

Review on Web Performance

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Abstract: Web performance is a part of network services and application. In this study, researchers present an overview of web performance. Researchers focus on ways to increase website performance. Researchers mainly discuss the role of web performance, problems, effect and action to be taken to increase the performance. Hypertext Transfer Protocol (HTTP), Hypertext Markup Language (HTML), Cascading Style Sheet (CSS), JavaScript (JS), size of image and caching are among mentioned and used as the reference of the increase in web performance. Researchers, also discuss about web performance analyzer tool and software.

Key words: HTTP, HTML, CSS, JavaScript, cache, web, web performance

INTRODUCTION

Web Performance Optimization (WPO) or website optimization is the field of knowledge about increasing the speed for web pages that are downloaded and displayed on the user's web browser. According to Souders (2008), there are 14 performance rules that need to be followed in order to increase the web pages speed (Souders, 2008). It is important for these web pages to download faster, since all website with faster download speed is shown to increase visitor loyalty and satisfaction, mostly for users with slow Internet connections and on mobile devices. Web performance, also lead to less data travelling across web which help to reduce website power consumption and environment impact (Killelea, 2002; Consulting, 2009).

In this study, researchers present a survey on the role of web performance. Researchers outline about basic things related to web performance and provide explanation about them, aided with figures and coding.

WEB PERFORMANCE HISTORY

About the first decade of the web's existence, web performance improvement was focused mainly on optimizing website code and pushing hardware limitations. The early techniques used, such as using

simple servlets or Computer-Generated Imagery (CGI), increase server memory and finding for packet loss and retransmission as mentioned by Killelea (2002). Although, these principles now comprise much of the optimized foundation of internet applications, they are different from current optimization theory in that there was much less of an attempt to improve the browser display speed.

The term of WPO were given by Souders (2008). Sounders made several predictions regarding the impact that WPO as an emerging industry would bring to the web, such as website being fast by default, consolidation, web standards for performance, the optimization environmental impacts and speed as differentiator.

One of the main points made by Souders is that at least 80% of the time that it takes to download and view website is controlled by the front-end structure. This lag time can be decreased through awareness of typical browser behavior, as well as of how Hypertext Transfer Protocol (HTTP) works (Souders, 2008).

Problem with web performance: Many performance issues existed and three prominent problems are the sheer size of web pages, how the pages are built and how it is consumed by different browser types. There also a problem with users page-load expectations which outpacing most websites ability to deliver (Heydari *et al.*, 2011).

The first problem is that web pages are bigger and more complex. Figure 1 shows the growth in average page size over 2 years in which from November, 2010-2012. The average page came in at 1042 Kilo Bytes (KB), just over 1 Mega Byte (MB) (Van Duyne *et al.*, 2003).

The second problem is not all browsers works the same way. It would be much helpful if the browser gets updated by the web user but not everyone like to keep on updating. Some of these users choose not to concern and waited for the browser to face with trouble before fixing it. Another problem is when the user treated every browser as the same. Each browser are different and if the user begin to treat each browser as no different from the other, it made the servers start to stuff inefficient pages across variety of browsers which is equivalent of forcing square pegs into round holes.

The final problem that contributes to lag in web performance is upon the user itself. Users do not aware about the laying problems, such as the first and second problems. They only expect the dynamic, feature-rich and content-rich pages to load in 3 sec or less. They want the web page to load as quickly as it could; without considering the main problems. Ignorance from the user is a big mistake that could affect the whole performance of the web (Juwaini *et al.*, 2012). However, the user alone is not to be blame. The website developers have to find efficient ways to solve the problem with the web performance. The good news about this ordeal is there are some ways that can be considered to increase the performance of the web, thus satisfying the user (Mueen *et al.*, 2013).

The effect of web performance: Web performance has a great impact for the user and developer. Web performance matters to customers. From the research on 1500 consumers, it was confirm that >75% of online consumers left for competitor's site instead of waiting for delays. About 88% of online consumers are less likely to return to the site after experiencing the bad experience. Half of them expressed an overall less positive perception of the company after a single bad experience and >3rd told others about it.

This study clearly shown that poor availability and page load times have an immediate and negative impact on customer. It reveals that the visitor lack of loyalty that they willing to change to another site if their current web page takes a longer time to load. This is certainly not worthy for the developer and could cause a huge amount of loss in business. In Fig. 2, it is shown the change in page response time versus percentage of increase in page abandonment. The highest percentage of abandonment is 38% when the response time took 2-10 sec to change (Liu *et al.*, 2003).

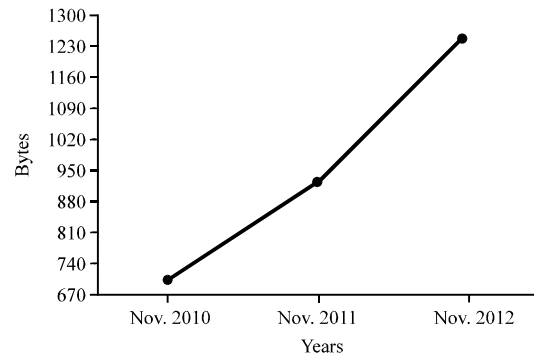


Fig. 1: Average bytes per web page

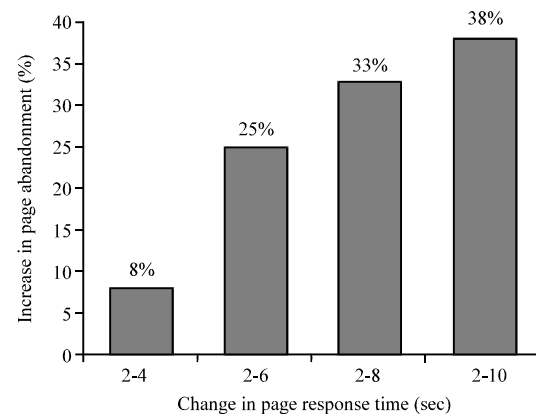


Fig. 2: Change in page response time versus percentage increase in page abandonment

WAYS OF INCREASING WEB PERFORMANCE

Based from Yahoo!'s exceptional performance team, they have identified 34 rules that can affect the web page performance but among that play a prominent roles are HTTP, HTML, CSS, JavaScript, images and several others that will later be explain on each of the subsection.

HTTP in increasing web performance: There are a few ways to help increasing the web performance. One of it is by minimizing HTTP requests. In other word, this will minimize the number of round trip times that the browser needs to make to the server. Every file in the website includes (such as CSS, JavaScript or images) need to be downloaded to the browser. By minimizing these requests, the page significantly speeds up the increase. It is more beneficial to include all the CSS in one style sheet for the site than separates it to different parts. The same apply for JavaScript or other resources (Souders, 2009; Wu and Wang, 2010).

Minifying HTML, CSS and JavaScript: In order to make it more understandable, some people format the code

written in a way that is easier and simplified to read. Although, the code may be easier to read, it includes a lot of unnecessary characters. However, if this was a large scale site with thousands upon thousands of lines of code, then it would make an impact on the web performance. These unnecessary characters include white space, comment and new line characters. It can be removed without affecting the code's performance. The benefit for this removal is that the file size of the code can be reduced which lessens the data needs to be downloaded to the browser. Other than that Uniform Resource Locator (URL), data can also be used to reduce the number of HTTP request made by the images.

Optimizing the image: One of the important things that most browsers need to download are images. This causes the site to be slow. A way to avoid this is by using CSS to generate graphics instead of images. This is great for items, such as buttons but in some cases CSS may not be capable of recreating the design such as a case in photograph or a detailed decorative element.

In this case, there are needs in properly formatting and compressing images. This is so that the data can be downloaded and result in attractive images for the web.

Optimizing the use of CSS Sprites in the website: CSS Sprites is a process of putting multiple background images into one composite image and displayed using CSS background position. This technique is used in order to decrease the time load taken for a page, thus reducing the server request and the saving the bandwidth. CSS sprites were used by Yahoo! to reduce the number of HTTP request for tiny icons on Yahoo!'s homepage. It can help to minimize the use of data on the web by reducing HTTP request and increasing the speed of web performance. It is quite difficult to create CSS Sprites but there are online tools, such as Sprite Pad that can help create the sprites by drag and drop the images and have them available, as one Portable Network Graphic (PNG) Sprite+CSS code immediately. Figure 3 shows examples of CSS Sprites in two known websites, Facebook and Yahoo!

Compressing images: Not all photographs on the designed site are convenient or practical to serve as CSS sprites. Thus, it is important to know how to compress the images. Many bytes of data are able to be saved by properly formatting and compressing images.

Tools, such as Photoshop or Firework, the resultant contain extra data including color data that may even be unused in the image. The data that needs to be downloaded can be saved by compressing the images without losing its look or visual quality (Souders, 2009).



Fig. 3: CSS Sprites used in Facebook and Yahoo! Websites

Caching: Both web browsers and web servers allow for caching. These caches store previous request on the browser or server request, such as images, web pages, CSS/JS files and other data such as cookies. By storing these responses bandwidth use is reduced and help improve a web performance.

SOFTWARE TO IMPROVE AND ANALYZE WEB PERFORMANCE

Aside on trying to improve the web performance on your own, researchers can also analyze it by using special software. Among software that can be used to analyze the web performance are these 4; Yottaa Site Optimizer, YSlow, Google Page Speed and Web Page Test (Stefanov, 2012).

Yottaa site optimizer: As an easy-to-use cloud service, Yottaa provides a service that brings speed, scale and security to any website. It accelerates the site for faster page loads, better user experience and prevents the site from failing under heavy load or attacks. It scales the web infrastructure to be a global cloud network with over 20 locations.

YSlow: YSlow, a tool developed by Yahoo!'s exceptional performance team functions to analyze web pages and suggest ways to improve their performance based on a set of rules for high performance web pages. It functions through the Firebug plugin on Firefox. However over the past year, Marcel Duran had also built extension for YSlow Chrome, Opera and Safari as well. Yslow functions to grade web page based on one of three predefined rule set, offering suggestions for improving the pages performance, summarizes the pages components and display statistic about the page.

Grade **D** Overall performance score 65 Ruleset applied: YSlow(V2) URL: http://www.seoconsult.com/

ALL (23) FILTER BY: CONTENT (6) | COOKIE (2) | CSS (6) | IMAGES (2) | JAVASCRIPT (4) | SERVER (6)

F	Make fewer HTTP requests	1	Grade F on Make fewer HTTP requests [Suggestion] This page has 34 external Javascript scripts. Try combining them into one. This page has 8 external stylesheets. Try combining them into one. This page has 56 external background images. Try combining them with CSS sp
F	Use a Content Delivery Network (CDN)	2	
A	Avoid empty src or href	3	
F	Add Expires headers	4	
F	Compress components with gzip	5	Copyright © 2012 Yahoo! Inc. All rights reserved.
B	Put CSS at top	6	
F	Put JavaScript at bottom	7	
B	Avoid CSS expressions	8	
n/a	Make JavaScript and CSS external	9	
F	Reduce DNS lookups	10	
D	Minify JavaScript and CSS	11	
A	Avoid URL redirects	12	
A	Remove duplicate JavaScript and CSS	13	
F	Configure entity tags (ETags)	14	
A	Make AJAX cacheable	15	
A	Use GET for AJAX requests	16	
A	Reduce the number of DOM elements	17	
A	Avoid HTTP 404 (Not Found) error	18	
A	Reduce cookie size	19	
A	Use cookie-free domains	20	
A	Avoid AlphaImageLoader filter	21	
A	Do not scale images in HTML	22	
A	Make favicon small and cacheable	23	

Fig. 4: Result analyzed using YSlow tool

Overview

High priority (4)

- Optimise images
- Leverage browser caching
- Enable compression
- Combine images into CSS s

Medium priority (3)

- Minify JavaScript
- Defer parsing of JavaScript
- Avoid bad requests

Low priority (9)

- Serve resources from a con
- In-line Small CSS
- Specify a cache validator
- Minify CSS
- Minify HTML
- Put CSS in the document h
- Specify a character set
- Remove query strings from
- Specify a Vary: Accept-Enco

Experimental rules (3)

Already done! (10)

Overview

The page SEO, Search Engine Optimization, Webs... got an overall Page Speed Score of **62** (out of 100). [Learn more](#)

This Page Speed report is generated for this page as it appears in desktop browsers. To get suggestions on how to optimize the performance of this page for mobile devices, generate a [mobile report](#).

Suggestion Summary

Click on the rule names to see suggestions for improvement.

- High priority.** These suggestions represent the largest potential performance wins for the least development effort. You should address these items first:
Optimise images, Leverage browser caching, Enable compression, Combine images into CSS sprites
- Medium priority.** These suggestions may represent smaller wins or much more work to implement. You should address these items next:
Minify JavaScript, Defer parsing of JavaScript, Avoid bad requests
- Low priority.** These suggestions represent the smallest wins. You should only be concerned with these items after you've handled the higher-priority ones:
Serve resources from a consistent URL, In-line Small CSS, Specify a cache validator, Minify CSS, Minify HTML, Put CSS in the document head, Specify a character set, Remove query strings from static resources, Specify a Vary: Accept-Encoding header
- Experimental rules.** These suggestions are experimental, but do not affect the overall Page Speed score. Consider these items as points to an area to explore, but your mileage might vary:
Reduce request serialisation, Avoid a character set in the meta tag, Eliminate unnecessary refloads
- Already done!** There are no suggestions for these rules, since this page already follows these best practices. Good job!

Fig. 5: Result analyzed using Google Page Speed online

Yahoo! Exceptional performance team determines 34 different factors that affect web page performance and the YSlow tool analyses 23 of those factors. These include minimizing HTTP request, Gzipping components, minifying CSS and JavaScript, using Content Delivery Networks and others. Figure 4 shows the YSlow tool when run using Firebug. It shows the overall performance score of the site and all 23 list of factors that are analyze by using YSlow tool on user left side. When the user click on one of these factors, the grade will be shown and suggestion is displayed on user right side, as well as linking to the several tools that can be used to improve the performance.

Google page speed online: Google page speed online is a Google webpage performance tool which designed to help optimizing performance of website. It helps identify performance best practices that can be applied to the site and optimization tools to help automate the process. It has a clean, user-friendly interface that is easy to understand.

In Fig. 5, it is shown that google page speed online tools provided results that came in 5 categories; depending on how strong their influence is on page load time. The 1st category is high priority which have the biggest impact on the performance. Medium priorities have the moderate impact on page load time. Low priority

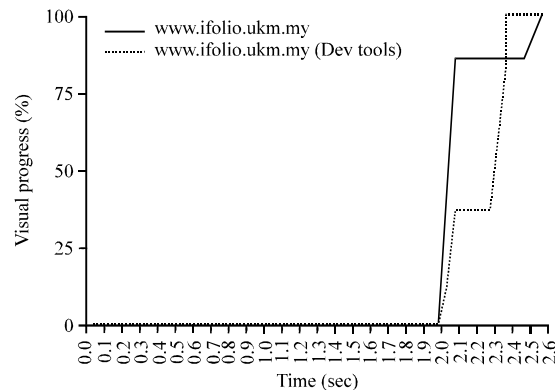


Fig. 6. Result analyzed using Web Page Test for page load

changes are recommended but probably will not have a significant impact. Experimental rules and already done! means that there are no suggestion for the rules given as the page already follows these best practices (Stefanov, 2012).

Web page test: Web page test is a free tool that provides a range of basic and advanced analysis features that give the user a level of control how the website actually tested. The advance features includes the customization of the test to account for various real consumer connection speeds, able to change the browser according to target place in website, ignoring Secure Sockets Layer (SSL) which a protocol used over the internet for securing transactions made between clients to server and stop the test from running after a particular item, component or document have been loaded. Figure 6 shows the test result for the website; www.ifolio.ukm.my by using web page test analyzer. In this result, it is shown that the total time taken for iFolio website page to load is 2.6 sec.

CONCLUSION

Web performance is important as it could cause problems for both user and the developer if it is not handling wisely. Most customers that use the web prefer faster web page loads. The failure in faster web page loads will be a costly effect to the developer. There are a lot of ways that can be used in order to increase the web performance but most important are the ones that is related to HTTP, HTML, CSS, JavaScript, cache and images. Each and one of these plays an important role and the failure in noticing it shall affected the overall web performance. Besides that, there also an easier way to analyze the web performance which is by using web performance analyzer software and tool. There are 4 web performance analyzer tools mentioned in this study and

they are Yottaa Site Optimizer, YSlow, Google Page Speed online and Web Page test. These tools provides the user with more detailed reports on certain website or page and by using it, user can learn the about the overall webpage performance instead of using tedious methods such changing codes or resizing the image. The best advantage of using web performance analyzer tool is that some of the tool, also provided great suggestions that are considered helpful in increasing the web performance.

RECOMMENDATIONS

In the future, researchers will investigate the differences between these website analyzers to find which one is the best analyzer. Besides that, researchers would also conduct a poll on the internet to figure out how many people cares about increasing web performance in their daily life.

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