

History and Evolution of the Browser

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Abstract. Summary of our paper (70-250 words)

1 Introduction

1.1 What is a Browser

A Browser is an application that interprets HTML documents and data to render them to a Web page making the Web accessible. A browser lets you visit websites and do activities within them like login, view multimedia, link from one site to another, visit one page from another, print, send and receive email, among many other activities. The most common browser software titles on the market are: Microsoft Internet Explorer, Google's Chrome, Mozilla Firefox, Apple's Safari, and Opera. Browser availability depends on the operating system your computer is using (for example: Microsoft Windows, Linux, Ubuntu, Mac OS, among others).

2 History

2.1 The first browsers

The first browser for the web was also an invention of the founder of the web, Tim Berners-Lee. The browser was called *WorldWideWeb* and was introduced to the world in the year 1990. A few years later, in 1994, the Browser was renamed *Nexus*. The browser *WorldWideWeb* was, a part of the fact that it was the first browser, also the first HTML editor. To view pictures you had to follow the link of the picture, download it and open it on the computer. Another browser with a different name but a similar functionality was *Lynx*, which was published 1992 by Thomas Dickey.

2.2 First graphical browsers

When the Web was published Tim Berners-Lee wanted his invention to succeed. To ensure the success he knew he needed more people to get interested. He needed as many developers as possible to work on web based projects, so there is a constant flow of new content, and he needed the general public to get occupied with the web to make it a long lasting success. For that reason Tim Berners-Lee helped many project that tried to produce new graphical based browsers. In the year 1992 many browser were invented by students as small projects with exactly that goal, were *ViolaWWW* or otherwise called *Viola* was one of the most prominent and *Erwise* was one of the lesser known graphical browsers. But not long after *Viola* came a new competitor. This new browser was *Mosaic*.

2.3 Mosaic

In January 1993 *Mosaic* was published for free and its distribution numbers skyrocketed. Marc Andreessen and Eric Bina, the developers of the *Mosaic* browser, constructed the browser with the intention that a broader audience could use

the World Wide Web. That was only possible when the team of NCSA engineers would make their browser accessible for other systems than Unix. Andreessen and Bina, together with some of their NCSA associates, worked on the versions for Mac and PC which came out in late spring of the same year. With this the user numbers of *Mosaic* rose even higher, with 5000 downloads per month. After the graduation of Marc Andreessen and Eric Bina they met James H. Clark, the founder of Silicon Graphics, and discussed how to make the Web commercialisable. That set the starting point for a new Browser called *Netscape*. So Andreessen and Bina left NCSA, with some of their colleagues, in 1994 and settled down in Silicon Valley. After the 2 left the NCSA assigned all commercial rights for *Mosaic* to Spyglass, Inc. Spyglass licensed their technology to many other companies, including Microsoft. In the year 1997 the NCSA discontinued the support for the *Mosaic*, shifting their research focus to other developments projects. The last release for the *Mosaic* browser dates back to August 1997.

2.4 Netscape

Netscape marks the beginning of many important things, that shaped the idea of the browser we know today. The first version of the browser was launched in October 1994 and was programmed by the NCSA team of Andreessen and Bina, that they acquired. In the beginning the team was not sure how to earn money with their browser, but later on their browser marked the end of research-project status of the Web and started the era of the Web of commercial interest and exploitation. The Browser also invented the cookie feature, what lets the browser save data, and the Secure Socket Layer (SSL), what protects the privacy and integrity of transactions. The first browser was the *Mosaic Netscape* release 0.9. Because of problems with the name the company adapted the name *Netscape Communications* and launched by the end of december the *Netscape Navigator 1.0*, what also solved the problem with the name conflict regarding the NCSA Mosaic browser.

Because of the few competitors in the field of browsers, *Netscape* became the most popular browser in a short time. The main income for the company was through B2B-business and the stock markets. Especially the stock markets were lucrative, because on the first day (August 9th, 1995) their stock price rose from 28\$ per share to a high of 74.75\$ and at the end of the day they closed off with 58.25\$. That was a great sign and it didn't end there; yet. They rose in popularity, until Microsoft started competing in the Web sector. With Microsoft and Netscape Communications the browser wars started.

2.5 Internet Explorer

Internet Explorer 1.0 (furthermore called IE) was the first attempt of Microsoft on 17 August 1995 to dethrone Netscape as the market leader on the browser territory. For the first 2 versions of IE, Microsoft used the licensed code of Spyglass Inc. from *Mosaic*, as a starting point. The first version that was mostly independently made in the company, would be IE 3.0. It introduced as the first

browser ever CSS and it was the first version that did not use the Spyglass source code; only Spyglass technology. It was also the first true competitor for *Netscape*. The following years would become known as the **Browser Wars** between Netscape and IE, where both parties would improve their browser in a rapid pace. The tides turned with IE 4.0, where Microsoft changed their strategy. Before IE 4.0 their browser was a free browser for the home, like Netscape, but Microsofts' browser was inferior in technology and had to be installed first, before you could use it. But IE 4.0 shipped with all Windows and Macintosh PCs', means the first browser most people interacted with after they bought a new PC was IE and not Netscape. With that IE dethroned Netscape as the most used browser and send Netscape into the depths of nothingness. After the defeat of Netscape the development of Microsofts browser slacked down after the release of IE 6.0 in 2001. But this error made it possible for new competitors to emerge and evolve.

2.6 Mozilla Firefox

Mozilla Firefox, originally called Phoenix or Firebird, is the unofficial offspring of Netscape created in the year 1998. The first version of Firefox, Firefox 1.0, was released on 9 November 2004. Shortly before the release of the first full version Mozilla gained a bunch of new users, because of the warning from the US government against the exploit in IE. Firefox and its predecessor were created on the bases of the Netscape source code, which was published on 31 March 1998 in the attempt of Netscape Communications to get more programmers that could improve the code and help defeat Microsoft in the **Browser Wars**. Unfortunately that was not enough to save Netscape. But it does not mean that Mozilla Firefox was going down with Netscape. The reason behind this was because *Mozilla Firefox* had already its standalone browser, with a big community and enough programmers to keep working on the browser. Another reason is the browser was back financially by many investors and the Mozilla Corporation, which was founded as a totally owned branch of the Mozilla Foundation. Nowadays Firefox is still fairly popular browser with 6-8, even while Safari and Google Chrome have a bigger market share.

2.7 Opera

Opera is one of the oldest browsers we have nowadays, next to IE. *Opera 1.0* was first released in the year 1995. It was not as widely used as Netscape or IE, but it gained popularity with time. The intention was to build a fast browser on any system. That is why it was build from scratch and not based on the Mosaic code (like IE and Netscape). But *Opera* gained enough popularity with version 2.1, which was in the on 9 December 1996 and introduced feateures like keyboard shortcuts, zoom and sessions.

2.8 Safari

Safari is a browser exclusively developed for iOS, which was released January 7th, 2003. Initially it was published on Mac desktop systems, later on version 3,4 and 5 it was also published on Windows, but after the 5th version the Windows edition was not further supported. The browser was released for the mobile devices of Apple Inc. in the year 2007. Safari was a pioneer in the browser segment, especially in the early years, but now it is failing to keep with its competitors. Since then the quality decreased from browser version to browser version, compared to its contestant. Currently we have the version 12.1 of the browser for all iOS systems.

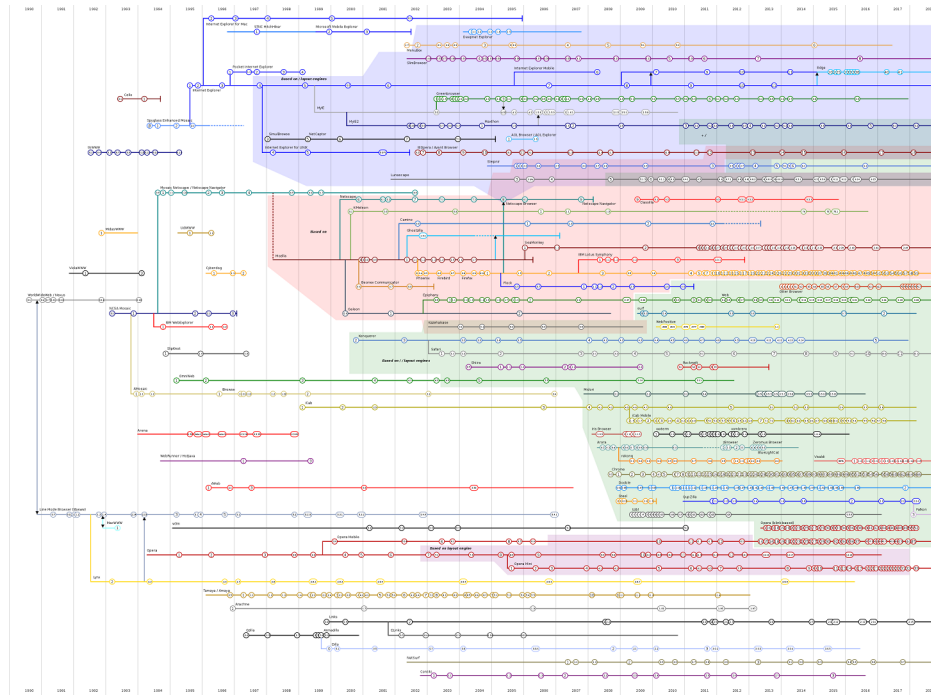
2.9 Google Chrome

It was rumored in 2004 that Google was working on a browser, but the development only began in the year 2006. The reason why Google wanted to do their own browser, was because the other options at this time were not that satisfying. The first version was released in 2008 and gained immense popularity. In the year 2012 even surpassed IE in the market share race and since then is dominating the 2nd browser wars and is slowly winning as well. Google also developed an engine for browsers called Chromium, which many browser competitors slowly start using for their own browsers.

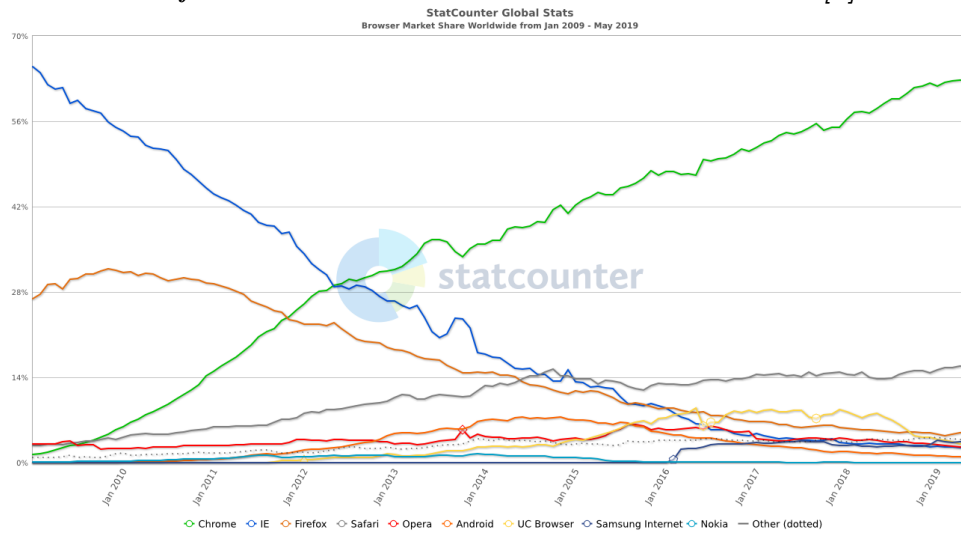
2.10 Tor Browser

The *Tor Browser* is a browser with one goal: internet user should have access to an uncensored web, without being tracked by anyone. Tor stands for "The Onion Routing", the technology that fuels the *Tor Browser*. October 2002 the Tor network was deployed but no browser to access it, so people without technology experience were not able to access the network. The work on the *Tor Browser* started in 2008 to help those without the knowledge to do so before. The browser was later on tool to many political movements, like the Arabic Spring in 2010, and popularity after Snowden's revelations in 2013.

2.11 Timeline of all browsers



A timeline of all browsers and browser versions ever made. [1]



A market share timeline from 2009 to 2019 for the most used browsers. [2]

2.12 Browser nowadays

Today Google Chrome dominates the browser market, with roughly 60%-65%. Safari is the follow up with 15%-19% and after that comes Mozilla Firefox with 4%-6% market share. Another fact to mention is that most browser use Chromium, the browser engine of Google, including Opera, Microsoft Edge and other browsers. The only widely used browsers that don't use Chromium are Mozilla Firefox and Safari.

3 Evolution

3.1 The meaning of Evolution

With every new browser and browser version being released features and improvement have been added. Browsers became more secure, user and developer friendly, and more efficient. These were implemented because of new technologies, bugs being discovered and in trying to run out the competition. If you add all of the changes to a timeline you can overview the Evolution of the browser.

3.2 How Patches influenced Browsers

“I call such changes patches, as they are attempts to fix the original design of the web” Marco Aiello *The Web was Done by Amateurs* S. 65

By changing the Web, patches also influenced browsers when they were introduced. In this chapter we will have a short summary of what these patches were and how browsers evolved and adapted through these changes.

Cookies

Like mentioned before Cookies were introduced with Netscape in 1994 for websites to be able to save data to be remembered for processes on the clients side. The original idea The webbrowser is being used by the server of the website to save textinformation on the Computer of the client. These have made it possible to save login and shopping cart informations but also made Webtracking possible. Later they received criticism for being able to damage the users privacy and threatening security when surfing the web. Under the EU's GDPR Law websites are now forced now ask and inform users about saving data in their Browser.

SSL

SSL is the short form for Secure Sockets Layers, which was an introduction of a security system in the Web. One could say that SSL is an application layer based security protocol but that is not entirely true. It actually is used in the session layer which is above the transport layer and beneath the application layer [3]. It was introduced by Netscape and shaped the security protocols we use nowadays. SSL had many flaws that were corrected by its successors TLS, that's why the latest version was deprecated in the year 2015.

CSS**Java**

In the year 1995, Sun Microsystems published the object-oriented programming language *Java*, inspired by James Gosling. *Java*, formerly called Oak, is able to run on every computer. This is made possible by the Java Virtual Machine, which takes the standard bytecode instructions of the Java program and interpretes it. The only problem is that the JVM is not uniformly implemented across all hardware vendors. The combination of Java and the Web is only possible if the JVM is available to browser on the client side. The Java code is send with the the Web page, where this code is known as Applet. When the browser hits the point where the code should be run, it starts an instance of the JVM and gives it the bytecodes for the execution.

JavaScript Engines

While it would have been possible to couple the handling of JavaScript to the browser engine, every major browser uses a dedicated script engine. This is due to the fact, that JavaScript, while originally created for use in web browsers, is now also used elsewhere. In the web browser these two engines interact with each other through the shared DOM data structure. The first JS engines started with bare interpreters and evolved to full engines with several additional features. The first JavaScript engine was developed by Brendan Eich, co-founder of the Mozilla project, in 1995 for *Netscape*. It was a bare interpreter for the language he was inventing at this time. The first modern JavaScript engine was Googles V8 engine, created for Chrome in 2008. The key innovations was just-in-time compilation, boosting performance significantly. As a result other browser vendors had to overhaul their interpreters to develop into full JavaScript engines. This lead to the development of the Nitro engine for Apples *Safari* browser. Mozilla used portions of Nitro to improve SpiderMonkey, which resulted from Brendan Eichs original JavaScript interpreter. Opera replaced their interpreter with their Carakan engine, also boosting performance significantly. Since 2017 all major browser have added support for WebAssembly to their JavaScript engines. This gives the ability to execute pre-compiled scripts for performance-critical parts of the web page. The code is executed in the same sandbox as the regular JS code.

SVG**3.3 Basic Technological Changes****HTTP****HTML****URL**

Browser Engines The browser engine, also called "layout engine" or "rendering engine", is the core component of most major web browsers. The job of a browser engine is the transformation of HTML files and other required resources to an interactive web page. While it is possible to separate the engine for the layout and the rendering of the page, in practice they are mostly coupled and not separated. The browser engine is also responsible for enforcing the web pages security policy and creating the DOM data structure used in scripts. It is also responsible for handling hyperlinks and web forms. Browser engines may also be reused in other application. An email client, for example, may use such an engine for rendering HTML emails. Another example is the "Electron Framework", which uses the engine of *Google Chrome*, used to create many applications. The layout to be rendered is specified by the CSS file of the web page. There are several different browser engine implementations and the most major web browsers use their own browser engine. Examples are Gecko by Mozilla, WebKit by Apple and Blink by Google. Microsoft used to have their own browser engines Trident and EdgeHTML, but use Google's Blink browser engine now.

3.4 Features

History

Incognito mode Private browsing was first added in 2005 by *Safari* on Mac. The feature has since been adapted by many other browsers so that most modern browser have some form of private browsing.

Bookmarks Bookmarks were a quite early feature and have been included since *Mosaic* in 1993, although called hotlists back then. Newer browsers have expanded the feature of bookmarks. *Firefox* for example, introduced so called "Live Bookmarks" which are essentially bookmarks provided as RSS feed.

Browser Extensions As the first major browser, *Internet Explorer* introduced browser extensions with Version 5 in 1999. The other major browsers also added extensions over the years with Firefox in 2004, Opera in 2009 and Google Chrome and Safari in 2010. Nowadays most browsers support extensions to customize the user experience.

Tabs The first web browsers did not have tabs as we know them from most modern browsers. While many may consider *Opera* to be the browser to introduce tabbed browsing, *Opera* had a *Multiple Document Interface* instead. This may seem similar but is substantial different to a *Tabbed Document Interface*. The actual first browser supporting tabs was the *Internet Explorer Shell "Net-Captor"*, first released in 1997. The browser to mainstream browser tabs was however Firefox or more specifically its predecessor *Phoenix*.

Browser Cache**4 Future of the Browser**

Nowadays there are already many ways to interact with a browser which seem rather futuristic. You can control via voice, by hand gestures and even by just looking with your eyes. You are not just having your browser on your Computer but also on your phone, your watch and floating in the air in front of you.

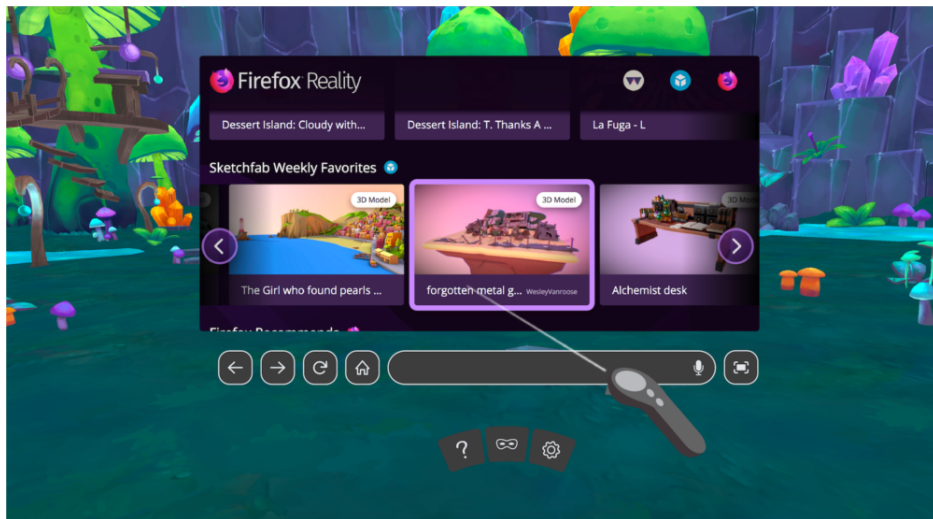
4.1 Browsers becoming operating systems

One of Alan Kay's main criticisms about the Web is the absence of a computational ability for the browser. His vision is for them to be like mini-operating systems and being able to execute locally. So it is possible for example if you want to learn a programming language you can just write code on the website and execute it on your computer. The patches were already steps into the right direction and with web applications like Google Docs or Microsoft Office Home the browser is going towards that vision. These make it possible to create, send and receive content like documents or tables while other people can access them simultaneously.

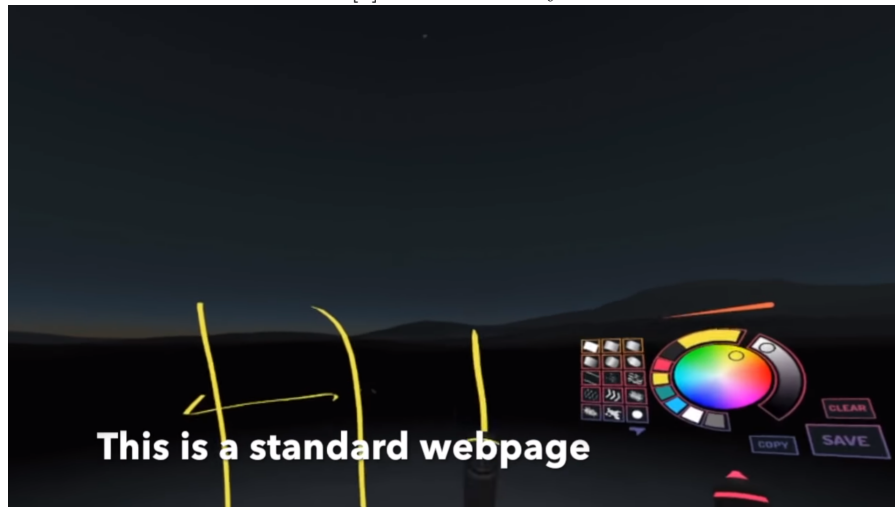
An good example for a website supporting Alan Kay's vision is lively-web.org. Everything that is displayed on the website is an object and can be changed, moved or overwritten and gives immediate feedback to the user. Every textfield is able to execute Javascript. You can create your own website or application and are able to edit and download it from everywhere.

4.2 New technologies

WebVR Browsers Virtual Reality Browsers are making it possible to access the Web with VR-Glasses. To navigate the voice or a virtual keyboard can be used. The Browsers makes it possible to watch 360 degrees videos or pictures. Developers are able to create WebVR Applications themselves and put them on the web just like a website. VR-Browsers like Firefox Reality or Supermedium Browser allow to display websites not like a 2D Sheet but rather like a 3D environment without having to download content. These environments can also be experiences, see second picture, games or creative activities like 3D painting.



[4] Firefox Reality



[5] Supermedium Browser

AR Browsers

4.3 Quantentechnik?

4.4 Future based on past guess

Little changed so far faster, performance, Ux (Opera Neon), Vr-*i* Being in a store?
Getting closer to mini-operating system, Sicherheit

4.5 Devices

5 Evaluation

6 Summery/Conclusion

7 Sources

- [1]https://upload.wikimedia.org/wikipedia/commons/thumb/7/74/Timeline_of_web_browsers.svg/3560px-Timeline_of_web_browsers.svg.png
- [2]<http://gs.statcounter.com/browser-market-share#monthly-200901-201905>
- [3]<https://security.stackexchange.com/questions/19681/where-does-ssl-encryption-take-place>
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- [5]https://www.supermedium.com/#gallery_1-1