Chapter 13
Mobile Video Streaming Over Heterogeneous Networks

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ABSTRACT

All-IP networks are under development with multimedia services in mind. Video multicast is an efficient way to deliver one video simultaneously to many users over such heterogeneous wired-to-wireless networks, such as in wireless IP applications where a mobile terminal communicates with an IP server through a wired IP network in tandem with a wireless network. Unicast video streaming is also an attractive way to deliver time-shifted TV to mobile devices. This Chapter presents a simple cross-layer model that leads to the optimal throughput to multiple users for multicasting video over a heterogeneous network. An adaptive forward-error-correction scheme is applied at the byte-level as well as at the packet-level to reduce channel errors. The results show that a server can significantly adapt to the bandwidth and FEC codes to maximize the video quality of service. For unicast streaming, the Chapter presents a single negative acknowledgment scheme in which a video stream is transmitted over a heterogeneous network from a streaming server to a mobile device in a WiMAX network. The broadband streaming system is compared to several candidate solutions based on originally wired network congestion controllers. Multi-connection streaming is also investigated.

INTRODUCTION

Video multicast is an efficient way to deliver one video simultaneously to many users over heterogeneous wired-to-wireless networks, such as in wireless IP applications where a mobile terminal communicates with an IP server through a wired IP network in tandem with a wireless network as in Figure 1. Such a network is commonly called an all-IP network (Lin & Pang, 2005) in

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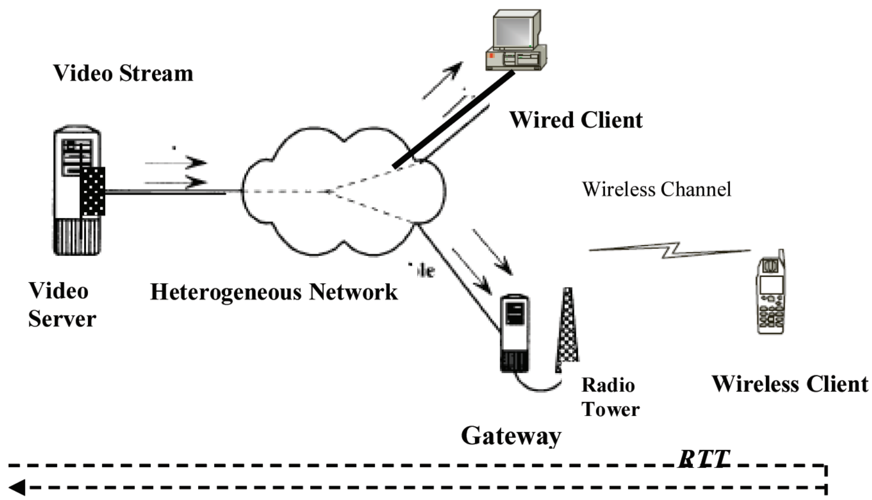
Figure 1. Video multicast system over heterogeneous wired-to-wireless network



which Internet Protocol (IP) framing is standardized. Compared to unicast, multicast improves bandwidth efficiency by sharing video packets delivered through network. However, it suffers some particular problems arising from the use of wireless network applications. For example, a multicasting wireless network is often characterized by having a physical channel that is highly error-prone and time-varying. In addition, users in such a network can often have diverse channel conditions (Liu et al., 2007). Unicast video streaming, also over a heterogeneous network as in Figure 1, is generally introduced to provide a value-added addition to multicast video streaming. At the protocol level for heterogeneous networks, various extensions of traditional congestion control using TCP-Friendly Rate Control (TFRC) (Handley et al., 2003) have occurred. Some extensions (Fu et al., 2006; Görkemli et al., 2008), employ a cross-layer approach as in the multicast case study in this Chapter, while others use multi-connections (Chen & Zakhor, 2006; Al-Majeed & Fleury, 2010). Another approach is to use corruption-aware TCP (Balan et al., 2001; Tickoo et al., 2005; Cui et al., 2007), though there is a risk to throughput on the wired channel if TCP transport is used when congestion is high, because of TCP's reliability mechanism. Another scheme for unicast streaming is multi-connection TCP as in the Stream Control Transmission Protocol (STCP) (Stewart, 2007). In the unicast case study, a specific study of IEEE 802.16e (mobile WiMAX) (IEEE, 2005; Andrews et al., 2007) occurs, though the approach is general. The Chapter considers single negative acknowledgment broadband video streaming (Al-Majeed & Fleury, 2010a), which is a simplified method of approaching the problems of heterogeneous networks.

This Chapter introduces two case studies, the first of which considers multicast distribution of video and the second of which examines unicast distribution. The first study is wireless technology agnostic, while the second concentrates on wireless broadband, specifically IEEE 802.16e (mobile WiMAX). The first case introduces a framework of TCP-Adaptive Forward Error Correction (FEC) scheme to improve the link reliability via achieving a maximum TCP throughput for each client of MPEG-4 video multicast over a hybrid network. The cross-layer design consid-

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