ISSN : 2394-0905

Energy-as-a-Service (EaaS): Interfacing Android Application with Cloud to Save Smartphone Energy

Vinod Mawani, Kalleshwar Kalshetty, Aniket Kadam, Sagar Chavan, Ranjana Badre
Department of Computer Engineering
MIT Academy of Engineering,University of Pune
Pune,India
Email: EaaScloud@gmail.com

Abstract-The use of the smartphones has grown rapidly due to availability of applications that are useful in varoius domains however, the limitation of energy capacity of these devices is not satisfactorialy solved. In the era of cloud computing, the limitation on energy capacity can be eased off in an efficient way by offloading heavy tasks to the cloud.

The solution provides an evaluation of energy cost of multimedia applications on smartphones that are connected to Multimedia Cloud Computing (MCC). In this solution , we investigate the feasibility of MCC to provide the Energy-as-a-Service (EaaS). Besides this the solution will extensively use the capabilities of MCC for uploading, downloading and encoding of video file to save smartphone energy. The use of MCC will hence provide the smartphones with many multimedia functionalities and save smartphone energy from 30 to 70 percent.

Technical Keywords-Multimedia Cloud Computing (MCC); Multimedia Cloud Server (MCS); Power Consumption; Energy Cost;Handheld Device (Smartphone); Video Encoding; Network Interface;

I. Introduction

Smartphone technology is advancing at a rapid pace. It was not that long ago that iPhone deals were the only smartphone deals worth having if you wanted to ahead of the pack, but that was in the days before Google introduced us to Android and stimulated a whole new generation of advanced smartphones.

Smartphones are becoming increasingly popular because of their capabilities and functionalities. Their small size and light weight make them very easy to carry, and they provide useful services as they run PC-like applications. In contrast to that, smartphones have some unique constraints, such as limited battery energy, processing, and memory capacity. In recent years, some of these constraints, such as memory and storage capacity, have been addressed to some extent. However, the advances in the semiconductor and telecommunication technologies are faster than that of the battery capacity. Therefore, energy constraint, which is result of limited capacity of the smartphone battery, has not been solved satisfactorily.

Cloud computing, or the cloud, is a colloquial expression used to describe a variety of different types of computing concepts that involve a large number of computers connected through a real-time communication network such as the Internet. Cloud Computing, more commonly used to refer to network-based services which appear to be provided by real server hardware, which in fact are served up by virtual hardware, simulated by software running on one or more real machines.CC provides a multimedia functionality, which includes storage, encoding, and play ondemand, this is Multimedia Cloud Computing (MCC) [1]. Multimedia Server can access any content on the Internet and upload it to user in desired file formats when the user specifies the file through Universal Resource Locator(URL).

Mobile Cloud Computing at its simplest, refers to an infrastructure where both the data storage and the data processing happen outside of the mobile device.MCC as a new paradigm for mobile applications whereby the data processing and storage are moved from the mobile device to powerful and centralized computing platforms located in clouds. These centralized applications are then accessed over the wireless connection based on a thin native client or web browser on the mobile devices

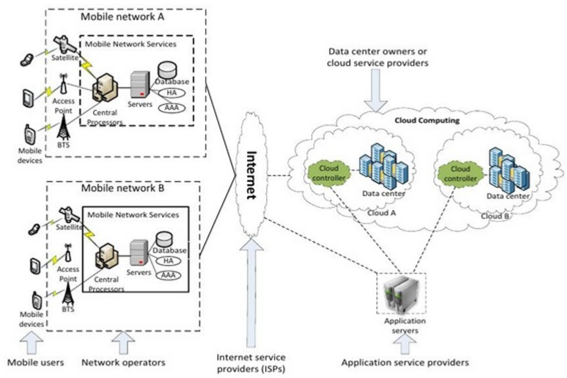

Figure 1: Mobile Cloud Computing

In order use Energy-as-a-Service(EaaS) model to save battery of smartphone it is important to understand the relationship between battery and application. Handheld devices use rechargeable electrochemical batteries. Their charging time is between 1.54 hours and they run for a few hours, though newer pocket personal computers run as long as 14 hours. For efficient and effective utilization of a battery, it is important to treat the battery as a measurable resource whose attributes are available to the operating system and applications on demand.
Some of the important battery attributes are:

- Full design capacity:It is the remaining capacity of a newly manufactured battery.
- Full charge capacity: It is the remaining capacity of a fully charged battery at the beginning of a discharge cycle.
- Theoretical capacity: It is the maximum amount of charge that can be extracted from a battery based on the amount of active materials it contains.
- Standard capacity: It is the amount of charge that can be extracted from a battery when discharged under standard load and temperature conditions.
- Actual capacity: It is the amount of charge a battery delivers under given load and temperature conditions.

The smartphone constraints can be eased off by offloading heavy task from the smartphone to the MCC. An example of heavy task is the video encoding where there is no existing of efficient encoding application on smartphones [2] [3] [4]. In particular, a heavy energy consuming application is offloaded to the MCC for smartphone

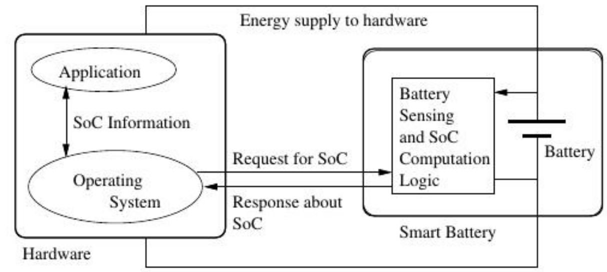

Figure 2: Relationship between Smartphone battery and Application

energy saving. Thus, MCC appears to be promising to fill the gap between smartphone performance limitations and expectation of the users by the Energy-as-a-Service (EaaS) service.

Since the offloading to MCC is in its initial state, it is important to understand whether or not MCC extends the smartphone battery life. The aim is to address the problem of running multimedia application on smartphones, and investigate the benefit of using MCC framework in this regard. This research will confirm that MCC provides an effective solution (i.e., EaaS) to extend smartphones battery life and enhance their multimedia capabilities.

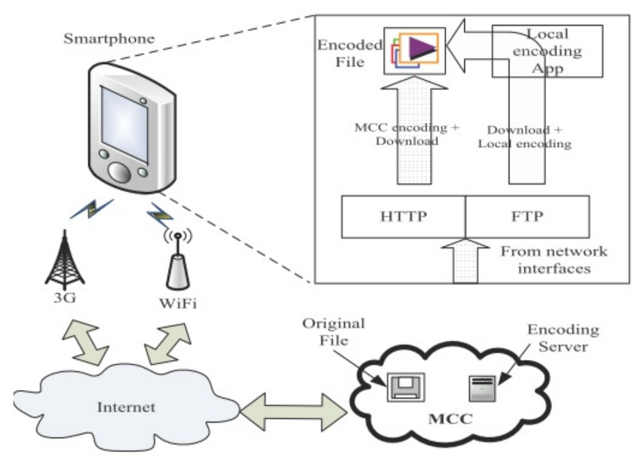

Figure 3: Encoding Scenario using MCC

Figure 3 depicts the architectural design, here the original file is present on MCC to be encoded: We consider the energy implications of: (i) FTP(File Transfer Protocol) protocols at the application level; and (ii) using the 3G (Third generation mobile telecommunication) and WLAN (Wireless Local Area Networks) communications at the wireless access interface level.

The rest of the paper is organized as follows: Section II summarizes the related work. Our system model described in Section III. Section IV summarizes the major constraints and limitations of our system. This paper is concluded in Section V.

II. Related Works

We focus on the approaches that involve task of offloading to servers on the Internet. Both 3G and Wifi network interfaces have same network traffic and for both progressive download and download-and-play. In general, the download-and-play consumes more energy than progressive download because the network modules continue to remain active for a while after the download is finished.

A number of techniques have been introduced at the application level to save energy. In order to run applications on handheld devices with virtual memory requirements, energy efficient network-based swaping has been proposed

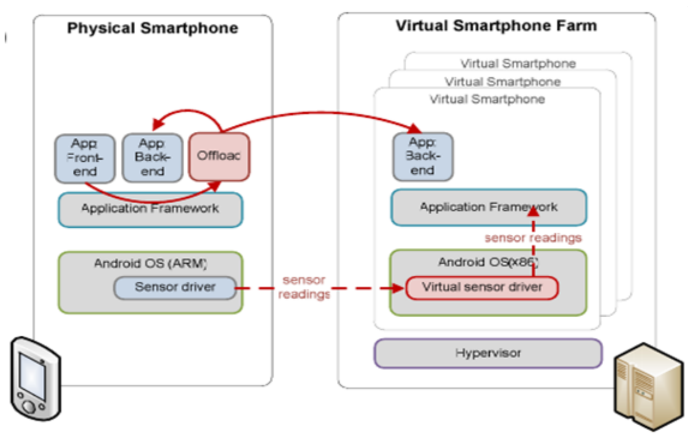

Figure 4: Virtual Smartphone in Cloud

Figure 4 shows the framework of Virtual Smartphone over IP. This allows a user to create a virtual Android image, is called as Virtual Smartphone, in the cloud as a dedicated external execution environment of the user?s physical smartphone. The user can offload an entire application to the Virtual Smartphone and control the application through remote desktop sharing such as VNC. Because sensor readings, such as GPS, accelerometer, orientation, magnetic field and temperature, are synchronized with the Virtual Smartphone in real time, the application installed in the remote Virtual Smartphone generates the same results as if it were installed locally in the physical smartphone. Virtual Smartphone can be used to boost up processing speed, to preserve smartphone?s battery life, to avoid untrusted applications from accessing local data on the physical device, and to prevent data leakage.

Similar to our work, CloneCloud [5] takes the approach of virtualizing smartphone OS on a remote server. It also clones the entire device environment and thus the name. Applications can be migrated to the remote machine when the user?s device is running on low resources. CloneCloud basically focuses on the theoretical computation models of exploiting the approach, we have focused on exploring the practical deployment.

III. System Model

Our system consists of two major parts: smartphones and MCC where both are linked to the Cloud Server through Internet, as depicted in Fig 5. The smartphones are connected to the Internet through a WLAN (i.e. WiFi) or a cellular data access point (i.e. 3G-HSDPA).

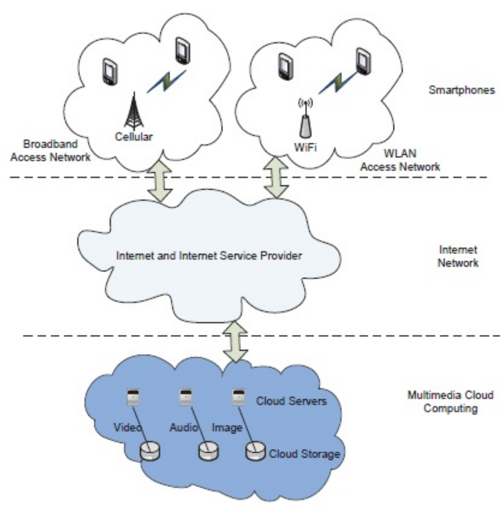

Figure 5: System model.

These smartphones provide all of multimedia functionalities to the end users. For instance, the user can play/recored a video or audio, and show/capture photos. The multimedia functionalities partially or fully interact with the corresponding MCC [3]. On the other hand, the MCC is a special type of cloud computing where its data center provides the users with all needs of multimedia functionalities such as storage and processing. Moreover,

ISSN : 2394-0905

the MCC has the capability to deal with a wide range of multimedia types and formats.

IV Summarizes the major constraints and limitations of our system

The major constraint is, the system requires the smartphone to have a ubiquitous and seamless internet connection. In general, it is found that 3G interface consumes more power than the WiFi interface. This means offloading via 3G has to be done carefully [2]. Moreover, the FTP protocol consumes less power than the HTTP protocol. But selection of either interface is difficult because each one provides the end user a unique experience. For instance, 3G supports a large range communication while WiFi supports short range.

V Conclusion

According to our study it will be beneficial to offload heavy applications, namely multimedia applications, from smartphones to MCC. MCC can significantly reduce the energy consumption on smartphones by using EaaS service. Moreover, MCC enriches smartphones capabilities for multimedia applications.

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