Chapter 2.10
Scalable Video Delivery over Wireless LANs

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ABSTRACT

Recent advances in wireless broadband networks and video coding techniques have led the rapid growth of wireless video services. In this chapter, we present a comprehensive study on the transmission of scalable video over wireless local area networks (WLAN). We analyze first the mechanisms and principles of the emerging scalable video coding (SVC) standard. We then introduce the IEEE 802.11 standards for WLAN and related quality of service (QoS) issues. We present some studies of SVC over WLAN using cross-layer design techniques. We aim to exploit the unique characteristics of the scalable video coding technology to enhance personalized experience and to improve system performance in a wireless transmission system. Examples and analyses are given to demonstrate system performances.

1. INTRODUCTION

The past decade has witnessed the success of wireless video applications which led to the remarkable progress in the research and development of video coding technologies and wireless communication standardizations. Nowadays, wireless networking technologies, such as wireless personal area network WPAN (IEEE Std 802.15), wireless local area network WLAN (IEEE Std 802.11, IEEE Std 801.11a, IEEE Std 802.11b, IEEE Std 802.11g, IEEE Std 802.11e, IEEE Std 802.11n), wireless metropolitan area network WMAN (IEEE Std 802.16), and cellular networks make people to communicate easier and more efficient. The improvement in long-life battery, low-cost mobile

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CPU, and small-size storage device enable the multimedia-rich applications in mobile devices. Moreover, the advanced of video coding technologies such as standardization of MPEG-2 (ISO 1994), MPEG-4 (ISO 1999), H.264 (JVT 2003) have provided efficient solutions with high compression performance, robust error resilience, and flexible functionalities for wireless video service. In addition, extensive research and development activities have been conducted to provide intelligent resource allocation and efficient power management to further enhance the seamless mobile multimedia experience.

Video delivery over wireless medium faces a multitude of challenges. Wireless networks are well-known for their volatile variation in channel conditions due to multipath propagation, fading, co-channel interferences and noise. As for the medium access, competition for channel access and bandwidth among users further complicate the networking design for bursty multimedia traffics. User mobility in mobile networks always leads to the varying network topology, which necessitates a frequent reformulation of optimal routing protocol. The negative effects caused by different factors always interweave between each other and complicate the system design. As mobile users always seek personalized experiences, an efficient multimedia transmission strategy should therefore be adaptive and content-aware. Unlike the data communication, multimedia communication over wireless networks is often characterized as bandwidth intensive, delay sensitive, but loss-tolerant. Provision of Quality of Service (QoS) for different users poses great challenges to the design of efficient algorithms and comprehensive strategies to effectively design the transmission strategy and provide trade-offs among multimedia quality, resource utilization, and implementation complexity.

A variety of video coding and streaming techniques have been developed. Among these comprehensively investigated techniques, the emerging scalable video coding technique shows distinctive advantages in coding efficiency and bitstream manipulation. Although different video applications provide different constraints and degrees of freedom in the system design, the main challenges are time-varying bandwidth, delay jitter, and packet loss. Scalable video coding is competent to provide solutions to these problems by its scalability and efficiency.

Scalable video coding (SVC) (H. Schwarz, D. & Marpeand et al. 2007) encodes video into base and enhance layers. The base layer contains the lowest level spatial and temporal resolutions and the coarsest quality representation. Enhance layers increase the quality and/or resolutions of the video. For example, the base layer of a stream might be encoded at 15 frames per second, in a QCIF resolution, and at a data rate of 100Kbps for viewing on mobile phone through cellular network. Additional layers could expand that stream to CIF video at 500Kbps for a larger display screen on PDA. If video is downloaded through Internet, more enhancement layers could be sent out concurrently. The highest supportable resolution and quality could go up to a relative high-quality streaming over the WLAN, say at 1280×720×60 with 4Mbps datarate to support viewing on TV screen. All the layers are incorporated into a single file, reducing the administrative expense of linking and encoding. Compared to H.264/AVC, SVC is very efficient, as the SVC-encoded bitstream is only about 10% larger than the H.264/AVC non-scalable video bitstream at the same quality (Schwarz & Wien 2008). In addition, the SVC base layer is compatible with existing H.264/AVC encoding standard. With existing hardware encoders, content producers can convert their current formats to SVC compatible streams on the fly. Therefore video publishers will not need to convert their existing library to leverage the new technology. The most distinctive feature comes from the easy adaptation of the encoded bitstreams to accommodate heterogeneous users. For a scalable encoded video, the base layer video at resolution 174×144 and frame rate 15fps

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