Chapter 4
Cross Layer Design for Multimedia Transmission over Wireless Networks

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ABSTRACT
Over the last years a number of new protocols have been developed for multimedia applications in the whole OSI layer’s scale. In addition wireless communications and networking fast occupy centre stage in research and development activity in the area of communication networks. In order to better support wireless user the cross layer design paradigm has been proposed. This chapter presents the challenges in design and implementation of cross layer adaptation schemes for multimedia transmission over wireless networks. In addition, this chapter presents the most important parameters and constrains that should be taken into consideration when attempting cross layer adaptation in wireless networks that involves different protocols in the overall protocol stack.

INTRODUCTION
This chapter examines the issue of cross layer design for multimedia transmission over wireless networks. In wireless networks multimedia data transmission inherits all the characteristics and constrains related to the propagation to the free space. One first striking difference between wired and wireless networks is the cause of packet losses. Packet losses in wired networks mainly occur due to congestion in the path between the sender and the receiver, while in wireless networks packet losses mainly occur due to corrupted packets as a result of the low Signal to Noise Ratio (SNR), the multi-path signal fading and the interference from neighboring transmissions. A second difference between wired and wireless networks is the “mobility factor”. Mobility in wireless networks
introduces a number of additional barriers in multimedia data transmission.

As wireless communications and networking fast occupy centre stage in research and development activity in the area of communication networks, the suitability of the layered protocol architecture is coming under close scrutiny from the research community. Although layered protocol architectures have served well for wired networks, they seem not to be suitable for wireless networks. To illustrate this point, researchers usually present what they call a “cross layer design” proposal. Thus, there have been a large number of cross layer design proposals in the literature recently (Raisinghani, 2004), with some of them focusing on multimedia transmission (Van der Schaar, 2005, Exposito, 2008, Kofler, 2007). Generally speaking, cross layer design refers to protocol design done by actively exploiting the dependence between protocol layers to obtain performance gains. This is unlike layering, where the protocols at the different layers are designed independently.

This chapter presents the challenges in designing and implementation of cross layer adaptation schemes for multimedia transmission over wireless networks. The remaining of this chapter is structured as follows: The next section presents the international experience in the area of cross layer design for multimedia transmission over wireless networks. The third section presents the challenges in cross layer design for multimedia transmission over wireless networks. The fourth section presents the future trends in the area. Finally, the fifth section concludes this chapter.

BACKGROUND

Over the last years a number of new protocols have been developed for multimedia applications in the whole OSI layer’s scale. The RTP and RTCP protocols (Schulzrinne, 2003), which operate on the transport layer usually on top of the UDP protocol, have been especially designed for multimedia data transmission. The RTSP (Schulzrinne, 1998) protocol offers control mechanisms over real time multimedia transmission whereas SIP (Schulzrinne, 2002) and H.323 are used in multimedia conferencing.

Apart from the above developments there have been a number of proposals for improving Quality of Service (QoS) in multimedia applications through cross layer adaptation strategies. In Van der Schaar, 2005 the need of a cross layer optimization is examined and an adaptation framework is proposed amongst the APP, the MAC and the Physical (PHY) layers. In Shakkottai, 2003 the issue of cross layer design in wireless networks is addressed. The focus is on the way that higher layers share knowledge of the PHY and MAC layers conditions in order to provide efficient methods to allocate network resources over the Internet. In Van der Schaar, 2003 a joined APP and MAC adaptation is proposed with the use of MPEG-4 and the latest Fine Granularity Scalability (FGS) extension. In this work, packets containing multimedia data are classified into different classes and in the light of poor network conditions only packets with high value are transmitted. The network conditions are jointly measured by combining the information obtained by the retransmission number of a lost MAC frames (Automatic Repeat-reQuest, ARQ) and the information provided by the RTCP protocol. Signaling issues between the layers for cross layer optimization over wireless networks are examined in Wang, 2003. The authors propose a new signaling framework in which signaling can be done between two non-neighboring layers, through light-weighted messages and the use of a message control mechanism to avoid message dissemination overflow. Although this proposal avoids heavy the Internet Control Message Protocol (ICMP) messages for out-bound signaling between the layers that is proposed in Sudame, 2001, it introduces very high complexity. In
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