

The Concept of a Mobile Cloud Computing to Reduce Energy Cost of Smartphones and ICT Systems

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Abstract. In spite of the dramatic growth in the number of smartphones in the recent years, the energy capacity challenge for these devices has not been solved satisfactorily. Moreover, the global demand for green Information and Communication Technology (ICT) motivates the researchers to consider cloud computing as a new computing paradigm that is promising for green solution. In this paper, we propose new green solutions that save smartphones energy and at the same time achieve the green ICT goal. Our green solution is achieved by what we call Mobile Cloud Computing (MCC). The MCC migrates the content from the main cloud data center to local cloud data center temporary. The Internet Service Provide (ISP) provides the MCC, which holds the required contents for the smartphone network. Our analysis and experiments show that our proposed solution significantly reduces the ICT system energy consumption by 63% - 70%.

Keywords: Green ICT, Energy Saving, Cloud Computing, Mobile Cloud Computing, Data Center, Mobile, Handheld, Smartphones.

1 Introduction

The number of handheld devices is growing dramatically. Most of these devices are smartphones with WiFi, and 3G that give Internet access capability. With the success of PC-like applications on the smartphones, new constraints and challenges are introduced in design and implementation of these devices. One of the major challenges is the low and limited energy capacity of the device's battery since the handheld devices should be lightweight. On the other hand, the improvement in battery capacity has less pace than the advances in the semiconductor technologies. To overcome this unique challenge, new approaches from other smartphones technologies, such as communication technology, should consider this challenge.

Global warming encourages many technologies to become environment friendly. As Information and Communication Technology (ICT) is one of the most growing technologies, it is important to involve the green goal in ICT current and future design [1]. Cloud computing (CC) is a new computing paradigm that is

promising in different aspects such as environment friendliness. Cloud computing provides its resources as processing, networking, and storage capabilities to the end user with less impact on the environment because of it has high utilization of its resources [8,3,2,9]. Moreover, much has been reported in the literature for saving energy in smartphones [6]. For example, the handheld device could save its battery lifetime by offloading energy consumer task to the CC [5,4]. Therefore, the CC is the best candidate for our system.

This work proposes new green solution that save smartphones energy and at the same time achieve the green ICT goal. This solution is call Mobile Cloud Computing (MCC). The MCC provides all cloud computing functionalities: (i) Software as a Service (SaaS), (ii) Platform as a Service (PaaS), and (iii) Infrastructure as a Service (IaaS). In this work, we focus on IaaS functionality where the MCC saves the ICT system energy by migrating the contents from the main CC data center to a local cloud. This migration reduces the traffic on the Internet. That is only one transfer for the requested content is made from the CC to MCC. In addition, the handheld devices save their energy by using this MCC.

This paper makes the following contributions:

- Introduce the concept of a Mobile Cloud Computing (MCC).
- Consider the entire ICT system energy cost for green ICT technology.
- Analyze and experimentally measure smartphone energy consumption.

The order of the paper is as follows. Our system model is described in Section 2. The detail analysis of our system are shown in Section 3. Section 4 shows our system evaluation, and this paper is concluded in Section 5.

2 System Model

Our system consists of four major parts: handheld devices network, MCC data center, Internet, and CC data center, as depicted in Figure 1. Each handheld device is considered as a smartphone in this paper. Hereafter, we use smartphone and handheld device alternatively for the same meaning. Second, the data center provides the cloud computing functionality. This center has a LAN network, servers, and storage hard-disk arrays. There are two types of data center in our system: local and main data center. The local data center represents the infrastructure for the MCC where the main data center is for the public CC. The MCC is called by this name because of it exists to service mobile devices and its content is roaming and not static as in the case of public CC. Finally, the Internet is a set of high-speed routers and links.

3 Energy Cost Evaluation

Assume that we have N users forming the smartphones network. The users use smartphones that can access the Internet through an access point (AP) that is either Wireless Local Area Network (WLAN) or cellular 3G network. The users have the same interests and activities such as in conferences, museums,