

# AdaptiveContent

*by* Mohammad Suryawinata 26/03/2019

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## Adaptive Content Server for Optimizing Battery Life in Mobile Devices

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## Adaptive Content Server for Optimizing Battery Life in Mobile Devices

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**Abstract.** The latest growth of mobile technology has resulted in more users accessing network services via mobile devices, such as tablets or smartphones. Personalized look and content becomes more important. Mobile devices have different properties than desktop computers. Mobile devices do not have a large screen, convenient input-output devices, and have limited computing capabilities. Content adaptation is a common definition used for adaptation or customization of content transferred from the server via the HTTP protocol to the client. The research method is to adjust the content which will be transferred to the user based on the device resources i.e. the battery on the client side so that higher service quality will be achieved. In this study, researchers will conduct the development of content adaptation methods that consider the condition of battery resources on the devices. Battery resource estimation is done to determine the current condition of existing battery in accessing device. The appropriate content determination mechanism will be based on the value generated from the estimated resource of the battery on the device that has been done.

### 1. Introduction

Mobile devices are now a very popular device and many users are doing daily activities through this device. By the end of 2013 the number of mobile devices has grown to 7 billion devices with 77% of them smartphone [1]. Smartphones and tablets dominate the largest amount of traffic by 88% of total internet traffic [1]. The website was originally designed specifically for desktop computer use. The website has a size (resolution) of 800 x 600 pixels at first, and continues to grow with the development of desktop monitors [2]. This is because in a large screen, a web designer can include a lot of important information in one page. Another reason is that desktop computers come with convenient input devices and have great computing capabilities [2], so images and videos can be displayed via websites for desktop

Lately, many users access the website via mobile devices, such as tablets or smartphones. Personalized look and content becomes more important. Mobile devices have different properties than desktop computers. The mobile device does not have a large screen, convenient input-output device, and has limited computing capabilities [2] [3]. If the website for a desktop computer is instantly displayed on a mobile device, then the information that appears on the screen of the mobile device will be difficult to read. Therefore a different website appearance is required for the level of legibility of



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information to be higher. Web browsers are becoming one of the most important apps in any mobile device. Almost all smartphones have web browser software. However, this default web browser does not provide content adaptation or support features [4]. The average web server that exists only provides two service schemes based on its accessory devices. When a user accesses a web server from a desktop device, it will be given a page that is usually displayed on a desktop device. Meanwhile, if users access through mobile devices such as smartphones or tablets, it will be given a page that is adjusted for the average mobile device.

The content customization mechanisms commonly performed by service providers are still less than optimal. With the diversity of mobile device resources and specifications and conditions, it needs a content adjustment mechanism that can support the diversity of the device in terms of its resources.

From the above problems, the authors have conducted research to provide solutions by presenting the results of research on the mechanism of content adjustment based on information resources on mobile devices. In addition the authors will also present the concept for the development of a further model of content adjustment.

The authors' contribution to this research is the proposal to develop a content adjustment mechanism that takes into account the conditions of the dynamic battery resources on the device so that the batteries on the mobile device can last longer. The server will provide adaptive content that will be transferred according to realtime condition of accessing mobile device.

## 2. Related Research

Research related to research conducted by the author has been done, but most of the research that has been done only provides an adaptation mechanism that only provides the concept and minimize the amount of data sent to the user. In other words, the content will be kept to a minimum so that quality can be achieved.

Research conducted by Tian, et al [5] has a primary focus on measuring mobile website performance. The background of the research conducted by Tian is the use of XML in the web service resulting in the size of the web the greater, therefore it is necessary to use compression on web services, especially on mobile clients that tend to have poor connectivity and high communication costs. Compression is one way to overcome the problem of message size in the web service. This study also shows that compression is very helpful to clients who have poor connectivity and limitations of the device used.

Compression process also has some limitations of CPU time on the client device used for compression and decompression. The compression process also decreases CPU performance on the server due to the additional time used to compress and decompress the content. The method used by Tian is by compressing the XML response data in the web service. This study shows that on both ends of computing, both servers, and clients with poor connectivity, show that compression provides benefits through an approach made using XML compression.

Meanwhile, research from Guirguis et al [6] has a major focus on content adaptation on the device. Mobile website users experience a common problem that most web content is designed for desktop computer users who have a large screen size and have a fast internet connection. On mobile devices, the screen size is limited and has a slower Internet connection. Therefore Guirguis, et al consider to deal with the restrictions that exist in this mobile device.

Mobile devices have limited computing capabilities, smaller memory, smaller screen size, small bandwidth, small resources, and short durability [2] [3] [6]. Guirguis et al proposed the framework for web content and resources adaptation in mobile device (WRAMD). WRAMD can be used by webmaster as a tool to develop mobile website and desktop website in one process. WRAMD can facilitate the production of content on the website, both mobile and desktop and will make the website become lighter. The purpose of this study is to provide a good website view, minimize the use of bandwidth for access to mobile devices and provide a specific look at each mobile device.

Content adaptation is an important technique for mobile devices. The existing content adaptation system has been developed for specific purposes, Jiang proposes an extensible content adaptation

system called Xadaptor [7]. Jiang uses a rule-based approach to facilitate an extensible and systematic content adaptation system. This integrates adaptation mechanisms for some content types and groups these content into the rule base. Rules will be organized based on information from individual clients.

Jiang classifies objects on HTML pages into structures, content and pointer objects. Content adaptation techniques that already exist, are generally focused on the content and do not consider adaptation techniques for structured HTML documents. Xadaptor uses an object structure on an HTML page for an adapted content adaptation system<sup>4</sup>

With the increasing diversity of content access on devices and network technology, as well as user preferences, content delivery has evolved into a ubiquitous service issue where production, delivery and access to content form new challenges for content providers, network operators and users. Content adaptation has been recognized as one of the important aspects of ubiquitous content delivery. But this is still a big challenge not only because of the complexity and diversity of technology, but also the implications of system development that impact content providers, network operators, users, and third-party service providers. Ding developed a framework called the Adaptation Management Framework (AMF) [8]. AMF targets the distribution of content evenly through the content delivery chain.

### 3. Experimental Method

The system to be created, is illustrated in Figure 1 below.

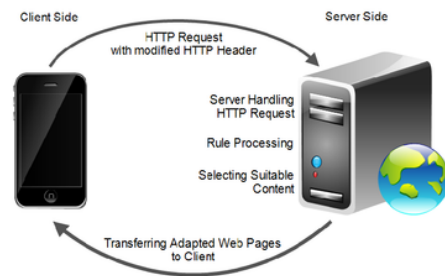


Figure 1. Proposed Research Model.

The algorithm begins by performing resource detection on client devices such as battery levels. After some of these parameters are known the value will be made the process of determining adaptation strategy. This process of determining adaptation strategies will determine the appropriate adaptation scenarios for clients.

When HTTP Request takes place, the browser on the mobile device will send information in the modified HTTP header to the server shown in Figure 2. This modified HTTP header difference with the default HTTP Header is just one line that shows the battery levels in the accessing device.

```
1 Get request from 202.67.46.26 on 22-08-2017 07:54:22 with
header detail:
--> Battery-level = [82.0]
--> Connection = [keep-alive]
--> Host = [36.85.90.238:8080]
--> User-agent = [Wee Browser]
--> Accept-language = [en-US]
--1 X-requested-with = [com.example.adaptivewebbrowser]
--> Accept=
[text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,*/*;q=0.8]
```

Figure 2. Modified HTTP Header.

Battery resource detection in accessing device is done using BatteryManager class. The batteryManager.EXTRA\_SCALE method is used to determine the battery scale of the mobile device. Of the two variables generated by the method, the realtime battery condition will be compared to the scale on the mobile device so that it will know the remaining value of battery power in percentage form. Flowchart of the process for adapting the content in the server side is shown in Figure 3.

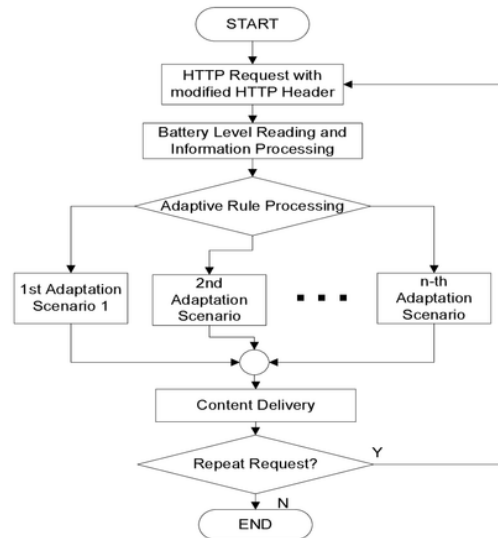


Figure 3. The process of adaptive content in server side.

#### 4. Results and Discussion

The test was conducted to find out whether the research optimization of battery resources has been achieved. The following is the testbed used in this study:

##### Web Server

##### Hardware Specifications:

- Processor: Intel Core2Duo T6400 2.40 GHz
- Memory: 2 GB DDR3
- Hard drive: 250 GB SATA
- NIC: TP Link Gigabit Ethernet
- OS: Ubuntu Server 14.04

##### Mobile Device

##### Hardware Specifications:

- Processor: Intel Atom dual core 1.2 GHz
- Memory: 2GB
- Storage: 8 GB NAND Flash Memory
- WiFi: 802.11.b / g / n
- Network: 2G & 3G
- OS: Android 4.3 Jelly Bean
- Browser: Android Java Browser

Trials based on residual battery power on mobile devices are performed to measure the conformity of content sent by the server by considering the remaining battery power on mobile devices. If the battery is still high, it will deliver good quality content. Conversely, if the battery is low, it will send content that will not drain the battery quickly.

**Table 1.** Rule Based on Battery Power Level.

| No | Battery Level | Content    | Quality     | Size     |
|----|---------------|------------|-------------|----------|
| 1  | 91% - 100%    | Content 1  | High        | Biggest  |
| 2  | 81% - 90%     | Content 2  | High        |          |
| 3  | 71% - 80%     | Content 3  | Middle-High |          |
| 4  | 61% - 70%     | Content 4  | Middle-High |          |
| 5  | 51% - 60%     | Content 5  | Middle      |          |
| 6  | 41% - 50%     | Content 6  | Middle      |          |
| 7  | 31% - 40%     | Content 7  | Middle-Low  |          |
| 8  | 21% - 30%     | Content 8  | Middle-Low  |          |
| 9  | 11% - 20%     | Content 9  | Low         |          |
| 10 | 0% - 10%      | Content 10 | Low         | Smallest |

The test results based on the remaining battery power are shown to find out how far the browser is tailoring the service in the form of content provided to users based on the remaining battery power on the mobile device. Figure 4 Shows the remaining battery power available on a mobile device of 82% or nearly full when HTTP requests take place.

```

1 Get request from 202.67.46.26 on 08-08-2017 07:54:22 with
header detail:
--> Battery-level = [82.0]
--> Connection = [keep-alive]
--> Host = [36.85.90.238:8080]
--> 1 per-agent = [Wee Browser]
--> Accept-language = [en-US]
-- 1 X-requested-with = [com.example.adaptivewebbrowser]
--> Accept=
[text/html,application/xhtml+xml,application/xml;q=0.9,imag
e/webp,*/*;q=0.8]
    
```

**Figure 4.** HTTP Header Scenario.

The test results based on the remaining battery power are also performed for dynamic conditions. For example in some other test scenario, it is shown that the server access test is performed under the condition of the battery resources in the accessing device is below 82% when the HTTP request takes place. In all of scenarios tested, the modified HTTP header that sent from the mobile device always sent the battery information accurately. The server response in accordance to the received HTTP header that shown in Figure 5.

```

Get request from 36.82.97.110 on 09-08-2017 17:06:42 with
header detail:
--> Accept-encoding = [gzip,deflate]
--> Accept = [image/webp,*/*;q=0.8]
--> Connection = [keep-alive]
--> Referer = [http://36.85.90.238:8080/index.html]
--> Host = [36.85.90.238:8080]
--> User-agent = [Mozilla/5.0 (Linux; Android 4.4.2;
ASUS_T00F Build/KVT49L) AppleWebKit/537.36 (KHTML, like
Gecko) Version/4.0 Chrome/30.0.0.0 Mobile Safari/537.36]
--> Accept-language = [en-US]
--> X-requested-with = [com.example.adaptivewebbrowser]
--> Cache-control = [max-age=0]
C:/Wee/MiniWebServer/Perpus7.jpg
    
```

**Figure 5.** Server Response.

The experiment was done in repetitively until the smartphone shuts down itself. Table 2. shows the results has been adapted to the remaining battery power conditions on mobile devices. It shows the content conformity to the rules that have been set before. The conformity test result shows that the conformity of the content is 100%.

**Table 2.** Results on Battery Power Level and Content.

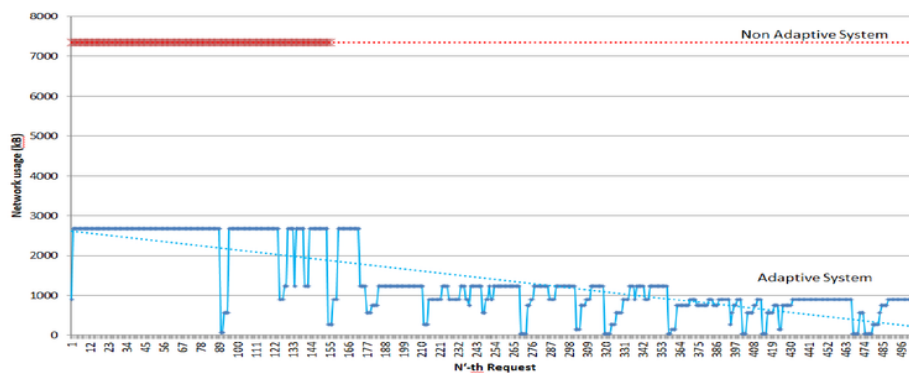
| No. | Battery Level | Content    | Rule | Conformity |
|-----|---------------|------------|------|------------|
| 1   | 100           | Content 1  | 7    | Conform    |
| 2   | 96            | Content 1  |      | Conform    |
| 3   | 92            | Content 1  |      | Conform    |
| 4   | 88            | Content 2  |      | Conform    |
| 5   | 84            | Content 2  |      | Conform    |
| 6   | 80            | Content 3  |      | Conform    |
| 7   | 76            | Content 3  |      | Conform    |
| 8   | 72            | Content 3  |      | Conform    |
| 9   | 68            | Content 4  |      | Conform    |
| 10  | 64            | Content 4  |      | Conform    |
| 11  | 60            | Content 5  |      | Conform    |
| 12  | 56            | Content 5  |      | Conform    |
| 13  | 52            | Content 5  |      | Conform    |
| 14  | 48            | Content 6  |      | Conform    |
| 15  | 44            | Content 6  |      | Conform    |
| 16  | 40            | Content 7  |      | Conform    |
| 17  | 36            | Content 7  |      | Conform    |
| 18  | 32            | Content 7  |      | Conform    |
| 19  | 28            | Content 8  |      | Conform    |
| 20  | 24            | Content 8  |      | Conform    |
| 21  | 20            | Content 9  |      | Conform    |
| 22  | 16            | Content 9  |      | Conform    |
| 23  | 12            | Content 9  |      | Conform    |
| 24  | 8             | Content 10 |      | Conform    |
| 25  | 4             | Content 10 |      | Conform    |

From the results of tests conducted found that the study of adaptive browsers on resource information on the accessory device has been successfully done in accordance with the rules designed. This will provide a new alternative for web app developers to adapt content according to resource conditions on accessory devices. If this is applied, there will be an increase in battery life in the access device.

This result can also be viewed in Figure 6. This figure, shows the difference between the non adaptive content with the adaptive ones. The trial results of network usage on WiFi networks show that from 157 times the request experiments show that the average network usage in smaller adaptive browsers is 406.65 kB compared to non-adaptive browsers that show an average network usage rate of 7350 kB. This is because the higher the quality of content received, the greater the network traffic. In an adaptive browser, the content quality level is determined on the resources of the accessing device. Content received by accessory devices has a more optimal quality of resource conditions. The positive impact of this adaptive browser usage of network usage on accessory devices is getting lower.

Figure 6 also shows that in the conducted stress test, the adaptive server can give the device more than 500 times request-reply whereas the non adaptive server can access just 157 times. This is shows that it is a great deal for adaptive system to be implemented in mobile environment.





**Figure 6.** Network Usage Test Result.

## 5. Conclusions

In today's modern era, mobile technology and devices have become a primary need to access information. More than 80% of internet users use mobile devices. Limitations of the battery power on mobile devices also become one of the constraints of users to access information in a long time. In this research battery consumption in mobile device can be prolonged up to 300%. With this research, expected battery power will last longer because the information obtained can be adjusted to the condition of the battery resources in the device. The next development suggestion is to insert other information on the HTTP header that can support the quality of content delivery, both in terms of response time, processing speed, memory load and so on.

## Acknowledgements

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