World Wide Web

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Last modified: September 8, 2024

The Birth of the Web (1)

- The World Wide Web was born in CERN.
- Both the idea and the implementation came from Tim Berners-Lee (TBL).
  - For more information about TBL, see: https://www.w3.org/People/Berners-Lee/
- The idea:
  - Tim Berners-Lee. *Information Management: A Proposal*. March 1989. https://www.w3.org/History/1989/proposal.html
    - He recommended a hypertext information system to CERN.
  - Tim Berners-Lee, Robert Cailliau. *WorldWideWeb: Proposal for a HyperText Project*. 12 November 1990. https://www.w3.org/Proposal.html

The Birth of the Web (2)

- TBL is the creator of the following:
  - The first web server (CERN httpd) (December 24, 1990) https://www.w3.org/Daemon/
  - The first web browser and HTML editor (WorldWideWeb) (December 25, 1990) https://www.w3.org/People/Berners-Lee/WorldWideWeb.html
  - HTML (HyperText Markup Language) https://info.cern.ch/hypertext/WWW/MarkUp/MarkUp.html
  - HTTP (HyperText Transfer Protocol) https://www.w3.org/Protocols/HTTP/AsImplemented.html
  - URI (Universal Resource Identifier), originally called as UDI (Universal Document Identifier) https://info.cern.ch/hypertext/WWW/Addressing/Addressing.html

The Birth of the Web (3)

- The first public website: http://info.cern.ch/ (launched on: August 6, 1991)
  - See: *Restoring the first website* https://first-website.web.cern.ch/first-website/

History

- See:
  - http://www.storyoftheweb.org.uk/
  - https://thehistoryoftheweb.com/

Idea

- Originally, the idea of the Web is based on the following cornerstones:
  - Identifying resources by global identifiers (URIs)
  - Client-server model
  - Hypertext markup language (HTML)

Web Architecture

- Architecture of the Web from a contemporary viewpoint:
  - *Architecture of the World Wide Web, Volume One* (W3C Recommendation, 15 December 2004) https://www.w3.org/TR/webarch/
    - The client-server model is not mentioned at all in the text!

Web Architecture: Concepts (1)

- **World Wide Web**: an information space in which the items of interest (referred to as resources) are identified by URIs.
- **Resource**: anything that might be identified by a URI.
  - **Information resource**: a resource which has the property that all of its essential characteristics can be conveyed in a message.
- **Uniform Resource Identifier** (**URI**): a global identifier in the context of the Web.
- **Representation**: data that encodes information about resource state.

Web Architecture: Concepts (2)

- **Content negotiation**: offering multiple representations for a resource and selecting the one that is the most appropriate when a representation must be served.
- **Dereferencing a URI**: using a URI to access the referenced resource.
  - Access may take many forms, including retrieving, adding, or modifying a representation of the resource, and deleting some or all representations of the resource.

Web Architecture: Concepts (3)

- **Web agent**: a person or a piece of software acting on the Web on behalf of a person, entity, or process.
  - For example, a web crawler.
- **User agent**: one type of Web agent, a piece of software acting on behalf of a person.
  - For example, a web browser.

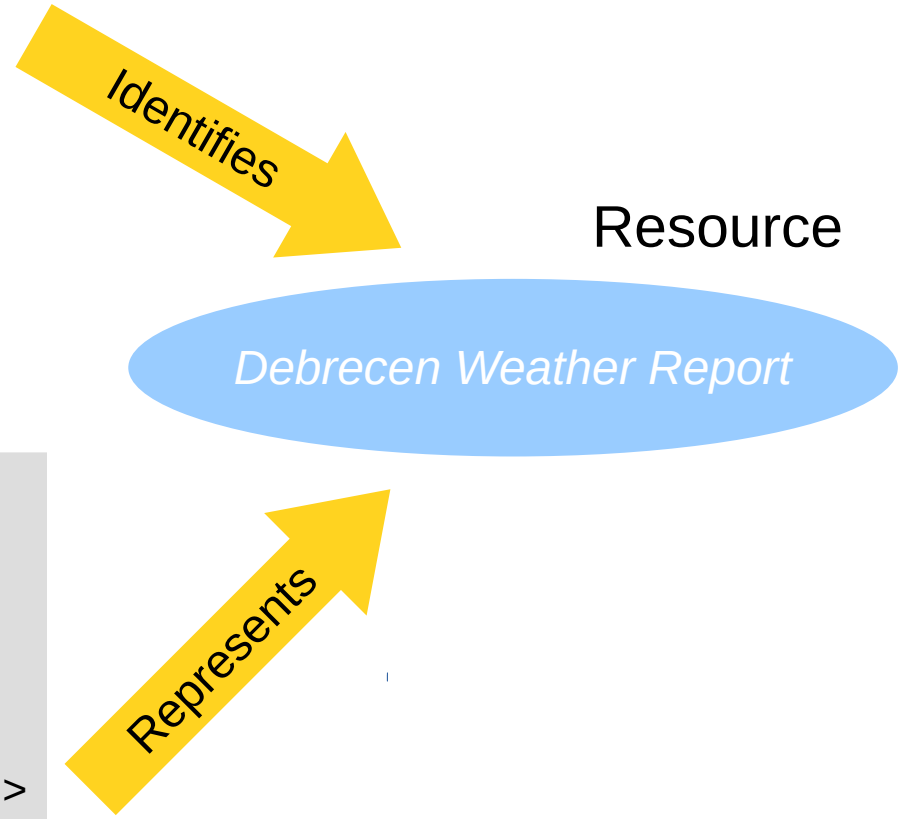
Architectural Bases of the Web

- **Identification**:
  - Resources are identified by global identifiers called URIs.
- **Interaction**:
  - Web agents communicate using standardized protocols that enable interaction through the exchange of messages.
    - Web protocols include, for example, HTTP, HTTPS, and WebDAV.
  - A message may include data as well as metadata about a resource, the message data, and the message itself.
- **Data Formats**:
  - The choice of interaction protocol places limits on the formats of representation data and metadata that can be transmitted.
  - The Web itself does not constrain the data formats that can be used by content providers.
    - For a data format to be usefully interoperable between two parties, the parties must agree (to a reasonable extent) about its syntax and semantics.

Web Architecture: Example Scenario

URI

```
http://weather.example.com/debrecen
```



Representation

Metadata:

```
Content-Type:
application/xhtml+xml; charset=utf-8
```

Data:

```
<!DOCTYPE html>
<html xmlns="http://www.w3.org/1999/xhtml">
  <head>
    <title>10 Day Weather Forecast for
      Debrecen</title>
    ...
```

Standards (1)

- A standard is a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose.
  - See: https://web.archive.org/web/20200101101550/https://www.iso.org/standards.html

Standards (2)

- By origin, there are three types of standards:
  - **De facto standards**: arise from common usage or market acceptance.
    - Examples: the QWERTY keyboard layout, TeX, PDF (before 2008).
  - **De jure standards**: are mandated by regulators at the local, state, federal, and/or international level.
    - Examples: International System of Units (SI), PDF (from 2008).
  - **Voluntary consensus standards**: are specified within a range of private institutions, including engineering societies, trade associations, accredited standards-setting organizations, and industry consortia.
    - Examples: the Internet protocol suite (commonly known as TCP/IP), HTML, CSS.
- See:
  - Andrew L. Russell. *Open Standards and the Digital Age*. Cambridge University Press, 2014. https://arussell.org/open/

Open Standard (1)

- There is no single, universally accepted definition:
  - *OpenStand: The Modern Paradigm for Standards* (IEEE, ISOC, IETF, IAB, W3C, …) https://open-stand.org/
  - *Open Standards Requirement for Software* (Open Source Initiative) https://opensource.org/osr/
  - …
- Further information: *Open standard* https://en.wikipedia.org/wiki/Open_standard

Open Standard (2)

- In general, an open standard is a standard that is freely available for use and adoption to anyone.
- Open standards are typically developed via a collaborative process.

Web Standards

- The following organizations are responsible for web standards:
  - *Ecma International* https://www.ecma-international.org/
  - *International Organization for Standardization* (ISO) https://www.iso.org/
  - *Internet Engineering Task Force* (IETF) https://www.ietf.org/
  - *Unicode Consortium* https://unicode.org/consortium/consort.html
  - *Web Hypertext Application Technology Working Group* (WHATWG) https://whatwg.org/
  - *World Wide Web Consortium* (W3C) https://www.w3.org/
  - …

Internet Assigned Numbers Authority (IANA)

- Coordinates the allocation of codes and numbers that form the basis for the operation of the Internet. https://www.iana.org/
  - Manages the DNS root zone, and the `.int` and `.arpa` domains.
  - Coordinates the allocation of IP addresses globally.
  - Maintains registries of codes and numbers used in a variety of Internet protocols.
    - See: *Protocol Registries* https://www.iana.org/protocols
- IANA is a function that is currently performed by the Internet Corporation for Assigned Names and Numbers (ICANN), a not-for-profit corporation.

Internet Engineering Task Force (IETF)

- An international standards organization developing Internet standards.
  - For example, IETF develops the Internet protocol suite (commonly known as TCP/IP).
  - The IETF has no formal membership, no membership fee, participation is open to anyone.
    - Mailing lists: https://www.ietf.org/list/
  - The technical work is done in working groups.
- Formation: 1986
  - See: *IETF Turns 25 on 16 January 2011* https://www.ietf.org/mail-archive/web/ietf-announce/current/msg08366.html
- Publishes Internet standards-related specifications in the RFC series of documents.

Request for Comments (RFC) (1)

- The RFC series contains technical and organizational documents about the Internet.
- The RFC series of documents began in 1969 as part of ARPANET project.
  - The first RFC:
    - Steve Crocker. *Host Software*. RFC 1, 7 April 1969. https://www.rfc-editor.org/info/rfc1

Request for Comments (RFC) (2)

- RFC Editor edits, publishes, and catalogs RFCs.
  https://www.rfc-editor.org/
- By origin, the RFC series is split into four streams:
  - The Internet Engineering Task Force (IETF) Stream
  - The Internet Architecture Board (IAB) Stream
  - The Internet Research Task Force (IRTF) Stream
  - The Independent Submission Stream
- Further information about the RFC series:
  - Russ Housley (ed.), Leslie L. Daigle (ed.). *The RFC Series and RFC Editor*. RFC 8729, February 2020.
    https://www.rfc-editor.org/rfc/rfc8729

Request for Comments (RFC) (3)

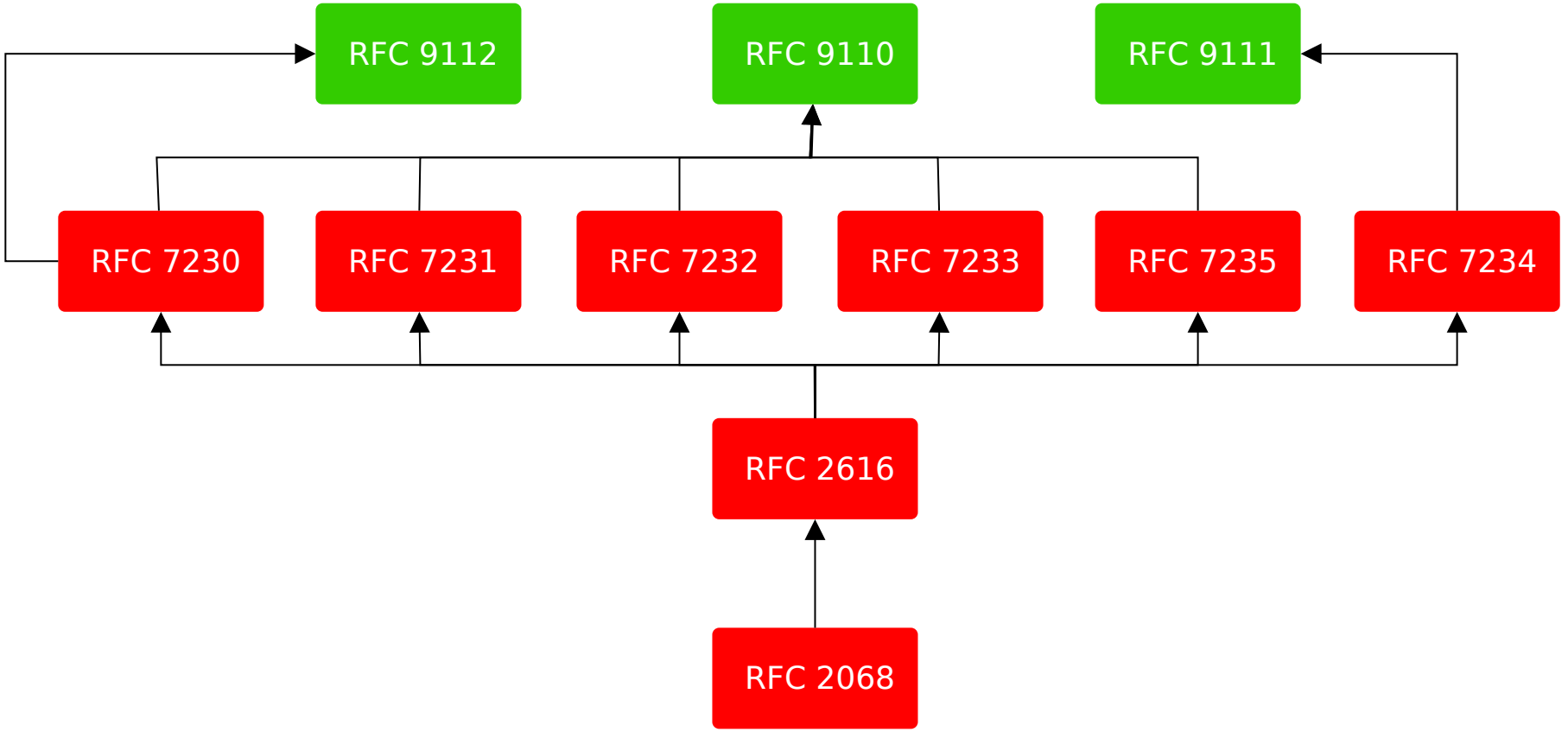
- Each RFC is identified by a number, such as RFC 9110.
- Each RFC is available in ASCII text, such as: https://www.rfc-editor.org/rfc/rfc9110.txt
  - The same RFC in HTML: https://www.rfc-editor.org/rfc/rfc9110.html
- The list of all RFCs: https://www.rfc-editor.org/rfc-index.html

Request for Comments (RFC) (4)

- Published RFCs never change.
- Various errors are fixed by errata.
- Amendments can be also made by writing and publishing a revised RFC.
  - An RFC can obsolete or update earlier RFCs.

Request for Comments (RFC) (5)

- Example: Hypertext Transfer Protocol – HTTP/1.1



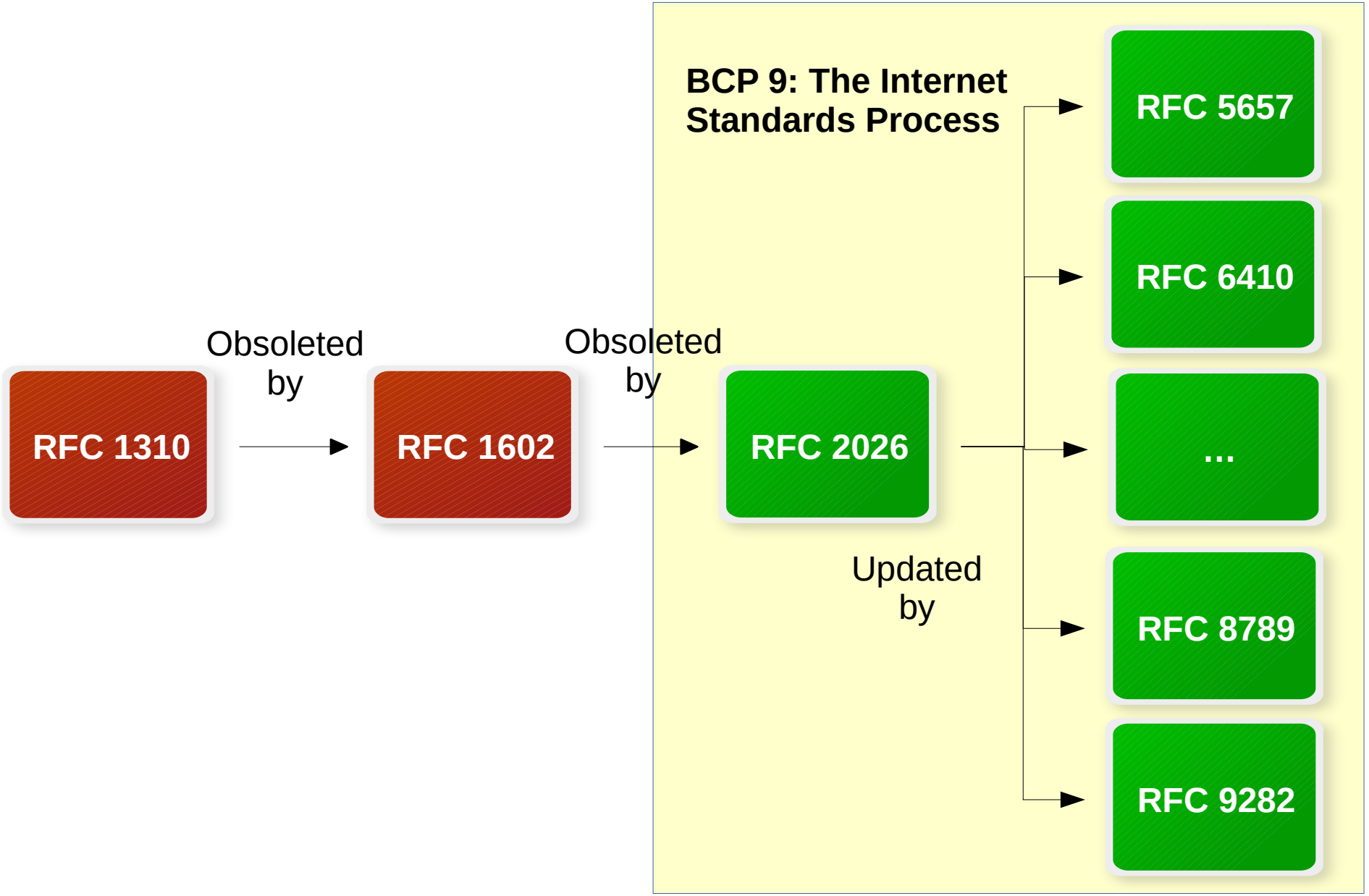
Request for Comments (RFC) (6)

- The series of IETF RFCs contains the following two important sub-series:
  - ***Best Current Practice*** (**BCP**):
    - BCPs document guidelines, processes, or the operation of the IETF itself.
    - *BCP Index*: https://www.rfc-editor.org/rfc/bcp/
  - ***Internet Standard*** (**STD**):
    - *STD Index*: https://www.rfc-editor.org/rfc/std/

Request for Comments (RFC) (7)

- BCPs and STDs are assigned a number in their subseries while retaining their RFC number.
  - Example:
    - Scott O. Bradner. *The Internet Standards Process – Revision 3*. **BCP 9**, RFC 2026, October 1996. https://www.rfc-editor.org/rfc/rfc2026
    - Tim Berners-Lee, Roy T. Fielding, Larry Masinter. *Uniform Resource Identifier (URI): Generic Syntax*. **STD 66**, RFC 3986, January 2005. https://www.rfc-editor.org/rfc/rfc3986
- Several RFCs may share the same BCP or STD number.
  - For example, an STD number identifies a standard not a document.

Request for Comments (RFC) (8)



Request for Comments (RFC) (9)

- ***Standards Track***: the set of maturity levels of RFCs that are intended to become Internet Standards.
  - Originally, three maturity levels were used:
    - Proposed Standard
    - Draft Standard
    - Internet Standard
  - Currently, the Proposed Standard and Internet Standard maturity levels are used.
- See:
  - Scott O. Bradner. *The Internet Standards Process – Revision 3*. BCP 9, RFC 2026, October 1996. https://www.rfc-editor.org/rfc/rfc2026
  - Russell Housley, Dave Crocker, Eric W. Burger. *Reducing the Standards Track to Two Maturity Levels*. BCP 9, RFC 6410, October 2011. https://www.rfc-editor.org/rfc/rfc6410

Request for Comments (RFC) (10)

- **Internet-Draft**: a draft version of a specification made available for informal review and comment during the development.
  - May or may not eventually be published as an RFC.
  - Is subject to change or removal at any time.
  - Is valid for a maximum of six months.
  - Should not be cited or quoted in any formal document, except as “work in progress”.
  - Example:
    - Austin Wright (ed.), Henry Andrews (ed.), Ben Hutton (ed.), Greg Dennis. *JSON Schema: A Media Type for Describing JSON Documents*. 10 June 2022. https://datatracker.ietf.org/doc/id/draft-bhutton-json-schema-01.html

Request for Comments (RFC) (11)

- On nearly every April 1 since 1989, one ore more funny RFCs has been published.
  - Example:
    - Jogi Hofmueller (ed.), Aaron Bachmann (ed.), IOhannes Zmoelnig (ed.). *The Transmission of IP Datagrams over the Semaphore Flag Signaling System (SFSS)*. RFC 4824, April 1 2007. https://www.rfc-editor.org/info/rfc4824
- See:
  - *April Fools' Day Request for Comments* https://en.wikipedia.org/wiki/April_Fools%27_Day_Request_for_Comments

World Wide Web Consortium (W3C)

- The W3C is an international community where member organizations, a full-time staff, and the public work together to develop open web standards.
  - See: https://www.w3.org/about/
- W3C publishes documents called Recommendations that define Web technologies and are considered Web standards.
  - See: https://www.w3.org/standards/

W3C Design Principles

- **Web for All**: the Web must be available to all people, whatever their hardware, software, network infrastructure, native language, culture, geographical location, or physical or mental ability
  - Related concepts: web accessibility, internationalization
- **Web on Everything**: the Web must be accessible from a wide variety of devices.
  - E.g., mobile phones, smart phones, interactive television systems, domestic appliances, …
- See:
  - *Our mission – Our design principles* https://www.w3.org/mission/#principles
  - *Vision for W3C* https://www.w3.org/TR/w3c-vision/

History of the W3C

- Was founded at MIT in October 1994.
- The director is Tim Berners-Lee, the inventor and creator of the Web.
- Has published more that 300 recommendations since 1996.
  - See: https://www.w3.org/TR/?status%5B0%5D=standard

W3C: A Few Milestones (1)

- **October 1996**: *PNG (Portable Network Graphics) Specification Version 1.0*
  https://www.w3.org/TR/REC-png-961001
- **December 1996**: *Cascading Style Sheets, level 1*
  https://www.w3.org/TR/REC-CSS1-961217
- **February 1998**: *Extensible Markup Language (XML) 1.0*
  https://www.w3.org/TR/1998/REC-xml-19980210
- **April 1998**: *Mathematical Markup Language (MathML) 1.0 Specification*
  https://www.w3.org/TR/1998/REC-MathML-19980407/

W3C: A Few Milestones (2)

- **October 1998**: *Document Object Model (DOM) Level 1 Specification* https://www.w3.org/TR/REC-DOM-Level-1/
- **November 1999**: *XSL Transformations (XSLT) Version 1.0* https://www.w3.org/TR/1999/REC-xslt-19991116
- **December 1999**: *HTML 4.01 Specification* https://www.w3.org/TR/html401/
- **January 2000**: *XHTML 1.0: The Extensible HyperText Markup Language* https://www.w3.org/TR/2000/REC-xhtml1-20000126/
- **May 2001**: *XHTML 1.1 – Module-based XHTML* https://www.w3.org/TR/2001/REC-xhtml11-20010531/

W3C: A Few Milestones (3)

- **October 2004**: *XML Schema* https://www.w3.org/TR/xmlschema-0/ https://www.w3.org/TR/xmlschema-1/ https://www.w3.org/TR/xmlschema-2/
- **June 2011**: *Cascading Style Sheets Level 2 Revision 1* (CSS 2.1) Specification https://www.w3.org/TR/CSS2/
- **September 2011**: *Selectors Level 3* https://www.w3.org/TR/2011/REC-css3-selectors-20110929/
- **June 2012**: *Media Queries* https://www.w3.org/TR/2012/REC-css3-mediaqueries-20120619/
- **October 2014**: *HTML5 – A vocabulary and associated APIs for HTML and XHTML* https://www.w3.org/TR/2014/REC-html5-20141028/

W3C: A Few Milestones (4)

- **December 2019**: *WebAssembly Core Specification* https://www.w3.org/TR/wasm-core-1/
- **April 2020**: *Web of Things (WoT) Architecture* https://www.w3.org/TR/wot-architecture10/
- **January 2021**: *WebRTC 1.0: Real-Time Communication Between Browsers* https://www.w3.org/TR/2021/REC-webrtc-20210126/
- **April 2022**: *Media Queries Level 3* https://www.w3.org/TR/mediaqueries-3/
- **May 2023**: *EPUB 3.3* https://www.w3.org/TR/epub-33/
- **August 2024**: *Geolocation* https://www.w3.org/TR/geolocation/

W3C Operation (1)

- Currently, W3C has 360 Members from around the world (September 8, 2024).
  - The list of members: https://www.w3.org/membership/list/
    - Adobe, Amazon, Apple, CERN, Google, IBM, Intel, Meta, Microsoft, SZTAKI, …
- Geographic or interest-based communities of individuals interested in W3C's activities: W3C Chapters https://chapters.w3.org/
  - Hungary Chapter https://chapters.w3.org/hungary/

W3C Operation (2)

- Development is carried out by working groups.
- Deliverables produced by working groups include technical reports, test suites, and open source software.
- Working groups are composed of experts in the area in question, each of whom can be any of the following:
  - a member of the W3C Team (e.g., a W3C employee),
  - an individual representing a member organization (typically, an employee of a member organization)
  - an individual participating as an invited expert.

W3C Operation (3)

- Currently, W3C has 43 working groups (September 8, 2024). https://www.w3.org/groups/wg/
  - Cascading Style Sheets (CSS) Working Group https://www.w3.org/Style/CSS/members
  - HTML Working Group https://www.w3.org/groups/wg/htmlwg/
  - Internationalization Working Group https://www.w3.org/International/i18n-activity/i18n-wg/
  - Web Applications Working Group https://www.w3.org/groups/wg/webapps/
  - Web Machine Learning Working Group https://www.w3.org/groups/wg/webmachinelearning/
  - …

W3C Participation

- Participation is open to the public, you can:
  - Review specifications and provide feedback https://www.w3.org/standards/review/
  - Join mailing lists https://www.w3.org/email/
  - Join community and business groups https://www.w3.org/community/
  - Contribute to W3C open source software https://www.w3.org/Status
  - Translate specifications and other resources https://www.w3.org/Consortium/Translation/
  - Attend events (e.g., conferences, workshops) organized by W3C https://www.w3.org/events/
  - …
- See: https://www.w3.org/get-involved/

W3C Technical Reports

- See the following about the various technical reports published by W3C:
  - *W3C Process Document* (3 November 2023) https://www.w3.org/Consortium/Process/
  - *Types of documents W3C publishes* https://www.w3.org/standards/types
- All technical reports: https://www.w3.org/TR/
- W3C documents are licensed under the W3C Document License.
  - See: *Document License* https://www.w3.org/copyright/document-license/
  - Further information: https://www.w3.org/copyright/

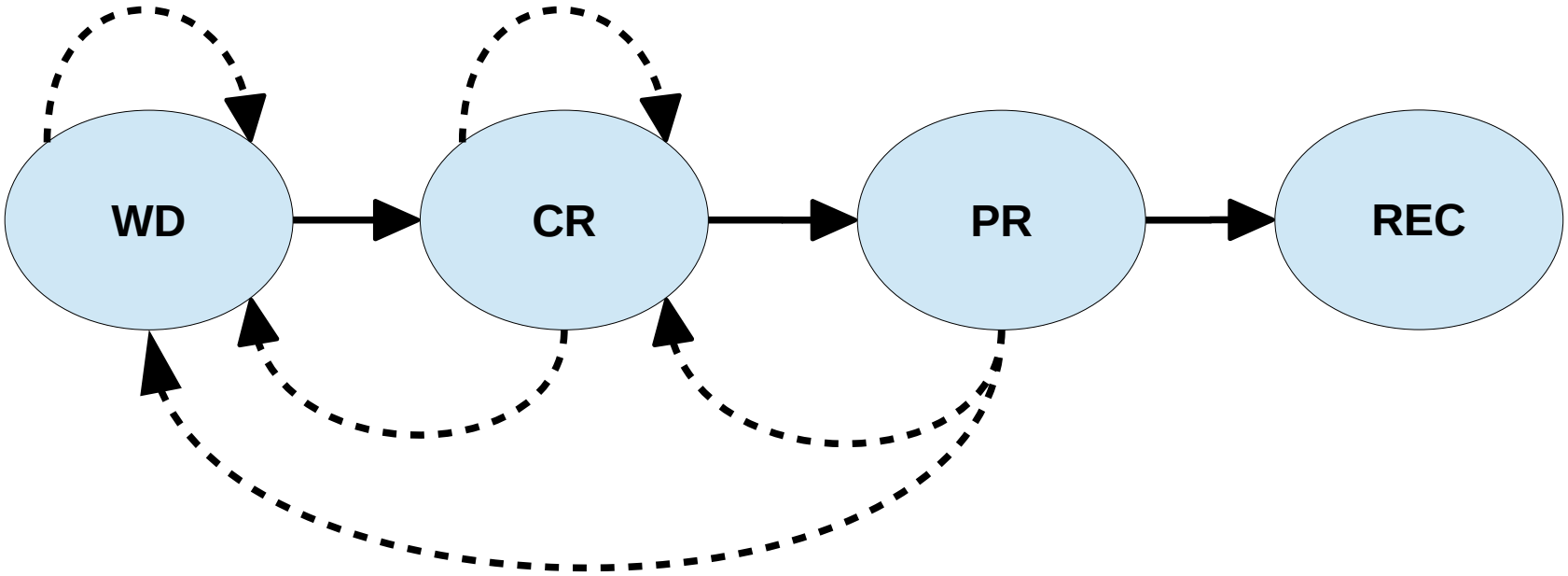
Maturity Levels of W3C Technical Reports (1)

- **Working draft** (**WD**): a document that is published for review by the community (including W3C members), the public, and other technical organizations.
  - Some, but not all, Working Drafts are meant to advance to Recommendation.
- **Candidate Recommendation** (**CR**): a document that has already received wide review and is published to gather implementation experience.
- **Proposed Recommendation** (**PR**): a document that is of sufficient quality to become a Recommendation.
- **Recommendation** (**REC**): a Web standard suitable for wide adoption.
- **Group Note** (**NOTE**): a document that is not intended to be a formal standard.
  - Are published to document information other than technical specifications, such as use cases motivating a specification and best practices for its use.

Maturity Levels of W3C Technical Reports (2)

- A recommendation may become superseded,obsolete, or rescinded:
  - **Superseded Recommendation**: a specification that has been replaced by a newer version.
    - Example:
      - *XHTML 1.0 The Extensible HyperText Markup Language (Second Edition)* https://www.w3.org/TR/xhtml1/
  - **Obsolete Recommendation**: a specification that the W3C has determined lacks sufficient market relevance to continue recommending it for implementation.
    - Example:
      - *The 'view-mode' Media Feature* https://www.w3.org/TR/view-mode/
  - **Rescinded Recommendation**: a specification that W3C no longer endorses.

Maturity Levels of W3C Technical Reports (3)



WHATWG (1)

- *Web Hypertext Application Technology Working Group* (WHATWG) https://whatwg.org/
  - A community committed to the evolution of the Web that develops standards implementable in web browsers.
  - Pronunciation: *what-wee-gee*, *what-wig*, *what-double-you-gee*
    - Lásd: *How do you spell and pronounce WHATWG?* https://whatwg.org/faq#spell-and-pronounce
  - Further information: *WHATWG – FAQ* https://whatwg.org/faq

WHATWG (2)

- Standards:
  - DOM https://dom.spec.whatwg.org/
  - Fullscreen API https://fullscreen.spec.whatwg.org/
  - HTML https://html.spec.whatwg.org/
  - URL https://url.spec.whatwg.org/
  - WebSockets https://websockets.spec.whatwg.org/
  - XMLHttpRequest https://xhr.spec.whatwg.org/
  - …
- See: *WHATWG – Standards* https://spec.whatwg.org/

WHATWG (3)

- History:
  - It was founded by programmers of Apple, the Mozilla Foundation, and Opera Software in 2004 who were concerned about the W3C's activity related to the development of HTML.
- Operation:
  - Its operation is coordinated by the Steering Group whose current members are Apple, Google, Microsoft, and Mozilla.
- Participation:
  - Participation is open to the public.
  - See: *WHATWG – Participation* https://participate.whatwg.org/

WHATWG (4)

- Development model:
  - The WHATWG develops specifications called “Living Standards” that are continuously updated.
- Living standards are licensed under the CC BY 4.0 license. https://creativecommons.org/licenses/by/4.0/
  - See: *WHATWG – Intellectual Property Rights Policy* https://whatwg.org/ipr-policy

Size of the Web

- The total number of indexed web pages: > 4 billion.
  - See: https://www.worldwidewebsize.com/
- The total number of web sites: > 1 billion.
  - See: *Netcraft – August 2024 Web Server Survey* https://www.netcraft.com/blog/august-2024-web-server-survey/

Wayback Machine (1)

- A service that allows people to visit archived versions of Web sites.
  - Website: https://archive.org/web/
  - It makes the phrase “The internet doesn't forget” true.
  - A sub-project of the Internet Archive project launched in 1996.
  - Contains over 2 petabytes of data compressed, or 150+ billion web captures, including content from every top-level domain, 200+ million web sites, and over 40 languages.
- Further information:
  - https://help.archive.org/help/wayback-machine-general-information/
  - https://help.archive.org/help/using-the-wayback-machine/
  - https://blog.archive.org/2016/10/23/defining-web-pages-web-sites-and-web-captures/

Wayback Machine (2)

- Collects web pages that are publicly available.
- When a dynamic page contains forms, JavaScript, or other elements that require interaction with the originating host, the archive will not contain the original site's functionality.

Wayback Machine (3)

- Example:
  - Snapshots saved for https://www.w3.org/:
    - https://web.archive.org/web/*/https://www.w3.org/
      - Snapshot saved on September 3, 2003 at 14:02:22:
        - https://web.archive.org/web/20030903140222/https://www.w3.org/

Wayback Machine (4)

- A useful feature: **Save Page Now**
  - Capture a web page as it appears now for use as a trusted citation in the future.
  - Saves a specific web page one time only.