Modeling Mobile Web Characteristics for Energy Optimized Delivery

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ABSTRACT

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As mobile traffic and data consumption continue to rise, there is a growing need to investigate increased energy efficiency and optimizations to reduce the bandwidth when browsing the mobile web. Use cisco figure citations here???? To determine the reduction in energy consumption of mobile devices, there is also a need for a way to measure the energy consumption of mobile devices. By investigating the composition and characteristics of mobile web pages, statistical models can be derived for describing the characteristics of a typical mobile web page, such as the individual response sizes and expiration ages of responses that mobile browsers request for web pages.HTTP Archive will be a great source of data that may be utilized to derive models for describing the mobile web. Additionally, this pool of data is updated on a bimonthly basis, providing a constantly updated pool of data to update the developed models with and validate them. These models can then in turn be used to provide more accurate results when estimating the possible energy and bandwidth savings by using these models for generating artificial web pages that will contain characteristics that closely resemble those characteristics often found on the actual mobile web. Investigating the models and data further, they can be extended to create prediction models that will describe the growing mobile web for future years. With these models in place, they can be applied to projects for optimizing energy and bandwidth consumption on mobile devices, such as the possible energy and bandwidth savings that can result from cache forwarding between desktop computers and mobile devices. To measure the possible energy consumption savings from these projects, a low cost test bed for measuring the power consumption of mobile devices can be employed as a baseline

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CHAPTER I

INTRODUCTION

HTTP Archive

HTTP Archive is an online repository of web performance information containing information on both desktop and mobile versions of websites. Information gather includes all the details about the responses each webpage makes such as the response sizes, expiration age, HTTP Archive gathers their data using a private instance of WebPageTest [CITATION????].

CHAPTER II

An Inexpensive Testbed for Mobile Device Power Measurement

Introduction

Over the last few decades, there has been an enormous increase in the ubiquity of mobile devices. With this increase, has also come the increase in demand for data-driven services and this demand is predicted to continue [1]. The battery consumption of mobile devices represents a limiting bottleneck and thus power optimizations suggestiosn have been suggested [2]. Software-based energy profilers do exist [3], however they are not always feasible for implementing in a straightforward manner or desirable due to rapid development cycles. To overcome these barriers, a real world test bed that can be implemented which to perform measurement of power consumptions on mobile devices.

Hardware Configuration

The main component in this testbed is the mobile device. This can be realized by using a smartphone and replacing the battery with connectors to the power supply; alternatively one of the common development board packages, such as Pandaboard (see www.pandaboard.org) or Wandboard (see www.wandboard.org) packages. Development boards and smartphones were utilized together with the Android operating system, which provides log output via USB to the measurement control device, which can be a regular PC or another development board with Android debugging support. The mobile device is then networked with a wireless access point, which allows for wired and wireless evaluations. The switchable power supply has an external serial or USB port to communicate the current and power in small time intervals to the control device. A BK Precision 1696 switchable power supply is utilized, as it offers fine granularity in power, current, and time intervals. While other equipment, such as Arduino with custom circuits, were used in other measurement approaches, these

Figure 1. Illustration of measurement testbed.

power supplies are common lab equipment and offer overall robust features.

Software Configuration

The software components are comprised of several Python scripts that execute the Android Debugging Bridge (ADB) and capture the output either to a local file or allow sending the output to a remote receiver, as illustrated in Figure 1. The scripts allow for easy customization on the locally connected control device or at a remote location, e.g., filtering by specific events in the log. Similarly, a locally executing script captures the output from the power supply and is enabled to forward the data to a remote location as well.

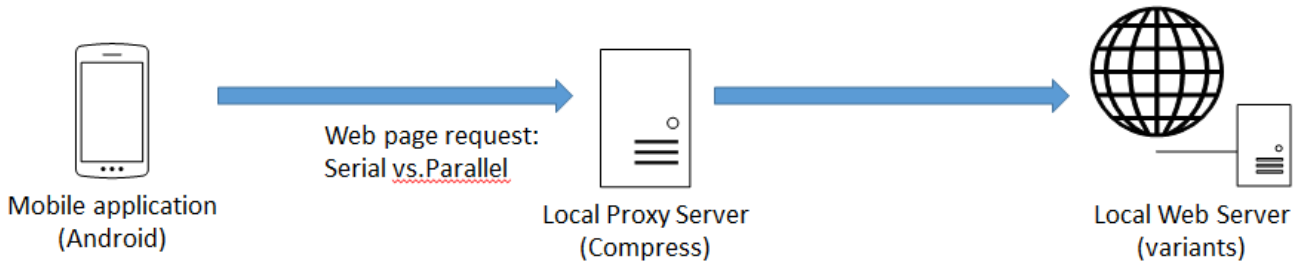

Figure 2. Workflow of mobile application tested on testbed.

Demonstration Description

To demonstrate the usefulness of the testbed, two different aspects of the measurement setup were utilized using an example Android application that performs web requests. This application makes requests to a local proxy server either serially or in parallel and the proxy server goes out and fetches what the phone requested. The workflow for the application ca be seen in figure 2. Both, wired and wireless access scenarios were exhibited for accessing a remote web service and retrieving results in order to demonstrate the functionality of the testbed. With these demonstrations, real time visualizations of the data about power consumption were created and stored on log files on a remote computer where they can be readily parsed for automatic evaluation of application power consumption.

CHAPTER III

Power Consumption Overhead for Proxy Services on Mobile Device Platforms

Introduction

Current predictions by Cisco show that the amount of data that users consume has increased significantly and will continue to increase into the foreseeable future [1]. Previous studies show that the network interfaces of mobile devices consume much of the limited battery life [4]. Thus, heavy research efforts have been poured into studying the possibilities of energy efficient mobile data delivery. Some research avenues have middleware that acts as an on-device proxy service to realize benefits or enable new interaction paradigms, such as display networks [5] or mobile content sharing [6],[7]. To determine whether or not these local proxy servers result in a large overhead in terms of power consumption and time delays, the measurement framework testbed described in Chapter II can be implemented to determine what kind of overheads can be expected from local proxy servers.

CHAPTER IV

CONCLUSION

Future Work

REFERENCES

[1] Cisco, Inc. Cisco visual networking index: Global mobile data traffic forecast update, 2013–2018. Technical report, February 2014.

[2] Feng Qian, Zhaoguang Wang, Yudong Gao, Junxian Huang, Alexandre Gerber, Zhuoqing Mao, Subhabrata Sen, and Oliver Spatscheck. Periodic transfers in mobile applications: Network-wide origin, impact, and optimization. In *Proceedings of the 21st International Conference on World Wide Web*, WWW '12, pages 51–60, New York, NY, USA, 2012. ACM.

[3] Andre Luiz Tinassi DAmato, Linnyer Beatrys Ruiz, Anderson Faustino da Silva, and Jose Camargo da Costa. Eprof: An accurate energy consumption estimation tool. In *Proceedings of the 2011 30th International Conference of the Chilean Computer Science Society*, SCCC '11, pages 210–218, Washington, DC, USA, 2011. IEEE Computer Society.

[4] Aaron Carroll and Gernot Heiser. An analysis of power consumption in a smartphone. In *Proceedings of the 2010 USENIX Conference on USENIX Annual Technical Conference*, USENIXATC'10, pages 21–21, Berkeley, CA, USA, 2010. USENIX Association.

[5] N. Davies, M. Langheinrich, R. Jose, and A. Schmidt. Open display networks: A communications medium for the 21st century. *Computer*, 45(5):58–64, May 2012.

[6] Patrick Seeling. An overview of energy savings potentials through mobile forwarding proxy framework. *Int. J. Ad Hoc Ubiquitous Comput.*, 16(4):260–267, September 2014.

[7] Patrick Seeling. Caching proxying for mobile users. In *Vehicular Technology Conference (VTC Spring), 2013 IEEE 77th*, pages 1–5, June 2013.