Comparative study of modern Web browsers based on their performance and evolution

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Abstract— **Internet is the most revolutionary invention of 20th century. It has contracted the world and made the lives of the people lucid and simple. Web browsers act as medium to access internet features and help us browse different websites for our daily purpose making most difficult tasks easier. In this paper, we will talk about advancement in field of web browser. Since it plays major role in field of internet, we will catch the significance and utility of popular browsers like Google Chrome, Internet Explorer, Mozilla Firefox, Opera, etc. performance evaluation will be done based on their performance in different user's environment. We have seen lot of variations in the versions of these web browsers from past decade and we will also focus on the variation and evolution of browsers with the alteration.**

Keywords — **Browsers, CPU Utilization, Disk Usage, Users Response Time.**

I. INTRODUCTION

Technological advancement has led to an enormous growth in the usage of internet all around the globe. Internet has now become a trend and World Wide Web acts as the medium for the users to explore the limitless services available on the web. WWW is often mistaken with internet. Web is a service that runs on the internet while internet is a global scenario of different interconnected networks. Starting viewing the web page is one simple process that involves entering the URL in the browser address bar that uses Domain Name Service (DNS) to resolve the IP associated with the entered URL. All this is done through a web browser [2]. Web Browser is application software that sends request to the server and retrieves the data to display. It displays texts, multimedia and navigates through various web pages on the World Wide Web [9]. It helps the user to download useful data. It also caches the data and is then useful when opening the same web page again. Thus browsers form an integral part of web browsing [3][9].

The history of web browsers started with WorldWideWeb which was then renamed as Nexus which was the first graphical browser developed in 1991 by Tim Lee. In 1993 was launched Mosaic that laid down the foundation for GUI characteristics for the browsers that succeeded it [1]. Netscape was then founded in 1994 that gave the first commercial web browser; Netscape Navigator. The Silicon giant Microsoft came in the browser market raging the browser war with the release of Internet Explorer [7]. Later in 1996 Telenor, the largest Norwegian Telecommunication company offered Opera to the users capturing the mobile platform market. The year 1998 saw two milestones in the browsers' world, where Netscape on one side went open source releasing the source code of Communicator and then started a new project Mozilla. It aimed to develop the next generation of communicator [8]. During this time the usage of Netscape reduced drastically while IE was reaching the top. In 2002 Microsoft's Internet Explorer ended the browser war with Internet Explorer coming up as the winning horse when IE reached 95% share [2]. Following the trend Apple entered the browser market with Safari. It also introduced layout engine called WebKit that was then adopted in many mobile devices including Nokia and Google phones [8]. The year 2004 started the second browser war with the release of Firefox 1.0 comprising of 7.4% of browsers being used by the end of the year. IE 7 released in 2006 adopted many features from its open source competitor Firefox such as tabbed browsing, etc. [7]. The year 2008 saw a revolution with Google launching Chrome that further intensified the browser war. Chrome started well in the first year and by the end of five years it had more than 50% of the users' share [4].

II. ANALYSIS

Different browsers taken into consideration went through many tests. These different measures gave diversified result declaring the best browser in each of the section.

A. CPU Utilization

CPU utilization percentage is the per-cent of the CPU's cycle being spent on the given process. This CPU time can also be interpreted as the amount of time it spent waiting for I/O operation. This can be considered as one good measure to check the browsers' pressure on the CPU for the process execution.

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We have taken three most popular browsers for the comparison namely Google Chrome v30, Mozilla Firefox 18 and Internet Explorer 11 on a system having Intel i5 quad core processor running Windows 8.1.

All the three browsers are tested setting http://www.google.com as the home page and hence the CPU utilization to open the web browser along with the web page. During the testing, no other main processes were working and also the observations were taken after checking that the CPU is stable with 1-2% CPU Utilization for a considerable amount of time [5].

In the first case taking chrome, we realized that it initially takes a lot of CPU cycles and hence with a number of fluctuations gets stable after a good amount of time.
Here is the graph depicting the above scenario.

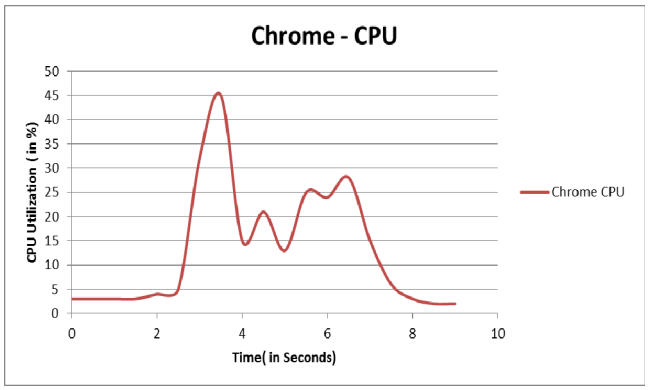


Fig. 1. CPU Utilization for Chrome

Second comes Firefox, that doesn't take many cycles initially but as the browser loads up, utlizes CPU for opening the required web page.
Here is the graph showing the utilization for Firefox.

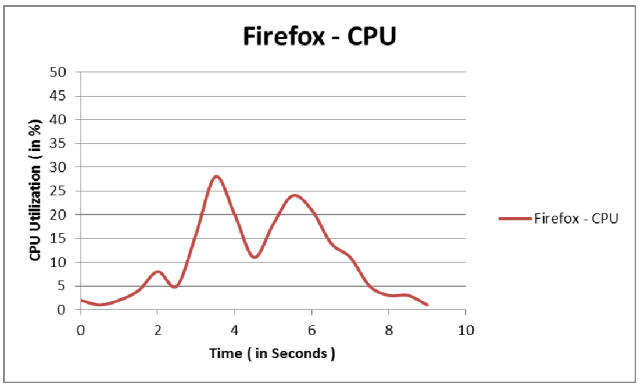


Fig. 2. CPU Utilization for Firefox

Third browser Internet Explorer initially utilizes some amount of CPU cycles but gets stable very soon with fast opening of the browser and the web page, and hence comes out to be more efficient taking an average amount of cycles in a single take and utilize it efficiently to accomplish the required tasks. Thr graph shows the CPU utlization for Internet Explorer

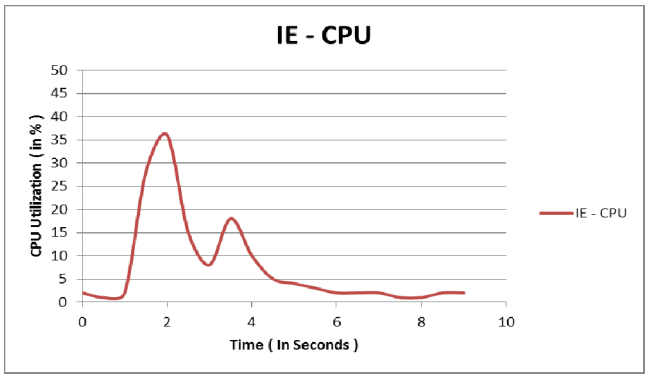


Fig. 3. CPU Utilization for Internet Explorer

Plotting all the three browsers on a single graph, we noticed that the peak of the chrome is highest as it takes maximum CPU cycles, while the firefox though utilize less CPU at a given point of time but the average CPU utilization is still more than IE and Chrome. Whereas Internet Explorer initially takes an average CPU cycles and then stablizes very soon. Thus if we consider the average CPU utilization, we find that IE is much more efficient as it completes all the tasks in less average CPU cycles and also loads faster.

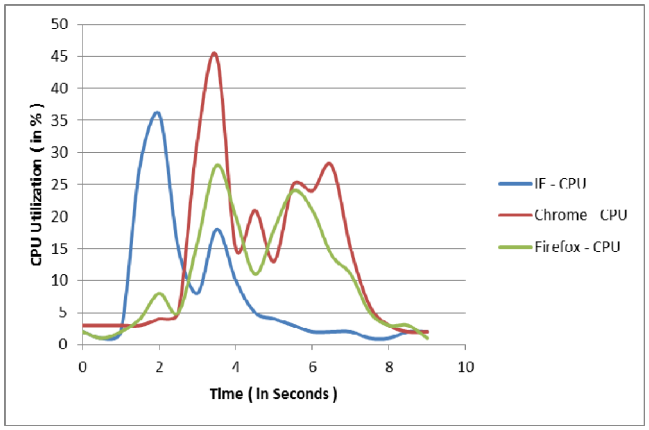


Fig. 4. CPU Utilization for all the three browsers

Result: Internet Explorer – Firefox – Chrome.

B. Disk Usage

The browser also uses disk space while starting up and hence utilizes the Hard disk for the time span.

The graph shows the disk usage for Chrome, where it is evident that it takes a lot of disk space for the initial startup.

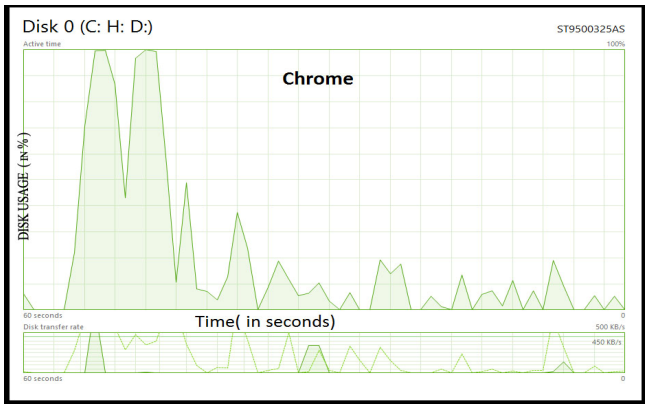


Fig. 5. Disk Usage for Chrome

Firefox however takes a lot less space as compared to chrome and also it doesn't mount all the pressure on the disk at a single moment and hence makes it easier for the system to allocate the disk space for the initial start-up.

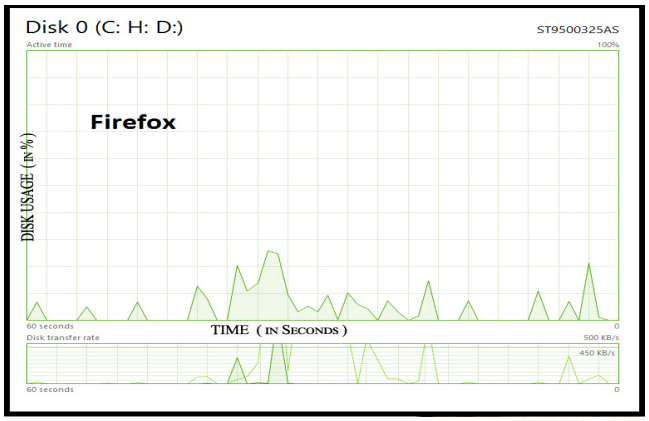


Fig. 6. Disk Usage for Firefox

The Internet Explorer in the third case uses a considerable amount of disk space but the utilization is divided in patches of small disk space request and allocations, hence doesn't put all pressure on the system but takes time for the disk utilization process to be over.

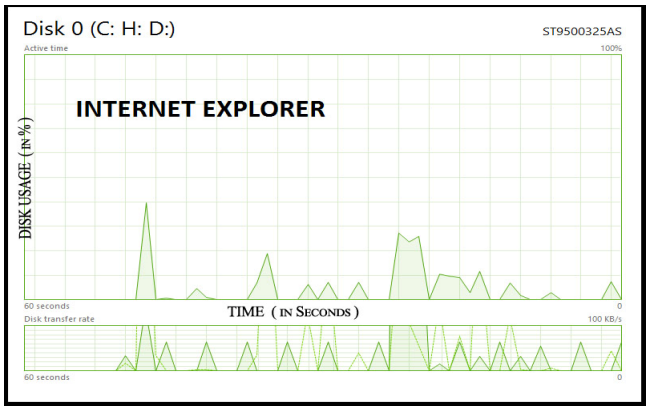


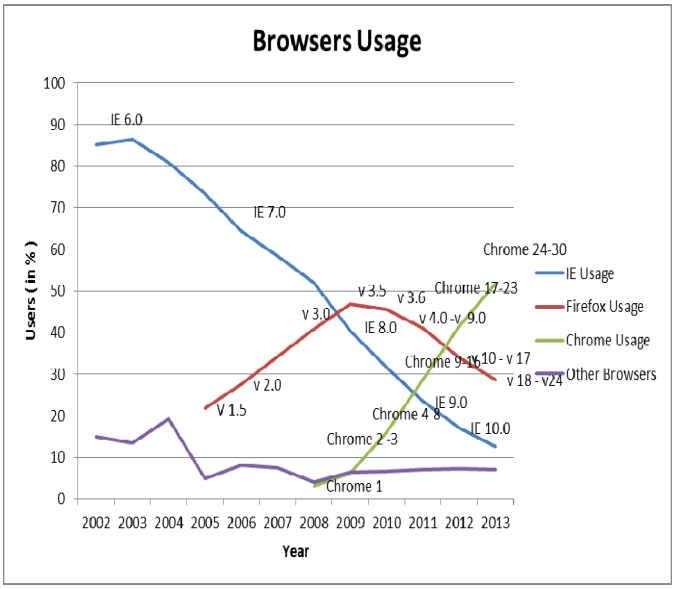
Fig. 5. Disk Usage for Internet Explorer

Plotting for all the three browsers on a single graph, it is evident that chrome and IE take up a lot of disk space while Firefox is memory efficient as proved through the above observations.

Result: Firefox – Internet Explorer – Chrome.

C. Browser Usage

From the data collected for the past eleven years, the evaluated graph is plotted describing the per cent usage of the different browsers. The graph on the other also points out the year of launch of various versions of the browsers.
The Internet Explorer saw a big decline in the per cent usage when compared to the launch in 2002 while Google Chrome has seen a rapid increase in the usage with more features in every version.
Firefox on the other hand had a good share of users when launched over taking Internet Explorer at that time. But as Chrome joined the league, there was a decline in the users for Firefox as well.



Result: Chrome – Firefox – Internet Explorer.

The above plotted graph describes the variations obtained about the usage of different modern web browsers by the users through consecutive years.

D. Multiple Tabs Performance

Normal usage of browsers gives a different performance but the real test of a browser is when it has to deal with multiple tabs. Hence we used a script provided by

www.geek.com that opens up 20 of the most popular websites in a browser instance automatically. One page is opened in a new tab automatically after every 1.5 seconds. The figure shows how it works.

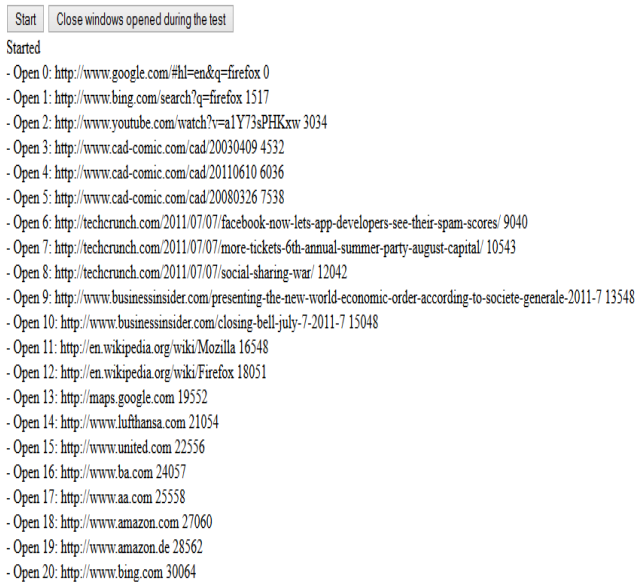


Fig. 5. Opening 20 different tabs on Firefox using the script.

Here are the results for the same.

TABLE I
RESULTS FOR MULTIPLE TABS PERFORMANCE

	Browsers		
	Chrome	Firefox	Internet Explorer
Time (in Seconds)	33.554	30.064	36.445

Hence, Firefox has shown better results because of the fact that chrome uses multi process model where a new process is started on a per tab basis while Firefox has a single process running that handles all the data.
Internet Explorer started struggle when it goes over 10 tabs.

Result: Firefox – Chrome – Internet Explorer.

E. HTML5 and CSS3 Support

HTML5 and CSS3 define the overall overview of the web browsers. They are responsible for the user UI experience as well as multiple level of support through the browser application. Browsers can be distinguished and classified based on the support provided by them to these web technologies. Web is advancing every moment and these modern browsers try to maximize the utilization of present features. Below is the analysis of support of HTML5 by multiple modern browsers.

According to html5test.com, Google chrome gets 503/555 points based on the features provided and supported by it compared to 447/555 of Mozilla Firefox and 377/555 of Internet Explorer browser. The analysis shows that Chrome scores maximum in form elements as it provides almost all the possible features. CSS selectors and other attributes have maximum support by the chrome browser compared to the other available browsers. Firefox on the other hand is famous for the microdata support as it creates the data dictionary. So considering this, browsers can be segregated as web applications are more or less dependent on the browser being used by the user. More updated browser provides better user experience of the web application.

Here is the tabulated result for the HTML5 support test.

TABLE II
ANALYSIS BASED ON HTML5 SUPPORT

	Browsers		
	Chrome	Firefox	Internet Explorer
Score (Out of 555)	503	447	377

Result: Chrome – Firefox – Internet Explorer.

F. JavaScript Engines

Google chrome has V8 as its open source JavaScript engine. V8 is written in quite popular language C++. It implements ECMAScript as specified in ECMA-262, 5th edition, and supported by Windows (XP or newer), Mac OS X (10.5 or newer), and Linux systems that employs x64, IA-32 or ARM processors. It can run standalone, or can be embedded. V8 is the fastest, because it compiles all JS to machine code.
On the other hand Firefox uses SpiderMonkey. It is fast too, but compiles to an intermediate byte-code, not machine code. That's the major difference with V8. EDIT- Newer Firefox releases come with a newer variant of SpiderMonkey; that is TraceMonkey. It does JIT compilation of critical parts, and other smart optimizations in certain cases [6]. Rhino compiles JavaScript into Java classes, thus allowing you to basically write "Java" applications in JavaScript. Rhino is also used as a way to interpret JS in the backend and perform changes into it, and have complete code understanding, like reflection. This is used for example by the YUI Compressor. The reason why Rhino is preferred over V8 in most of the places is

probably because V8 is relatively new, so a lot of projects have already been developed using Rhino/Spidermonkey as their JS engine, for example Yahoo widgets. (I assume that's what you're referring to with "scripts on their desktops").

III. MAJOR ISSUES WITH THE BROWSERS

Though there have been a lot of technical improvements in all the browsers with time but still there are some factors that are still lacking in these browsers. The different vendors are constantly working to make their browser the most preferred one and hence these problems need to be eradicated as early as possible. Internet Explorer in its 11th version also has issues with HTML5 and CSS3 support, a lot of the websites open on this browser without a lot of transitions and HTML properties. New HTML5 properties like the slider, placeholder and different input types like time, etc. Microsoft has still not added the synchronization feature to synchronize the tabs and bookmarks in phone and windows browser, which adds to the disliking of IE among the users.

Chrome on the other hand faces some issues in synchronization and a lot many times the chrome crashes when many tabs are opened. Hence it is evident that chrome can't take up lot of load while working and hence it is preferred while dealing with a limited number of processes or tabs in the browser. Though it has a lot of app support and with the new Chrome the applications have come in use but since these apps is developed by the service providers not Google itself, hence some apps have issues running smooth and crashes.

Talking about IE, we came across lot of issues. Still we have seen a lot of modifications and alterations in current version of IE 11. Placeholder property of html5 does not work properly and similar case with some CSS3 properties. It still does not provide sync options in the browsers. Firefox has its issues regarding flash usage and custom usage in the web browsers by the users.

IV. CONCLUSION

Through the analysis we have done, we tried to compare the modern browsers in terms of speed, response time, ping response time, compatibility with modern web technologies as well as usage. We found that web is advancing every day and browsers need to be updated to remain intact in the users system. Each browser showed their merits and demerits in certain field and we can only show comparative study of each of them. Chrome offered maximum support to HTML5 and CSS3 and other web technologies but on other hand, Firefox emerged as efficient browser in case of multi-tab usage.

So basically it depends on the type of users and type of usage of browsers. As we found that for developers of web application, Firefox is quite efficient. Chrome has its own pros and cons and they are shown through the analysis of its response time and issues. Similarly we can state the corresponding usage of Internet Explorer in case of CPU utilization when user is more concerned about the usage of its available resources present in the system.

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