Chapter 3
Addressing Fundamental Challenges in Mobile Cloud Computing with 4G LTE-Advanced

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ABSTRACT

Today, mobile tools, such as smartphones and tablets, have become primary computing devices for many users. One mobile tool to satisfy this is the 4G network technology LTE (Long-Term Evolution)-Advanced. These mobile tools are resource-poor due to limited battery life. Mobile Cloud Computing (MCC) is intended to provide services to mobile users by supplementing the resource-paucity of mobile devices (i.e. off-loading tasks/data on the Internet and providing the resources to a local client on-demand). However, despite LTE-Advanced's improved network quality, much needs to be done before MCC can reach its true potential. This chapter characterizes key challenges for deployment of MCC with 4G: device battery lifetime, latency, quality of service/experience, and handover. Statistical modeling is a powerful tool to address these issues. Once MCC with 4G network behavior is characterized, it is translated into the future development of innovative mobile technologies for a wide variety of new applications.

INTRODUCTION

The mobile cloud ecosystem is rapidly evolving globally. Meanwhile, an increasing number of operators are now offering cloud-based services with 4th generation long-term evolution advanced (4G LTE-Advanced) in mind. 4G LTE's higher bandwidth capabilities, nearly ubiquitous broadband access and improved quality of user experience have the potential to deliver the innovative cloud-based mobile multimedia services with fast, cost-effective, accessible, and scalable deployment. To maximize its potential, research needs to be conducted for Mobile Cloud Computing (MCC) with 4G.

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Without the development of 4G technologies, emergence of MCC would not be substantiated or vice versa. 4G systems enable ultra-broadband Internet access to mobile devices thereby handling cloud offloading, whereas 4G counts on cloud computing to manage resource-demanding applications. The key contribution of MCC with 4G is the capacity for advanced multimedia services which demands large amount of resources. To achieve optimal mobile multimedia cloud services, there are several challenges to overcome.

In this chapter, we will discuss the following fundamental challenges in MCC with 4G: maximizing device battery lifetime, improving interaction latency, provisioning of the quality of service/experience (QoS/QoE), and providing seamless handover. Our objective is to understand these challenges and explore the means to address them.

BACKGROUND

Today's Mobile Communications. The advancement of mobile technologies has profoundly affected our lives. It is a rapidly growing trend that more users are becoming dependent on the mobile tools as their primary computing devices, replacing the traditional stationary hardware (Mei 2011), while the mobile-only Internet population is projected to grow up to 788 million people worldwide by 2015 (Rao 2011); hence the impact of the mobile communication market on the global economy is obvious. Now the features for handling multimedia (images, videos, music, and other media) are integrated into the smartphones, and thus the potential for mobile communication keeps expanding.

However, there is a major obstacle for further development and that is the resource-paucity of portable devices. Even though mobile hardware keeps evolving, they will always be resource-poor relative to stationary hardware (Satyanarayanan 2009). The reason is that, first, battery technologies for mobile devices only allow limited computing power on a portable lightweight package, and second, the processing power and the memory of mobile hardware are much smaller than those of traditional desktops and laptops. This presents another challenge for a mobile device to execute resource-hungry user applications. Hence, a logical and obvious solution is to leverage cloud computing. With cloud computing, the resource intensive applications can be stripped out of the mobile devices and out-sourced for remote execution over the Internet.

Cloud computing: Cloud computing has become an important paradigm for delivering shared resources on-demand (e.g., infrastructure, platform, software, and so on), to a user's devices (e.g. computer or mobile device), over the Internet (Garg 2011), just like other utilities (e.g. water, electricity and gas). End-users can access cloud applications through a web browser on the desktop computer or on their mobile device. While the software and data is stored on servers at an unknown remote location, the end-users can receive the same, or better, level of service and performance, as if the software programs were installed on their local computing device. Synergy between these features of cloud computing and mobility of portable handsets is termed Mobile Cloud Computing.

Mobile Cloud Computing: When the cloud works together with mobile networks, all the data and complicated computing modules can be processed in the cloud and thus, mobile devices do not require a powerful configuration such as high CPU speed and large memory capacity. Usage of the mobile cloud can grow with the development of mobile applications (apps) as Apple states: "There's an app for that®". MCC is expected to become the leading mobile application development/deployment strategy, and some mobile cloud apps have already been in use, such as mobile Gmail and Google Maps. The cloud app-users can access applications from a cloud-based location via their handset's browser, which enables richer functions with less handset resource consumption.