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School of Science
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Master's Thesis
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DRAFT! — Tuesday 17th January, 2012 — DRAFT!

Supervisor: Professor Petri Vuorimaa, Aalto University
Instructor: Risto Sarvas D.Sc.(Tech.)

Aalto University
School of Science

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ABSTRACT OF
MASTER'S THESIS

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!FIXME Decide city... FIXME!, !FIXME Add English date FIXME!

Kimmo Puputti

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0.1 Thesis Git repository info

Build time: **Tuesday 17th January, 2012 16:22**

Git HEAD:

```
commit 3b6c7ce197576cf76926c0b2e622dfc7e88789e0
Author: Kimmo Puputti <kpuputti@gmail.com>
Date:   Thu Jan 12 15:45:15 2012 +0200
```

Add performance guidelines.

Repository status:

```
# On branch master
# Changes not staged for commit:
#   (use "git add <file>..." to update what will be committed)
#   (use "git checkout -- <file>..." to discard changes in working directory)
#
# modified:   results.tex
# modified:   sources.bib
# modified:   thesis.pdf
# modified:   thesis.tex
#
no changes added to commit (use "git add" and/or "git commit -a")
```

Mobile OS Type	Skill Set Required
Apple iOS	C, Objective C
Google Android	Java (Harmony flavored, Dalvik VM)
RIM BlackBerry	Java (J2ME flavored)
Symbian	C, C++, Python, HTML/CSS/JS
Windows Mobile	.NET
Windows 7 Phone	.NET
HP Palm webOS	HTML/CSS/JS
MeeGo	C, C++, HTML/CSS/JS
Samsung bada	C++

Table 1.1: Required skill sets for different mobile platforms. [2]

Chapter 1

Introduction: Smartphone Market and the Need for Cross-Platform Support

1.1 Smartphone Landscape

1.2 HTML5

1.2.1 History

1.2.2 Markup

1.2.3 CSS3

1.2.4 JavaScript APIs

1.2.5 Related APIs

1.3 Modern Mobile Web Application Architecture

1.3.1 Single-Page applications

1.3.1.1 JavaScript MVC Libraries

1.3.2 Responsive Design

1.3.3 Progressive Enhancement

1.3.4 UI Libraries

1.3.4.1 jQuery Mobile

1.3.4.2 jQTouch

1.3.4.3 Sencha Touch

1.3.5 Hybrid Applications

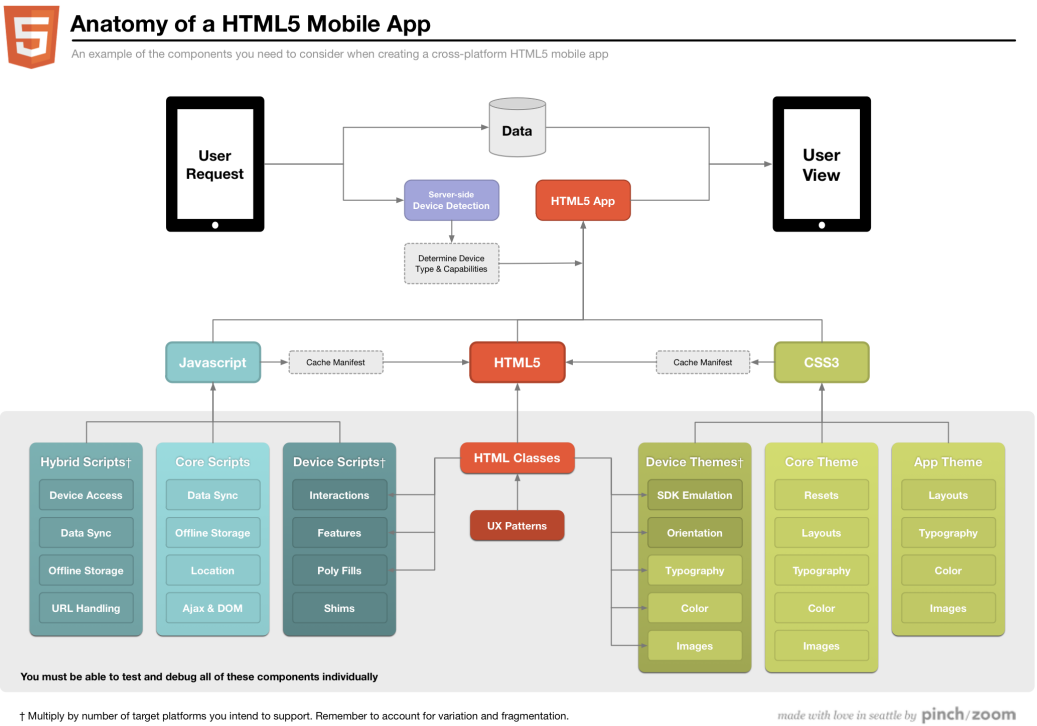


Figure 1.1: HTML5 Mobile Application Anatomy (citation needed)

1.4 Performance Guidelines

There are several web application performance best practices and related guidelines. According to Souders [7], only 10–20% of the end user response time is spent generating and transferring the HTML document from the web server to the client. Therefore, most of the optimization should be done in the frontend for best improvement opportunities. Below we list the performance guidelines defined by Souders [7, 8].

- **Make Fewer HTTP Requests**

According to Souders, 80–90% of the end user response time is spent downloading components in a page other than the requested HTML page. Therefore, the simplest way to improve the response time is to reduce the number of HTTP requests needed to get all the required components.

There are several ways to reducing the number of needed HTTP requests. Combining images into sprites, inlining images, or combining separate JavaScript and CSS files result in fewer components needed to download in a page.

- **Use a Content Delivery Network**

As web applications are deployed and become accessible worldwide, latency might become an issue for users far from the application’s web servers. Geographically distributed servers allow for serving the application as close to the user as possible.

- **Add an Expires Header**

Avoiding a HTTP request altogether is the best option for reducing the response time when downloading the components in a page. Good caching strategies help browsers to know which resources are valid and for how long until they should be updated.

The Expires header in HTTP tell the client how long a resource is valid, and especially far future Expires headers reduce the need for downloading an updating the components in a page after the initial download.

- **Gzip Components**

Compressing HTTP responses is an easy and effective way to reduce the size of the data needed to transfer across the network. Compression is supported widely in web browsers and the impact of reduced response

sizes is huge. Using Gzip, the response size is reduced generally about 70%.

- **Put Stylesheets at the Top**

Putting the CSS files to the top of the document allows the page to load progressively and the browser show visual feedback to the user as early as possible.

- **Put Scripts at the Bottom**

Because scripts block parallel downloads, they should be included to the page after all other resources. They also block progressive rendering of all content below them in the HTML document, and should therefore be at the bottom of the document.

- **Avoid CSS Expressions**

CSS expressions are a way to dynamically set CSS properties in Internet Explorer by evaluating a JavaScript code in a stylesheet. However, despite the obvious upsides, the expressions are evaluated at such a high frequency that they negatively impact the performance.

- **Make JavaScript and CSS External**

There are performance tradeoffs between making JavaScript and CSS external versus inlining them in the HTML document. In the typical case, however, making them external enables the browser to leverage the HTTP caching semantics and thus reduces the needed network transfer.

- **Reduce DNS Lookups**

Apart from cached DNS lookups, the browser typically needs 20–120 milliseconds to look up the IP (?) address for a given hostname. The cache lifetime of a lookup depends on the TTL (?) value of the DNS record and having the components of a page distributed across several domains might accumulate into a noticeable response time.

There is also a trade off between unique hostnames and allowed parallel connections and therefore these settings should be configured based on the application architecture and needs.

- **Minify JavaScript**

Because JavaScript is an interpreted language that must be sent to the web browser as source code, minifying the code reduces the required

network transfer. Minifiers and obfuscators optimize the size of the source code by stripping extra whitespace and comments as well as renaming variable and function names to shorter ones without changing the interpreted behavior of the code.

- **Avoid Redirects**

Rerouting any component in a page takes time, and avoiding any kind of redirects improves the response times.

- **Remove Duplicate Scripts**

Including a resource several times serves no purpose but is actually quite common. Developers should make sure to include resources only once.

- **Configure ETags**

ETags (?) are a mechanism in HTTP for servers and browsers to validate cached resources. The typical default values set by commonly used web servers might hurt performance, and should thus be configured properly to address the application architecture and needs.

- **Make Ajax Cacheable**

Highly dynamic web sites have a lot of Ajax (?) functionality, and developers should make sure all the requested URLs for data fetching follow the performance best practices such as having the proper caching in place.

- **Splitting the Initial Payload**

Nowadays, web sites include a lot of resources and JavaScript functionality, but only a small part of the downloaded components are used in the typical use cases of the application. Splitting the resources into bundles that can be lazily downloaded when first needed reduces the initial payload needed to transfer on application startup.

- **Loading Scripts Without Blocking**

Most browsers block the downloads of other resources when scripts are being downloaded and executed. There are several ways to circumvent this behavior to allow browsers download scripts in parallel with other resources as well as with other script files.

- **Coupling Asynchronous Scripts**

Related to the previous item, when using parallel downloads with scripts that are dependent on each other, race conditions might occur due to the varying order of download and execution. Therefore, asynchronous scripts dependent on each other should be coupled to preserve the correct order of execution.

- **Positioning Inline Scripts**

Inline scripts do not introduce a HTTP request, but they can still block parallel downloads of other resources and they might affect also the progressive rendering of the page. With the correct positioning of the scripts, these problems can be handled properly.

- **Writing Efficient JavaScript**

After networking, the obvious place to optimize the runtime speed of a web application is the JavaScript code.

Because the whole UI (?) and the JavaScript code run in the same browser thread, there can be only one thing happening at a time. Long running functions block the UI from updating and can result in bad UX (?).

Splitting the running code into properly sized chunks, appropriately leveraging the asynchronous patterns of JavaScript in the application architecture, understanding the details and slow parts of the DOM API, and using several JavaScript programming best practices can result in big improvements in the perceived application performance. [10]

- **Scaling with Comet**

For real-time data-driven applications, there are various optimization techniques related to optimizing the constant data transfer between the server and the client. The collection of there various technologies is unofficially called Comet.

- **Going Beyond Gzipping**

Although Gzipping is widely supported in web browsers, there are cases when it is not supported or when the support is not indicated. Stripping extra content such as unneeded whitespace and comments reduces the payload size for uncompressed responses. There are also ways to detect Gzip support if the client does not directly indicate that.

- **Optimizing Images**

Images typically tend to account for a large portion of the page weight, and since the page weight is highly correlated to the response time, images are a natural target for optimization. There are several ways to optimize images either with lossy or lossless conversions.

- **Sharding Dominant Domains**

By tuning the amount of unique hostnames used for serving all the resources of an application, parallel downloads can be better leveraged. Also, by using HTTP 1.0 with proper Keep-Alive headers or HTTP 1.1 with proper persistent connections the parallel downloads can be tuned for better performance.

- **Flushing the Document Early**

Some web application frameworks allow flushing parts of the document to the user before the whole document is generated. This enables progressive rendering and gives faster feedback to the user and thus improves the perceived performance.

- **Using Iframes Sparingly**

Iframes enable developers to embed a separate HTML document inside another document. They are useful in sandboxing external documents in the same view, but the iframe element is the most expensive DOM element related to the page performance.

- **Simplifying CSS Selectors**

There are several ways to choose elements in CSS stylesheets to apply the defined properties to. Some selectors are faster than others and some have terrible performance.

Chapter 2

Research Question: HTML5 - Hype versus Realities?

Chapter 3

Methods: Example Application and Library

3.1 Qt Developer Days 2011 Conference Schedule Application

The Qt Developer Days¹ is a conference for developers using the Qt cross-platform application and UI (?) framework². We created a mobile web application with contextual and personalized session information and daily schedule for the conference.

3.1.1 Application Architecture

The conference schedule³ is a single-page application (citation needed) with a lightweight backend written in Python using the Django Web Framework⁴.

The backend provides the static assets (JavaScript, CSS (?), images, etc.) and an API (?) for persisting session feedback to a MySQL⁵ relational database. It also generates the HTML5 AppCache (citation needed) offline cache manifest file based on the categorized device type.

The frontend is a JavaScript application written using the Backbone⁶ MVC (?) framework. Other used JavaScript libraries include Underscore⁷

¹<http://qt.nokia.com/qtdevdays2011/>

²<http://qt.nokia.com/>

³<http://m.qtdevdays2011.qt.nokia.com/>

⁴<https://www.djangoproject.com/>

⁵<http://www.mysql.com/>

⁶<http://backbonejs.org/>

⁷<http://underscorejs.org/>

for data manipulation, jQuery⁸ for DOM (?) API abstraction, Handlebars⁹ for templating, and Modernizr¹⁰ for feature detection. The HTML5 Mobile Boilerplate¹¹ was used as an initial markup structure for the application. The architecture of is depicted in Figure 3.1.

Wireless networks can be unreliable in conference settings, so offline support was also added using several different JavaScript techniques and HTML5 APIs.

The application was designed for touch screens on various platforms and screen sizes. The layout adjusts to the available space and provides rich interactive components. Integration to social networking services was also added as an additional functionality.

!FIXME add screenshots on different devices (at least phone and tablet **FIXME!**

3.2 JSONCache JavaScript Library

JSONCache is a lightweight JavaScript library for fetching JSON (?) data in unreliable networks. The library was designed especially to handle unreliable mobile networks with connection problems and short interruptions. The goal is to avoid networking as long as possible and failing gracefully if the network connections are not stable.

JSONCache provides two main functionalities: data caching and attempting to fetch the data multiple times.

The caching layer uses the client side localStorage (citation needed)cache of HTML5 (?). Data requests can be done using the JSONCache API (?) which always checks the local cache first before opening any network connections. If the data is already in the cache, the cached data is checked for validity and if the data has not been expired, it is returned immediately. If the data is not in the cache or it has been expired, a new network request is made and the received data is cached and returned. The expiration time of a data item can be configured in the library settings.

JSONCache also tries to fetch the data multiple times to handle small interruptions in network connections. **!FIXME add example and explain that it is very common** **FIXME!**. If a data fetch fails, a new fetch is issued after a timeout (defined in the configuration). On subsequent attempts the

⁸<http://jquery.com/>

⁹<http://handlebarsjs.com/>

¹⁰<http://www.modernizr.com/>

¹¹<http://html5boilerplate.com/mobile>

timeout is increased, and after a defined number of attempts the fetch error is issued.

Figure 3.2 shows an interactive demo of the JSONCache library. The demo¹² simulates the caching and fetching functionality of the library by simulating a unreliable network based on the configuration.

¹²<http://kpuputti.github.com/JSONCache/demo/index.html>

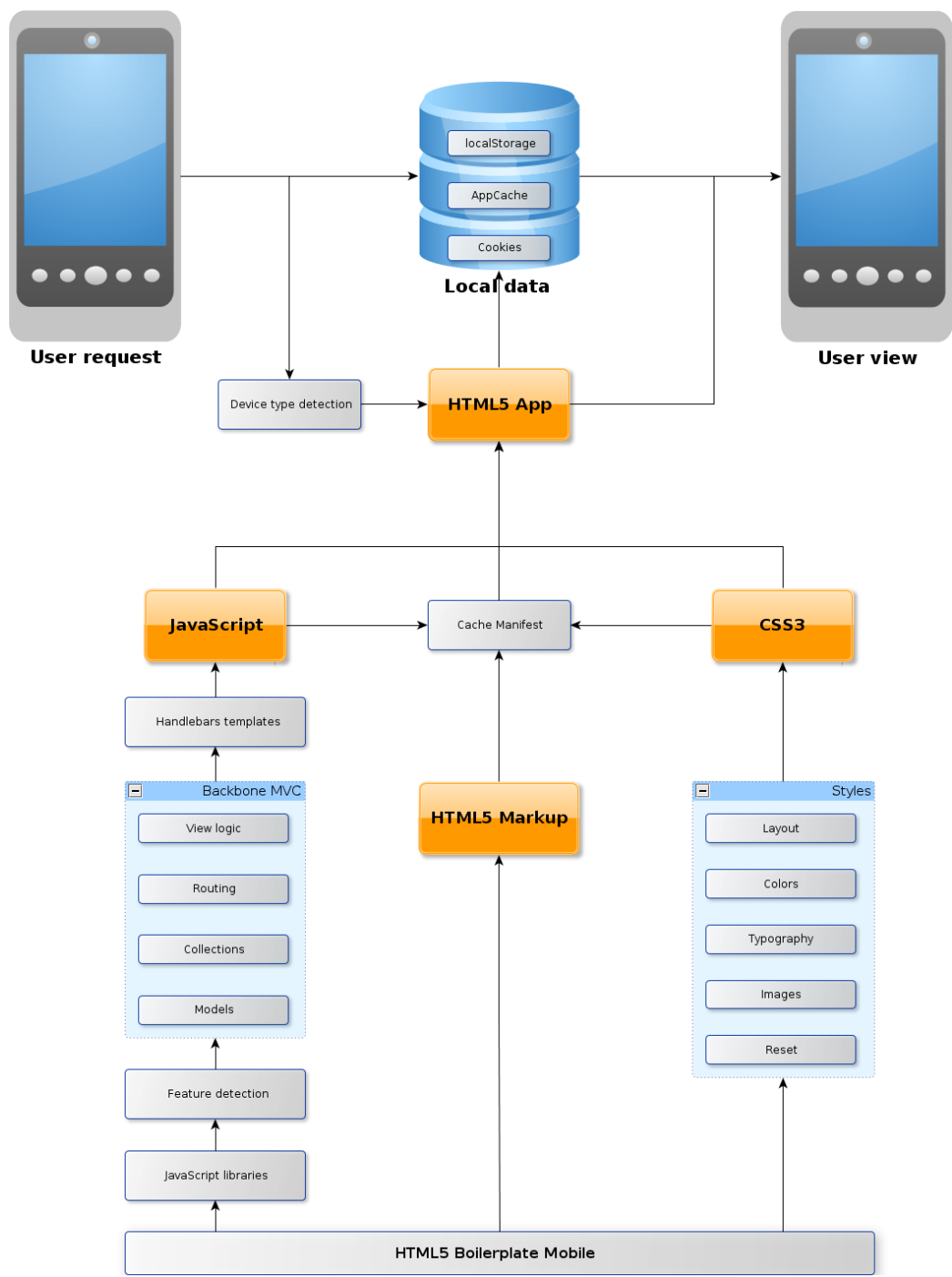


Figure 3.1: Conference schedule application architecture.

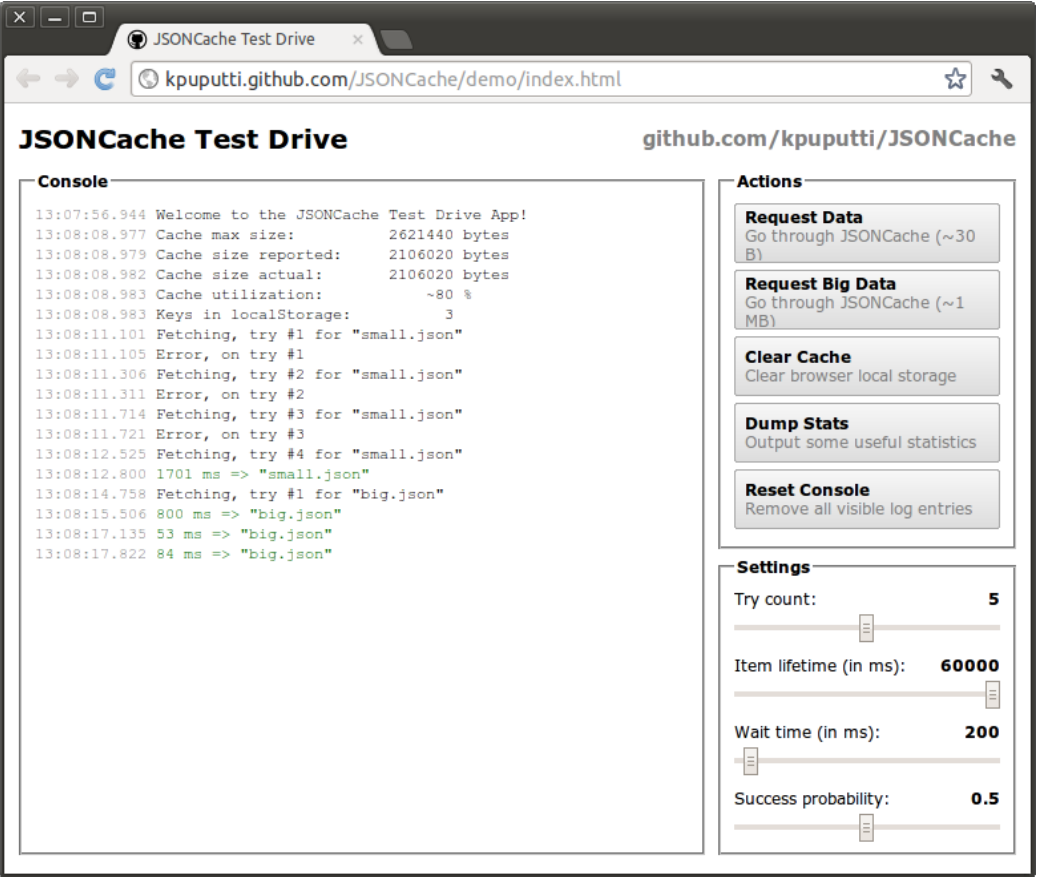


Figure 3.2: Interactive JSONCache demo.

Chapter 4

Results: What Was Good and Where Were the Compromises

4.1 Targeting Different Platforms

Despite the web browser being the unified environment for different platforms, there are lot of differences between different devices. The form factors vary from tiny mobile screens to touch screen tablets and desktop monitors and each device and platform has its own feature set. There are also known bugs in the browsers that have to handled.

Therefore, means to detect the user's device are needed. Here we present two such means: device detection and feature detection. Both of these were used in our conference application.

4.1.1 Device Detection

The User-Agent (UA (?)) HTTP (?) header contains detailed information of the web browser and platform where the request originates. As we can see from Table 4.1.1, we can extract platform and browser specific information from the UA header.

!FIXME **Check table reference numbering** FIXME!

In the conference application, device detection was used in the backend to provide a different offline AppCache manifest to different device groups.

However, despite getting detailed information from the UA header, it is considered a bad practice to detect a device from it and provide device specific bug fixes or additional features. The header can easily be changed and some browsers or browser plugins even provide preconfigured values for certain browsers or devices for spoofing. Also, the device specific bug fixes might become obsolete with platform updates, and the application might

Device	Platform	User-Agent
Samsung Nexus S	Android 2.3.4	Mozilla/5.0 (Linux; U; Android 2.3.4; en-us; Nexus S Build/GRJ22) AppleWebKit/533.1 (KHTML, like Gecko) Version/4.0 Mobile Safari/533.1
Apple iPhone	iOS 3.1.3	Mozilla/5.0 (iPhone; U; CPU iPhone OS 3_1_3 like Mac OS X; de-de) AppleWebKit/528.18 (KHTML, like Gecko) Version/4.0 Mobile/7E18 Safari/528.16
Apple iPad	iOS 5.0	Mozilla/5.0 (iPad; CPU OS 5_0 like Mac OS X) AppleWebKit/534.46 (KHTML, like Gecko) Mobile/9A334
?	Android	Opera/9.80 (Android; Opera Mini/6.5.26571/26.1023; U; de) Presto/2.8.119 Version/10.54

Table 4.1: Example User-Agent strings.

Rule	Device Type
'iPad' in UA	highres
'iPhone' in UA	iphone
'Android 3' in UA	highres
'mobile' (case insensitive) in UA	mobile
'MIDP' in UA	mobile
'Opera Mobi' in UA	mobile
'Opera Mini' in UA	mobile
otherwise (desktop computer)	highres

Table 4.2: Device type detection rules.

break due to invalid expectations. This is why feature detection is generally the recommended option whenever possible.

4.1.2 Feature Detection

4.2 Targeting Different Screens And Orientations

4.3 Handling Mobile Networks

4.3.1 Minimizing Data Transfer

4.3.2 Caching

4.3.3 Preloading

4.3.4 Offline Support

4.3.5 Handling Interruptions

4.4 Graphics and Animations

4.5 Following JavaScript Best Practices

4.5.1 JSLint

4.5.2 Lazy initialization

4.5.3 Efficient DOM Manipulation

4.5.4 Efficient Event Handling

4.6 Performance Analysis

4.6.1 YSlow

4.6.2 PageSpeed

Chapter 5

Discussion: Bright Future Ahead for HTML5

Chapter 6

L^AT_EXtest

6.1 Citing

- Berners-Lee [1]
- Mikkonen & Taivalsaari [5]
- Taivalsaari & Mikkonen [9]
- Pilgrim [6]
- Crockford [3]
- Souders [7]
- Garrett [4]
- Zakas [10]

Bibliography

- [1] BERNERS-LEE, T. Long live the web. *Scientific American* 303, 6 (2010), 80–85.
- [2] CHARLAND, A., AND LEROUX, B. Mobile Application Development: Web vs. Native. *Communications of the ACM* 54, 5 (2011), 49–53.
- [3] CROCKFORD, D. *JavaScript: The Good Parts*. O'Reilly Media / Yahoo Press, 2008.
- [4] GARRETT, J. J. Ajax: A New Approach to Web Applications. *Adaptive path* 18 (2005). Available at: <http://www.adaptivepath.com/ideas/ajax-new-approach-web-applications>. Accessed 5-January-2012.
- [5] MIKKONEN, T., AND TAIVALSAARI, A. Apps vs. Open Web: The Battle of the Decade. In *2nd Annual Workshop on Software Engineering for Mobile Application Development* (2011).
- [6] PILGRIM, M. *HTML5: Up And Running*. O'Reilly Media, 2010.
- [7] SOUDERS, S. *High Performance Web Sites*. O'Reilly Media, 2007.
- [8] SOUDERS, S. *Even Faster Web Sites*. O'Reilly Media, 2009.
- [9] TAIVALSAARI, A., AND MIKKONEN, T. The Web as an Application Platform: The Saga Continues. In *Software Engineering and Advanced Applications (SEAA), 2011 37th EUROMICRO Conference on* (2011), IEEE, pp. 170–174.
- [10] ZAKAS, N. C. *High Performance JavaScript*. O'Reilly Media / Yahoo Press, 2010.