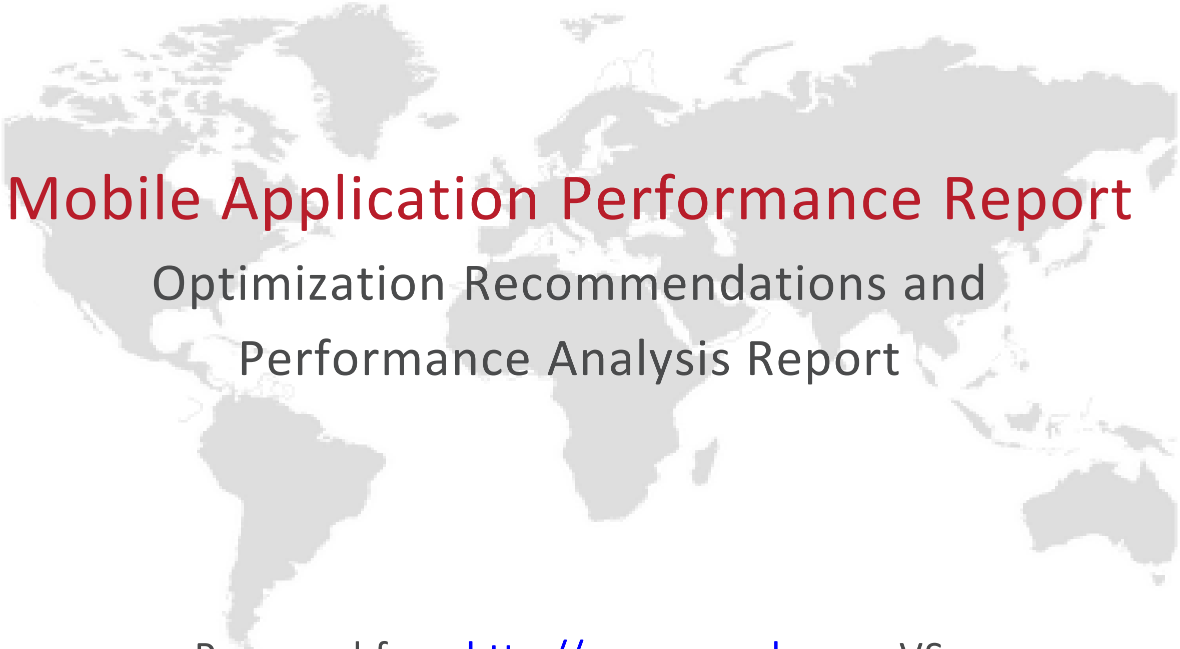

Mobile Application Performance Report

Optimization Recommendations and Performance Analysis Report

Prepared for - http://www.google.com VS http://www.yahoo.com

Emulated Device Type: iPad

OVERALL PERFORMANCE SCORE: **A** 92/100 points

Thursday, May 05, 2011

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Overview

With the rise in mobile application development and deployments – a recent Shunra survey showed 93% of responding companies had current or planned mobile initiatives – organizations are increasingly exploring and implementing best practices to manage the complexity of mobile environments and proactively predict and fine tune performance levels.

Mobile service level agreements (SLAs) are becoming more commonplace as end users become more geographically distributed and reliant on anywhere-anytime access to applications and information. In fact, Morgan Stanley's State of the Internet Report expects mobile Internet access to surpass PC-based Internet access by 2014[1]. And, by 2015, over half of all mobile subscribers are expected to be engaged in m-payments[2], over 1 billion subscribers will access financial services from mobile devices[3], and the mobile commerce market will exceed $119 billion[4].

The numbers are staggering and point to a mobile tipping point that is upon us. Shunra recognizes the challenges presented by mobile environments and is pleased to provide a free solution for testing your webpages and gaining insight into how those pages are experienced by your end users. In the following pages, you will find key performance indicators for your end user's experience, including webpage load times, a component download analysis, insight into additional performance metrics and specific optimization suggestions based, in part, on industry accepted best practices.

Webpage Load Times

To establish webpage load times, performance tests were executed on a test server in the Amazon EC2 Cloud Computing Environment – Eastern US availability zone. A baseline was gathered approximating the performance a mobile user might encounter while using a WiFi connection to access your test page(s). For simplicity sake, a Firefox browser was used for all tests. While page rendering and other performance variations are expected from mobile devices, , the point of this report is to highlight general issues with webpages, and the substantial vulnerability to network performance that often dwarfs local mobile device performance limitations such as CPU speed. Network emulation technology was applied to

[1] "Internet Trends" by Mary Meeker, Morgan Stanley (April 12, 2010).

[2] "Mobile Payments for Digital and Physical Goods," Juniper Research (April 20, 2010).

[3] "Mobile Banking," Global Industry Analysts (February 1, 2010).

[4] "Shopping by Mobile Will Grow to $119 Billion in 2015,", ABI Research (February 16, 2010).

simulate the various connection speeds and latencies we have found to be representative of mobile network performance in the United States for early 2011.

Mobile networks have highly variable latency, packet loss, and bandwidth characteristics. Our testing leverages Shunra NetworkCatcher to record real-world network conditions and Shunra PerformanceSuite – vCat Edition™ to emulate those same network conditions. These conditions include, but are not limited to, statistical latency models, asymmetric bandwidth, bit errors and variable packet loss.

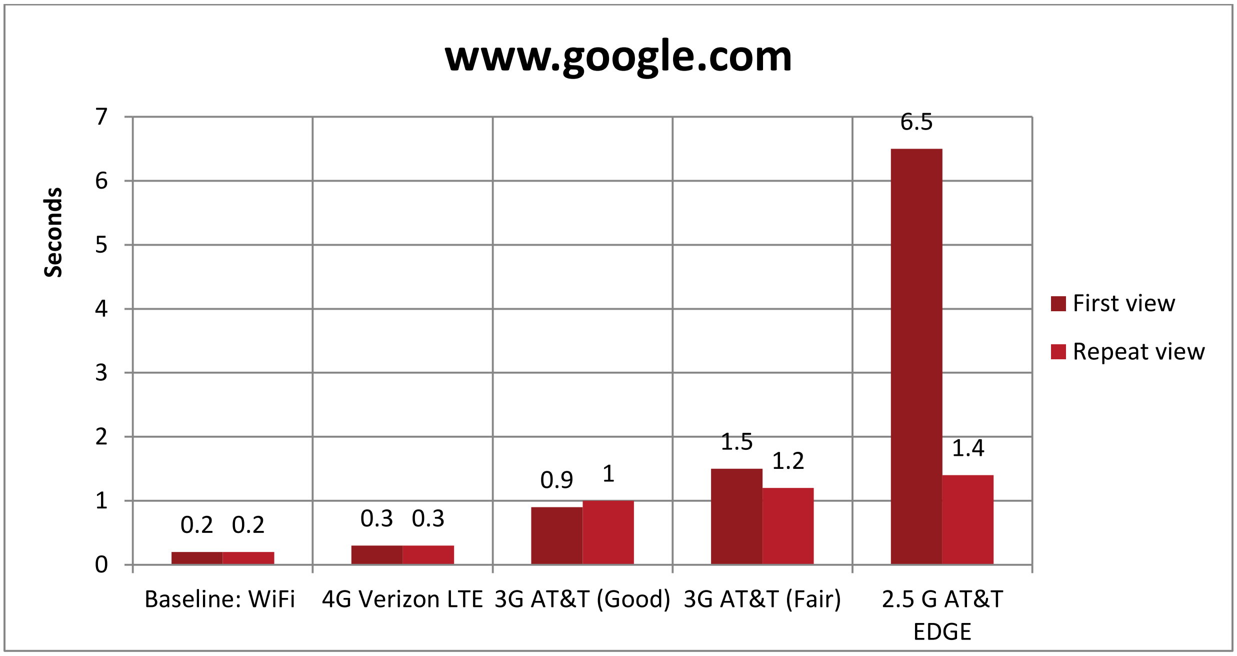


Figure 1 - First View Load Times vs. Repeat View Load Times

Performance Summary for http://www.google.com

	Baseline : PC WIFI	4G Verizon LTE	3G AT&T (Good Network Performance)	3G AT&T (Fair Network Performance)	2.5G AT&T-EDGE
	Performance Test Results				
Load time – first view	0.2s	0.3s +48%	0.9s +339%	1.5s +671%	6.5s +3154%
Load time – repeated view	0.2s	0.3s +51%	1.0s +514%	1.2s +629%	1.4s +741%

Webpage Performance Comparison

The following graphs show the comparative performance of the two webpages you submitted for testing.

Comparison of http://www.google.com vs. http://www.yahoo.com

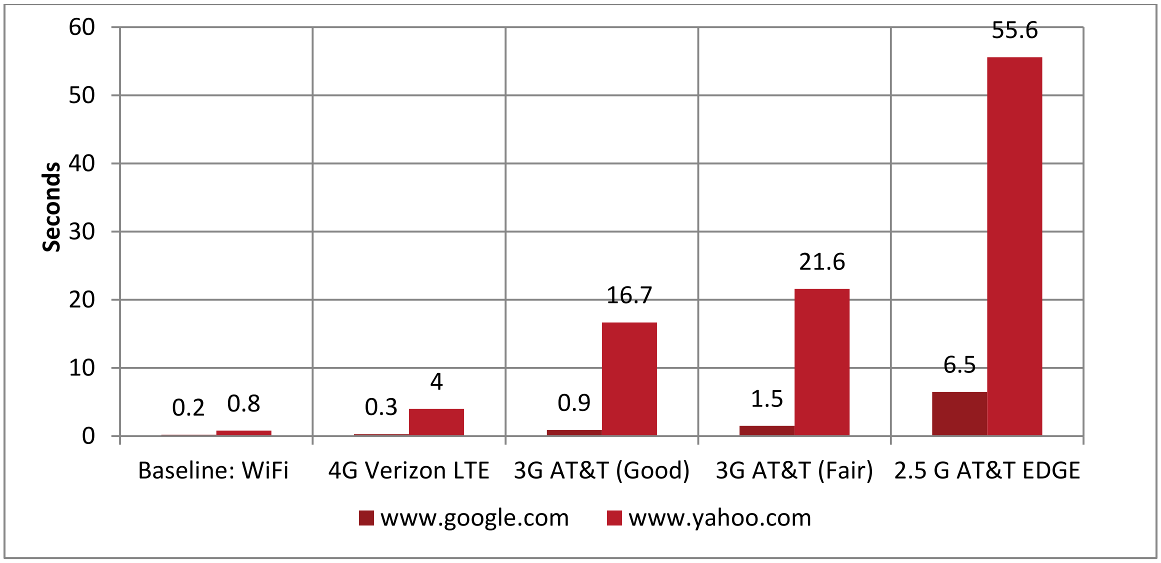


Figure 2 - First View Comparison

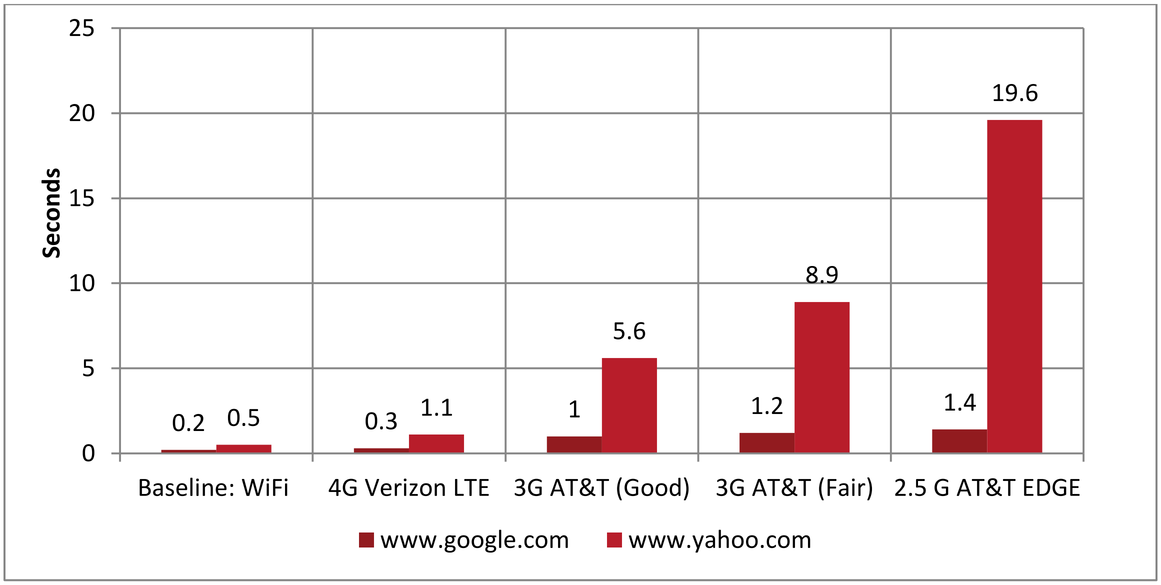


Figure 3 - Repeat View Comparison

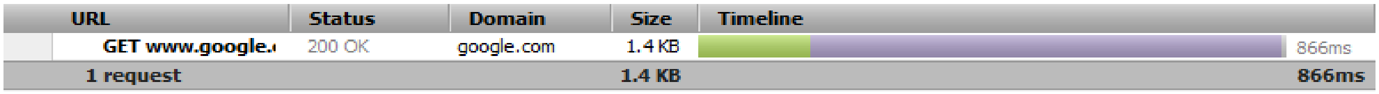
Waterfall Analysis

The following figures show a waterfall timeline view for of http://www.google.com tested with 3G AT&T 3G (Good) test conditions.

Legend:

DNS 🟦 Connect 🟩 Sending 🟥 Waiting 🟪 Receiving ⬜

First View:



URL	Status	Domain	Size	Timeline
GET www.google.(	200 OK	google.com	1.4 KB	🟩🟪 866ms
1 request			1.4 KB	866ms

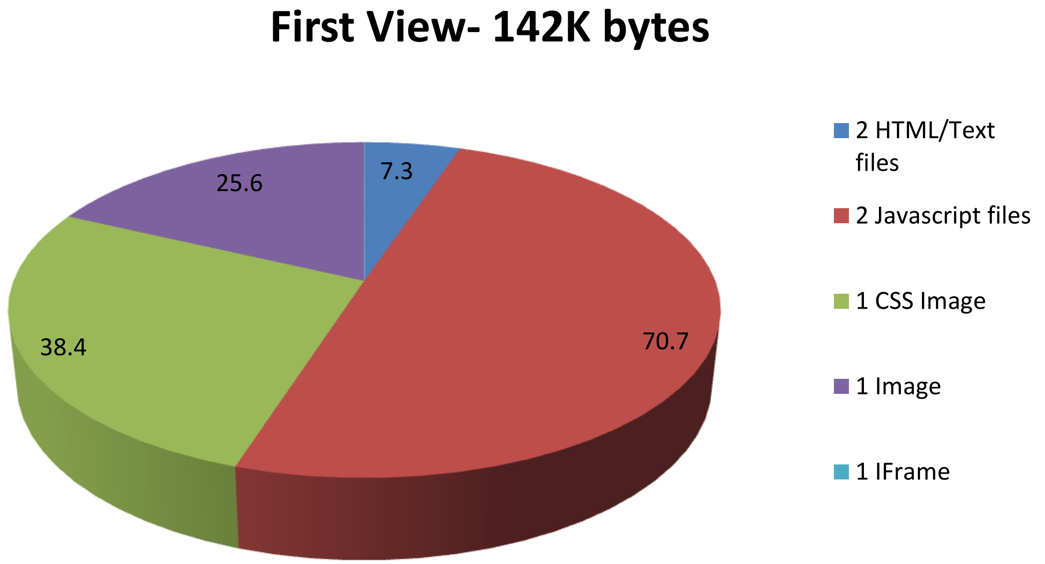
Repeat View:

Component Download Analysis

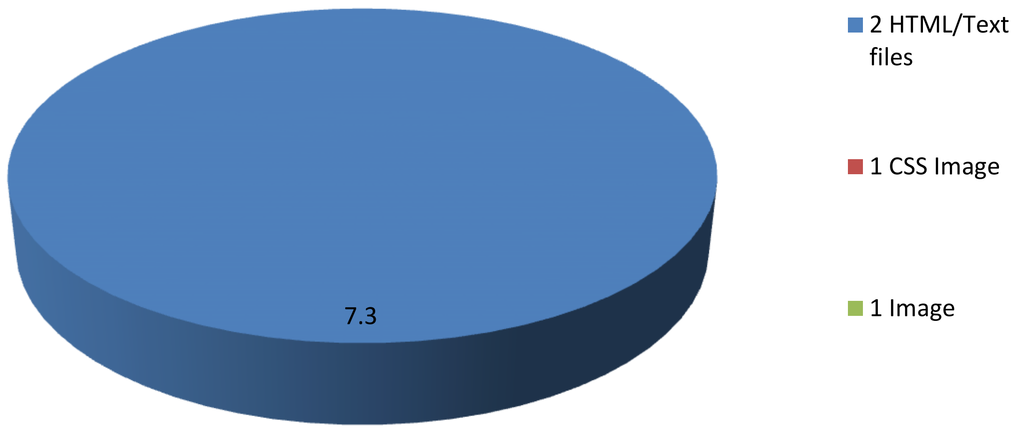
Industry estimates show that up to 80% of the end user response time is spent on the front-end of a webpage – the downloading of components such as images, stylesheets and scripts. The following Component Download Analysis shows the components and their associated download size for the webpage(s) you provided.

HTTP://WWW.GOOGLE.COM resulted in **7** Object requests (**145368** bytes) associated with a First View of the site (unprimed browser cache), and **4** requests (**7513** bytes) during a Repeat View.

The following charts show the number of requests by component type.



Repeat View- 7.3K bytes



Component Analysis Comparison

The following table compares **http://www.google.com** vs. **http://www.yahoo.com**

	Page Performance Score	First View		Repeat View	
		Size	# Requests	Size	# Requests
www.google.com	A 92/100 points	**145368**	**7**	**7513**	**4**
www.yahoo.com	B 89/100 points	**207964**	**19**	**13050**	**4**
Performance difference		**+43%**	**+171%**	**+74%**	**+%**

Optimization Recommendations for Mobile Web Applications

Shunra is pleased to offer the following performance optimization recommendations. These recommendations are specific to website HTTP://WWW.GOOGLE.COM These recommendations are based on the Yahoo YSlow rules, and several new rules that Shunra has developed while evaluating and testing optimization techniques for accelerating website access via mobile browsers. The recommendations are guidelines that should be tested and validated with your website before being implemented.

During our testing, we were able to speed up the load time of 17 selected mobile optimized websites by an average of 17.6%. When applying this set of best practices on standard websites accessed by an iPhone, we were able to improve the load time by up to 44%. For more details, please visit Shunra's APE blog, "Mobile performance engineering rules for the iPhone."

Summary for HTTP://WWW.GOOGLE.COM

Overall page performance score: **A** 92/100 points

Rule	Performance score
Optimizing Caching	
Add Expires headers	C 78/100 points
Minimizing Round-trips	
Make fewer HTTP requests	A 100/100 points
Avoid URL redirects	A 100/100 points
Avoid empty src or href	A 100/100 points
Remove duplicate JavaScript and CSS	A 100/100 points

Make AJAX cacheable	A 100/100 points
Avoid HTTP 404 (Not Found) error	A 100/100 points
Remove unsupported components	A 100/100 points
Minimizing Request overhead	
Use cookie-free domains	B 80/100 points
Reduce cookie size	A 100/100 points
Minimizing Payload size	
Compress components with gzip	A 100/100 points
Minify JavaScript and CSS	A 100/100 points
Optimizing Browser rendering	
Put CSS at bottom	A 100/100 points
Avoid CSS expressions	A 100/100 points
Remove unnecessary CSS rules	A 100/100 points
Reduce the number of DOM elements	A 100/100 points
Do not scale images in HTML	A 100/100 points
Maximizing Network utilization	
Use more than one domain	F 0/100 points
Minimizing Latency Impact	
Use a Content Delivery Network (CDN)	A 100/100 points
Reduce DNS lookups	A 100/100 points
Use GET for AJAX requests	A 100/100 points
iPhone / iPad recommendations	
Put JavaScript at the bottom	A 100/100 points
Reference CSS images in HTML	A 100/100 points
Resize images	E 58/100 points
Use HTML5	A 90/100 points

Optimization Details

<table>
<tr><th>Grade</th><th>Recommendation</th></tr>
<tr><td>C 78/100 points</td><td>*Add long term headers expiration dates*</td></tr>
<tr><td colspan="2">Near future headers expiration dates prevent effective caching and cause a repeat visit to your site from the iPad to be slower than necessary.
There are **2** static components without a far-future expiration date:
• (2011/5/5) http://www.google.com/images/nav_logo65.png
• (2011/5/5) http://www.google.com/images/logos/ps_logo2.png</td></tr>
<tr><td>A 100/100 points</td><td>*Make fewer HTTP requests*</td></tr>
<tr><td colspan="2">Latency has a substantial impact on mobile application performance. Reducing the number of unique objects on the page will help reduce sensitivity to latency.</td></tr>
<tr><td>A 100/100 points</td><td>*Avoid URL Redirect*</td></tr>
<tr><td colspan="2">Redirects can cause significant delays for mobile user web access. Try to reduce the number of redirects or use 301 redirects which are cached by the iPad.</td></tr>
<tr><td>A 100/100 points</td><td>*Avoid Empty SRC or HREF*</td></tr>
<tr><td colspan="2">You may expect a browser to do nothing when it encounters an empty image src tag. However, it is not the case in most browsers. Safari will make a request to the actual page itself. This behavior could possibly corrupt user data, waste server computing cycles generating a page that will never be viewed, and in the worst case, cripple your servers by sending a large amount of unexpected traffic.</td></tr>
<tr><td>A 100/100 points</td><td>*Remove duplicate JavaScript and CSS*</td></tr>
<tr><td colspan="2">Duplicate JavaScript and CSS files hurt performance and consume mobile bandwidth. Duplicate JavaScript scripts cause wasted time evaluating the same scripts more than once. This redundant script parsing happens regardless of whether the script is cacheable.</td></tr>
<tr><td>A 100/100 points</td><td>*Make AJAX cacheable*</td></tr>
<tr><td colspan="2">One of AJAX's benefits is it provides instantaneous feedback to the user because it requests information asynchronously from the backend web server. However, using AJAX does not guarantee the user will not wait for the asynchronous JavaScript and XML responses to return. Optimizing AJAX responses is important to improve performance, and making the responses</td></tr>
</table>

cacheable is the best way to optimize them.

A 100/100 points **Avoid HTTP 404 (Not Found) error**

Making an HTTP request and receiving a 404 (Not Found) error is expensive and degrades the user experience. Some sites have helpful 404 messages (for example, "Did you mean ...?"), which may assist the user, but server resources are still wasted.

A 100/100 points **Remove unsupported components**

The iPad doesn't support all types of components (e.g. Flash).

B 80/100 points **Use cookie-free domains**

When the browser requests a static image and sends cookies with the request, the server ignores the cookies. These cookies result in unnecessary network traffic. To work around this problem, make sure that static components are requested with cookie-free requests by creating a subdomain and hosting them there.

There are **4** components that are not cookie-free

- http://www.google.com/.../gmbzumRDGfQ.js
- http://www.google.com/extern_chrome/4a687d8a82bcb253.js
- http://www.google.com/images/nav_logo65.png
- http://www.google.com/images/logos/ps_logo2.png

A 100/100 points **Reduce cookie size**

HTTP cookies are used for authentication, personalization, and other purposes. Cookie information is exchanged in the HTTP headers between web servers and the browser, so keeping the cookie size small minimizes the impact on response time. Also consider use of HTML 5 instead of cookies for retaining application state information.

A 100/100 points **Compress components with gzip**

Compression reduces response times by reducing the size of the HTTP response. Gzip is the most popular and effective compression currently available and generally reduces the response size by about 70%.

A 100/100 points **Minify CSS and JavaScript**

Minification removes unnecessary characters from a file to reduce its size, thereby improving load times. When a file is minified, comments and unneeded white space characters (space, newline, and tab) are removed. This improves response time since the size of the download files is reduced.

A 100/100 **Put CSS at bottom**

<table>
<tr><td colspan="2">points</td><td></td></tr>
<tr><td colspan="3">Stylesheets prevent progressive rendering of everything below them. Also, stylesheets in the HEAD can block downloads and script running.</td></tr>
<tr><td>A</td><td>100/100 points</td><td><b><i>Avoid CSS expressions</i></b></td></tr>
<tr><td colspan="3">CSS expressions are a powerful, and dangerous, way to dynamically set CSS properties. These expressions are evaluated frequently: when the page is rendered and resized, when the page is scrolled, and even when the user manipulates the page via touch events. These frequent evaluations can degrade the user experience.</td></tr>
<tr><td>A</td><td>100/100 points</td><td><b><i>Remove unnecessary CSS rules</i></b></td></tr>
<tr><td colspan="3">Any rule in the CSS that is not necessary for the current page shouldn't be downloaded. Consider evaluating your CSS with an automated tool that identifies unused selectors and analyzes CSS Coverage.</td></tr>
<tr><td>A</td><td>100/100 points</td><td><b><i>Reduce the number of DOM elements</i></b></td></tr>
<tr><td colspan="3">A complex page means more bytes to download, and it also means slower DOM access in JavaScript. Reduce the number of DOM elements on the page to improve performance.</td></tr>
<tr><td>A</td><td>100/100 points</td><td><b><i>Do not scale images in HTML</i></b></td></tr>
<tr><td colspan="3">Web page designers sometimes set image dimensions by using the width and height attributes of the HTML image element. Avoid doing this since it can result in images being larger than needed. For example, if your page requires image myimg.jpg which has dimensions 240x720 but displays it with dimensions 120x360 using the width and height attributes, then the browser will download an image that is larger than necessary.</td></tr>
<tr><td>A</td><td>100/100 points</td><td><b><i>Reference images in the html</i></b></td></tr>
<tr><td colspan="3">Images that are only referenced in the CSS won't be downloaded until the CSS is downloaded. Consider referencing the images in the main html page to speed up mobile page rendering time.</td></tr>
<tr><td>F</td><td>0/100 points</td><td><b><i>Use more than one domain</i></b></td></tr>
<tr><td colspan="3">The iPad will download up to 4 files in parallel from a single domain. Consider distributing components evenly between 2 and 3 additional domains via sharding.</td></tr>
<tr><td>A</td><td>100/100 points</td><td><b><i>Use a Content Delivery Network (CDN)</i></b></td></tr>
<tr><td colspan="3">The proximity of the mobile carrier’s internet gateway to web servers can impact response times. Deploying content across multiple geographically dispersed servers with low latency to the carrier’s gateway improves performance.</td></tr>
</table>

A 100/100 points — ***Reduce DNS lookups***

The Domain Name System (DNS) maps hostnames to IP addresses, just like phonebooks map people's names to their phone numbers. When you type URL www.yahoo.com into the browser, the browser contacts a DNS resolver that returns the server's IP address. DNS has a larger cost on mobile networks than on traditional wired networks; typically it takes 120 to over 400 milliseconds for a mobile look up of the IP address associated with a hostname. The browser cannot download anything from the host until the lookup completes.

A 100/100 points — ***Use GET for AJAX requests***

When using the XMLHttpRequest object, the browser implements POST in two steps: (1) send the headers, and (2) send the data. It is better to use GET instead of POST since GET sends the headers and the data together (unless there are many cookies). IE's maximum URL length is 2 KB, so if you are sending more than this amount of data you may not be able to use GET.

A 100/100 points — ***Put Javascript at the Bottom***

The problem caused by scripts in the HEAD section is that they block iPad parallel downloads. This rule is a subset of the original YSlow rule calling to put all scripts at the bottom. The iPhone actually downloads components in the order it sees fit, so scripts and stylesheets are always downloaded first. As long as your scripts are above the stylesheets and not in the HEAD, they won't block anything and will always be among the first things downloaded, so there's no actual necessity to put all of them at the bottom.

A 90/100 points — ***Use HTML5***

HTML5 offers new features that can reduce the number of bytes going from your server to the client. These features include localStorage, manifest and databases.

There are 95 bytes of cookies on this page. Consider use of HTML 5 localStorage for local data persistance.

E 58/100 points — ***Resize images***

The iPad has a limited screen size. There's normally no reason to have images larger than the screen size.

Found 2 images that are bigger than 1/4 of the iPad's screen size, or wider or taller than 480 pixels:

- http://www.google.com/images/logos/ps_logo2.png
- http://www.google.com/images/nav_logo65.png

Improve mobile user experience with Shunra

Shunra PerformanceSuite enables you to easily test performance of your website or application using our mobile emulation library, our ability to monitor and record real-world network conditions, and powerful performance analytics to validate user performance based on actual wireless network performance scenarios.

With the Shunra PerformanceSuite, you can deploy applications and make infrastructure changes with confidence:

- Gain accurate insight into production network conditions and precisely replay those conditions in the test lab
- Discover network related performance bottlenecks before you launch your website
- Achieve service level objectives from keyboard to eyeball
- Accurately compare the performance of different versions of your site or application
- Simulate projected peak seasonal traffic loads
- Test and validate infrastructure and software "fixes" under production conditions - before going live

Shunra PerformanceSuite is available in different editions to meet your specific application performance engineering needs. Please contact Shunra at info@shunra.com or 1.877.474.8672 for more information.

APPENDIX 1: Mobile Application Performance Test Methodology

The following chart details the network conditions emulated for this Mobile Application Performance Test. We captured network performance using Shunra NetworkCatcher and also performed tests to a set of popular websites using an instrumented iPhone from several high-traffic US airports at varying times of day including peak load and off hours. We measured the detailed performance characteristics of each tested network including DNS lookup times, TCP connect times, and time to first byte of web responses. We then used our analysis tools to summarize real-world data across each network, providing the following emulation values for bandwidth, latency, and packet loss.

	Baseline : PC WIFI	4G Verizon LTE	3G AT&T (Fair Network Performance)	3G AT&T (Good Network Performance)	2.5G AT&T- EDGE
	Network Emulation Details				
Emulated Latency	0ms	48-64ms (avg. 52)	150-1600ms (avg. 450ms)	100-1200ms (avg. 360ms)	200-2000ms (avg. 900ms)
Emulated Bandwidth	Down: Unlimited Up: Unlimited	Down: 13Mbps Up: 3.5Mbps	Down: 0.4Mbps Up:0.1Mbps	Down: 2.0Mbps Up: 0.75Mbps	Down: 0.15Mbps Up: 0.04Mbps
Emulated Packet Loss	0%	1%	1.5%	.8%	3%

The Mobile Application Performance Test also leverages the YSlow ruleset, along with Shunra's custom ruleset to deliver optimization recommendations. Yahoo! YSlow analyzes web pages and suggests ways to improve their performance based on a set of rules for high performance web pages. YSlow is a Firefox add-on integrated with the Firebug web development tool. YSlow grades web pages based on one of three predefined rulesets or a user-defined ruleset. Most files compromising YSlow are licensed for use under the Mozilla Public License Version 1.1; an online version of the license agreement is available at developer.yahoo.com/YSlow/license.html. YSlow includes jslint by Douglas Crockford, which is licensed under a BSD-style license. YSlow also includes files from the Yahoo! User Interface library, which are licensed under the BSD license.

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