Alignment, E. Etemad, T. Atkins. W3C.

[CSSANIMATIONS]

[CSSATTR]
  CSS Style Attributes, T. Çelik, E. Etemad. W3C.

[CSSBG]
  CSS Backgrounds and Borders, B. Bos, E. Etemad, B. Kemper. W3C.

[CSSBOX]
  CSS Box Model, E. Etemad. W3C.

[CSSCASCADE]
  CSS Cascading and Inheritance, E. Etemad, T. Atkins. W3C.

[CSSCONTAIN]
  CSS Containment, T. Atkins, F. Rivoal, V. Levin. W3C.

[CSSCOLOR]
  CSS Color Module, T. Çelik, C. Lilley, L. Baron. W3C.

[CSSCOLORADJUST]
  CSS Color Adjustment Module, E. Etemad, R. Atanassov, R. Lillesveen, T. Atkins. W3C.

[CSSDEVICEADAPT]
  CSS Device Adaption, F. Rivoal, M. Rakow. W3C.

[CSSDISPLAY]
  CSS Display, T. Atkins, E. Etemad. W3C.

[CSSFONTLOAD]
  CSS Font Loading, T. Atkins, J. Daggett. W3C.

[CSSFONTS]
  CSS Fonts, J. Daggett. W3C.

[CSSFLEXBOX]
  CSS Flexible Box Layout, T. Atkins, E. Etemad, R. Atanassov. W3C.

[CSSGC]
  CSS Generated Content, H. Lie, E. Etemad, I. Hickson. W3C.

[CSSGRID]
  CSS Grid Layout, T. Atkins, E. Etemad, R. Atanassov. W3C.

[CSSIMAGES]
  CSS Images Module, E. Etemad, T. Atkins, L. Verou. W3C.

[CSSIMAGES4]
  CSS Images Module Level 4, E. Etemad, T. Atkins, L. Verou. W3C.

[CSSINLINE]
  CSS Inline Layout, D. Cramer, E. Etemad. W3C.
[CSSLISTS]  
CSS Lists and Counters, T. Atkins. W3C.

[CSSLOGICAL]  
CSS Logical Properties, R. Atanassov, E. Etemad. W3C.

[CSSMULTICOL]  
CSS Multi-column Layout, H. Lie, F. Rivoal, R. Andrew. W3C.

[CSSOM]  
Cascading Style Sheets Object Model (CSSOM), S. Pieters, G. Adams. W3C.

[CSSOMVIEW]  
CSSOM View Module, S. Pieters, G. Adams. W3C.

[CSSOVERFLOW]  
CSS Overflow Module, L. Baron, F. Rivoal. W3C.

[CSSPAINT]  
(Non-normative) CSS Painting API, I. Kilpatrick, D. Jackson. W3C.

[CSSPOSITION]  
CSS Positioned Layout, R. Atanassov, A. Eicholz. W3C.

[CSSPSEUDO]  
CSS Pseudo-Elements, D. Glazman, E. Etemad, A. Stearns. W3C.

[CSSRUBY]  
CSS3 Ruby Module, R. Ishida. W3C.

[CSSSCOPING]  
CSS Scoping Module, T. Atkins. W3C.

[CSSSIZING]  
CSS Box Sizing Module, T. Atkins, E. Etemad. W3C.

[CSSSCROLLANCHORING]  
(Non-normative) CSS Scroll Anchoring, T. Atkins-Bittner. W3C.

[CSSSYNTAX]  
CSS Syntax, T. Atkins, S. Sapin. W3C.

[CSSTRANSITIONS]  
(Non-normative) CSS Transitions, L. Baron, D. Jackson, B. Birtles. W3C.

[CSSTABLE]  
CSS Table, F. Remy, G. Whitworth. W3C.

[CSSTEXT]  
CSS Text, E. Etemad, K. Ishii. W3C.

[CSSVALUES]  
CSS3 Values and Units, H. Lie, T. Atkins, E. Etemad. W3C.

[CSSVIEWTRANSITIONS]  
CSS View Transitions, T. Atkins Jr.; J. Archibald; K Sagar. W3C.

[CSSUI]  
CSS3 Basic User Interface Module, F. Rivoal. W3C.

[CSSWM]  
CSS Writing Modes, E. Etemad, K. Ishii. W3C.

[DASH]  
Dynamic adaptive streaming over HTTP (DASH), ISO.

[DEVICEPOSTURE]  
(Non-normative) Device Posture API, D. Gonzalez-Zuniga, K. Christiansen. W3C.
DOM, A. van Kesteren, A. Gregor, Ms2ger. WHATWG.

DOM Parsing and Serialization, T. Leithead. W3C.

DOT
(Non-normative) The DOT Language, Graphviz.

E163

ENCODING
Encoding, A. van Kesteren, J. Bell. WHATWG.

EXECCOMMAND
execCommand, J. Wilm, A. Gregor. W3C Editing APIs CG.

EXIF
(Non-normative) Exchangeable image file format, JEITA.

FETCH
Fetch, A. van Kesteren. WHATWG.

FILEAPI
File API, A. Ranganathan. W3C.

FILTERS
Filter Effects, D. Schulze, D. Jackson, C. Harrelson. W3C.

FULLSCREEN
Fullscreen, A. van Kesteren, T. Çelik. WHATWG.

GEOMETRY
Geometry Interfaces, S. Pieters, D. Schulze, R. Cabanier. W3C.

GIF
(Non-normative) Graphics Interchange Format, CompuServe.

GRAPHICS

GREGORIAN

HRT
High Resolution Time, I. Grigorik, J. Simonsen, J. Mann. W3C.

HTMLAAM
HTML Accessibility API Mappings 1.0, S. Faulkner, A. Surkov, S. O'Hara. W3C.

HTTP
Hypertext Transfer Protocol (HTTP/1.1): Message Syntax and Routing, R. Fielding, J. Reschke. IETF.
Hypertext Transfer Protocol (HTTP/1.1): Semantics and Content, R. Fielding, J. Reschke. IETF.
Hypertext Transfer Protocol (HTTP/1.1): Conditional Requests, R. Fielding, J. Reschke. IETF.
Hypertext Transfer Protocol (HTTP/1.1): Range Requests, R. Fielding, Y. Lafon, J. Reschke. IETF.
Hypertext Transfer Protocol (HTTP/1.1): Caching, R. Fielding, M. Nottingham, J. Reschke. IETF.
Hypertext Transfer Protocol (HTTP/1.1): Authentication, R. Fielding, J. Reschke. IETF.

INDEXEDDB
Indexed Database API, A. Alabbas, J. Bell. W3C.

INBAND
Sourcing In-band Media Resource Tracks from Media Containers into HTML, S. Pfeiffer, B. Lund. W3C.

INFRA
Infra, A. van Kesteren, D. Denicola. WHATWG.
[MFREL]
Microformats Wiki: existing rel values. Microformats.

[MIMESNIFF]
MIME Sniffing. G. Hemsley. WHATWG.

[MIX]
Mixed Content. M. West. W3C.

[MNG]

[MPEG2]

[MPEG4]
ISO/IEC 14496-12: ISO base media file format. ISO/IEC.

[MQ]
Media Queries. H. Lie, T. Çelik, D. Glazman, A. van Kesteren. W3C.

[MULTIPLEBUFFERING]
(Non-normative) Multiple buffering. Wikipedia.

[NAVIGATIONTIMING]
Navigation Timing. Y. Weiss. W3C.

[NPAPI]
(Non-normative) Gecko Plugin API Reference. Mozilla.

[OGGSKELETONHEADERS]

[OPENSEARCH]

[ORIGIN]
(Non-normative) The Web Origin Concept. A. Barth. IETF.

[PAINTTIMING]
Paint Timing. S. Panicker. W3C.

[PAYMENTREQUEST]
Payment Request API. M. Cáceres, D. Wang, R. Solomakhin, I. Jacobs. W3C.

[PDF]

[PERFORMANCETIMELINE]
Performance Timeline. N. Peña Moreno, W3C.

[PERMISSIONSPOLICY]
Permissions Policy. I. Clelland, W3C.

[PICTUREINPICTURE]
(Non-normative) Picture-in-Picture. F. Beaufort, M. Lamouri, W3C

[PINGBACK]
Pingback 1.0. S. Langridge, I. Hickson.

[PNG]

[POINTEREVENTS]
Pointer Events. J. Rossi, M. Brubeck, R. Byers, P. H. Lauke. W3C.

[POINTERLOCK]
Pointer Lock. V. Scheib. W3C.

Presentation API, M. Foltz, D. Röttches. W3C.

Referrer Policy, J. Eisinger, E. Stark. W3C.

Cooperative Scheduling of Background Tasks, R. McIlroy, I. Grigorik. W3C.

Resource Timing, Yoav Weiss; Noam Rosenthal. W3C.


Requirements for Internet Hosts -- Application and Support, R. Braden. IETF, October 1989.

Multipurpose Internet Mail Extensions (MIME) Part Two: Media Types, N. Freed, N. Borenstein. IETF.

The "data" URL scheme, L. Masinter. IETF.

Internet Calendaring and Scheduling Core Object Specification (iCalendar), B. Desruisseaux. IETF.

URI Resolution Services Necessary for URN Resolution, M. Mealling, R. Daniel. IETF.

The Text/Plain Format and DelSp Parameters, R. Gellens. IETF.

Updates to ECMAScript Media Types, M. Miller, M. Borins, M. Bynens, B. Farias. IETF.

MIME Type Registration for MPEG-4, Y. Lim, D. Singer. IETF.

Guidelines and Registration Procedures for URI Schemes, D. Thaler, T. Hansen, T. Hardie. IETF.

Internet Message Format, P. Resnick. IETF.

The 'Codecs' and 'Profiles' Parameters for "Bucket" Media Types, R. Gellens, D. Singer, P. Frojd. IETF.

Use of the Content-Disposition Header Field in the Hypertext Transfer Protocol (HTTP), J. Reschke. IETF.

vCard Format Specification, S. Perreault. IETF.

The Canonical Link Relation, M. Ohye, J. Kupke. IETF.

Additional Link Relation Types, J. Snell. IETF.

HTTP Header Field X-Frame-Options, D. Ross, T. Gondrom. IETF.

XML Media Types, H. Thompson, C. Lilley. IETF.
[RFC7578] Returning Values from Forms: multipart/form-data, L. Masinter. IETF.

[RFC8297] An HTTP Status Code for Indicating Hints, K. Oku. IETF.

[SCREENORIENTATION] Screen Orientation, M. Cáceres. W3C.


[SECURE-CONTEXTS] Secure Contexts, M. West. W3C.

[SELECTION] Selection API, R. Niwa. W3C.


[SMS] (Non-normative) URI Scheme for Global System for Mobile Communications (GSM) Short Message Service (SMS), E. Wilde, A. Vahasi-Sipila. IETF.

[STRUCTURED-FIELDS] Structured Field Values for HTTP, M. Nottingham, P-H. Kamp. IETF.


[STORAGE] Storage, A. van Kesteren. WHATWG.


[TOR] (Non-normative) Tor.


[TZDATABASE] (Non-normative) Time Zone Database. IANA.


[URL] URL, A. van Kesteren. WHATWG.
[URN]
  URN Syntax, R. Moats. IETF.

[UTF7]
  (Non-normative) UTF-7: A Mail-Safe Transformation Format of Unicode, D. Goldsmith, M. Davis. IETF.

[UTF8DET]
  (Non-normative) Multilingual form encoding, M. Dürst. W3C.

[UTR36]

[WASMJS]
  (Non-normative) WebAssembly JavaScript Interface, D. Ehrenberg. W3C.

[WCAG]

[WEBAUDIO]

[WEBAUTHN]

[WEBCODECS]
  WebCodecs API, C. Cunningham, P. Adenot, B. Aboba. W3C.

[WECRYPTO]
  Web Cryptography API, D. Huigens. W3C.

[WEBDRIVER]
  WebDriver, S. Stewart, D. Burns. W3C.

[WEBDRIVERBIDI]
  WebDriver BiDi, W3C

[WEBGL]

[WEBGPU]
  WebGPU, D. Malyshau, K. Ninomiya. W3C.

[WEBIDL]
  Web IDL, E. Chen, T. Gu. WHATWG.

[WEBLINK]
  Web Linking, M. Nottingham. IETF.

[WEBMCG]
  WebM Container Guidelines. The WebM Project.

[WEBNFC]
  (Non-normative) Web NFC, F. Beaufort, K. Christiansen, Z. Kis. W3C.

[WEBRTC]
  (Non-normative) Web RTC, C. Jennings, F. Castelli, H. Boström, J. Bruaroey. W3C.

[WEBSOCKETS]
  WebSockets, A. Rice. WHATWG.

[WEBTRANSPORT]
  WebTransport, B. Aboba, N. Jaju, V. Vasiliev. W3C.
[WEBVTT]
WebVTT, S. Pieters. W3C.

[WHATWG WIKI]
The WHATWG Wiki. WHATWG.

[X121]

[XFN]
XFN 1.1 profile, T. Çelik, M. Mullenweg, E. Meyer. GMPG.

[XHR]
XMLHttpRequest, A. van Kesteren. WHATWG.

[XKCD1288]
(Non-normative) Substitutions, Randall Munroe. xkcd.

[XML]
Extensible Markup Language, T. Bray, J. Paoli, C. Sperberg-McQueen, E. Maler, F. Yergeau. W3C.

[XMLENTITY]
(Non-normative) XML Entity Definitions for Characters, D. Carlisle, P. Ion. W3C.

[XMLNS]
Namespaces in XML, T. Bray, D. Hollander, A. Layman, R. Tobin. W3C.

[XMLSSPI]
Associating Style Sheets with XML documents, J. Clark, S. Pieters, H. Thompson. W3C.

[XPATH10]
XML Path Language (XPath) Version 1.0, J. Clark, S. DeRose. W3C.

[XSLT10]
(Non-normative) XSL Transformations (XSLT) Version 1.0, J. Clark. W3C.

[XSLTP]
(Non-normative) DOM XSLTProcessor, WHATWG Wiki. WHATWG.
Thanks to Tim Berners-Lee for inventing HTML, without which none of this would exist.

Thanks also to everyone who has ever posted about HTML to their blogs, public mailing lists, or forums, including all the contributors to the various W3C HTML WG lists and the various WHATWG lists.

Special thanks to Richard Williamson for creating the first implementation of canvas\textsuperscript{671} in Safari, from which the canvas feature was designed.

Special thanks also to the Microsoft employees who first implemented the event-based drag-and-drop mechanism, contenteditable\textsuperscript{646}, and other features first widely deployed by the Windows Internet Explorer browser.

Special thanks and $10,000 to David Hyatt who came up with a broken implementation of the adoption agency algorithm\textsuperscript{1322} that the editor had to reverse engineer and fix before using it in the parsing section.

Thanks to the participants of the microdata usability study for allowing us to use their mistakes as a guide for designing the microdata feature.

Thanks to the many sources that provided inspiration for the examples used in the specification.

Thanks also to the Microsoft blogging community for some ideas, to the attendees of the W3C Workshop on Web Applications and Compound Documents for inspiration, to the \#mrt crew, the \#mrt.no crew, and the \#whatwg crew, and to Pillar and Hedral for their ideas and support.

Thanks to Igor Zhbanov for generating PDF versions of the specification.

Special thanks to the RICG for developing the picture\textsuperscript{339} element and related features; in particular thanks to Adrian Bateman, Bruce Lawson, David Newton, Ilya Grigorik, John Schoenick, Leon de Rijke, Mat Marquis, Marcos Cáceres, Tab Atkins, Theresa O’Connor, and Yoav Weiss for their contributions.

Special thanks to the WPWG for incubating the custom elements\textsuperscript{744} feature. In particular, thanks to David Hyatt and Ian Hickson for their influence through the XBL specifications, Dimitri Glazkov for the first draft of the custom elements specification, and to Alex Komoroske, Alex Russell, Andres Rios, Boris Zbarsky, Brian Kardell, Daniel Buchner, Dominic Cooney, Erik Arvidsson, Elliott Sprehn, Hajime Morita, Hayato Ito, Jan Mikovsky, Jonas Sicking, Olli Pettay, Rafael Weinstein, Roland Steiner, Ryosuke Niwa, Scott Miles, Steve Faulkner, Steve Orvell, Tab Atkins, Theresa O’Connor, Tim Perry, and William Chen for their contributions.

Special thanks to the CSSWG for developing the worklets\textsuperscript{1223}. In particular, thanks to Ian Kilpatrick for his work as editor of the original worklets specification.

For about ten years starting in 2003, this standard was almost entirely written by Ian Hickson (Google, jan@hixie.ch).

As of 2015, Simon Pieters (Mozilla, zcorpan@gmail.com), Anne van Kesteren (Apple, annevk@anniek.nl), Philip Jägenstedt (Google, philip@foolip.org), and Domenic Denicola (Google, d@demonic.me), all previously long-time contributors, have joined Ian in editing the text directly.
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The diagram showing how async and defer impact script loading is based on a similar diagram from a blog post by Peter Beverloo.  (CC0 1.0)

The image decoding demo used to demonstrate module-based workers draws on some example code from a tutorial by Ilmari Heikkinen.  (CC BY 3.0)

The <flag-icon> example was inspired by a custom element by Steven Skelton.  (MIT)

Part of the revision history of the picture element and related features can be found in the ResponsiveImagesCG/picture-element repository, which is available under the W3C Software and Document License.

Part of the revision history of the theme-color metadata name can be found in the whatwg/meta-theme-color repository, which is available under CC0.

Part of the revision history of the custom elements feature can be found in the w3c/webcomponents repository, which is available under the W3C Software and Document License.

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Part of the revision history of the navigation API feature can be found in the WICG/navigation-api repository, which is available under the W3C Software and Document License.

Part of the revision history of the Close requests and close watchers section can be found in the WICG/close-watcher repository, which is available under the W3C Software and Document License.

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