Mobile internet costs of web advertisements

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ABSTRACT
Browsing the internet with an iPad, Tablet PC or phone with mobile internet is becoming a real trend. Mobile internet providers sometimes offer data plans, but if the data limit of a plan is reached, a prepaid plan is used or a user is roaming, a user will pay per data traffic produced. Advertisements can be seen as a cause of unwanted data traffic raising the bill of a mobile internet user. In this paper the amount of data traffic and costs of web advertisements for an average user will be investigated.

For this purpose the behaviour of an average user was simulated while measuring the total data traffic when advertisements were and were not blocked. The results show that web advertisements take up between 7% and 9% of the total data traffic produced when an average user is only browsing the web. This depends on whether Flash is or is not used. When a user is roaming, data traffic costs increase about 6 or 9 times the normal costs, which makes roaming users pay a lot for web advertisements.

Keywords
data traffic, costs, mobile internet, advertisements, websites, Flash, iPad, tablet PC

1. INTRODUCTION
Mobile internet is an upcoming trend for users of mobile devices such as PDAs, mobile phones, tablet PCs, etc. [9]. Just like with web browsing on a PC, these mobile users will load web pages with advertisements. Apart from annoyance, they cause data traffic. When mobile users do not have a (large) data plan, they pay per amount of data traffic they produce. If advertisements produce a big amount of data traffic, this means a mobile internet user pays a lot of money, simply for loading advertisements.

Some providers, like in the Netherlands and the United States (US) offer flat fee data plans that offer mobile internet users a relatively cheap rate. At the moment there is a lot of fuss going on about providers wanting to reduce or even stop offering these plans, as these plans cost the providers more money for investments in the infrastructure than the plans bring in [26]. Also, when mobile internet is used outside the provider’s base country (roaming), these costs are usually much higher than when using mobile internet domestically (in the provider’s base country) and often are not included in regular flat fee data plans.

There are some plugins for browsers available, such as Adblock Plus [16] and Opera’s URL filtering [19], but these are often not available for PDAs, mobile phones or certain browser variants. As a consumer’s mobile internet usage depends highly on the cost models of mobile internet [18], it is meaningful to investigate whether the amount of redundant data traffic (and thus costs), produced by advertisements on web pages, is significant.

1.1 Specific problem
Advertisements on websites are increasingly making use of rich media content [12]. This means that more and more advertisements make use of video, flash, javascript and DHTML content and other ways of making advertisements interactive and dynamic. These rich media advertisements require a lot more data to be downloaded compared to more traditional ways of web advertisements, like animated GIFs or text-based advertisements. More (advertisement) data that needs to be downloaded means more costs for the mobile internet user. This, again, leads to a decrease in mobile internet usage [18]. Certain (mobile) browsers might not support all rich media advertisement formats like Flash [1]. Though, in this case this content can and will not be downloaded.

1.2 Related work
Roto et al. [18] looked that how mobile internet costs influence the experience users get of mobile internet use. By questioning and observing their research participants they found there is indeed a relation and also the type of billing model (for example pay per data transferred, pay per time online or flat fee) affects the user’s mobile browsing behaviour.

Simons [19] had a different look on web advertisements. His research was about the influence of web advertisements on the energy consumption of a computer. By emulating the browsing behaviour of an average internet user and using several blocking tools for web advertisements he found that web advertisements add an additional energy consumption of 2.5 Watt for an average user.

1.3 Research questions
To outline the research to the costs of web advertisements, the following research questions have been defined:

1. Do web advertisements take up a significant amount of data traffic?

The answers to this question can be found by measuring the difference in data traffic generated when browsing the
web with and without web advertisements. Whether this amount is found to be significant is a bit abstract, but we think if the advertisements take up more than about 5% of the total data traffic, the amount is significant.

2. Do these amounts vary per browser (and mobile device used)?

The same approach of research question 1 can be adopted, but different browsers will be needed to run the same experiment.

3. Is there a significant difference in web advertisement data traffic when Flash is or is not enabled?

Using the same browser, again, this experiment can be run. For finding whether there is a difference in data traffic, the same experiment should be run for the browser with Flash enabled and another run with Flash disabled.

4. How much money do web advertisements cost mobile internet users browsing the internet?

Whether web advertisements cost mobile internet users a lot depends on the contribution they have to the total data traffic produced when browsing the internet. Results of the previous research questions can be used for these calculations. Also, the costs web advertisements currently cost mobile internet users can be derived when finding the current rates providers charge their customers.

In the next section the approach to the experiment will be explained. The choices that had to be made for the experiment will be discussed here as well. Section three presents the measurement results of this experiment and shows how the average rates for mobile internet were calculated exactly. The section thereafter will discuss the measurement results and the assumptions made in this paper. In section five conclusions will be drawn and the research questions will be answered. Finally, this paper ends with some subjects for future work in the area of this paper.

2. EXPERIMENT APPROACH

This research will attempt to find the average costs of web advertisements when browsing on the mobile internet. The approach of this research is based on the research questions defined in the section above and are used as a guideline for outlining the research approach.

2.1 Do web advertisements take up a significant amount of data traffic?

The approach to answer this first research question is to set up a test environment for making measurements of data traffic when browsing to web pages an average internet user would do. If the same browsing behaviour can be emulated a second time without advertisements loaded, the difference in data traffic produced between the two emulations is exactly the amount of data traffic web advertisements take up. When comparing these data, significance of the web advertisements data traffic can be determined.

2.1.1 Advertisement blocking

First of all a method for blocking web advertisements is needed. There are several methods available for this purpose. Most methods make use of at least URL filtering, which means advertisements are blocked based on their URL (prefix). The Opera web browser [14] includes this feature by default, but has no default entries in this filter.

Most advertisement blocking solutions include more complicated methods such as css- and JavaScript-based filtering. The Adblock Plus plugin for Mozilla Firefox [16] for example. As the dependency of the type of web browser is also investigated in this research, browser-specific advertisement blocking solutions are no option.

Another method frequently used is filtering by using a proxy server. A proxy server is a computer that can receive website retrieval requests from other computers, like the second computer in the test environment, and will perform these website requests by itself and receives all website data, which it will pass on, again, to the other computer that requested this data in the first place. Because all data passes the proxy server, it can simply measure all data traffic that is going to the other pc. Also, this data can be modified by the proxy for, for example, advertisement filtering.

Proximodo [3] is this kind of proxy server that filters based on a URL blacklist. Unfortunately the program is not further developed and out of date. Privoxy [17] is a better proxy server that also filters based on these more complicated methods described above. Then, there is also the possibility to convert an Apache web server to a proxy server by the "mod_proxy" module [2], but it takes a lot of time and specific knowledge about Apache web servers to create a well working proxy server out of this, so the latter is also no option. This leads to the choice of Privoxy as advertisement blocking method.

The test set-up that is used for the measurements will therefore consist of a computer that will emulate a normal internet user’s browsing behaviour and a second computer that will serve as a proxy server. This second server will also measure the data traffic that goes to the other computer. Also in the cases we do not want to filter out web advertisements for measuring purposes, we will use this proxy server as it can also be configured not to filter out advertisements.

2.1.2 Browsing behaviour

It is assumed that the browsing behaviour of mobile internet users is about the same as that of "normal" internet users. This is a big assumption, but there are no behavioral studies available about specifically mobile internet users. Therefore URLs of web pages that are visited on average daily basis will have to be found out. It is found that simply looking at website rankings for most popular websites is not sufficient, as website rankings only link to the home page of these popular websites, while on average users open more pages than only the home page of a website.

According to Simons [10] a good way for obtaining a list of web pages that are often loaded is looking at the most popular posts on Digg.com. This is a community website that allows its users to post links to websites with content that the users find interesting [8] and thus gives a good reflection of web pages loaded on average by these users. Digg provides an API (application program interface) based on the PEAR package of PHP for retrieving their content. This gives also the option to retrieve XML-files containing the top stories. Using this option the top 100 stories can be retrieved. Filtering out the URLs of these stories results in a list of URLs an average internet user would browse to.

Next to the URLs, also the average time spent on these web pages needs to be found, as some "heavier" rich media advertisements might need some time to load. There has
been some research on the average time a person stays on a web page. This concludes that a pageview lasts on average about 12 seconds, but this result also includes pageviews of non-interesting web pages, which a user might accidentally navigated to or made a mistake. These pages will be loaded, but will be viewed for at maximum one or two seconds. This research assumes that the web pages visited by the average users are all pages of interest for the user, and thus no pages will be loaded by accident and all pages will be viewed for about the same time as all pages are of the same interest rate for the user.

Based on these assumptions the average time spent on each web page must be higher. There is no literature available that writes about the average time a user views a web page, when all pages are of interest to the user. The program that is used for browsing emulation (see the section below) has 30 seconds set as default setting for having each web page opened. This default setting is also set for our measurements.

While 30 seconds might not be a good value, it is of little importance for our measurements. Within this interval each website can be loaded perfectly. The only problem that could occur is that some advertisements that are reloaded every several seconds on a web page, but the amount of websites that include this kind of advertisements is very limited and therefore not of great influence on the measurements results.

### 2.1.3 Browsing emulation

For emulating a user’s daily browsing behaviour the AutoBrowse program, written by a colleague student, will be used. This is a JavaScript tool that loads in any present-day web browser and can load a given list of URLs to surf to, every given interval. The list of URLs obtained using the method described above can be inserted in this program and the interval is set to 30 seconds, as also described above.

One test run is defined as a complete execution of this AutoBrowse program, where the program navigates to and away from each given URL. One complete measurement is defined as two complete test runs, where both runs have the same configuration (i.e. browser used and Flash used or not used), but with one run the advertisements filter is enabled and with the other it is not.

### 2.1.4 Data traffic measurement

For measuring data traffic there exist several tools. Tcpdump can monitor network activity and offers some options for filtering the captured network traffic trace. Wireshark is based on Tcpdump, but offers a graphical interface for it and has better and more comprehensive filtering options than Tcpdump. Also, statistics can easily be obtained. For wireless network analysis, Kismet is a well-developed wireless network detector and sniffer, which can come in handy for analyzing mobile internet traffic. It also has the ability to export its traces to Wireshark compatible file formats, so Wireshark’s terrific statistical analyses can also be applied to these traces.

Due to limited time and resources this research will not emulate actual wireless data transferral, but will use wired ethernet connections, which should yield about the same results. Therefore in this case the packet sniffing program Wireshark will be set up and used at the proxy server side. This, so all network traffic that goes to the other test pc can be captured. Wireshark allows us to track and trace easily and orderly only the traffic that we want to measure due to its filter capability.

In our case we can filter based on the IP-address of the other test system, so only data packets sent and received by the test system are captured and used in our measurements. After filtering out unwanted packets of a measurement, the Wireshark statistics function offers us the amount of total data traffic produced by the test system along with other trace information. This amount of total data traffic produced is used in our further calculations.

### 2.1.5 Advertisement filtering

To prevent advertisements from loading on a website, a few methods are available like URL-based filtering, css- and JavaScript-based filtering. Most of them are browser-specific, like Mozilla Firefox’ Adblock Plus plugin, or based on a proxy server. If browser-specific advertisement filtering is applied, our test results would not be consistent when different browsers would be tested. Therefore a proxy server will be used, which is browser and operating system independent and can be used in any present-day web browser. There are several proxy servers available, but for this research Privoxy will be used as its configuration is easy and it already has an advanced built-in advertisement filter that does not need additional configuring.

### 2.1.6 Measurement set-up

The sections above describe all considerations for the set-up used for the measurements. Figure 1 shows the measurement set-up actually used for the measurements, keeping in mind the considerations made before.

The set-up used consists of a client PC, a server and a connection to the rest of the internet, linked up as shown in Figure 1. For this experiment the client PC has an Intel Core 2 Duo 2.40 GHz processor, 4.00 GB RAM and runs Windows 7 Professional. The server used is a dedicated Dell Latitude D830 laptop with an Intel Core 2 Duo 2.20 GHz processor, 2.00 GB RAM and also runs Windows 7 Professional. These configurations are considered to be good enough that they will not influence the measurements.

The client PC only runs a browser with the AutoBrowse program loaded in it. To find whether there is a difference in data traffic produced when using different browsers, two different browsers are used during different measurement runs: Mozilla Firefox version 3.6.12 and Opera version 10.63. This will be explained more in the next subsection about research question 2. The AutoBrowse program emulates the web browsing behaviour of the average user. The internet traffic produced by this client PC will all go via the server, as it acts like a proxy. The server runs the Privoxy program, which enables the server to act as a proxy server and to filter the internet traffic that passes it, such as web advertisements. Wireshark is also run on the server. This allows measuring the amount of data traffic.
that passes through the server from the client pc to the internet and vice versa. The cloud with "Internet" written on it represents the connection of the server to the world wide web. In our case only the URLs that are in the URL list will be connected to.

2.2 Do these amounts vary per browser (and mobile device used)?

For finding an answer on this second research question, different browsers will be used. As it is described above, the use of a proxy server as advertisement filter makes the research results independent of the way of filtering the advertisements. Therefore the only difference in the measurements results could be caused by browser-specific properties. As the Mozilla Firefox and Opera browser are currently two of the most used internet browsers, these will be used for the browsing experiment and thus to indicate whether the data traffic amounts vary per browser used.

2.3 Is there a significant difference in web advertisement data traffic when Flash is or is not enabled?

The approach to answer this research question is to extend our measurements with the browser having Flash enabled or disabled. In other words, the measurements that will be done will not only measure the data traffic produced when advertisements are blocked or are not per given browser, but will also go along all these options; each with Flash enabled or disabled.

2.4 How much money do web advertisements cost mobile internet users browsing the internet?

Answering this fourth research question will be done by looking at the average costs of mobile internet in the Netherlands and the United States (US). By multiplying the mobile internet rates with the average measurements results, found in the previous research questions, the costs of mobile internet users can be found.

The average rates of mobile internet providers will be collected from their websites. To prevent inconsistencies between the rates of different providers, the rates for prepaid mobile internet plans will be collected. All other special offer or flat fee plans are found to be incomparable between different providers.

3. EXPERIMENT RESULTS

3.1 Data traffic measurements

Table 1 shows the measurements results. Each row in the table represents one measurement using the approach described in the previous section. Each measurement is identified by a unique measurement number and per measurement one browser is used. Per measurement it is stated whether Flash was enabled (used) during the test run, how many pages were loaded during each test run and the data traffic produced during both runs of the measurement. (It was defined that one measurement comprises two runs, where both runs have the same configuration (i.e. browser used and Flash used or not used), but with one run the advertisements filter was enabled and with the other it is not.)

This gives two numbers of data traffic produced during each test run; "Normal browsing" indicates the run where the advertisements filter was disabled and "Ads blocked" indicates the run where the filter was enabled. Both amounts are totals of a complete run with the number of web pages loaded specified in the appropriate column. The "Difference per page (kB)" column shows the difference between these two data traffic amounts per web page loaded, calculated with Equation 1 showed below. This amount is specified per page, which explains the number of pages loaded as divisor in the equation. Because the difference per page gets so small, it is better showed in kB instead of MB, where a kB is a factor 1024 smaller than an MB and thus needs to be a multiplier in the equation.

The results in the table are grouped by usage of Flash; the first four measurements had Flash enabled and the second four measurements had it disabled. Both groups are given an average value for the data traffic produced and the data traffic difference per page to give an easy overview of the average difference between the measurements with Flash enabled and disabled.

The average difference in data traffic produced when Flash is enabled is 109.41 kB per page and if Flash is disabled 71.47 kB per page. When we look at the data traffic produced if Flash is enabled, about 127.22 MB is produced when browsing normally and about 116.54 MB when advertisements are filtered out. If Flash is disabled, these amounts are 102.23 MB and 95.25 MB respectively. From these amounts it can be deducted that web advertisements increase data traffic about 9.2% if Flash is enabled and about 7.3% if Flash is disabled.

\[
\text{Diff. per page} = \frac{\text{Normal browsing} - \text{Ads blocked}}{\text{No. of pages loaded}} \times 1024
\]

(1)

3.2 Mobile internet rates

Table 1. Results of measurements. Data traffic produced while browsing the web.

<table>
<thead>
<tr>
<th>No.</th>
<th>Browser</th>
<th>Flash used</th>
<th>No. of pages loaded</th>
<th>Normal browsing (MB)</th>
<th>Ads blocked (MB)</th>
<th>Difference per page (kB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Opera 10.63</td>
<td>Yes</td>
<td>100</td>
<td>133.38</td>
<td>120.65</td>
<td>107.51</td>
</tr>
<tr>
<td>2</td>
<td>Firefox 3.6.12</td>
<td>Yes</td>
<td>100</td>
<td>117.70</td>
<td>108.10</td>
<td>98.99</td>
</tr>
<tr>
<td>3</td>
<td>Firefox 3.6.12</td>
<td>Yes</td>
<td>100</td>
<td>144.61</td>
<td>132.55</td>
<td>123.52</td>
</tr>
<tr>
<td>4</td>
<td>Firefox 3.6.12</td>
<td>Yes</td>
<td>100</td>
<td>113.18</td>
<td>104.92</td>
<td>84.62</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td></td>
<td></td>
<td>127.52</td>
<td>116.54</td>
<td>109.41</td>
</tr>
<tr>
<td>5</td>
<td>Opera 10.63</td>
<td>No</td>
<td>100</td>
<td>91.66</td>
<td>86.12</td>
<td>56.74</td>
</tr>
<tr>
<td>6</td>
<td>Firefox 3.6.12</td>
<td>No</td>
<td>100</td>
<td>102.05</td>
<td>94.52</td>
<td>77.10</td>
</tr>
<tr>
<td>7</td>
<td>Firefox 3.6.12</td>
<td>No</td>
<td>100</td>
<td>107.71</td>
<td>101.99</td>
<td>58.57</td>
</tr>
<tr>
<td>8</td>
<td>Firefox 3.6.12</td>
<td>No</td>
<td>100</td>
<td>107.51</td>
<td>98.38</td>
<td>93.46</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td></td>
<td></td>
<td>102.23</td>
<td>95.25</td>
<td>71.47</td>
</tr>
</tbody>
</table>
Table 2. Average prepaid rates for mobile internet in the Netherlands.

<table>
<thead>
<tr>
<th>Provider</th>
<th>Domestic rate (€/MB)</th>
<th>Roaming rate (€/MB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KPN</td>
<td>0.04</td>
<td>5.95</td>
</tr>
<tr>
<td>Vodafone</td>
<td>0.33</td>
<td>12.50</td>
</tr>
<tr>
<td>Telfort</td>
<td>0.50</td>
<td>14.87</td>
</tr>
<tr>
<td>T-Mobile</td>
<td>0.30</td>
<td>10.09</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>0.29</strong></td>
<td><strong>10.83</strong></td>
</tr>
</tbody>
</table>

Table 3. Average prepaid rates for mobile internet in the United States.

<table>
<thead>
<tr>
<th>Provider</th>
<th>Domestic rate ($/MB)</th>
<th>Roaming rate ($/MB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verizon</td>
<td>0.02</td>
<td>19.97</td>
</tr>
<tr>
<td>AT&amp;T</td>
<td>0.10</td>
<td>15.00</td>
</tr>
<tr>
<td>Sprint</td>
<td>0.05</td>
<td>15.00</td>
</tr>
<tr>
<td>T-Mobile</td>
<td>0.10</td>
<td>15.00</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>0.07</strong></td>
<td><strong>17.48</strong></td>
</tr>
</tbody>
</table>

To calculate what the cost is for mobile internet users browsing the internet, an average rate per data transferred that providers ask need to be calculated. This is done by looking at the 4 most popular wireless communication providers of the US and the Netherlands (flat fee plans are not taken into account). Tables 2 and 3 give an overview of the costs for mobile internet per provider and gives an average rate per country. For the US Verizon Wireless [27], AT&T [3], Sprint [20] and T-Mobile [23] give an average rate of $0.07 per MB domestic and $17.48 per MB when roaming. Information about roaming rates are unknown of Verizon and Sprint, because their websites state roaming costs are “variable”. KPN [11], Vodafone [28], Telfort [25] and T-Mobile [23] in the Netherlands give an average rate of €0.29 per MB domestic and €10.83 per MB when roaming.

### 3.3 Web advertisement costs

In order to calculate the average costs of web advertisements we need to know about the browsing behaviour of the average mobile internet user. As mobile internet is relatively new, few information can be found about this behaviour. Opera, used by the majority (about 25%) of all mobile internet users [21], publishes the statistics of usage of their mobile browser [15] every month. We can see that mobile internet usage is growing enormously every month. For example, in september 2010, the number of users increased with about 100% [15].

Currently Opera measured an average daily number of pageviews per user of 11.0 in the United States and 6.7 in the Netherlands in september 2010. These numbers will be used for calculating the current costs of mobile internet browsing. Combining these average daily pageviews with the average data rates and the data traffic produced by web advertisements averaged per page loaded, the average monthly costs of web advertisements can be calculated.

As there is a noticeable difference between data traffic measurements with Flash enabled versus Flash disabled, both cases are showed separately in Table 4. Each row in the table shows the monthly costs of web advertisements for an average user in the Netherlands (NL) or the United States (US). Domestic refers to the usage of mobile internet inside the same country as the provider’s base country. Roaming refers to the usage of mobile internet outside the country of the provider’s base country.

### 4. DISCUSSION

First of all the measurements results showed in the previous section show a clear distinction in data traffic differences when Flash is used and not used. This is an important factor for for example the Apple iPad, that does not (yet) support Flash in its browser [5].

When we look at the absolute data traffic produced including web advertisements, an average data traffic of about 1.2 MB produced per page loaded can be found. This is quite a large amount for a single web page and its elements. In the measurements of this research, the URLs opened were generated from the most popular diggs on Digg.com [8] where people post links to web pages they find interesting. These pages often include many large sized videos or pictures that produce a lot of data traffic. As this large sized content is loaded in both cases of the experiment (normal browsing versus browsing with advertisements blocked), this does not interfere with the measurements results.

Here it is quietly assumed that the behaviour of mobile internet users on PCs, PDAs, tablet PCs and mobile phones is all the same. In reality there might be some differences in behaviour, but as the users probably will load the same web pages anyway, independent of the platform they use for mobile internet, it can be assumed that the same web pages will be loaded if a different device would be used. Therefore one URL list containing the most popular web pages satisfies as representation for the web pages opened by average mobile internet users.

A reason why the individual measurement results differ a bit is that some websites might have advertisements loading randomly or semi-randomly and thus different advertisements of different file sizes can be loaded on the same web page. Also, advertisement blocking is not perfect; some advertisements can slip through the advertisement blocking filters and can be loaded anyway. Due to the limited time for this paper the amount of measurements is very limited and therefore the accuracy of the measurements is as well.

### 5. CONCLUSION

A method for measuring the amount of data traffic web advertisements take up has been defined and carried out in this paper. Special attention was given to the influence on this, of the use of different web browsers and whether Flash was enabled or not in the browser. Also the average costs of these web advertisements were estimated using information about current mobile internet usage and costs of mobile internet providers in the Netherlands and the United States.

Assumptions have been made about the browsing behaviour
of mobile internet users to be the same of that of the users of normal internet and that 30 seconds is sufficient time to fully load all content of a web page.

The research found that the amount of data traffic loading web advertisements on average mobile internet usage are about 109 kB per page if Flash is supported, and about 72 kB per page if Flash is not supported or not enabled in the browser. Note that these amounts can vary based on the type of the actual advertisement loaded on each page, as some websites have a mechanism to load a random advertisement.

A significant variance in data traffic has not been found when different browsers were used (research question 2), but the findings do imply that web advertisements take up a significant amount of data traffic (research question 1) and that there is a significant difference when Flash is enabled or disabled (research question 3). Web advertisements are found to increase the total data traffic about 9.2% if Flash is enabled and about 7.3% if Flash is disabled. This means that, in any case, web advertisements increase the total data traffic, and thus costs, between 7% and 9% for an average mobile internet user.

Currently web advertisements are found to cost an average mobile internet user in the US around $2.41 per month if Flash is supported, or about $1.58 per month if Flash is disabled. This means that, in any case, web advertisements increase the total data traffic, and thus costs, between 7% and 9% for an average mobile internet user.

Roaming (i.e. using mobile internet outside the base country of the provider) is not always supported by (US) providers, but when it is, a US roaming user that would continue his device supports Flash, or about $1.58 per month if his device does not support Flash. For a Dutch user that is around €6.33 and €4.14 per month respectively.

A roaming (i.e. using mobile internet outside the base country of the provider) is not always supported by (US) providers, but when it is, a US roaming user that would continue his normal browsing behaviour, would monthly pay around $627 with Flash or $410 without. That is about 20 and 14 times the costs of an average monthly data plan. A roaming Dutch user would be charged about €72 and €50 with Flash or €455 with Flash if Flash is enabled or disabled, respectively. This means that, in any case, web advertisements increase the total data traffic, and thus costs, between 7% and 9% for an average mobile internet user.

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5.1 Future work
This study only looked at the costs of average mobile internet usage. There are many different ways and techniques for loading web pages to drop the CPU usage and/or the data traffic produced. Also specifically for mobile devices, such as the Opera Turbo feature [13]. The impacts of these features could be researched and compared with each other.

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7. REFERENCES


