Energy-Aware Web browsing in 3G Based Smartphones

Archana Naik¹, Swati Kamble² & Trupti Pund³
¹Student, SCSM, Department Of Computer Engineering, Ahmednagar
²,³Student, SCSM, Department Of Computer Engineering, Ahmednagar

Abstract: Nowadays, one of the most popular android application is smartphones. Smartphone based web browsing perform downloading of web pages using the features of 3G radio interface. But for performing such processing, it requires large amount of power and because of the wastage of power, there is a need to develop a system to solve such issues. To overcome this we develop a system in order to address power consumption and by observing special characteristics. For this two novel techniques are mainly used. In first techniques calculate computation sequence at the time of web page loading. Then first computation is executed by web browser and generate outcomes is in the form of data transmission and at the receiver side web server retrieve. And then 3G radio interface put into low power set by using web browser for the purpose of releasing resources. And then remaining computation is executed. In second techniques used practical data mining techniques for to predict the user during the time when they read the contents of web pages.

Introduction

Smartphone is one of the most important application used for various purpose. Web browsing based on smartphones is most commonly techniques or a scheme provided by a Smartphone. There are various smartphones available in market but they used large amount of power to perform their action or at the time of web page downloading operation. Lot of research are done on power required for smartphones. And they focused on only power consumption of smartphone component like as its display, wireless interface, wifi interface which having characteristics of high power consumption. For reducing power consumption there is a need to make control on radio resources. UMTS techniques are mainly focused on such issues, it is used to control the radio resources and their timeline values at the time of releasing resources. One major advantage of our system is to reduce the latency at the time of data transmission that arrive before the timer is expire because there is still a connection is available between backbone network and smartphone. In particular, energy efficiency is defined in our scheme because mobile devices are usually charged by batteries having a limited capacity. Although energy saving for mobile device has been studied, the power consumption in bandwidth aggregation has not been defined. In our proposed system, transmissions of data are made on both WiFi and 3G interfaces in the manner of an energy efficiency.

In this paper, we focused on the power consumption issue in smartphone based web browsing by using two novel techniques. In first techniques we retrieve the sequence of the computation of the web browser at the time of loading of webpages. There are different computations during loading a webpage such as HTML parsing, execution of JavaScript code, decoding of image, style formatting, page layout, etc. These computations divide in to two categories relayed on whether they will create new data transmissions from the web server. So We want to separate these two types of computations so that the web browser can first execute the computations that will create new data transmissions and get that data. Then, the web browser can put the 3G radio interface into low power state, release the radio resource, and then run the remaining computations which take 40–70% of the processing time for loading webpages. Thus a large amount of power and radio resource can be saved.

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Related Work

The power efficiency of mobile devices has been extensively introduced in current years. The energy consumption of mobile devices in different areas of 3G and WLAN is considered. The authors have
define a mathematical model, e-Aware, by considering two elements of power consumption that is signaling and media transfers, to estimate how application layer protocol properties affect the power consumption of mobile devices. Activating a mobile device network interface at the same time incurs more consumption of power Chowdhury et al. present an efficient interface selection method Mahkoum et al. shows an infrastructure with power-efficiency management from a global point of view. The basic goal behind is to power off the idle interface but at the exact time to keep in virtual idle mode in the network by extending IEEE 802.21 on both mobile node and network side. Chen et al. present the balancing between the power consumption and output of devices using MPTCP. WiFi and 3G interfaces having a different characteristics of energy consumption. By using 3GPP regulations a Radio Resource Control (RRC) protocol define three states: IDLE, DCH, and FACH, for 3G network interface, which shows different channels like as an idle channel, dedicated channel and forward access channel, respectively. At the time of data transmission, the 3G-interface is in the DCH state with a large energy consumption. After data transmission it remains in DCH for about 5 second, then changes to FACH for about another 5 second, and eventually switches to IDLE. In the opposite the WiFi-interface switches to idle state immediately after the completion of data transmission. The power consumption modeling and measurement reveal that LTE and 3G are having minimum power efficiency than WiFi. Generally, 3G and LTE are more power conservative compared with WiFi.

A. IDLE state:

The smartphone is a wireless; it does not have any wired or signaling connection with the backbone network, though it cannot deliver any type of user data. Smartphones having the radio interface in IDLE state consumes very low power.

B. DCH state:

The backbone network allows dedicated transmission channels (uplink and downlink) to the smartphone, so that the smartphone can transmit user data and signaling information at very high speed.

C. FACH state:

In this state smartphone don’t have any dedicated transmission channel. Hence, it can only transmit user data and signaling information through common shared transmission channels at low speed. FACH state requires about half of the power in the DCH state for data transmission.

Proposed System

A. Reorganizing the Computation Sequence:

To get or retrieved all data in the webpage as fast as possible, computation sequence of the web browser is invented. In the original design of web browser, the data transmission computation and the layout computation are combined, as shown in following figure. In this we explain how to separate them to save power by comparing the computation sequence of energy aware approach with that of the original web browser for opening a webpage. At time slot 1, the real web browser spends its computation resource on both data transmission and layout computation. It processes on one object and adds it to the DOM tree. In our scheme, the browser focuses on data transmission and ignores the layout. So our scheme can process more objects and adds them to the DOM tree at time slot 1. At time slot 2, our approach processes all the objects and builds the complete DOM tree. At time slot 3, data transmission does not happen, and our system focuses on computing the page layout. Whether the original web browser can display partial webpage content on the screen at each time slot, it keeps creating data transmission until time slot 3. Finally, both approaches have the same complete DOM tree and display the same webpage though our approach may be a little bit faster in practice.

Figure 1. The computation sequence for opening webpage and building the DOM tree

B. Intermediate Display:

Original web browsers always draw intermediate display and update it frequently when loading webpages for the purpose of improving user experience. But, this approach has two drawbacks. First, although the web browser already has the web content, it has to wait before displaying the
intermediate results. This is because the browser needs to associate DOM nodes and CSS style rules to lay out these data.

However, since the CSS file is large and complex, it takes a lot of processing time to extract the rules. Another drawback is that the browser wastes a lot of computation resource to frequently redraw and reflow the intermediate display before the final display.

C. Predicting the Reading Time:

In this, we define a machine learning based approach to predict the reading time of user, based on which we can decide if the smartphone should switch to IDLE.

1. Gradient Boosted Regression Trees:

Gradient Boosted Regression Tree (GBRT) is a technique of predictive data mining, which is mainly used for constructing statistical decision tree models from historical data. Decision tree is a decision support tool that uses a tree-like graph or model of decisions and their possible consequences. These models are used to predict the value of future data.

Algorithm For Energy Aware Approach:

1. Start to open a webpage
2. Data transmission computation is done.
3. Layout computation is finished
4. Collect features \( x = \{x_1, \ldots, x_{10}\} \)
5. Webpage is opened
6. Wait for \( \alpha \) seconds.
7. Get \( Tr \) from the prediction model with \( x \)
8. if (\( Tr > Td \)) OR (\( Tr > Tp \) AND mode == power) then
9. switch to IDLE state
10. end

Our Energy-Aware Approach:

Here, we define our energy-aware approach as gives steps in an Algorithm. The algorithm has two different modes: the delay driven mode which works to optimizes delay, and the power driven mode which is used to optimizes power. Recall that improperly moving to the IDLE state may increase the power consumption and the data transmission delay. In delay driven mode, if the predicted reading time (\( Tr \)) is shorter than \( Td \), new data transmission arrive during the FACH state, and hence the smartphone will not go to IDLE to avoid increasing the data transmission delay. Here we set \( Td \) to 20 seconds which is \( T1 + T2 \). In power driven mode, as long as the predicted reading time is longer than \( Tp \), the smartphone will go to IDLE to save power although it may increase the transmission delay in some cases.

(a) Original takes 17.6 seconds
(b) Energy-Aware takes 7 seconds

Figure 2. Shows the energy aware approach

Power Consumption:

The power consumption of smartphones includes the power consumed for display and maintenance of system. Table IV shows the power consumption of the smartphone in different states, where the DCH state consumes the largest amount of power. When the smartphone stays in FACH, it consumes almost the same amount of power as CPU fully running at IDLE state. When the smartphone is in IDLE, the power is mainly consumed by screen display and system maintenance. Since our energy-aware approach reduces the time at FACH and DCH states, it can save power for web browsing.

Table 1. Power Consumption Table

<table>
<thead>
<tr>
<th>State</th>
<th>Power(W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDLE State</td>
<td>0.15</td>
</tr>
<tr>
<td>FACH State</td>
<td>0.63</td>
</tr>
<tr>
<td>DCH State without transmission</td>
<td>1.15</td>
</tr>
<tr>
<td>DCH state with transmission</td>
<td>1.25</td>
</tr>
<tr>
<td>CPU fully running (IDLE State)</td>
<td>0.6</td>
</tr>
</tbody>
</table>
In this paper, we proposed an energy-aware approach for web browsing in 3G based smartphones. A system in order to address power consumption and by observing special characteristics. First, we reorganize the computation sequence for loading webpage so that the web browser can first run the computations that will generate new data transmissions and retrieve these data. Then, the web browser can put the 3G radio interface into IDLE, release the radio resource, and then run the remaining layout computation. In second techniques used practical data mining techniques for to predict the user during the time when they read the contents of web pages. We implement a low overhead prediction algorithm based on Gradient Boosted Regression Trees (GBRT). The final results show that our approach can reduce the power consumption of smartphone during web browsing, and reduce the webpage loading time.

References


