

BEST PRACTICES FOR CREATING WEBSITES OPTIMIZED FOR MOBILE DEVICES

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Abstract

In recent years, we witness increased mobile devices usage. Even though mobile devices has become seemingly powerful, they are still relatively limited compared to mainstream desktop PCs and laptops. Due to a number of differences in software and hardware, difficulties in a proper display of the website content, on different devices, started to occur even more often, and therefore necessity of delivery of diversified websites content has become fact. As a result, the issue of website optimization for mobile devices, has emerged. The aim of the paper is to present a proprietary method of creating optimized mobile websites. As understood, optimized webpage is a project that combines both technical features such as speed, limited amount of downloaded data and attributes as particularly relevant to the user, such as usability and readability. The proposed method, in the form of a set of rules can be helpful for developers of websites during the process of adapting their services for mobile devices. The creation of such a method requires analysis and testing of existing solutions. Selection of the most optimal solution was done on the basis of statistical and empirical methods. Based on the results of this study, the authorial method of implementing optimized websites and sample service was created and described.

Keywords - Mobile devices, best practices, display & load time optimization.

1 INTRODUCTION

Year after year processors are getting smaller and have better parameters and hence better and better performance. Batteries have overlong life time. Various sensors are cheaper and more sensitive. Phones are well designed, robust and reliable, which brings excellent user experience. All of these reasons make mobile devices more and more popular. It can be said that nowadays almost everybody has a handheld, a smartphone or a tablet. Interestingly these devices were accountable for more than 10% of web traffic in 2012 [11]. That paper can be proved by statistics, which show that there are over 6 billion mobile devices around the world, growing 45 percent annually for the past years [4].

The wide group of potential customers has made mobile devices market an attractive area for businessmen and developers. The easiest and the most effective way to distribute information and sometimes even a product are to share them via the Internet network. With introduction of the 3G networks, handhelds have an easy and fast Internet access by Wi-Fi or mobile network. People can browse standard websites and use some services, although they are designed for desktop users.

However, sometimes it is very hard, because there are a lot of differences between mobile and regular user behavior and the used equipment. While a desktop computer owner is static and can put almost 100% of attention to the current task, a mobile user is almost all the time on the move. He is waiting for a train, doing the shopping, chatting with someone; therefore he can be easily distracted. That fact forces the designer's different approach while creating mobile optimized solutions. User interface should be clear and easy to use without any instruction. Tasks should be performed with a minimal number of interactions [1, 3]. It is better to provide it with a few readable functions than tons of features which will never be used, because of their maladjustment.

Unfortunately, this piece of advice is only the tip of the iceberg and the whole topic of optimizing of mobile devices for the user expectations is very wide, and presented in various publications [1, 3, 5, 6, 7] that deal with various aspects of optimization. In this paper the focus will be put on optimizing websites, which are a sort of companies' business cards and require special attention.

2 AUTHORIAL METHOD OF OPTIMIZATION

2.1 Server side optimization

Server is the basic element of the website and preparing it to the optimal work at the beginning saves a lot of time. Caching mechanism implementation accelerates the development and testing phase. Device recognition and client redirection automates the process of choosing correct version of website for the given device. The full process of server side optimization is visualized in a form of block diagram presented on the Figure 1.

A. Detection of device's type and parameters

Device detection is probably the most important server-side feature of the mobile optimized website. Without it, there is no point in creating various versions of webpage, because always the same one will be displayed. Thanks to the mechanism of device type detection, a developer can divide the set of handhelds into a few categories basing on their parameters and redirect to the appropriate version of website.

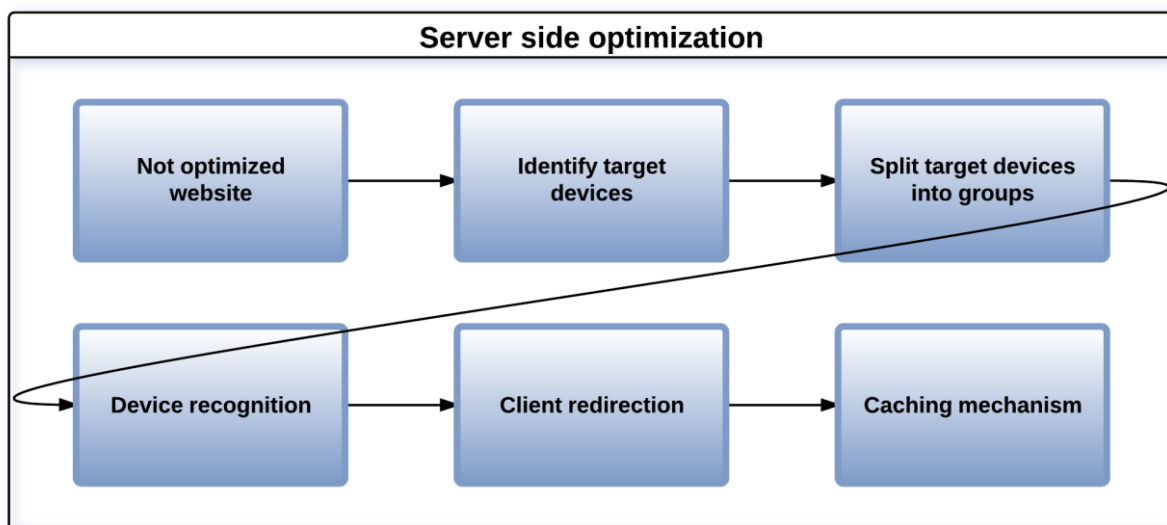


Figure 11. Server side optimization block diagram

A webmaster has to make his choice between various technologies providing device detection support. Let us focus on two, in our opinion, most interesting ones: Device Atlas and WURFL. The comparison is presented in the following table (Table 1).

Table 11. Device Atlas and WURFL comparison

	Device Atlas	WURFL
License	Commercial	Open-source
Data format	JSON	XML
Data source	Vendors, Producers, WURFL	User community
Data structure	Hierarchical and grouped by parameters	Hierarchical and grouped by parameters
APIs	Java, PHP, .NET, Python, Ruby	Java, PHP, .NET, Perl, Ruby
Created by	dotMobi organization	Open-source community
Other	Claims to be the fastest and the most precise tool	Configurable by patches Over 500 capabilities for each device.

Device Atlas is the commercial product of dotMobi organization and is created for enterprises with cooperation of mobile vendors and device producers, while WURFL is the open-source data base

supported by the large community. Both of them use hierarchical data structure, devices grouped divided by the parameters and an extensive range of supported APIs. Thanks to that, they can be easily installed on the server and used by almost every web administrator.

Those solutions have some pros and cons and it is hard to clearly state which the best one is. It should be fitted to the webmaster's expectations. After testing both technologies, WURFL has been chosen. It is easy to install, deploy and configure on the popular PHP server. It works flawlessly with the tested set of handhelds. It detects every phone and its most important capabilities very fast and without errors.

To make use of the device recognition mechanism, a webmaster has to divide handhelds into a few categories and create various versions of mobile optimized webpage for them. WURFL script will redirect the user to the most suitable one, basing on the given setup. For the purpose of this paper devices have been categorized into four groups, based on their capabilities:

- *Desktop devices* - a group for traditional web browsers installed on desktop personal computers, laptops or notebooks. There is no need to optimize a website code for them. Therefore the device detection mechanism redirects the user to the rich version of webpage with all features and a full version of resources.
- *Smartphones* - the category of the most sophisticated handhelds available on the market. It is mainly occupied by the devices with touch screens and some mobile operational system like Android, iOS, Windows Phone or Blackberry. Those mini computers have great computing power, large screens and support for JavaScript and Ajax. Therefore users want to get a great user experience and take advantage of the capabilities of that equipment. To become the part of that group a device should be marked as mobile, support XHTML Mobile Profile, JavaScript and Ajax technology.
- *Regular phones* - a group for the handhelds with intermediate capabilities. They have average computing power, moderate screen size and various input modes. Therefore the website should be lightweight and easy to use. A typical user wants to get information quickly and in the readable and clear format. It means that JavaScript and Ajax are not used as well as a lot of heavy resources. To belong to that category a device should meet the following requirements: be a mobile device and support the XHTML Mobile Profile.
- *Feature phones* - the category for handhelds with a limited number of features. Usually they have small displays and low computing power. A website should be very simple and lightweight and contain a limited number of functionalities. A webmaster should avoid using scripts, resources and even CSS style sheets, because they can be not supported. This group is created for the oldest devices, which do not support XHTML Mobile Profile and JavaScript.

B. *Best practices*

The operation starts from the desktop version of website. The next step is to identify target devices, the most popular handhelds, which are about to be supported. The information about device type is contained in the user agent header. Webmaster can gather the statistic about the regular visitor's phone models from it. Developer can also browse statistics available in the Internet about the ongoing trends and make the choice basing on them.

The next step is to split target devices into groups based on their capabilities. For each class dedicated version of website will be created in later part. While choosing the group for particular handheld, following features should be considered: input methods, display size, processing power and supported technologies, especially JavaScript, Ajax, Flash and markups languages. It is good to split devices into maximum four or five divisions, because the bigger amount will be very hard to maintain in the later time. The best choice is to create a version with JavaScript usage and without it. Additional one for the smartphones with extended functionalities and rich interface. Very lightweight version for the oldest handhelds is also useful. It is good practice to make additional webpage for the tablets, because their popularity is growing very fast.

Once the groups are prepared it is time to create device recognition mechanism. WURFL is the optimal tool for performing this task. It provides a set of methods for defining handheld's functionalities for example `getCapability('is_wireless_device')` for checking if device is mobile or `('ajax_support_javascript')` in order to indicate if handheld support JavaScript. Basing on the output of those methods device is assigned into particular group. Having separated handhelds classes the client redirection mechanism should be added by changing the location parameter in the header.

The last part of server size optimization is implementation of caching mechanism [2]. For detailed description please see "Caching Tutorial for Web Authors and Webmasters" [10]. The basic setup with cache control parameter set to public, must revalidate flag to true and with five minute expiration time should be sufficient for the most of websites.

2.2 Usability optimization

The next phase is usability optimization, which is presented on the figure 2, in form of block diagram. This stage is starting with design of the website version for each device group. In each case designer should base on the set of principles contained in the subchapter below. In addition he should also consider the handhelds capabilities and choose appropriate components to them.

A. Usability

Usability can be defined as the extent to which a product can be used by specified users to achieve specified goals quickly and effectively. Usable software is easy to use and learn. It means that a user takes less time to accomplish a particular task and is more satisfied. It has become a very important issue in software design and development.

Mobile websites usability is presented and compared on selected examples from most popular international and Polish portals. Firstly, let us consider some examples of wrong practices as far as leading information portals are concerned.

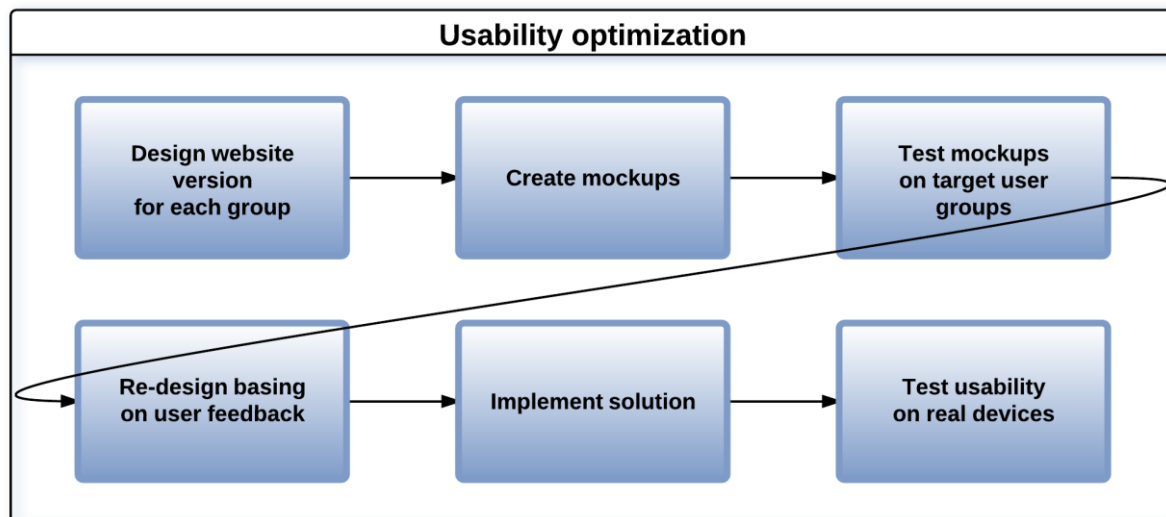


Figure 22. Usability optimization block diagram

Browsing "thetimes.co.uk" website is extremely hard for handhelds users because this portal favors the usage of mobile application in order to read it. When used for the first time it prompts to download the application, and when the user declines it, he has to browse the traditional website. A desktop version is almost unreadable for the smartphone users. It contains a lot of information and features, but it is hard to distinguish even the headlines. The input fields and tabs are too small, which makes them almost impossible to select. In addition, there are a lot of heavy-weight resources such as video or large pictures, which consume a lot of valuable bandwidth. In order to ensure a high level of usability and user experience, a mobile optimized website should follow the practices presented in the Table 2.

B. Best practices

The best way to design user interface is to create a mockups in form of sketches with the particular website pages. Such a solution should be tested on the target user groups in order to check whether it is intuitive and hence usable. Basing on the given feedback graphic user interface should be re-designed and after that it is ready for the implementation step. When views are created and are working fine, it is good practice to test it one more time on the target user group. It is always different to use mockups and real devices, therefore user experience can be different.

2.3 Source code optimization

The last stage in adjusting website to the mobile Web is source code optimization. It is the most complex and time consuming part and it requires a technical knowledge. Webmaster should keep in mind all best practices presented below.

The starting point for the analysis of the mobile websites technological aspects is the home pages of two competing organizations which are creating mobile Internet standards - W3C and dotMobi. Although their standards differ in some areas, the message is the same: optimizing not reducing the content, using mobile profiles and the most important one: testing, testing and once again - testing on various devices.

Table 22. Best practices for creating a usable mobile optimized website

Desired feature	
Menu	<ul style="list-style-type: none"> • The most important feature should be the first one. • Small menu bar at the top with only a few hyperlinks. • Links should be large and distinguishable, to avoid miss click. • Present a link in a graphical form, which is more intuitive for the user. • Use numerical shortcuts for the devices without touch screens.
Content	<ul style="list-style-type: none"> • Only the most important information. • Large and readable fonts. • Short links. • Distinguish the most important elements by the color or bolded font. • Use clear, short and concise terms and sentences. • Avoid repeating elements such as 'Help' or 'FAQ' on every page.
Features	<ul style="list-style-type: none"> • Not many advertisements or none. • Do not port all the functions of a website to a mobile. • Minimized amount of clicks to get to the content. • Not exceed 10 links per page. • Enable one-click calls for phone numbers. • No splash screens. • Do not require that user's login each time. • Do not mask user input when entering a password. • Navigation mechanism home/back link at the end of a page.
Layout	<ul style="list-style-type: none"> • Link or switcher to the traditional version. • Content takes a 100% of the screen width. • Content should be scrollable only vertically. • Lack of unnecessary elements. Present it in another way. • No large graphics and multimedia. • Limited whitespace.

A. *Technological aspects*

The suggested and most popular markup language is the XHTML MP for the 95% of handhelds and WSDL for the older feature phones [8], however the future may belong to HTML5, which is gradually being introduced. JavaScript is enabled in the majority of web pages, however the mobile optimized version is not always used. The situation is the same for the CSS style sheets.

There are a lot of differences between the traditional version of "thetimes.co.uk" and other mobile optimized sites. Starting from the markup language, through the lack of device recognition and ending with no code optimization. But the most important one is the extensive content due to which the size of the website is almost 1.5 MB. It is 10 times larger than the biggest mobile version and has too many requests. It all makes "thetimes.co.uk" very inconvenient for mobile devices. This site cannot be even validated by the W3C and dotMobi services.

The rest of the tested websites have a lot in common. They are using CSS 2.1 style sheets, have enabled JavaScript and are using graphics in JPEG format. Developers sometimes try to reduce the size of the website code and resources by optimizing the code, reformatting the images and disposal of multimedia. They recognize devices and adjust the webpage version to the user's needs and use caching to save time and bandwidth.

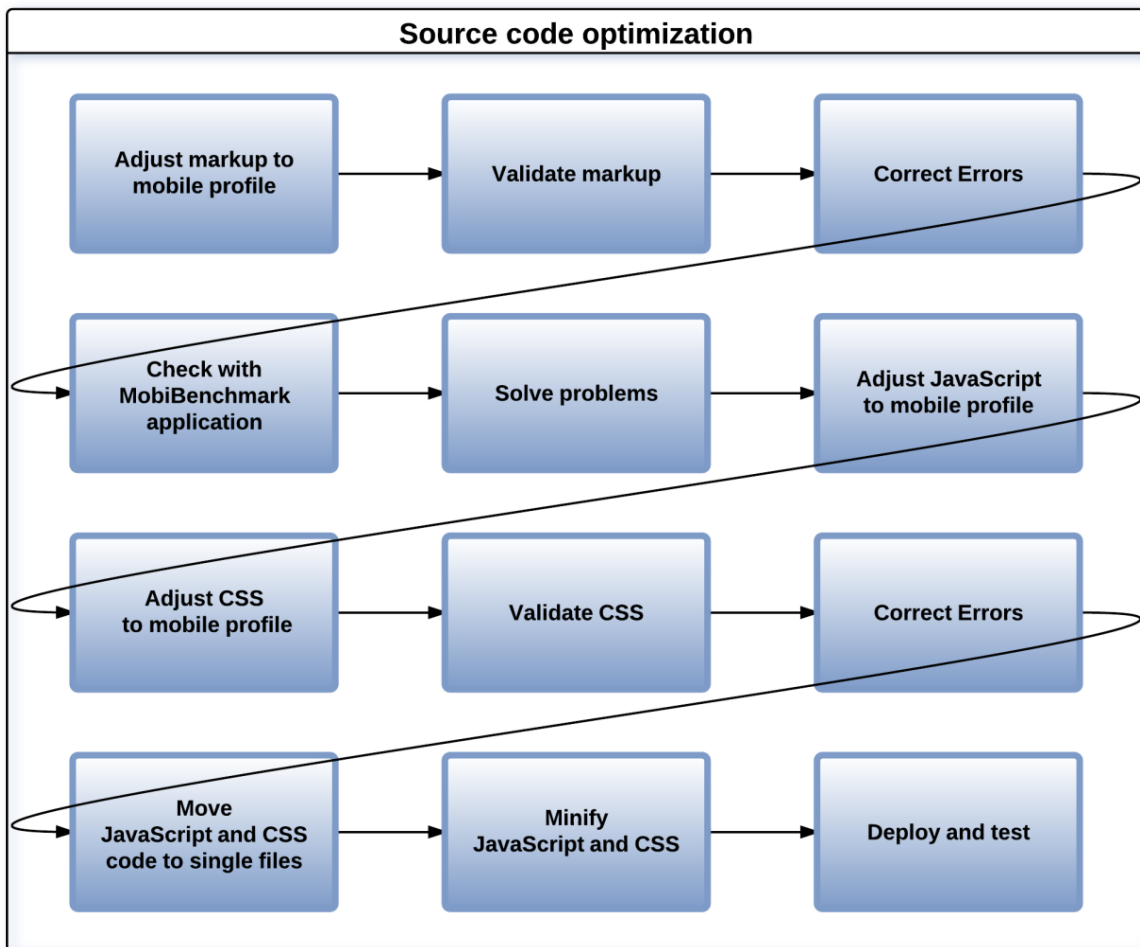


Figure 33. Source code optimization block diagram

On the other hand, the mobile optimized websites also do not pass the mobileOK and mobiReady tests. They have received very poor results. The main reason for this is the lack of validity of the markup languages, which have a lot of errors.

The best example of a mobile optimized website is "google.com", which received a perfect score in the mobileOK and mobiReady tests. It succeeded in passing a validity test of markups, combined with a great code optimization, which allows rendering this webpage with only 3 requests consuming only 6.2 KB of bandwidth. In addition, the expanded device recognition mechanism with the optimization for various device types provides a great user experience. Localization services and advanced personalization provides a high level of usability. A user does not need to login every time or input a lot of data while searching for some information, because "google" guesses for him. All of these features would not be usable without the rich caching mechanism, which makes it work very smooth and fast. To sum up, in order to ensure a high level of optimization, a mobile website should follow the technical practices presented in the Table 4.

B. Best practices

The best practice is to start with changing the doctype into the mobile profile and validates it with W3C validator. It shows the parts which are not supported by the mobile version of markup language as an errors. Those markups should be replaced by the mobile equivalents. Very often validator shows the correct tag in the error description as a hint. In other case developer should check it in documentation. Once all problems are solved, document should correctly pass the markup validation.

Afterwards website should be checked by the MobiBenchmark application in order to find out other problems for mobile users. Program lists features which are not consistent with the best mobile optimization practices and presents them as an error or warning, depending on the priority. After solving those problems it is good to look at the "Advices" tab, read provided information and consider introducing advised changes. At the end developer should receive a website which is downloading and loading very fast and has a high rating from the W3C's mobileOK validator.

Table 33. Technical comparison of popular websites

	The Times	The Guardian	Google
Markups	XHTML 1.0	XHTML MP 1.0	HTML 5
Validity (Bugs)	False (28)	False (45)	Passed
CSS	CSS 2.1	CSS 2.1	CSS 2.1
JavaScript	Enabled	Enabled	Enabled
Size	1425 KB	50 KB	6 KB
Code optimized	No	Yes	Yes
Graphics format	JPEG	JPEG	JPEG
Requests	80	18	3
Multimedia	No	No	No
Device recognition	No	Yes	Yes
Caching	Enabled	Enabled	Enabled
mobileOK rank	-	29 %	100 %
mobiReady rank	-	1.54	4.95

The next step is to adjust JavaScript into the mobile profile. This is about removing unsupported methods and heavy resource consuming operations like animations or transformations. In addition operations, which are running in the background, like for example auto refresh, should be disposed as well. Those operations can extend the battery life time, which is very important factor in the mobile devices. It is also very important to create website, which is working fine even with disabled scripts, by providing "no-script" blocks implementation with alternative behaviour.

Mobile optimization of CSS stylesheets is similar to the adjusting markups code process. However at the beginning developer should remove all in-line styles and inheritances. Then use W3C stylesheets validation tool. Results shows all elements which are not supported by the mobile profile subset. They should be replaced by their equivalents. It is also good practice to make website readable even without stylesheets, for devices which are not handling CSS at all.

When all components are consistent with the mobile profile and validation is successful it is time for post processing. First part of that task is to reduce the number of network requests by moving all JavaScript code into the single file. The same job should be performed for the CSS stylesheets source

code. At the end all documents should be minified using YUI compressor for markup and CSS files and jscompress.com tool for JavaScripts. It makes website download faster and hence display faster.

Table 44. Best technical practices for creating a mobile optimized website

Desired feature	
Markups	XHTML MP or HTML5 and/or WML. Validity should be ensured by following web standards and checking website in the validator.
JavaScript	Enabled – without using heavy resource consuming operations or operations in the background like auto refresh. Website should work fine with disabled scripts.
CSS	CSS 2 - using mobile profile subset and inheritance. Avoid in-line markups. Website should be readable without style-sheets.
Size	Without graphics it should be max 20 KB per page.
Code optimized	Yes. See the next subchapter for details.
Graphics format	JPEG/PNG + specified, not large sizes.
Requests	Minimized by putting all CSS style-sheets code in one file and the same for JavaScript code.
Multimedia	Should be avoided.
Device recognition	Works on server side and automatically redirects user to appropriate version of website, optimized for his device type.
Caching	Enabled with expiration time, not consuming a lot of data space. Remember user authentication and settings. Provide default values based on localization services.
MIME types	The MIME types sent by servers give important information to browsers as to how to treat a document and help to render it.
Character encoding	Non-English characters may display incorrectly on certain devices if the character encoding is not provided. Use UTF-8, it ensures that pages render correctly on devices.
Transcoders	No-transform directive should be included in order to disable proxies and transcoders. They can modify websites content without developer's knowledge.

Once the optimization process is done, website is ready to be deployed on the server and testing in the production environment. Thanks to the W3C validator and MobiBenchmark application the most of errors were detected in the previous phases, but it is always good practice to execute more restrictive check for final product. Webpage should be tested on various browsers and devices with varied capabilities. Examination should be performed by several users, because everyone has different approach to some tasks and diversity on this level helps with finding out more problems. It is also good practice to check how website works on network with different bandwidth, because it can seem to render very smooth on one network, but another one with high latency can show their weaknesses and even errors. Afterwards if there is no major problems, webpage can be published and developer can be proud of the well mobile optimized product.

3 CONCLUSION

Mobile websites optimization is a complicated and complex process, but it definitely worth it. The performed tests proved that a well-designed and implemented webpage can achieve much better performance on the handhelds. The performance means all the factors like reduced download and loading time and usage of resources like network data transfer and battery life time. In addition, the user experience and usability are also crucial factors in the world of mobile internet, because the

user's first impression can be his last, which indicates our failure. To avoid it, we should follow the guidelines provided by reputable organizations like World Wide Web Consortium or mobiReady.

Table 55. Guidelines for creation websites optimized for mobile devices

Avoid	Instead Use
One version of website	Many versions of website for various devices
Porting all functionalities	Only the most important for mobile user
No device recognition	Device recognition based on various factors
Desktop markup languages	Mobile optimized markup languages
Invalid markups or CSS	W3C Validated markups and CSS
Heavy resource consuming JavaScript	Lightweight JavaScript
In – line CSS markups	CSS in one separate file
Large and not optimized source code	Post processed source code
Bitmaps and GIFs	JPEG and PNG graphics
Large graphics	Compressed and average size graphics
Transcoders	Use no-transform directive
A lot of network requests	Put all JavaScript/ CSS code in one file
Lack of caching	Caching mechanism with expiration time
Not specified MIME types	Sent MIME types to help render website
Exotic character encoding	UTF-8
Small hyperlinks	Distinguishable buttons and access keys
Show everything you got	Present only the most important things
Small fonts and similar colors	Large font and contrasting colors
A lot of advertisements	No advertisements or mobile versions
Splash screens and popup windows	Present information in website content
Navigation mechanism on top	Navigation home/back at the end of page
Horizontal scrolling enabled	Only vertical scrolling should be available
Require to login each time	Remember the user
Lack of geolocalization data usage	Use geolocalization to hint user
Multimedia	Small graphics with JavaScript transitions
A lot of white space to separate content	Separators instead of white space
Lack of no-script block	Alternative markups for the users not using JavaScript should be provided

It is almost impossible to memorize all best practices and principles; therefore a webmaster should use some helper tools in order to create a well-optimized mobile website. The full list of best practices from the technical point of view is presented in Table 4.

Technical issues are the one thing, but a webmaster should first of all focus on the user's needs and expectations. Creating use cases and designing user interface should be performed before the implementation phase. It is also a good practice to make mockups of the website and present it to potential clients from the target group and check out their feelings and reactions. Thanks to that a developer can collect a lot of valuable feedback. Having this in mind at the beginning of the project lifecycle it creates an opportunity to save a lot of time, because the development resource consumption grows exponentially. After creating a list of desired functionalities, a mobile web developer should focus on delivering them in the easiest possible way.

Nowadays the internet is full of websites which are a real nightmare for the mobile devices. They do not render correctly, are not usable and contain a lot of errors, which have a large impact on the performance and the resource consumption. A mobile web developer should avoid the worst practices presented in the left column of Table 5 and replace them with better methods showed on the right. Mobile Web developer should get familiar with that list before designing the website. It would definitely help to make World Wide Web a better place for the group of users, which are always on the move.

Obviously not all of those practices fit to every kind of website. Some web pages should have rich graphics, which will gain user attention. It is especially important for the showcases and advertisements like in portals about commercial product or advertising agency. On the other hand website providing services for the mobile user should be lightweight to work faster and more robust. For example there is no need to add fancy graphics to the webpage with bus timetable. Summarizing web developer should consider all of those practices in a scope of his own project, because in the mobile web world there is no place for compromise.

A mobile website has a great advantage over dedicated one - it requires neither downloading nor installing. It can be displayed by simply mobile browser and it will be always faster than getting application from the mobile programs store. In addition mobile website does not occupy the device storage (only some data for cache). Limited storage capacity is still problem for many smartphones.

The biggest advantage of the mobile websites is portability. They are available for each kind of device, which have mobile browser supporting used markup language and other technologies. There is no requirement to have specific operating system installed on the handheld. One version of website suits all Operating Systems. It means that there is no need to create several dedicated applications.

Those kinds of programs cost more than mobile websites. Creating of such applications requires the knowledge about specific operating systems and programming language. Therefore applications are much more expensive than web pages. Despite that dedicated programs are better optimized for the mobile devices users, in authors' opinion they will be suppressed by the rich websites. Maybe the HTML5 will be the technology for creating such web pages or maybe some new solution will be invented. Anyway it will be faster and cheaper to create mobile optimized website, than a bunch of dedicated applications. Summarizing in our opinion the mobile optimized websites have a bright future. Webmasters should take care about mobile visitors and create a perfect environment for them, because it simply pays to.

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