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Review

A review on interworking and mobility techniques for seamless connectivity in mobile cloud computing

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ABSTRACT

Mobile Cloud Computing (MCC) leverages computational clouds for mitigating resources limitations in mobile devices. However, the mobility attribute of mobile devices and the intrinsic limitations of wireless access medium obstruct to achieve the goal of seamless connectivity for accessing distributed services in MCC. Mobility involves the issues of handover, service quality degradation and disruption, whereas the intrinsic limitations of the wireless access medium includes the issues of connectivity fluctuation and heterogeneity of wireless data networks. Therefore, interworking between heterogeneous wireless data networks and mobility management are employed to achieve consistency and seamless connectivity for accessing distributed services in MCC. However, such techniques lack of managing packet loss, handover latency, signaling overhead, service degradation and disruption, guaranteed QoS, and connectivity failure. Therefore, providing seamless connectivity in the network intensive computing environment of mobile cloud computing is a challenging research perspective. This paper reviews the state-of-the-art for interworking and mobility techniques to highlight issues and challenges in transparently leveraging the services of computational clouds for mobile devices. It proposes thematic taxonomy for the classification of the interworking and mobility techniques and qualitatively analyzes the implications and critical aspects of such techniques. The similarities and differences of interworking and mobility techniques are presented on the basis of latency, packet loss, mobility approach, signaling overhead and architecture. Furthermore, we identify the open issues and challenges in seamless connectivity that remains to be addressed.

Contents

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1. Introduction

The latest developments in mobile device technologies and demand for sophisticated mobile applications have changed user trends towards computing. Mobile devices are expected to provide complicated and ubiquitous services instead of simple telephony and computation. Applications such as m-commerce, mobile telemedicine, multiplayer mobile gamming, machine learning, natural language processing, pattern recognition, augmented reality service (Satyanarayanan et al., 2009) and interactive service make mobile devices an important part of everyday life. However, Smart Mobile Devices (SMDs) are still low potential computing devices which are constrained by the limitations in computing potential, battery life time and memory capacity. Mobile Cloud Computing (MCC) incorporates cloud computing with mobile computing for mitigating the resources limitations of mobile devices. Three recent trends of technology are employed to envision cloud based rich mobile computing environment. Recent developments in portable mobile devices such as smartphone, tablet with the features of compact size, lightweight, multimodal connectivity, high quality graphics, increasing computing and storage capacity, efficient power consumption and device tethering leading towards achieving the dream of “all time everywhere computing” (Poslad, 2011). Similarly, wireless data networks such as Wi-Fi, Wi-MAX, and Long-Term Evolution (LTE) are converging from circuit switched network to packet switching networks to provide ubiquitous internet environment (Vidales et al., Hopper). In the same way, the cloud computing focuses on the commercialization of computation and provides on demand resources and services for augmenting client devices (Buyya et al., 2009). In CISCO VNI Research (Cisco Visual Networking Index, 2012), the growth of mobile devices is predicted 10 billion and data traffic is expected to grow up to 10.8 Exabyte/month by 2016. At the same time the mobile network connection is expected to exceed up to 2.9 Mbps (Cisco Visual Networking Index, 2012). Hence, the pressure on wireless networks is predicted high and the demand of seamless service continuity is growing dramatically.

Mobile cloud computing is an evolving computing model which incorporates mobile computing with cloud computing. Cloud computing is a new paradigm of commercial computing that provides a highly available, pay-as-you-go, utility style computing resource infrastructure (Buyya et al., 2009) emerged from computing trends like utility computing, grid computing, distributed computing. It leverages the high cost of owing computing infrastructure and allows a user to lease a particular resource. Cloud computing is the latest version of distributed computing which employs virtualization for the provision of resources. Hypervisor masks the complications of accessing physical resources and provides a transparent computing platform. The business models of cloud computing is termed as on-demand, self-service, broad network access, resource pooling, elastic and measured computing services (Armbrust et al., 2010).

Mobile computing aims to enable computing services on the move. However, the growing demands of mobile augmented services, mobile applications and mobile gaming have pushed the researchers to think alternative to overcome the challenges of mobile computing. As a result, MCC is introduced to enable rich mobile computing by extending the on demand computing vision of cloud computing. MCC is defined as the availability of cloud computing services in a mobile ecosystem (Mobile Cloud Computing: Issues and Risks from a Security Privacy Perspective). The main motivation of bringing cloud computing in mobile computing is mobility, communication and portability (Forman and Zahorjan, 1994). Kovachev et al. (2011) defined MCC as *“A model for transparent elastic augmentation of mobile device capabilities via ubiquitous wireless access to cloud storage and computing resources, with context-aware dynamic adjusting of offloading in respect to change in operating conditions, while preserving available sensing and interactivity capabilities of mobile devices.”* Aepona describes (Mobile Cloud Computing Solution Brief, 2010) MCC as a branch of cloud computing that enables mobile devices to move the data processing and storage to powerful and centralized computing environment located in cloud. MCC model consists of three main elements: SMDs such as smartphone, tablet and palmtop; wireless data networks which are dynamic in nature and the computational cloud. SMDs use the IP networks such as GPRS, HSPDA, 3 G, and Wi-Fi to incorporate the cloud infrastructure which makes wireless data networks is an obligatory element of MCC. Figure 1 shows a generic model of MCC.

MCC aims to augment the capability of resources constrained SMD by leveraging the computing power of computational clouds. It employs intermediate and available wireless data networks intensively for long time while accessing the services and resources of computational clouds (Shiraz et al., 2013; Fernando et al., 2013). Due to distributed computing nature, MCC necessitates an uninterrupted and unobtrusive communication medium between remote cloud and SMD. This stimulates a new pursuit of “Seamless” connectivity which refers to enabling a user to maintain continuous and consistent connectivity irrespective to access technologies, mobility and dynamic nature of wireless networks. Seamless connectivity enables mobile user to maintain connectivity with a network without any QoS deterioration for ongoing application's

Fig. 1. General model of mobile cloud computing.