



Comparative Analysis of Web Browsers for Accelerated Decision Making by Researchers.

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ABSTRACT

As researchers deploy the use of web browsers to gain information about research variables of interest, it becomes imperative for them to make accelerated decision about choice of web browsers to be employed. This research work comparatively evaluate the performance of seven web browsers, namely: Internet Explorer, Mozilla Firefox, Opera, Google Chrome, Edge, Brave and Safari. The comparison is based on upload time, download time, CPU and RAM utilization, rendering table, security and the operating system platform. The result of the study shows that Microsoft edge has the highest CPU and RAM utilization capability. All the tested browsers besides Safari rendered table almost in a similar fashion. Mozilla fire fox, Microsoft edge and brave rank highest in terms of security based on the embedded security features in the web browsers.

Key Words: Web browsers, Security, CPU, RAM, Rendering table

I. INTRODUCTION

The World Wide Web (WWW) is one of the most accessible parts of the Internet. Its ease of use allows people to perform tasks quickly and easily [1]. But the creation of online shopping, banking, search engines, corporate websites and other personal services leads many users to pass information that should be kept private in an environment to which potentially everyone could have access. Web browsers make an effort to provide users with the best possible presentation as well as more options to enable better online services. In a similar vein, browsers also make an effort to alert users when programs are downloaded and attempt is made to run such programs on their computers. Nonetheless, different browsers produce different results based on a few helpful features [2].

Web standards indeed exist, however the behavior of different browsers varies (in fact, the platform might affect the behavior of the same browser). While many browsers, including Internet Explorer, have never fully supported W3C-compliant APIs, many others support pre-W3C APIs as well.

Netscape Navigator, Mozilla Firefox, Internet Explorer, Opera, Lynx, Enigma, Google Chrome, and so forth are a few examples of web browsers. There are fundamental approaches to make a Web application expandable for browser compatibility so that further browser support can be added later.

Possible browser differences must be taken into account while designing web applications, thus the developer should be aware of them. By adhering to certain rules, web applications may be made compatible with different platforms and browsers. These days, web browsers are a need in our everyday life. They are used by a lot of individuals for email access, research, shopping, and other tasks like streaming and downloading. Because web browsers are used for so many different purposes, they come with built-in features that help them do their numerous jobs and shield users from malicious content on the internet.

Because different browsers respond and show information in different ways, cross-browser compatibility should be taken into account when designing a website. There are millions of web pages with a wide range of content kinds on the World Wide Web. Many people are discouraged from having access to and enjoying faster access to the large amount of free information available on the internet due to a lack of awareness about available web browsers and their characteristics [3]. On the internet, there are a lot of commercial activities in addition to free resources that can be used for research and knowledge acquisition. Internet access and awareness are currently available in most part of the world. Though bandwidth is restricted, Surfers should be aware of the browser options they have and select them based on their most important criteria. For developers, the availability of a tool that performs the comparison helps to speed up the development time, assists them to become aware of the short comings, features and capabilities of each of the web browsers. This reduces the time it takes to track down bugs in the web applications hence improves development time and application performance. This Research study of web browsers becomes imperative to help serve as an educational and decision making tool for users [4]. This Research study exploits on and explains the web browser characteristics of seven web browsers from the various available web browsers.

The authors of [5] carried out a survey on comparative analysis of web browsers. They found that depending on the field, each browser had advantages and disadvantages. Chrome provided the highest level of support for CSS3, HTML, and other web technologies. On the other hand, while using multiple tabs, Fire Fox proved to be an effective browser. However, the study was restricted to four distinct browsers.

In another related work, the authors of [6] carried out a comparative study of top-ranked web browsers. The operating systems that the web browsers supported was one of the study's main concerns. The study's findings showed that Opera, Mozilla Fire Fox, and Google Chrome were compatible with Windows, Linux, Android, iOS, and OS X. Safari was limited to operating on OS X, while Internet Explorer was limited to Windows. Additionally, this research was restricted to five web browsers.

In order to construct an intelligent choice analysis tool that would educate people about browser technology and provide them the ability to choose online browsers based on their various purposes. The authors of [7] investigated four different internet browsers. A specially created portal was used in the study as an intelligent instrument for examining various web browsers. Based on the examination of the four internet browsers tested, the researchers concluded that Internet Explorer was the most suitable for their research due to its fast download speed and security features. On the other hand, graphic programmers would prefer Mozilla Firefox due to its superior page layout performance.

This research work covers seven browsers and the reviewed performance criteria in each of the reviewed earlier work by other researchers in the field will be applied to each of the web browser to be studied.

II. STATEMENT OF THE PROBLEM

Researchers all over the world make use of one type of web browser or the other during research work. Different web browsers have different performance capabilities. This research work when completed would reveal to researchers the performance capabilities of different browsers to enable them take quick decision when choosing a browser for their use. This will enormously save time, energy and resources during research. The research would provide information on how long it takes for a particular web browser to upload, download a file and also give the amount of memory used each browser subjected to the same condition. Information on how a browser display a web page and how they render a table when multiple tabs are opened would also be provided. Information regarding the type of operating system supported by each browser and performance of the browsers in terms of security will also be presented.

III. OBJECTIVES OF THE STUDY

Web browsers play essential roles in different fields, including medical science, computational technologies, business, education and research. Therefore, it is very important to know which browser offers required facilities for a particular field. The sole aim of this work is therefore to develop a research work that will be used by researchers all over the world in choosing a web browser suitable for their specific purpose. The research work will therefore meet the following specified objectives:

- To enable quick decision that will enhance speed of browsing to be taken.
- To save time, energy, and resources while searching for research variables.
- To obtain an optimum solution while carrying out research.
- To reduce cost of doing research

IV. METHODOLOGY

The research work was carried out in two stages.

1. Extensive review of related work in the field using reputable journals, reaching conclusion based on high level of consistent results previously obtained by other researchers. Both primary and secondary data was used to achieve this goal. A typical result obtained under this stage is shown in table 1.

2. Experiment is carried out using three different computers with the same specifications with a uniform internet network. Each task for a particular web browser will be carried out at the same time, the results obtained would be recorded and mean value computed to ensure high level of accuracy. Similar procedure would be replicated for another task until the tasks are completed and the seven browsers under study.

- Download and upload time for same sized video files was measured simultaneously using different laptop computers with the same system capabilities using stop watches over a uniform internet network. Average time taken to upload and download the files using the various browsers under test was obtained for three different trials to increase the accuracy of the obtained result. The experiment for file upload was carried out using both a small sized (15Kb) and medium sized (38.5Mb) video files to determine how the relative size of the files to be uploaded affect the upload time of the browsers. The obtained results are presented in table 2 and 3.
- To obtain the CPU and RAM utilization capabilities of the tested browsers, three websites were accessed using three separate tabs of the tested browsers. The results of the computer resources utilized by the sites using the tested browser was displayed on window task manager and

verified using the embedded task manager inbuilt in some of the browsers. The result was screen captured, mathematically analyzed and presented in figure 1 and 2.

- To determine which of the tested browsers render the best table, a code to create a table was written in a note pad using HTML. The table was designed to include cell borders, cell spacing, cell padding, colspan, rowspan and in line CSS was used to specify different fonts and colors for specific cell. The codes were opened using the tested browsers.
- To rank the browsers based on their security level, the security features present in the browser security settings were employed. The presence of a security feature is marked with a “yes” response while its absence is marked with a “No”. A “yes” response attracts a score of “1” while a “No” response attract a score of “0”. These scores are aggregated to obtain a final score for each of the browsers as indicated in table 4.

V. RESULT

Table 1: Web browser Supporting Operating System

S/N	Operating System	Web browsers supporting operating system
1	Windows	Google chrome, Mozilla fire fox, Microsoft edge, opera mini and brave
2	Mac Os	Safari, Google chrome, Mozilla fire fox, opera mini and brave
3	Linus	Mozilla Fire fox, , Google chrome, Mozilla ,opera mini and brave

Table 2: Showing the Upload time of small and medium sized video files using different browsers

S/N	File Size	Browser Type	Upload time (Sec)
1	Small sized	Google Chrome	17.33
2		Microsoft Edge	18.67
3		Opera Internet	21.66
4		Brave	23.33
5		Fire Fox	29.0
6	Medium sized	Brave	47.5
7		Microsoft Edge	62
8		Fire Fox	68.3
9		Google Chrome	70
10		Opera Internet	97

Table 3: Showing the Download time of a video files using different browsers

S/N	Browser Type	Download time (Sec)
1	Google Chrome	58.0
2	Microsoft Edge	59.0
	Brave	63.0
3	Fire Fox	78.0
5	Opera Internet	97.0

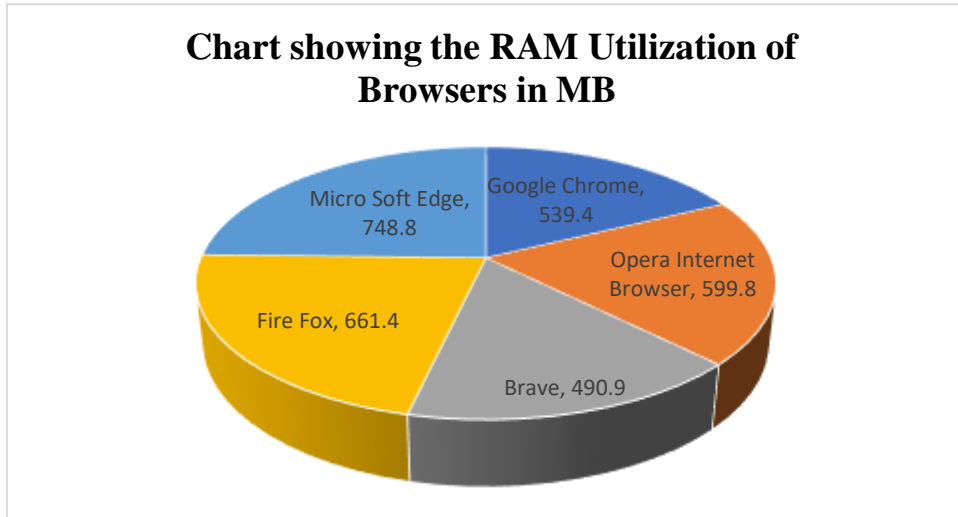


Figure 1: Showing RAM utilization of tested browsers

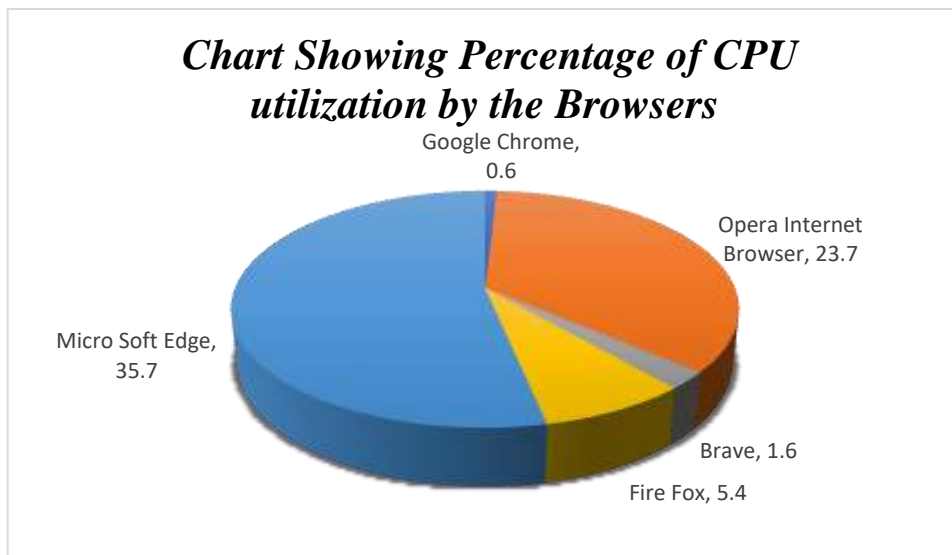


Figure 2: Showing CPU utilization of tested browsers

11/7/23, 11:10 PM Table Example

Header 1	Header 2	
Custom Font & Color	Different Font & Background Color	
Normal Cell	Cell with Colspan	
Cell with Rowspan	Normal Cell	Normal Cell

Figure 3: Table rendered in chrome web browser

Figure 4: Table rendered in opera internet browser

Figure 5: Table rendered in brave browser

Table 4: Ranking of browsers security level

Security Feature	Google Chrome	Mozilla Firefox	Microsoft Edge	Brave	Apple Safari	Opera
Built-in Phishing and Malware Protection	Yes	Yes	Yes	Yes	Yes	Yes
Sandboxing	Yes	Yes	Yes	Yes	Yes	Yes
Cross-Site Scripting (XSS) Protection	Yes	Yes	Yes	Yes	Yes	Yes
Same-Origin Policy Enforcement	Yes	Yes	Yes	Yes	Yes	Yes
HTTP Strict Transport Security (HSTS)	Yes	Yes	Yes	Yes	Yes	Yes
Content Security Policy (CSP)	Yes	Yes	Yes	Yes	Yes	Yes
Encrypted DNS Support (DNS over HTTPS)	Yes	Yes	Yes	Yes	Yes	Yes
Privacy Settings (Tracking Protection)	Yes	Yes	Yes	Yes	Yes	Yes
Extension Review and Security	Yes	Yes	Yes	Yes	Yes	Yes
Automatic Updates	Yes	Yes	Yes	Yes	Yes	Yes
In-Browser Password Manager	Yes	Yes	Yes	Yes	Yes	Yes
Pop-up Blocker	Yes	Yes	Yes	Yes	Yes	Yes
WebRTC IP Leak Protection	Yes	Yes	Yes	Yes	Yes	Yes
Secure Download Verification	Yes	Yes	Yes	Yes	Yes	Yes
Do Not Track (DNT)	No	Yes	Yes	Yes	No	No
Site Isolation	Yes	Yes	Yes	Yes	No	No
Score	15	16	16	16	14	14

VI. DISCUSSION

- When a relatively small size video file was uploaded using various browsers, the goggle chrome browser performed better with an upload time of 17.33 sec and the firefox browser performed least with an upload time of 29.0 sec. However, with the size of the file relatively increased, Google chrome came 4th in the list. Although the upload time of a file in a browser increases with size, and depend on the type of browsers used, there is a strong indication that the upload time is also dependent on whether the size of the file is small, medium or big.

- In table 3, google chrome downloaded a video file returning an average download time of 58 sec as compared to 59, 63, 78 and 97 sec returned by Microsoft edge, Brave, Firefox and opera internet browsers respectively. A researcher who intends to download a video file for his/her research work may consider making a choice of browser in the order presented in table 3.
- The amount of CPU and RAM resources utilized by a web browser determine the speed with which the computer would run. This ultimately determine the level of satisfaction experienced during a browsing session. Figure 1 and 2 shows that brave web browser has the best CPU and RAM utilization of 1.6% and 490.9MB respectively and Microsoft edge has the maximum CPU and RAM utilization of 35.7% and 748.8MB. This implies that Microsoft edge which utilizes greater CPU and RAM resources of the computer is expected to give the slowest browsing experience when the browsers are subjected to the same condition.
- Results of figure 3, 4 and 5 show that the browsers render the table in the same way as there is no elaborate distinctions in the rendered tables in terms of clarity, alignment and visual consistency. Samples of the rendered table are shown in figure 3, 4 and 5.
- From table 4, Mozilla firefox, Microsoft edge and Brave with a score of 16 are the most secure browsers. This is closely followed by Google chrome with a score of 15. Safari and Opera with a score of 14 are also relatively secure. It is crucial to remember that since browser security is always changing, categorizing browsers according to their security features is a difficult undertaking. Therefore, it is not safe to assume that a web browser's security is only dependent on its security features being enabled. While security features are a crucial component of a browser's security, a web browser's overall security is influenced by a number of other aspects. Frequent updates are essential for fixing security flaws and maintaining the browser's security. Users that engage in dangerous activity, such as downloading files from unknown sources, clicking on dubious links, or falling for social engineering scams, may compromise even the most secure browser. Security issues may be introduced by browser extensions. It is crucial to carefully check the permissions of extensions and to install them only from reliable sources. It is crucial to employ secure, reliable networks because a secure browser will not shield users from network-based threats. Another factor influencing browser security is the underlying operating system. Operating system vulnerabilities can impact browser security, which is why it is critical to have an updated operating system.

VII. CONCLUSION

This research work has successfully evaluated the performance of seven browsers based on the desired criteria. The result of the study indicated that Google chrome has the best download time and opera internet the highest. As expected, file upload time increased with size of the file for each of the tested browsers and was also shown to depend on whether the file is small, medium or big for a particular browser. Result from the study revealed that Microsoft edge has the highest CPU and RAM utilization capability which might impact negatively on the browsing sessions of users. All the tested browsers besides Safari (a non-window compliant operating system) rendered table generated using HTML codes almost in a similar fashion. All the tested web browsers are relatively secure based on the scores earn from the analysis of the embedded security features in the web browsers. However, Microsoft edge and brave rank highest in terms of security based on this approach.

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