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2013 STATE OF THE UNION
Mobile Ecommerce Performance

Two out of three mobile shoppers expect pages to load in four seconds or less, and that bar is steadily being raised. Google recently updated its mobile guidelines to state that sites should deliver “above-the-fold” content in less than one second. How do the top 100 retail websites measure up to these expectations?

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Introduction

In the ten short years since mobile devices were introduced to a mainstream audience, smartphones and tablets have surged to the forefront of Internet use. Today, 58% of all US consumers own a smartphone, and 55% of all time spent with online retail in June 2013 occurred on a mobile device.[1] By the end of 2013, mobile commerce (mcommerce) spending is expected to reach $25 billion, a 24% increase over 2012.[2] While mobile usage is higher than ever, however, most mobile users are not happy with the performance status quo.

Mobile Users are Increasingly Demanding

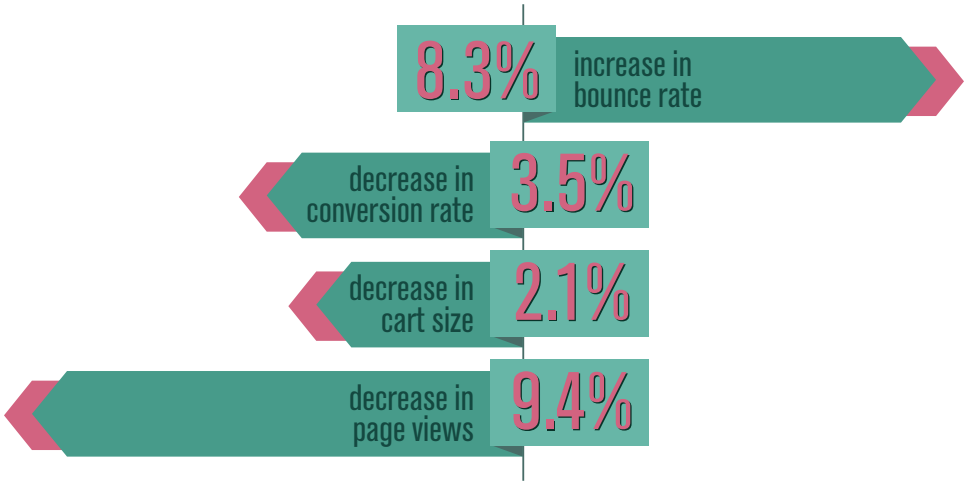
Slow pages are the number one complaint of smartphone users, ranking even higher than site crashes, and 85% of mobile users state that they expect pages to load as fast as, or faster than, they load on the desktop.[3] The majority of smartphone users expect pages to load in four seconds or less, while tablet owners have even greater expectations at three seconds or less.[4]

As if these expectations were not challenging enough, Google recently updated its mobile guidelines to state that sites should deliver "above-the-fold" content in less than one second.[5]

Slow Mobile Pages Have a Serious Business Impact

There are quantifiable reasons why delivering faster pages makes bottom-line sense. Three out of five mobile users report that they have a better opinion of a brand when it offers a good mobile experience,[6] but brand perception is just the tip of the impact iceberg. The abandonment rate for mobile shopping carts is 97%, compared to 70% for desktop carts, and performance is a significant abandonment factor.[7]

In a case study[8] by Radware, in which a segment of an ecommerce site's mobile traffic was served pages with a one-second HTML delay, the slower pages suffered across four key performance indicators, compared with the regular traffic:



There are Numerous Technical Roadblocks to Delivering Optimal Mobile Performance

Before mobile, web developers could rely on steady improvements in hardware and bandwidth to help deliver an optimal user experience to desktop users. In recent years, however, the explosion of mobile web browsing has developers struggling to keep up with mobile performance on many fronts. In addition to addressing the inherent limitations of mobile devices – lower bandwidth, smaller memory, greater latency, and less processing power – they must also consider several other constantly moving targets in the changing mobile landscape:

- Browser/device fragmentation (No single screen size owns more than 20% of the market share)
- Website versus app
- M.site versus full site
- Responsive web design

Summary

This report provides a snapshot of the current mobile performance landscape, as well as best practices that site owners should consider to optimize the mobile experience for their customers.

In August 2013, we engaged in a four-week study of the top 100 retail websites, as ranked by Alexa.com. We subjected the home page of each site – both the full-site version and the m.site version – to a series of page speed tests over 4G and Wifi networks, and calculated the median results for metrics such as load time and number of resources.

The goal of this research was to gain an understanding of how leading websites perform for real users in real-world settings, outside of development and testing environments.

Our key findings are summarized below and described in detail in this report. The report concludes with best practices that site owners should consider when developing their sites for today's multi-screen universe.

Except where specifically noted, results discussed throughout this report are for the iPhone 4s over a 4G connection, as this represents the most popular device[9] and the most rapidly adopted connection speed[10] currently in use.

Key Findings

1. **Only 2% of pages loaded in the expected time of <4 seconds.**
   20% of the home pages we tested took 10+ seconds to load. The median page took 7.84 seconds to load.

2. **The median load time for m.sites also fell short of user expectations.**
   The median m.site home page was 4.33 seconds. While this was 44% faster than the full site, it falls somewhat short of mobile users' stated load time threshold of 4 seconds.

3. **M.sites are on the rise, but 1 in 5 don't allow visitors to access the full site.**
   80% of companies have a mobile-specific site, up from 76% in 2012. Of these m.sites, 79% offer a link that allows users to view the full site, while 21% do not offer full site access.

4. **Even tablet-using shoppers get sent to the m.site.**
   Most sites served the full site to the iPad, and the few that did not offered a link to the full site; however, almost one-third of sites served the mobile site to the Android tablet, and 3% do not allow shoppers using Android tablet to access the full site at all.

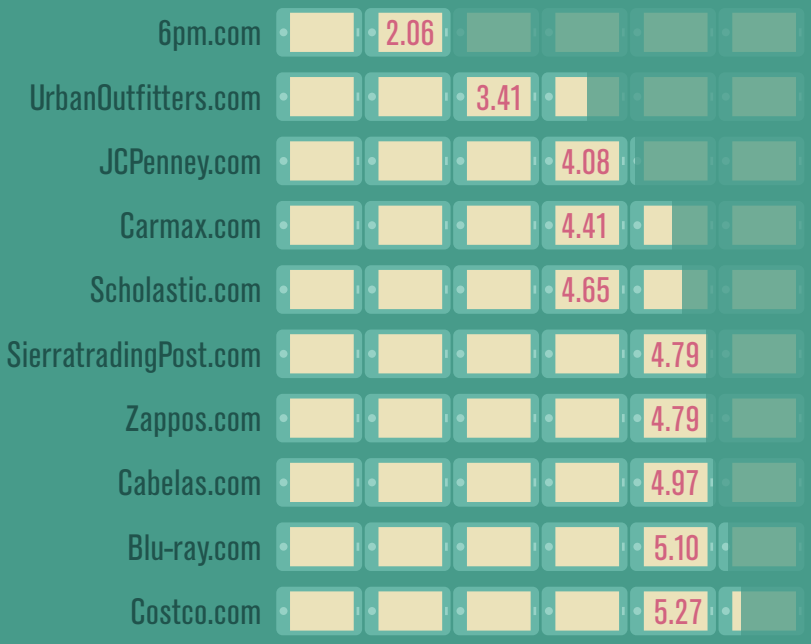
5. **Android smartphones outperformed iOS.**
   Performance varied widely among smartphones. Median load times across the five devices we tested ranged from 3.06 seconds for the Samsung Galaxy Note to 11.35 seconds for the iPhone 4.

6. **The Android tablet outperformed the iPad.**
   The Samsung Galaxy Tab 2 served pages 33% faster over Wifi than the iPad 2. This finding was consistent across most of the sites tested.

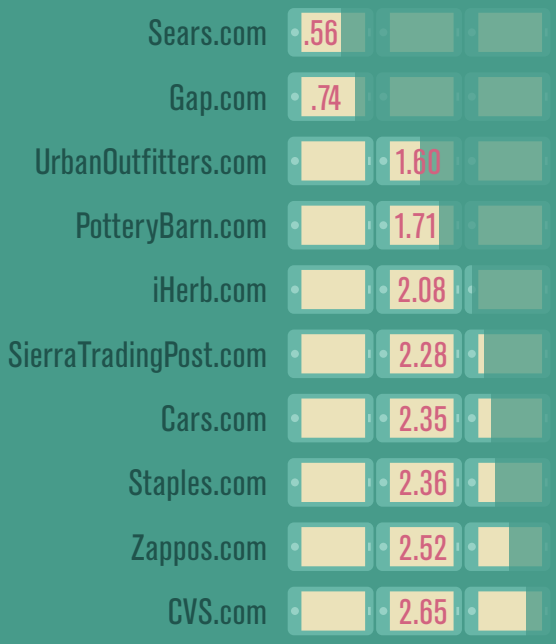
Which Sites Were Fastest?

All page load times are indicated in seconds.

The 10 Fastest Sites (Full Site)*



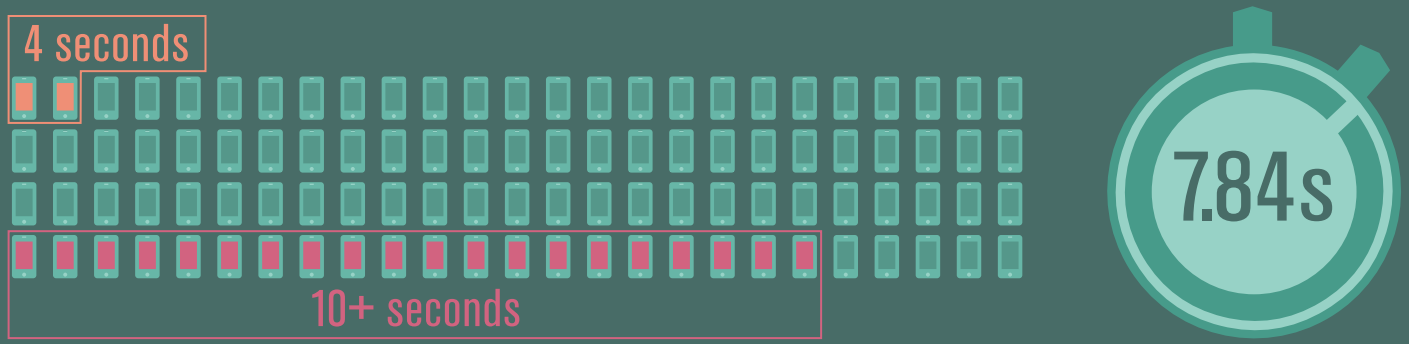
The 10 Fastest Sites (m.sites)



* These are the ten fastest home pages we tested on the iPhone 4s.

Finding #1: The median page loads in 7.84 seconds (full site).

On the iPhone 4s, the median page took almost 8 seconds to load over 4G. Only 2 out of 100 sites loaded in fewer than 4 seconds, while 20 sites took 10+ seconds to load. In other words, only 2% of the pages we tested are meeting users' expectations of pages that load in 4 seconds or less.



Why pages are slow

Mobile devices have inherent performance limitations, including lower bandwidth, smaller memories, and lower processing power. These challenges are exacerbated by external issues, notably:

1. **Web pages are bigger than ever.**
   The median top 100 retail home page carries a payload of 1258 KB and contains 92 resources such as images, JavaScript, CSS (cascading style sheets) files, etc.[11] This represents 15% growth since Summer 2013, when the median page was 1095 KB. While this increase in page size and complexity has a significant impact on desktop performance, its impact on mobile performance is much more dramatic. This impact will make itself increasingly felt over the next three years. At the current rate of growth, a typical Web page could surpass 2 MB by 2015.

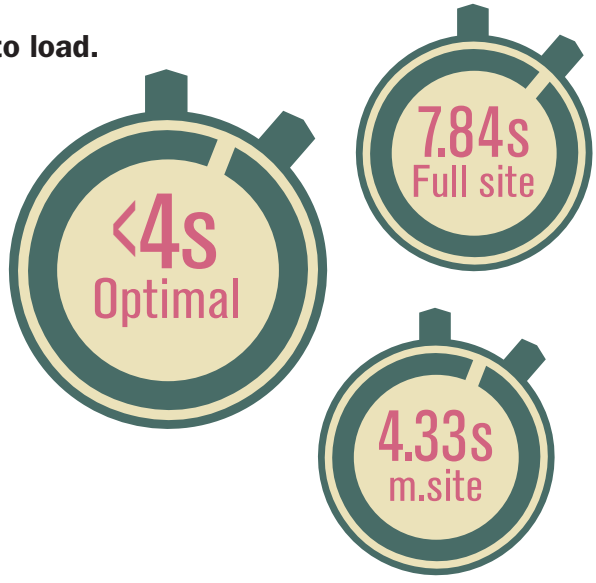
2. **Latency is unpredictable and can vary widely.**
   Latency – the amount of time it takes for a host server to receive and process a request for a page resource – can be vastly different for desktop versus mobile users. Typically, desktop latency is between 75-140 milliseconds, whereas mobile (3G) latency is 90-190 milliseconds;[12] however, mobile latency is much less predictable than desktop latency, even when measured at the same location. This is due to a number of variables beyond the amount of data passing through the tower. Factors such as the weather, and even the direction the user is facing, can have a measurable impact.

   Whatever the cause, the end result is latency that can range up to 990 milliseconds[13] – a significant delay, particularly in light of the fact that a typical web page contains 100 resources, each carrying its own latency penalty.

3. **Download speeds also experience significant variance.**
   Download speeds can range from a mere 1 Mbps over 3G to as much as 31 Mbps over LTE. It's interesting to compare this to the average U.S. broadband speed of 15 Mbps, and to note that 3G can be up to 15 times slower than broadband, while LTE can be up to twice as fast.

Finding #2: The median m.site took 4.33 seconds to load.

On the iPhone 4s, the median home page took 4.33 seconds to load over 4G. While this was 44% faster than the full site, it falls somewhat short of mobile users' stated load time threshold of 4 seconds, and well short of Google's 1-second target.



Why aren't m.sites faster?

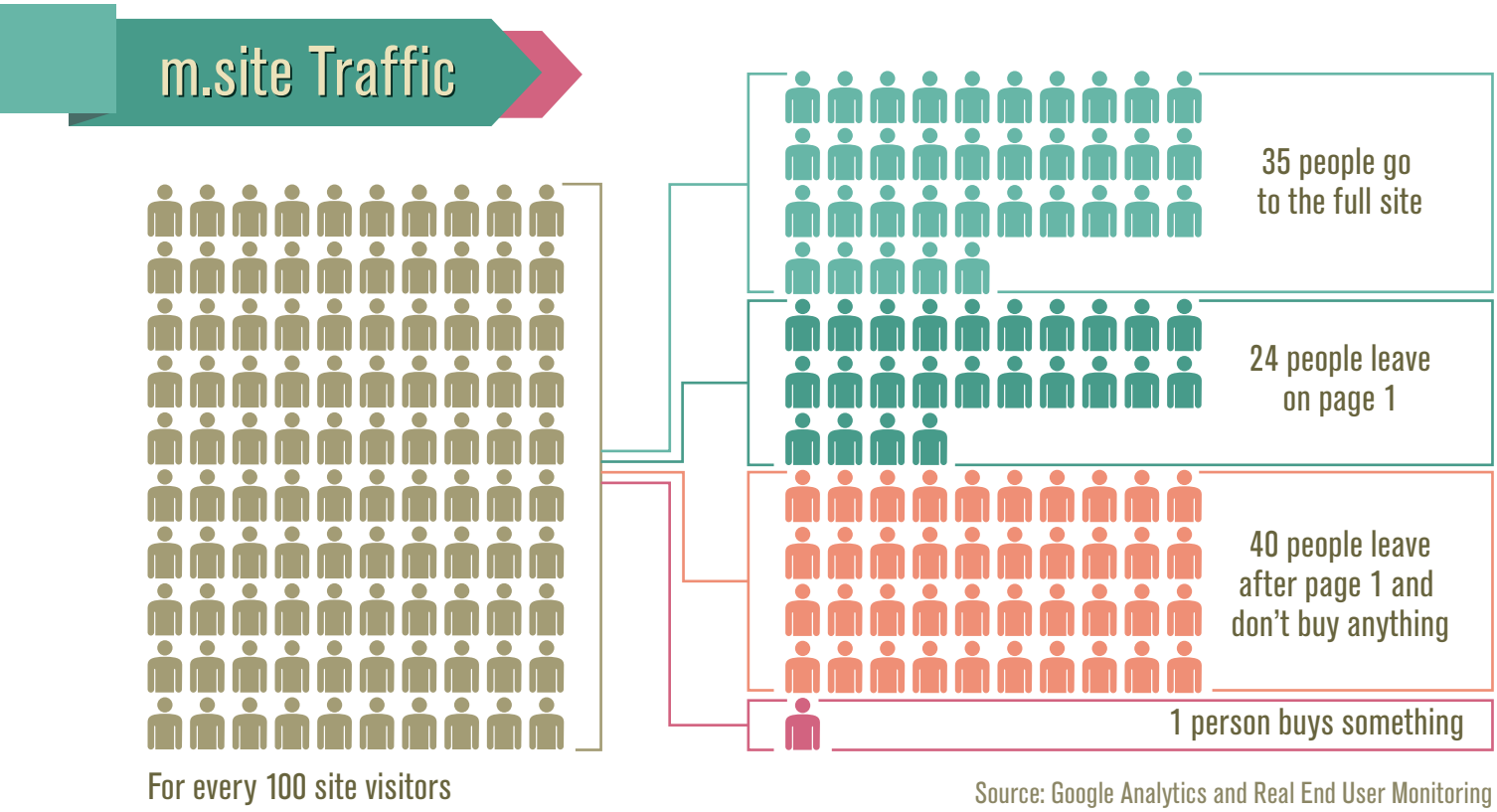
The median m.site page we tested contained 27 resources (e.g. images, CSS, etc.) – in other words, approximately one-third the number contained in the median full-site page. Given this, one might expect the m.site to be three times faster than the full site; however, other factors, such as latency and download speed – both of which can be very inconsistent on mobile devices – contribute to performance.

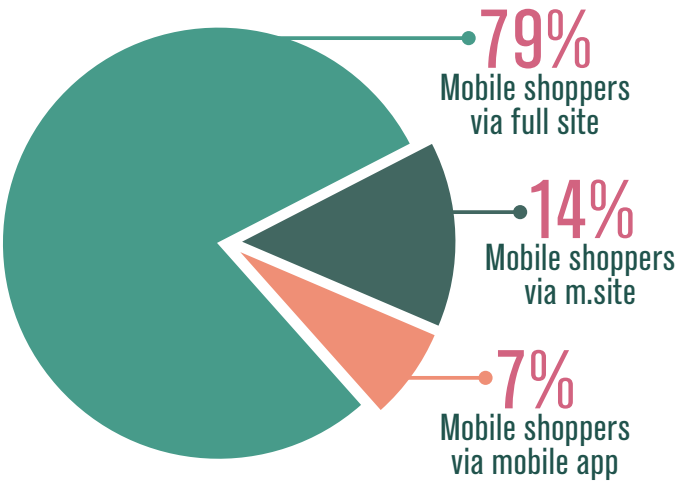
The takeaway is that site owners should be mindful that simply stripping down their sites into pages with fewer resources is not a performance cure-all. The next section of this report will further discuss why m.sites may solve some problems but create new ones.

Finding #3: While m.sites are on the rise, 1 in 5 don't allow visitors to access the full site.
80% of companies have a mobile-specific site, up from 76% in 2012. Shoppers are automatically served this version of the site when visiting from a mobile device.

Of these m.sites, 79% offer a link that allows users to view the full site, while 21% do not offer full site access. In other words, a significant number of mobile users are forced to confine themselves to the m.site.

M.sites do not meet the needs of either shoppers or site owners
While many mobile-specific sites have evolved somewhat beyond stripped-down menu-based designs, m.sites should not be considered a cure-all for performance pains. Most m.sites cannot serve the rich, dynamic experience — not to mention the depth and breadth of content — that most users expect. This is why **as many as 35% of mobile users will choose to view the full site when given the option.**[14]





Full-site visitors are also better customers than m.site visitors. One online retailer analyzed its mobile revenue and found that 79% was generated by shoppers visiting the full site on their devices. Only 14% of mobile revenues came via the m.site, and 7% via the mobile app.[15]

Finding #4: Even tablet-using shoppers get sent to the mobile site.

Most sites serve the full site to the iPad, and the few that don't offer a link to the full site. However, almost one-third of sites serve the mobile site to the Android tablet, and 3% do not allow Android tablet shoppers to access the full site at all.

iPad:
94% serve the full site
6% offer full-site access

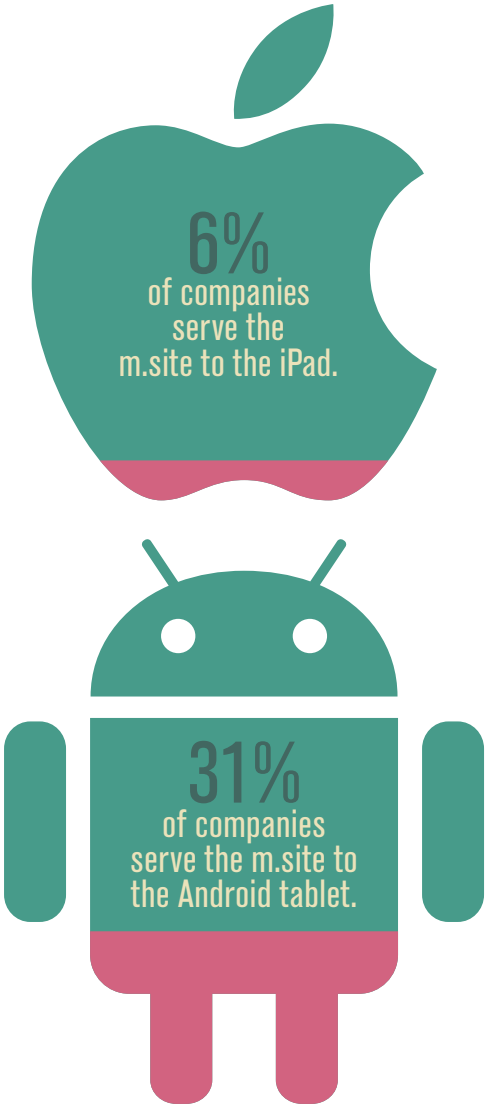
Android tablet:
69% serve the full site
28% offer full-site access
3% do not offer full-site access

Responsive web design to the rescue?

Any tablet user who has tried to visit a website, only to be served a stripped-down mobile-optimized page, will attest to how frustrating this experience is. Regardless of the brand of tablet being used, almost all tablet users expect the same experience on their tablet as on their desktop. Therein lies the challenge for site owners. **While tablets do not present as many performance and usability limitations as smartphones, they are limited in terms of processor power, screen size, and browser caching capabilities.**

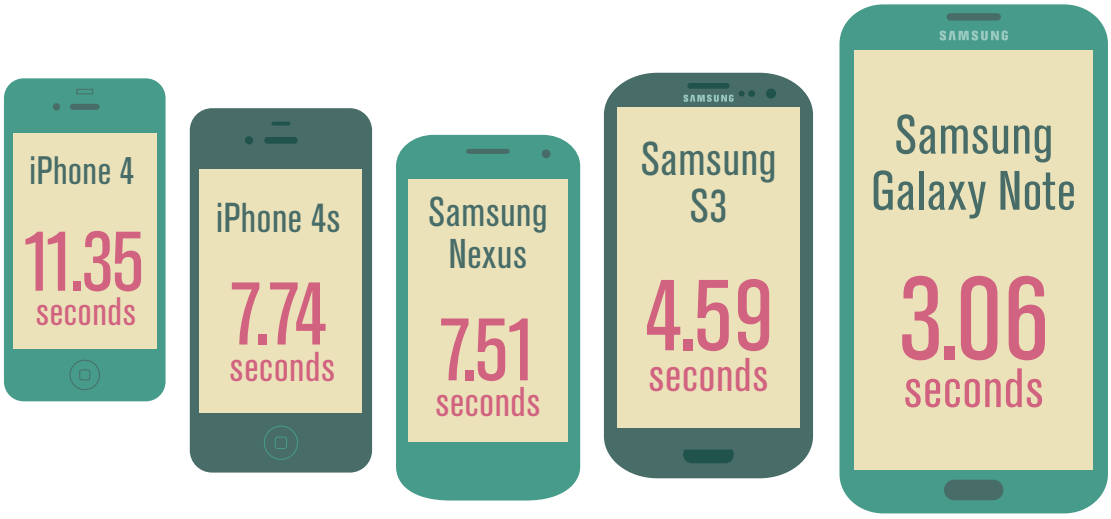
Some site owners have turned to responsive web design (RWD) to address the challenges of designing for a multi-screen world. RWD is a design approach that aims to craft sites to provide an optimal viewing experience across a wide range of devices and screen sizes; however, **responsive websites are complex, and that complexity can come with a serious performance price tag.**

While it is quite possible to design a website that is both responsive and fast, these two attributes do not automatically go hand in hand. **A properly optimized responsive site requires a deep understanding and knowledge of both design and front-end performance optimization.**



Finding #5: Android smartphones outperformed iOS.

Performance varied widely among smartphones. Median load times across the five devices we tested ranged from 3.06 seconds for the Samsung Galaxy Note to 11.35 seconds for the iPhone 4.



How to interpret these results

These tests are not intended to serve as a performance review of the devices tested, and the results should not be interpreted as such. Rather, they demonstrate how broadly performance can vary across smartphones, with **the slowest device performing almost four times more slowly than the fastest device**. Site owners should be aware that this degree of variance exists among their users, and this should serve as a reminder of the importance of testing performance across a range of devices.

Finding #6:
The Android tablet outperformed the iPad

The Samsung Galaxy Tab 2 served pages 33% faster over Wifi than the iPad 2. This finding was strikingly consistent across most of the sites tested, indicating that there is a common root cause behind the fact that pages loaded significantly faster on the Samsung tablet than on the iPad 2.

The iPad 2 and Samsung Galaxy Tab 2 have frequently been reviewed side by side and found to be comparable in terms of appearance, screen size and resolution, and overall ease of use.[16] These results suggest that performance may be one area of distinction between the two tablets.

It was also striking to note the difference between load times for the iPad 2 and iPad 3 over Wifi: the median page loaded more than twice as fast for the iPad 3.

Samsung Galaxy 2 – 4.85 seconds

iPad 2 – 7.24 seconds

How to interpret these results

It is difficult to speculate as to the factors that contribute to performance for the iPad, as Apple currently does not support the Navigation Timing API in Safari. The Navigation Timing API specification, which has been set out by W3C,[17] is the primary way to collect real user data. The API allows browsers to collect and share accurate timings for key milestones of loading a Web page. The specification has been adopted by every other browser developer, and at the time of authoring this report, there is an active petition requesting Apple to adopt the standard.[18]

Takeaway: Nine Best Practices for Mobile Performance

There is no magic bullet for mobile performance. Building web pages that perform well across all devices, browsers, and connection types remains a significant challenge for site owners – a challenge that has been brought into the spotlight in our emerging "mobile first" world.

The best tips for designing a mobile-friendly site are universal for all platforms: keep pages clear, simple, and concise. Serving an optimal experience to all visitors is a difficult proposition, particularly given the current state of device/browser fragmentation – a state that will only become more diverse.

97% of mobile response time happens at the front end, after the HTML arrives at the browser. This means that the front end – the web page itself – is where site owners can focus their performance optimization efforts and achieve maximum results.

The following are a few relatively easy fixes that site owners should consider.

1. Don't assume your CDN offers the same benefits to your mobile visitors as it does to your desktop visitors

Content delivery networks (CDNs) cache static page resources (e.g. images and CSS) in server nodes throughout a geographic network – ideally closer to a site's users. The shorter distance between users and content means shorter round trips between the user's browser and the server and, in theory, faster start render time.

While a CDN can be somewhat effective for mobile users, site owners should not expect it to consistently deliver the same benefits that a CDN offers to desktop users. In one case study that compared side-by-side CDN acceleration results for both desktop and mobile, it was found that:

- Load time improved by only 10% for mobile, compared to a 20% improvement for desktop.
- Start render time improved by less than one second, from 7.059 seconds to 6.245 seconds.[19]

2. Use "smarter" images

A typical retail page is more than 1 MB in size, and images account for up to 60% of that bandwidth. High-resolution images waste bandwidth, processing time, and cache space if the user will be viewing the images only in a small mobile browser window.

To speed up page rendering and reduce bandwidth and memory consumption, dynamically resize images in your application or replace images with smaller versions for mobile sites. Don't waste bandwidth by relying on the browser to scale a high-resolution image into a smaller width and height.

Another option is a technique called "progressive image rendering" (PIR) – loading a very low-resolution version of an image initially to get the page up as quickly as possible, and then replacing that with a higher-resolution version on the onload or ready event after the user has begun interacting with the page.

3. Compress text-based resources

While images are the number one consumer of bandwidth, text-based content presents a significant challenge as well. Some of this payload can be reduced through techniques such as minification and compression, both of which are relatively easy best practices.

Minification, which is usually applied to scripts and style sheets, eliminates inessential characters such as spaces, newline characters, and comments. A correctly minified resource delivers an average file-size reduction of about 20%. Minification not only reduces bandwidth consumption and latency, but also may mean the difference between a cacheable object and one that is too big for the cache on a particular mobile device.

Compression technologies, such as GZIP, reduce payloads at the slight cost of adding processing steps to compress on the server and decompress in the browser. These operations are highly optimized, however, and tests show that the overall effect is a net improvement in performance.

4. Limit or eliminate JavaScript

The demand for highly interactive and responsive applications has driven JavaScript (JS) usage through the roof. As JavaScript's popularity has surged, even tasks that were once performed by the server, HTML, or CSS – such as rendering HTML, ensuring accessibility, and managing page layout – have slowly migrated beneath the JS umbrella. As a result, today it is quite common for large sites to end up with 1 MB of JS code on their pages, even after minification.[20] Site owners should perform an audit of JavaScript on their sites, then reallocate appropriate tasks back to the server, HTML, and CSS.

5. Defer rendering "below-the-fold" content

Assure that the user sees the page quicker by delaying the loading and rendering of any content that is below the initially visible area, sometimes called "below the fold." To eliminate the need to reflow content after the remainder of the page is loaded, replace images initially with placeholder <img> tags that specify the correct height and width.

6. Don't have a separate m.site

There are a number of reasons why m.sites are, ultimately, a dead end. In addition to reasons mentioned earlier in this report (e.g. m.site visitors spend less, one-third of mobile users will opt to view the full site), Google does not like m.sites: "Using a single URL for a piece of content makes it easier for your users to interact with, share, and link to your content, and a single URL for the content helps Google's algorithms assign the indexing properties for the content."[21]

7. If you must have an m.site, allow users to navigate to the full site from every page

Mobile shoppers spend up to four times more, on average, when they shop via the full site than via the m.site or mobile app. A link to the full site should be clearly visible on every page of the mobile site. The current best practice is to place the link on the bottom of the page. Similarly, there should also be a clear link to the mobile site at the bottom of every page of the full site, for those shoppers who change their minds about using the full site.

8. Don't serve your m.site to tablets

Ensure that your site recognizes when users are vising via a tablet – any tablet, not just an iPad. The Google Webmaster Central blog explains that "for Android-based devices, it's easy to distinguish between smartphones and tablets using the user-agent string supplied by browsers: Although both Android smartphones and tablets will include the word "Android" in the user-agent string, only the user-agent of smartphones will include the word "Mobile". In summary, any Android device that does not have the word "Mobile" in the user-agent is a tablet (or other large screen) device that is best served the desktop site."[22]

9. Test before, during, and after deployment on a variety of devices, browsers, and connection speeds
Testing in a development or lab setting will not give an accurate measure of how your site performs in the real world. Remember that typical 3G latency is 90-190 milliseconds, and can range as high as almost one second. This latency affects every resource on your pages.

Methodology

The test group included 100 leading ecommerce sites, as ranked by Alexa.com. Each site's home page (both the full site and the m.site, when an m.site was offered) was tested 10 times per device across five smartphones – iPhone 4, iPhone 4s, Samsung Galaxy Nexus, Samsung Galaxy S3, and Samsung Galaxy Note 2 – and three tablets – the iPad 2, iPad 3, and Samsung Galaxy Tab 2. The median results were used in our analysis.

The tests were conducted over a four-week period, from Tuesday, August 6 to Friday, August 30, 2013.

The iPhone 4, iPhone 4s, Samsung Galaxy Nexus, Samsung Galaxy S3, and Samsung Galaxy Note 2 were tested over a 4G connection using their native browsers. The iPad 2, iPad 3 and Samsung Galaxy Tab 2 were tested over a Wifi connection using their native browsers.

For all tests, devices were positioned in the same location, in an attempt to mitigate the latency impact caused by location changes. For all tests, devices and radios were at full power and screens were not allowed to lock during testing.

For both smartphones and tablets, we calculated median results across these metrics:

- load time (mobile site)
- load time (full site)
- resource requests (mobile site)
- resource requests (full site)

Sites that did not yield a result were marked as null in the test results.

About Radware

Radware (NASDAQ: RDWR), is a global leader of application delivery and application security solutions for virtual and cloud data centers. Its award-winning solutions portfolio delivers full resilience for business-critical applications, maximum IT efficiency, and complete business agility. Radware's solutions empower more than 10,000 enterprise and carrier customers worldwide to adapt to market challenges quickly, maintain business continuity, and achieve maximum productivity while keeping costs down. For more information, please visit www.radware.com.

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