

Foreword

The CTA WAVE Project was launched at the 2016 CES in Las Vegas, NV. The goal of WAVE is to improve interoperability in the commercial Over-the-Top (OTT) video ecosystem using industry-standard protocols including HTML5 with MSE Extensions [[MEDIA-SOURCE](#)] and EME [[ENCRYPTED-MEDIA](#)], MPEG-CMAF¹, MPEG-CENC² and adaptive bit-rate streaming protocols MPEG-DASH³ and Apple HLS⁴.

The process under which WAVE develops specifications is available online at the WAVE public home page (<https://cta.tech/wave>).

The *Web Media API Snapshot 2020* was co-developed between the CTA WAVE HTML5 API Task Force and the W3C Web Media API Community Group. It is jointly published between CTA (as a CTA specification, CTA-5000-C) and W3C (as a Final Community Group Report), by agreement between the two organizations.

Web Media API Snapshot 2020

CTA Status: CTA Specification CTA-5000-C, “WAVE Web Media API Snapshot 2020”

W3C Status: Final Community Group Report, 14 December 2020

Latest editor's draft:

<https://w3c.github.io/webmediaapi/>

Test suite:

<https://webapitests2020.ctawave.org/wave/>

Editors:

Jon Piesing ([TP Vision Belgium N.V.](#))

John Riviello ([Comcast](#))

Former Editors:

David Evans ([British Broadcasting Corporation](#))

John Luther ([JW Player](#))

Mark Vickers ([Comcast](#))

Participate:

Web Media API Specification Repository: <https://github.com/w3c/webmediaapi>

File a bug: <https://github.com/w3c/webmediaapi/issues/>

Commit history: <https://github.com/w3c/webmediaapi/commits/gh-pages>

Pull requests: <https://github.com/w3c/webmediaapi/pulls/>

¹ ISO/IEC 23000-19:2018, “Information technology – Multimedia application format (MPEG-A) – Part 19: Common media application format (CMAF) for segmented media”, <https://www.iso.org/standard/71975.html>

² ISO/IEC 23001-7:2015, “Information technology – MPEG systems technologies – Part 7: Common encryption in ISO base media file format files”, <https://www.iso.org/standard/65271.html>

³ ISO/IEC 23009-1:2014, “Information technology – Dynamic adaptive streaming over HTTP (DASH) – Part 1: Media presentation description and segment formats”, <https://www.iso.org/standard/65274.html>

⁴ Pantos, R., Ed., and W. May, “HTTP Live Streaming”, <https://tools.ietf.org/html/draft-pantos-http-live-streaming-20>

Abstract

This specification lists the web APIs to support media web apps that are supported across all four of the most widely used user agent code bases at the time of publication. This specification should be updated at least annually to keep pace with the evolving web platform. We encourage manufacturers to develop products that support the APIs in the most recent version of Web Media API Snapshot. This specification is comprised of references to existing specifications in W3C and other specification groups. The target devices will include any device that runs a modern HTML user agent, including televisions, game machines, set-top boxes, mobile devices and personal computers.

This specification is being developed as part of the CTA WAVE Project⁵.

Status of This Document

This specification was published by the Web Media API Community Group⁶. It is not a W3C Standard nor is it on the W3C Standards Track. Please note that under the W3C Community Contributor License Agreement (CLA)⁷ there is a limited opt-out and other conditions apply. Learn more about W3C Community and Business Groups⁸.

⁵ <http://cta.tech/WAVE>

⁶ <https://www.w3.org/community/webmediaapi/>

⁷ <https://www.w3.org/community/about/agreements/cla/>

⁸ <https://www.w3.org/community/>

Table of Contents

1	Introduction	4
1.1	Out-of-date browsers.....	4
1.2	Integration issues.....	5
2	Conformance.....	5
3	Web Media APIs Currently Supported on all Platforms.....	5
3.1	Introduction	5
3.1.1	Features with limited implementation	6
3.1.2	At-risk features.....	6
3.1.3	Hardware limitations	6
3.2	Client code updates	6
3.3	Core web specifications	6
3.4	CSS specifications.....	7
3.5	Media specifications	8
3.6	Graphics specifications	8
3.7	Font specifications	8
3.8	Networking specifications.....	8
3.9	Security specifications.....	9
3.10	Web Performance specifications	9
3.11	Other web specifications	9
4	User Agent Integration Specifications	10
4.1	Introduction	10
4.2	Cookies.....	10
4.3	URLs.....	10
5	Web Media APIs Proposed to be Supported on all Platforms	10
5.1	Introduction	10
5.2	Media specifications	11
5.3	Other web specifications	11
A.	References	12
A.1	Normative references.....	12
A.2	Informative references	17

Web Application Video Ecosystem – Web Media API Snapshot 2020

1 Introduction

This section is non-normative.

Writing portable media web apps across browsers on consumer products (e.g. smart TVs, game machines, set-top boxes) is much more difficult than writing portable media web apps across personal computer browsers. Two main reasons for this are that the browsers on consumer products are often quite out-of-date and that they often have integration issues.

1.1 Out-of-date browsers

While browsers integrated into consumer products are often built from the same major HTML user agent code bases as personal computer browsers, it is not unusual for a consumer product to be using a code base release that is three or more years old, while personal computer browsers use recent code base releases. Furthermore, browsers on consumer products are often infrequently updated, if ever. This results in very different web API support across devices.

This specification is intended to address this problem by listing key specifications used by media web apps that are all supported in common by all of the four major web user agent code bases at the time of publication. The specification will then be used to generate a test suite. The versions of each of the four code bases used to generate the test suite are listed on the front page of the test suite (see test suite URL above).

The specification and test suite enable device manufacturers to specify and verify that their browsers are up-to-date with current web standards at the time of product release. The specification and tests can also be used to specify and verify updates to browsers in the field.

Note that this specification is not defining a subset or profile to be used in place of the full web platform. There are additional specifications that are included in all code bases that are not included in this specification. Furthermore, individual code bases include APIs that are not supported on all other code bases but are nonetheless widely used. Therefore, this specification and associated tests should only be used as verification of a minimum set of current APIs. There is no suggestion that APIs not included in this specification should be removed from implementations.

It is intended that this specification be updated periodically to reflect adoption of new specifications in the web platform. For example, the specification might be updated once a year for media devices being introduced onto the market in the following year.

1.2 Integration issues

There are many issues during integration of a web user agent with a hardware device that can affect the operation of web APIs. For example, if insufficient memory is allocated for cookies, they won't function as intended.

To address this issue, this specification includes a list of target values for several APIs which are known to have been impacted by integration issues. There will also be a test suite to verify these values are supported on a device. It is expected that additional integration requirements will be added in future updates.

Note that these values are not mandated by any web standards but are based on measurement of values supported by popular browsers. Supporting these values should provide better interoperability of web applications with personal computer and mobile browsers. Manufacturers may choose to exceed these values based on their expected application environments.

2 Conformance

As well as sections marked as non-normative, all authoring guidelines, diagrams, examples, and notes in this specification are non-normative. Everything else in this specification is normative.

The key words *MUST* and *SHOULD* in this document are to be interpreted as described in [BCP 14](#) [[RFC2119](#)] [[RFC8174](#)] when, and only when, they appear in all capitals, as shown here.

3 Web Media APIs Currently Supported on all Platforms

3.1 Introduction

This section is non-normative.

This section lists the web APIs to support media web apps that are supported across all four of the most widely used user agent code bases at the time of publication. We encourage manufacturers to develop products that support the APIs in the most recent version of this specification.

The approach taken in this draft is only to include specifications that are of particular significance to authors, but not include all the specifications cited by those included specifications. For example, HTTP is required by the HTML spec and is therefore not included here.

In addition, the specifications of the web APIs mentioned here may in turn (recursively) reference other specifications that are not supported across all four of the most widely used user agent code bases. This possibility is understood and accepted. For example, Service Workers 1 [SERVICE-WORKERS-1] references the `push` event from the Push API [PUSH-API], but the Push API is not yet widely supported. These unsupported referenced specifications are

not explicitly cited as exceptions in this specification but, in spite of this, will not be tested as part of our tests.

3.1.1 Features with limited implementation

Parts of some web specifications are not currently implemented across all user agent code bases and may never be. Consequently, these features will not be included in our tests. Any such features are noted as exceptions under that API.

3.1.2 At-risk features

Some specifications referenced in this section may not have reached Recommendation and, as such, may contain 'at-risk' features. Since the most common reason for features being marked as at-risk is lack of implementations, such features may not be present in some implementations of this specification and will not be tested as part of our tests.

3.1.3 Hardware limitations

While this specification does not specify a minimum or maximum number of media elements that can play content simultaneously, developers should note that due to hardware limitations of available decoders, the simultaneous playback of multiple media elements in a web application may not be possible.

3.2 Client code updates

The W3C Technical Architecture Group released a finding called *The Evergreen Web* which strongly recommends that “browsers must be regularly updated, especially to fix security and interoperability bugs — ideally with an automatic, secure update mechanism” [EVERGREEN-WEB]⁹.

Devices *SHOULD* regularly update their browsers, preferably automatically.

3.3 Core web specifications

Devices *MUST* be conforming implementations of the following specifications:

- DOM [[DOM](#)]
- ECMAScript 2020 Language Specification [[ECMAScript-2020](#)]
 - Exceptions:
 - [SharedArrayBuffer](#) is not yet widely supported in an effort to mitigate the [Spectre attack](#).
 - [Atomics](#) are not yet widely supported.

⁹ See <https://w3c.github.io/webmediaapi/#bib-evergreen-web>.

- [look-behind assertions](#) are not yet widely supported.
 - The [Function.prototype.toString revisions from ECMAScript 2019](#) are not yet widely supported.
 - [BigInt](#) is not yet widely supported.
- HTML [[HTML](#)]
 - Devices MUST support the conformance class **Web browsers and other interactive user agents**.
 - Devices *MUST* support a mechanism to construct instances of [TextTrackCue](#) or an interface that inherits from it.
 - Note: Current user agent implementations meet this requirement either by supporting [VTT Cue](#) or by supporting a constructor for [TextTrackCue](#) that is no longer included in the HTML specification [[HTML](#)].
 - Exceptions:
 - [SharedWorker](#) is not yet widely supported.

3.4 CSS specifications

Devices *MUST* be conforming implementations of the following specifications (CSS Snapshot 2018 [[CSS-2018](#)]):

- Cascading Style Sheets Level 2 Revision 1 (CSS 2.1) Specification [[CSS2](#)]
- Compositing and Blending Level 1 [[COMPOSITING](#)]
- CSS Animations [[CSS3-ANIMATIONS](#)]
- CSS Backgrounds and Borders Module Level 3 [[CSS3-BACKGROUND](#)]
- CSS Basic User Interface Module Level 3 (CSS3 UI) [[CSS-UI-3](#)]
- CSS Cascading and Inheritance Level 3 [[CSS-CASCADE-3](#)]
- CSS Color Module Level 3 [[CSS3-COLOR](#)]
- CSS Conditional Rules Module Level 3 [[CSS3-CONDITIONAL](#)]
- CSS Custom Properties For Cascading Variables Module Level 1 [[CSS-VARIABLES-1](#)]
- CSS Easing Functions Level 1 [[CSS-EASING-1](#)]
 - Exception: [jump- keywords for steps\(\)](#) are not yet widely supported.
- CSS Flexible Box Layout Module Level 1 [[CSS-FLEXBOX-1](#)]
- CSS Fonts Module Level 3 [[CSS-FONTS-3](#)]
- CSS Grid Layout Module Level 1 [[CSS-GRID-1](#)]
- CSS Image Values and Replaced Content Module Level 3 [[CSS3-IMAGES](#)]
- CSS Multi-column Layout Module [[CSS3-MULTICOL](#)]
- CSS Namespaces Module Level 3 [[CSS-NAMESPACES-3](#)]
- CSS Scroll Snap Module Level 1 [[CSS-SCROLL-SNAP-1](#)]
- CSS Shapes Module Level 1 [[CSS-SHAPES-1](#)]
- CSS Style Attributes [[CSS-STYLE-ATTR](#)]
- CSS Syntax Module Level 3 [[CSS-SYNTAX-3](#)]
- CSS Text Decoration Module Level 3 [[CSS-TEXT-DECOR-3](#)]
 - Exception: [text-orientation](#) property is not yet widely supported.

- CSS Transforms Module Level 1 [[CSS-TRANSFORMS-1](#)]
- CSS Transitions [[CSS3-TRANSITIONS](#)]
- CSS Values and Units Module Level 3 [[CSS-VALUES](#)]
- CSS Will Change Module Level 1 [[CSS-WILL-CHANGE-1](#)]
- CSS Writing Modes Level 3 [[CSS-WRITING-MODES-3](#)]
 - Exception: [text-orientation](#) property is not yet widely supported.
- CSSOM View Module [[CSSOM-VIEW](#)]
- Filter Effects Module Level 1 [[FILTER-EFFECTS-1](#)]
- Media Queries [[CSS3-MEDIAQUERIES](#)]
- Selectors Level 3 [[SELECT](#)]

3.5 Media specifications

Devices *MUST* be conforming implementations of the following specifications:

- Encrypted Media Extensions [[ENCRYPTED-MEDIA](#)]
- Media Source Extensions [[MEDIA-SOURCE](#)]
- Web Audio API [[WEBAUDIO](#)]
 - Exceptions: Since not all environments currently support Media Streams [[MEDIACAPTURE-STREAMS](#)], [MediaStreamAudioSourceNode](#) and [MediaStreamAudioDestinationNode](#) are not yet widely supported.

3.6 Graphics specifications

Devices *MUST* be conforming implementations of the following specifications:

- Fullscreen API Standard [[FULLSCREEN](#)]
- Graphics Interchange Format [[GIF](#)]
- HTML Canvas 2D Context [[2DCONTEXT](#)]
- JPEG File Interchange Format [[JPEG](#)]
- Portable Network Graphics (PNG) Specification (Second Edition) [[PNG](#)]
- WebGL Specification [[WEBGL-103](#)]

3.7 Font specifications

Devices *MUST* be conforming implementations of the following specifications:

- Open Font Format [[OPEN-FONT-FORMAT](#)]
- WOFF File Format 1.0 [[WOFF](#)]

3.8 Networking specifications

Devices *MUST* be conforming implementations of the following specifications:

- Fetch [[FETCH](#)]
- XMLHttpRequest [[XHR](#)]
- Note: Web sockets is also required as part of the HTML specification [[HTML](#)].

3.9 Security specifications

Devices *MUST* be conforming implementations of the following specifications:

- Content Security Policy Level 2 [[CSP2](#)]
- Referrer Policy [[REFERRER-POLICY](#)]
- Subresource Integrity [[SRI](#)]
- Upgrade Insecure Requests [[upgrade-insecure-requests](#)]
- Transport Layer Security (TLS) Protocol Version 1.2 [[RFC5246](#)]
- Transport Layer Security (TLS) Protocol Version 1.3 [[RFC8446](#)]
- Upgrade Insecure Requests [[UPGRADE-INSECURE-REQUESTS](#)]
- Web Cryptography API [[WEBCRYPTOAPI](#)]

Note: Along with these security standards for the user agent, all IoT devices should be designed with security in mind. An industry-developed voluntary consensus standard for a minimum security “baseline” for IoT devices can be found at

<https://shop.cta.tech/collections/standards/cybersecurity>.

3.10 Web Performance specifications

Devices *MUST* be conforming implementations of the following specifications:

- Beacon [[BEACON](#)]
- High Resolution Time Level 1 [[HR-TIME-1](#)]
- Navigation Timing [[NAVIGATION-TIMING](#)]
- Page Visibility Level 2 [[PAGE-VISIBILITY-2](#)]
- Performance Timeline [[PERFORMANCE-TIMELINE](#)]
- Resource Timing Level 1 [[RESOURCE-TIMING-1](#)]
- User Timing Level 2 [[USER-TIMING-2](#)]

3.11 Other web specifications

Devices *MUST* be conforming implementations of the following specifications:

- Indexed Database API [[INDEXEDDB](#)]
- File API [[FILEAPI](#)]
- Notifications API [[NOTIFICATIONS](#)]
 - Exception: It is possible for the user agent to support the Notifications API, but the operating system and/or device platform does not support a system to display notifications. In this scenario, it is critical that the current recommendations for feature detection of the Notifications API do not cause an error when run on the device.
 - Note: Best practices regarding feature detection of Notifications API capabilities are discussed in [Notifications API GitHub Issue #116](#) and the ["Using the Notifications API" guide from MDN](#).

- Service Workers 1 [[SERVICE-WORKERS-1](#)]
- UI Events [[UIEVENTS](#)]
- Note: Cross-document messaging, Channel messaging, Web storage and Web workers are also required as part of the HTML specification [[HTML](#)].

4 User Agent Integration Specifications

4.1 Introduction

This section is non-normative.

This section contains values for integrating a web user agent with a consumer device. The values are based on de facto requirements from browsers on personal computers and mobile devices. Supporting these integration specifications will increase interoperability with media web apps on other devices.

A test suite will evaluate client support for these specifications.

4.2 Cookies

- Devices *MUST* support cookies of length at least 4096 bytes.
- Devices *MUST* support at least 20 cookies per domain.
- Devices *MUST* support at least 100 total cookies.
- Devices *MUST* support persistence of cookies between application sessions.
- Devices *MUST* support persistence of cookies across power cycles of the device.

4.3 URLs

- Devices *MUST* support URLs up to a length of 2047 bytes.

5 Web Media APIs Proposed to be Supported on all Platforms

This section is non-normative.

5.1 Introduction

APIs in this section are important for web media delivery but are not yet implemented in all four code bases. We encourage the following APIs be implemented on all HTML user agents as soon as possible. It is expected that, as implementations become available, some of these specifications may be listed as supported on all platforms in a future version of this specification.

5.2 Media specifications

- Media Fragments URI 1.0 (basic) [[MEDIA-FRAGS](#)]
- Media Session Standard [[MEDIASESSION](#)]
- Sourcing In-band Media Resource Tracks from Media Containers into HTML [[INBANDTRACKS](#)]

5.3 Other web specifications

- Web App Manifest [[APPMANIFEST](#)]

A. References

For WHATWG living standards, while it is recommended that devices support the living standard, they must support the referenced review draft version of each WHATWG standard or a later commit snapshot version.

A.1 Normative references

[2DCONTEXT]

HTML Canvas 2D Context. Rik Cabanier; Jatinder Mann; Jay Munro; Tom Wiltzius; Ian Hickson. W3C. 19 November 2015. W3C Recommendation. URL:

<https://www.w3.org/TR/2dcontext/>

[BEACON]

Beacon. Ilya Grigorik; Alois Reitbauer; Arvind Jain; Jatinder Mann. W3C. 13 April 2017. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/beacon/>.

[COMPOSITING]

Compositing and Blending Level 1. Rik Cabanier; Nikos Andronikos. W3C. 13 January 2015. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/compositing-1/>

[CSP2]

Content Security Policy Level 2. Mike West; Adam Barth; Daniel Veditz. W3C. 15 December 2016. W3C Recommendation. URL: <https://www.w3.org/TR/CSP2/>

[CSS-CASCADE-3]

CSS Cascading and Inheritance Level 3. Elika Etemad; Tab Atkins Jr.. W3C. 28 August 2018. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/css-cascade-3/>

[CSS-EASING-1]

CSS Easing Functions Level 1. Brian Birtles; Dean Jackson; Matt Rakow. W3C. 30 April 2019. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/css-easing-1/>.

[CSS-FLEXBOX-1]

CSS Flexible Box Layout Module Level 1. Tab Atkins Jr.; Elika Etemad; Rossen Atanassov; David Baron. W3C. 19 November 2018. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/css-flexbox-1/>

[CSS-FONTS-3]

CSS Fonts Module Level 3. John Daggett; Myles Maxfield; Chris Lilley. W3C. 20 September 2018. W3C Recommendation. URL: <https://www.w3.org/TR/css-fonts-3/>

[CSS-GRID-1]

CSS Grid Layout Module Level 1. Tab Atkins Jr.; Elika Etemad; Rossen Atanassov. W3C. 14 December 2017. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/css-grid-1/>

[CSS-NAMESPACES-3]

CSS Namespaces Module Level 3. Elika Etemad. W3C. 20 March 2014. W3C Recommendation. URL: <https://www.w3.org/TR/css-namespaces-3/>

[CSS-SCROLL-SNAP-1]

- [CSS Scroll Snap Module Level 1](https://www.w3.org/TR/css-scroll-snap-1/). Matt Rakow; Jacob Rossi; Tab Atkins Jr.; Erika Etemad. W3C. 19 March 2019. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/css-scroll-snap-1/>.
- [CSS-SHAPES-1]
[CSS Shapes Module Level 1](https://www.w3.org/TR/css-shapes-1/). Vincent Hardy; Rossen Atanassov; Alan Stearns. W3C. 20 March 2014. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/css-shapes-1/>.
- [CSS-STYLE-ATTR]
CSS Style Attributes. Tantek Çelik; Erika Etemad. W3C. 7 November 2013. W3C Recommendation. URL: <https://www.w3.org/TR/css-style-attr/>
- [CSS-SYNTAX-3]
CSS Syntax Module Level 3. Tab Atkins Jr.; Simon Sapin. W3C. 16 July 2019. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/css-syntax-3/>
- [CSS-TEXT-DECOR-3]
[CSS Text Decoration Module Level 3](https://www.w3.org/TR/css-text-decor-3/). Erika Etemad; Koji Ishii. W3C. 13 August 2019. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/css-text-decor-3/>.
- [CSS-TRANSFORMS-1]
CSS Transforms Module Level 1. Simon Fraser; Dean Jackson; Theresa O'Connor; Dirk Schulze. W3C. 14 February 2019. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/css-transforms-1/>
- [CSS-UI-3]
CSS Basic User Interface Module Level 3 (CSS3 UI). Tantek Çelik; Florian Rivoal. W3C. 21 June 2018. W3C Recommendation. URL: <https://www.w3.org/TR/css-ui-3/>
- [CSS-VALUES]
CSS Values and Units Module Level 3. Tab Atkins Jr.; Erika Etemad. W3C. 6 June 2019. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/css-values-3/>
- [CSS-VARIABLES-1]
CSS Custom Properties for Cascading Variables Module Level 1. Tab Atkins Jr. W3C. 3 December 2015. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/css-variables-1/>
- [CSS-WILL-CHANGE-1]
[CSS Will Change Module Level 1](https://www.w3.org/TR/css-will-change-1/). Tab Atkins Jr.. W3C. 3 December 2015. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/css-will-change-1/>.
- [CSS-WRITING-MODES-3]
CSS Writing Modes Level 3. Erika Etemad; Koji Ishii. W3C. 24 October 2019. W3C Proposed Recommendation. URL: <https://www.w3.org/TR/css-writing-modes-3/>
- [CSS2]
Cascading Style Sheets Level 2 Revision 1 (CSS 2.1) Specification. Bert Bos; Tantek Çelik; Ian Hickson; Håkon Wium Lie et al. W3C. 7 June 2011. W3C Recommendation. URL: <https://www.w3.org/TR/CSS2/>
- [CSS3-ANIMATIONS]
CSS Animations Level 1. Dean Jackson; David Baron; Tab Atkins Jr.; Brian Birtles. W3C. 11 October 2018. W3C Working Draft. URL: <https://www.w3.org/TR/css-animations-1/>
- [CSS3-BACKGROUND]

- CSS Backgrounds and Borders Module Level 3*. Bert Bos; Erika Etemad; Brad Kemper. W3C. 17 October 2017. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/css-backgrounds-3/>
- [CSS3-COLOR]
CSS Color Module Level 3. Tantek Çelik; Chris Lilley; David Baron. W3C. 19 June 2018. W3C Recommendation. URL: <https://www.w3.org/TR/css-color-3/>
- [CSS3-CONDITIONAL]
CSS Conditional Rules Module Level 3. David Baron. W3C. 4 April 2013. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/css3-conditional/>
- [CSS3-IMAGES]
CSS Images Module Level 3. Tab Atkins Jr.; Erika Etemad; Lea Verou. W3C. 10 October 2019. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/css-images-3/>
- [CSS3-MEDIAQUERIES]
Media Queries. Florian Rivoal et al. W3C. 19 June 2012. W3C Recommendation. URL: <https://www.w3.org/TR/css3-mediaqueries/>
- [CSS3-MULTICOL]
CSS Multi-column Layout Module Level 1. Håkon Wium Lie; Florian Rivoal; Rachel Andrew. W3C. 15 October 2019. W3C Working Draft. URL: <https://www.w3.org/TR/css-multicol-1/>
- [CSS3-TRANSITIONS]
CSS Transitions. David Baron; Dean Jackson; Brian Birtles; David Hyatt. W3C. 11 October 2018. W3C Working Draft. URL: <https://www.w3.org/TR/css-transitions-1/>
- [CSSOM-VIEW]
CSSOM View Module. Simon Pieters. W3C. 17 March 2016. W3C Working Draft. URL: <https://www.w3.org/TR/cssom-view-1/>
- [DOM]
DOM Standard. Anne van Kesteren. WHATWG. 18 June 2019. Review Draft (use this version or later). URL: <https://dom.spec.whatwg.org/review-drafts/2019-06>.
- [ECMAScript-7.0]
ECMA-262 7th Edition, The ECMAScript 2016 Language Specification. Brian Terlson. Ecma International. June 2016. Standard. URL: <http://www.ecma-international.org/ecma-262/7.0/index.html>
- [ENCRYPTED-MEDIA]
Encrypted Media Extensions. David Dorwin; Jerry Smith; Mark Watson; Adrian Bateman. W3C. 18 September 2017. W3C Recommendation. URL: <https://www.w3.org/TR/encrypted-media/>
- [FETCH]
Fetch Standard. Anne van Kesteren. WHATWG. 13 December 2019. Review Draft (use this version or later). URL: <https://fetch.spec.whatwg.org/review-drafts/2019-12>.
- [FILEAPI]
File API. Marijn Kruisselbrink; Arun Ranganathan. W3C. 11 September 2019. W3C Working Draft. URL: <https://www.w3.org/TR/FileAPI/>
- [FILTER-EFFECTS-1]

- Filter Effects Module Level 1*. Dirk Schulze; Dean Jackson. W3C. 18 December 2018. W3C Working Draft. URL: <https://www.w3.org/TR/filter-effects-1/>
- [FULLSCREEN]
Fullscreen API Standard. Philip Jägenstedt. WHATWG. 29 January 2020. Review Draft (use this version or later). URL: <https://fullscreen.spec.whatwg.org/review-drafts/2020-01/>.
- [GIF]
Graphics Interchange Format. CompuServe Incorporated. 31 July 1990. URL: <https://www.w3.org/Graphics/GIF/spec-gif89a.txt>
- [HR-TIME-1]
High Resolution Time. Michael McKeough. W3C. 21 November 2019. W3C Recommendation. URL: <https://www.w3.org/TR/hr-time-1/>.
- [HTML]
HTML Standard. Anne van Kesteren; Domenic Denicola; Ian Hickson; Philip Jägenstedt; Simon Pieters. WHATWG. 29 January 2020. Review Draft (use this version or later). URL: <https://html.spec.whatwg.org/review-drafts/2020-01>.
- [INDEXEDDB]
Indexed Database API. Nikunj Mehta; Jonas Sicking; Eliot Graff; Andrei Popescu; Jeremy Orlow; Joshua Bell. W3C. 8 January 2015. W3C Recommendation. URL: <https://www.w3.org/TR/IndexedDB/>
- [JPEG]
JPEG File Interchange Format. Eric Hamilton. C-Cube Microsystems. Milpitas, CA, USA. September 1992. URL: <https://www.w3.org/Graphics/JPEG/jif3.pdf>
- [MEDIA-SOURCE]
Media Source Extensions™. Matthew Wolenetz; Jerry Smith; Mark Watson; Aaron Colwell; Adrian Bateman. W3C. 17 November 2016. W3C Recommendation. URL: <https://www.w3.org/TR/media-source/>
- [MEDIACAPTURE-STREAMS]
Media Capture and Streams. Daniel Burnett; Adam Bergkvist; Cullen Jennings; Anant Narayanan; Bernard Aboba; Jan-Ivar Bruaroey; Henrik Boström. W3C. 2 July 2019. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/mediacapture-streams/>
- [NAVIGATION-TIMING]
Navigation Timing. Zhiheng Wang. W3C. 17 December 2012. W3C Recommendation. URL: <https://www.w3.org/TR/navigation-timing/>.
- [NOTIFICATIONS]
Notifications API Standard. Anne van Kesteren. WHATWG. 29 January 2020. Review Draft (use this version or later). URL: <https://notifications.spec.whatwg.org/review-drafts/2020-01/>.
- [OPEN-FONT-FORMAT]
Information technology — Coding of audio-visual objects — Part 22: Open Font Format. International Organization for Standardization. URL: http://standards.iso.org/ittf/PubliclyAvailableStandards/c052136_ISO_IEC_14496-22_2009%28E%29.zip
- [PAGE-VISIBILITY-2]

- Page Visibility Level 2*. Ilya Grigorik; Arvind Jain; Jatinder Mann. W3C. 17 October 2017. W3C Proposed Recommendation. URL: <https://www.w3.org/TR/page-visibility-2/>
- [PNG]
Portable Network Graphics (PNG) Specification (Second Edition). Tom Lane. W3C. 10 November 2003. W3C Recommendation. URL: <https://www.w3.org/TR/PNG/>
- [REFERRER-POLICY]
Referrer Policy. Jochen Eisinger; Emily Stark. W3C. 26 January 2017. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/referrer-policy/>.
- [RESOURCE-TIMING-1]
Resource Timing Level 1. Arvind Jain; Todd Reifsteck; Jatinder Mann; Zhiheng Wang; Anderson Quach. W3C. 30 March 2017. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/resource-timing-1/>.
- [RFC2119]
Key words for use in RFCs to Indicate Requirement Levels. S. Bradner. IETF. March 1997. Best Current Practice. URL: <https://tools.ietf.org/html/rfc2119>
- [RFC5246]
The Transport Layer Security (TLS) Protocol Version 1.2. T. Dierks; E. Rescorla. IETF. August 2008. Proposed Standard. URL: <https://tools.ietf.org/html/rfc5246>.
- [RFC8174]
Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words. B. Leiba. IETF. May 2017. Best Current Practice. URL: <https://tools.ietf.org/html/rfc8174>
- [RFC8446]
The Transport Layer Security (TLS) Protocol Version 1.3. E. Rescorla. IETF. August 2018. Proposed Standard. URL: <https://tools.ietf.org/html/rfc8446>.
- [SELECT]
Selectors Level 3. Tantek Çelik; Erika Etemad; Daniel Glazman; Ian Hickson; Peter Linss; John Williams. W3C. 6 November 2018. W3C Recommendation. URL: <https://www.w3.org/TR/selectors-3/>
- [SERVICE-WORKERS-1]
Service Workers 1. Alex Russell; Jungkee Song; Jake Archibald; Marijn Kruisselbrink. W3C. 19 November 2019. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/service-workers-1/>
- [SRI]
Subresource Integrity. Devdatta Akhawe; Frederik Braun; Francois Marier; Joel Weinberger. W3C. 23 June 2016. W3C Recommendation. URL: <https://www.w3.org/TR/SRI/>
- [UIEVENTS]
UI Events. Gary Kacmarcik; Travis Leithead; Doug Schepers. W3C. 30 May 2019. W3C Working Draft. URL: <https://www.w3.org/TR/uievents/>
- [upgrade-insecure-requests]
Upgrade Insecure Requests. Mike West. W3C. 8 October 2015. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/upgrade-insecure-requests/>
- [USER-TIMING-2]

[User Timing Level 2](https://www.w3.org/TR/user-timing-2/). Ilya Grigorik. W3C. 26 February 2019. W3C Recommendation. URL: <https://www.w3.org/TR/user-timing-2/>.

[WEBAUDIO]

Web Audio API. Paul Adenot; Raymond Toy. W3C. 18 September 2018. W3C Candidate Recommendation. URL: <https://www.w3.org/TR/webaudio/>

[WEBCRYPTOAPI]

Web Cryptography API. Mark Watson. W3C. 26 January 2017. W3C Recommendation. URL: <https://www.w3.org/TR/WebCryptoAPI/>

[WEBGL-103]

WebGL Specification. Dean Jackson. Khronos. 27 October 2014. URL: <https://www.khronos.org/registry/webgl/specs/1.0.3/>

[WOFF]

WOFF File Format 1.0. Jonathan Kew; Tal Leming; Erik van Blokland. W3C. 13 December 2012. W3C Recommendation. URL: <https://www.w3.org/TR/WOFF/>

[XHR]

XMLHttpRequest Standard. Anne van Kesteren. WHATWG. 17 February 2020. Review Draft (use this version or later). URL: <https://xhr.spec.whatwg.org/review-drafts/2020-02/>.

A.2 Informative references

[APPMANIFEST]

Web App Manifest. Marcos Caceres; Kenneth Christiansen; Mounir Lamouri; Anssi Kostiaainen; Matt Giuca; Aaron Gustafson. W3C. 15 November 2019. W3C Working Draft. URL: <https://www.w3.org/TR/appmanifest/>

[CSS-2018]

CSS Snapshot 2018. Tab Atkins Jr.; Erika Etemad; Florian Rivoal. W3C. 22 January 2019. W3C Note. URL: <https://www.w3.org/TR/css-2018/>

[EVERGREEN-WEB]

The evergreen Web. Hadley Beeman. W3C. 9 February 2017. TAG Finding. URL: <https://www.w3.org/2001/tag/doc/evergreen-web/>

[INBANDTRACKS]

Sourcing In-band Media Resource Tracks from Media Containers into HTML. Silvia Pfeiffer; Bob Lund. W3C. 26 April 2015. Unofficial Draft. URL: <https://dev.w3.org/html5/html-sourcing-inband-tracks/>

[MEDIA-FRAGS]

Media Fragments URI 1.0 (basic). Raphaël Troncy; Erik Mannens; Silvia Pfeiffer; Davy Van Deursen. W3C. 25 September 2012. W3C Recommendation. URL: <https://www.w3.org/TR/media-frags/>

[MEDIASESSION]

Media Session. Mounir Lamouri; Zhiqiang Zhang; Rich Tibbett. W3C. W3C Editor's Draft.

URL: <https://w3c.github.io/mediasession/>

[PUSH-API]

Push API. Peter Beverloo; Martin Thomson. W3C. 4 February 2020. W3C Working Draft.

URL: <https://www.w3.org/TR/push-api/>.