Chapter 17
Video Distortion Estimation and Content-Aware QoS Strategies for Video Streaming over Wireless Networks

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ABSTRACT

This chapter describes several advanced techniques for estimating the video distortion deriving from multiple video packet losses. It provides different usage scenarios, where the Peak Signal to Noise Ratio (PSNR) video metric may be used for improving the end user quality. The key idea of the presented applications is to effectively use the distortion information associated to each video packet. This allows one to perform optimal decisions in the selection of the more suitable packets to transmit. During the encoding process, the encoder estimates first the loss impact (for instance the amount of error propagation) of each packet. Afterwards, it generates side information as a "hint" for making video content aware transmission decisions. In this way, it is possible to define new scheduling schemes that give more priority to the packets with higher loss impact, and to assign fewer resources to the packets with lower loss impact. To this end, the usage of hint tracks, introduced in the MPEG-4 systems part, provides a syntactic means for storing scheduling information about media packets that significantly simplifies the operations of a streaming server. Moreover, the prioritization scheme may be used to minimize the overall error propagation under the delay constraint imposed by the video presentation deadline. The chapter also reviews recent research advances in the field of QoS mechanisms that adopt video specific metrics to improve the end user perceived quality.

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I. INTRODUCTION

The last decade has shown the pervasive expansion of several Information Technologies (ITs) including both a phenomenal growth in wireless communications and a revolution in multimedia technologies. Wireless networks have enabled a large variety of existing and emerging applications due to their low cost and flexible infrastructure. Several classes of different wireless technologies have been successfully deployed in different countries and different application scenarios. They are: Wide Area Networks (WANs), Local Area Networks (LANs), and Personal Area Networks (PANs). Cellular wireless networks belong to the class of WANs, Wireless LANs (WLANs), such as IEEE 802.11, and HIPERLAN belong to LANs, while Bluetooth, ZigBee, and Ultra Wide Bands (UWBs) belong to PANs. WANs offer greater mobility to the users, but lower data rates; LANs offer wider bandwidth, but limited coverage range; PAN technologies, instead, are usually deployed for cable substitution, and WLANs are generally used as the wireless replacement of the wired LANs. Wireless networks exhibit a large variation in channel conditions not only because of the different access technologies, but also due to channel impairments. These are mainly due to multipath fading, co-channel interference, noise, and so on, as well as competing traffic from other wireless users that share the same medium.

Besides, given the availability of wider bandwidth in wireless networks, the Internet multimedia applications are becoming more and more attractive to the mobile users. In fact, the Internet is becoming a truly multiservice network, in which infrastructure services requiring multimedia communications are emerging. These multimedia services range from voice over IP to video applications over IP. These include video conference, video surveillance, TV entertainment, and also interactive television (iTV), with services ranging from video-on-demand and interactive program guides to real-time shopping. Moreover, Internet-like data services, such as tele-medicine, tele-education, and tele-working services are becoming more and more popular.

Thus, as the possible use of these wireless networks spreads from simple data transfer to bandwidth intense, delay-sensitive, and loss-sensitive video applications, addressing Quality of Service (QoS) issues becomes crucial. To overcome channel impairments during the transmission, several different protection and adaptation strategies exist at different layers of the Open Systems Interconnection (OSI) protocol stack. Hence, to best understand how the user experience is influenced by these strategies, an evaluation of them is necessary.

From this point of view, this chapter discusses content aware QoS strategies for resource demanding services (including video applications). Here, the packet importance information is used as a criterion to improve the end user perceived quality. A detailed review of the recent advances in the research fields of content aware QoS strategies and scheduling techniques is presented. This allows a deeper comprehension of the aspects and trade-offs involved in the transmission of multimedia data over wireless networks. The motivation for this review is that most packet scheduling schemes, currently used in wireless networks, do not achieve the best possible quality for video transmission. This is due to the fact that they do not take the video content into consideration when making scheduling decisions. Although more complex, content-aware schemes could perform significantly better in terms of the end user perceived video distortion, and utilize more efficiently the available network resources. To make the best possible scheduling decisions, any such scheduling scheme should take into account the video encoding method, the channel conditions, as well as the decoding and error-resilience methods employed at the decoder.