

Chapter 9

Mobile Video Cloud Networks

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ABSTRACT

Mobile multimedia computing has become ubiquitous in everyday life. However, mobile device users involved in resource-demanding visual applications such as video streaming often encounter performance degradations due to their mobile devices' intrinsic constraints in processing power, storage, and battery capacity. Cloud computing can be explored to circumvent such problems thanks to the vast resources available in the cloud. Mobile video cloud computing has thus emerged as an important research and development topic to achieve high-performance, innovative networked video applications. This chapter discusses the recent advances in mobile video cloud technologies and applications. The authors investigate mobile video cloud systems starting with the various mobile cloud paradigms and then present challenges and solutions of mobile video cloud management for mobility, context, and security. Furthermore, the authors examine the latest video coding standards and explore methods based on parallelisation and scalability for their optimised application over mobile clouds, followed by three highlighted mobile cloud video applications including streaming, transcoding, and gaming. Finally, future directions in this area are envisioned.

INTRODUCTION

Video content has become a ubiquitous presence with ever-growing demands for higher quality at any time, any location and an expanding variety of user equipment such as laptops, tablet PCs and

smart phones equipped with increasing media signal processing and networking capabilities. According to (Gartner, 2011; 2012), worldwide mobile device sales reached 1.6 billion in 2010, and the sales of smart devices (smartphones and tablets) alone will rise to 1.2 billion in 2013. Consequently, recent years have witnessed that video applications such as broadcasting, videocon-

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ferencing, video on demand, peer-to-peer streaming, and Internet Protocol (IP) TV are becoming a majority of network traffic worldwide in both wired and wireless/mobile networks. According to the yearly report from Cisco (2013), global mobile data traffic grew 70% in 2012, of which mobile video traffic account for 51%. It is the first time in history that mobile video traffic exceeded 50%. It is predicted that mobile video traffic will increase 16 fold between 2012 and 2017 and 2/3 of the world's mobile data traffic will be mobile video by 2017.

Meanwhile, despite the remarkable advances in technical specifications, smart mobile devices are struggling in handling the escalating computation and storage workload imposed by multimedia (especially video) applications of increasing complexity and quality. Because mobile devices have intrinsic constraints in storage, processing and battery capacity, mobile applications especially visual applications often hit a performance barrier. The vast computing and storage resources offered by cloud computing can be utilised to break through this barrier and convert the challenges into opportunities for the sustainable growth of mobile multimedia computing (Dey, 2012; Lawton, 2012). Therefore, recent years have been experiencing a major paradigm shift from conventional mobile computing to mobile cloud computing (Fernando, Loke & Rahayu, 2013), which combines the mobility convenience in mobile computing and the extraordinarily powerful capacity in existing and emerging Internet-based cloud infrastructure and beyond. Mobile cloud computing is thus gaining increasing global momentum. According to Juniper Research (Holden, 2010), the market for cloud-based mobile applications is expected to grow from \$400 million in 2009 to reach \$9.5 billion by 2014, yielding an average 88% phenomenal annual increase.

A mobile cloud offers on-demand, cost-effective (pay-as-you-go or sometimes almost free) computing utilities analogous to electricity or gas

utilities and mobile users can receive services from a cloud on the move as if they were employing a portable super computer. Mobile cloud networking promotes innovation in distributed, parallel, and pervasive mobile computing and applications, and creates new pathways between mobile devices and the wireless Internet. Resource-demanding, computation-intensive applications such as video networking are launched at mobile devices whilst the enormous volume of application data is stored and the tremendous intensity of the processing tasks is handled in the cloud, transparent to the mobile users. For instance, cloud-based video processing and networking can bridge the gap between mobile users' demanding application requirements and the limited resources in their mobile terminals. A number of applications can benefit from mobile cloud computing, including mobile commerce, mobile learning, mobile health-care, mobile gaming, and other practical applications e.g. for tourists such as various searching services and for social networking users such as mobile experience sharing (Dinh et al., in press).

In this book chapter, the authors focus on video applications over mobile cloud networks. The building blocks in mobile cloud video systems are illustrated in Figure 1. In the bottom layer, various mobile cloud paradigms are constructed to provide physical cloud computing and networking platforms for mobile users. In the middle layer, both mobile cloud management schemes (mobility support, context awareness and management, and security) and video coding standards are implemented over the mobile cloud paradigms to support mobile cloud applications. In the top layer, mobile cloud video applications and services are deployed to deliver cloud-based video applications such as streaming, transcoding and gaming.

The reminder of the chapter is organised as follows. The Background summarises the evolution of video coding standards, mobile networking and cloud computing. The subsequent four sections discuss the involved building blocks in details

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