Chapter 54
H.265 Video Streaming in Mobile Cloud Networks

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ABSTRACT

Mobile video applications have started to dominate the global mobile data traffic in recent years, and both opportunities and challenges have arisen when the emerging mobile cloud paradigm is introduced to support the resource-demanding video processing and networking services. This chapter offers in-depth discussions for content- and context-aware, adaptive, robust, secure, and real-time video applications in mobile cloud networks. The chapter describes and analyses the essential building blocks including the state-of-the-art technologies and standards on video encoding, adaptive streaming, mobile cloud computing, and resource management, and the associated security issues. The focus is context-aware adaptive streaming based on the latest video coding standard H.265 in the context of Internet-centric mobile cloud networking. Built upon selected building blocks underpinned by promising approaches and emerging standards, an integrated architecture is proposed towards achieving next-generation smart video streaming for mobile cloud users, with future research directions in this field identified.

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INTRODUCTION

Mobile video has become the dominant consumer of mobile network bandwidth in recent years. According to Cisco (2014), mobile video traffic exceeded 50% for the first time in history in 2012. It is predicted that mobile video will account for 69% of the total mobile data traffic by 2018, increasing 14 folds from 2013. Such remarkable growth in mobile video will pose tremendous challenges to mobile network operators, video service providers as well as end mobile users, who are equipped with mobile devices such as smartphones or tablets. These mobile devices are typically resource constrained in terms of storage, computation and processing capacity, energy (battery) and network bandwidth.

Meanwhile, the Mobile Cloud Computing and Networking (MCCN) model has emerged as a promising paradigm towards resolving the increasing conflict between the resource-demanding mobile video applications and the resource-limited mobile networks and devices. Such an integration between mobile devices and applications, and mobile cloud computing and networks has been widely recognised and indeed appears inevitable. According to Gartner (2013), Mobile Device Diversity and Management, Mobile Apps and Applications, and five cloud-related technologies are listed among the top ten technological trends for 2014. Although no universal definition exists for various mobile clouds, a mobile cloud is typically a mobile extension to an existing infrastructure-based cloud, which features a huge wealth of computing powers, storage and other resources. Mobile video processing tasks can thus be offloaded from the mobile device to the mobile cloud for faster processing, higher storage capacity and reduced battery consumption, among other potential benefits. By exploring MCCN, mobile application developers are enabled to develop applications that can harness the power of virtualised resources for processing huge volume of data and provisioning a richer app usage experience.

However, there are a number of open research issues to be addressed. In particular, there is typically a communication resource bottleneck between the cloud and the mobile cloud users. Fortunately, the latest advances in video compression standards can help substantially reduce the bandwidth requirement for transmitting or storing the videos. The ITU-T H.265 standard (ITU-T, 2013), also known as High Efficiency Video Coding (HEVC) and MPEG-H Part 2, was standardised in 2013 and is the next-generation video coding scheme. (It is noted that H.265 and HEVC are used inter-changeably in this chapter.) H.265 is capable of doubling the compression efficiency and thus halving the bandwidth demands without losing the visual quality, compared with the current H.264 Advanced Video Coding (H.264/AVC) standard (ITU-T, 2012). Such a remarkable bandwidth saving in H.265 coded videos particularly appeals to mobile communications, where bandwidth and storage is often constrained. On the other hand, the high compression efficiency in H.265 is achieved at the cost of high computation complexity. This in turn entails the exploitation of cloud computing technologies. Nevertheless, it is challenging to achieve real-time video processing in a mobile cloud environment.

Moreover, adaptive video transmission schemes, such as the MPEG Dynamic Adaptive Streaming over HTTP (DASH) standard (ISO/IEC, 2014a), are able to adapt to the context such as the variations in network conditions especially bandwidth and the end user's preference or device capability. Content awareness of the video stream being delivered can be leveraged to significantly improve the performance of the adaptation. For instance, it can be explored to prioritise the video packets in terms of their importance in affecting the end user's perceived visual quality. Consequently, the video application server or other Media-Aware Network Element (MANE) along the end-to-end route can selectively drop the least important packets first in response to the reduced bandwidth. When delivered over error- and/or loss-prone networks such as the concerned Internet Protocol (IP) based mobile clouds, end-to-end robust