

Chapter XVII

Cross-Layer Radio Resource Management Protocols for QoS Provisioning in Multimedia Wireless Networks

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ABSTRACT

This chapter introduces the cross layer design for resource allocation over multimedia wireless networks. Conventional layered packet scheduling and call admission control schemes are presented and a number of cross-layered protocols that are recently proposed are investigated. The chapter highlights the QoS improvement and the performance gain obtained while considering the interlayer dependencies concept for various real-time and non-real-time applications. The authors hope that this chapter will assist in the understanding of the cross layering and its enhancement of the layered design for QoS provisioning in future multimedia wireless networks.

INTRODUCTION

Future communication systems are expected to provide a broad range of multimedia services with guaranteed quality of service (QoS). Therefore, effective management of the limited radio resources

is important to enhance the network performance. Cross-layered radio resource management algorithms are some of the protocols that being designed to optimally adapt to channel conditions and specific applications requirements. Their purpose is to solve the issue of the lack of built-in

mechanisms for protocol layers that makes it very difficult to provide guaranteed QoS for multimedia applications. This chapter intends to provide an overview of the various QoS requirements in next generation wireless multimedia networks, and some of the proposed solutions for effective management of the limited radio resources to enhance the network performance.

In this context, the chapter concentrates on the packets scheduling and admission control schemes proposed for QoS provisioning in such networks. As data communication through the air interface faces the hardest challenges, the chapter attempts to focus on the radio channel conditions and to explore the novel approaches based on cross-layered radio resource management protocols while presenting an overview on such protocols presented in literature.

BACKGROUND

Radio Resource Management for Wireless Systems

The next generation wireless systems are deemed to support a broad spectrum of multimedia services with quality of service (QoS) guarantees. However, in a wireless environment QoS provisioning is a challenging task. The wireless link with its particular characteristics and the user mobility renders QoS provisioning difficult and complicated, especially in such communication systems developed to support simultaneously and efficiently a broad range of heterogeneous multimedia services. Indeed, the wireless channel varies over time and space and has short-term (or small-scale) memory due to multipath (Shakkottai, 2003). These variations are caused either due to motion of the wireless device, or due to changes in the surrounding physical environment, and lead to detector errors. This causes *bursts of errors* to occur during which packets cannot be successfully transmitted on the link. Fast chan-

nel variations due to fading are such that states of different channels can asynchronously switch from “good” to “bad” within a few milliseconds and vice-versa. Further, very strong forward error correction codes (i.e., very low rates) cannot be used to eliminate errors because this technique leads to reduced spectral efficiency. In addition to small-scale channel variations, there are also spatio-temporal variations on a much greater time-scale (Liu, Karol, El Zarki, & Eng, 1996). Large-scale channel variation means that the average channel state condition depends on user locations and interference levels. Thus, due to small-scale and large-scale changes in the channel, some users may inherently demand more channel access time than others based on their location or mobile velocity, even if their data rate requirement is the same as or even less than other users.

One of the most important elements in such wideband wireless systems is the resource access protocol. It defines how a common resource such as the wireless medium is shared among contending users, and hence determines the overall performance of the system. For multimedia cellular networks, the access protocol must ensure efficient and timely access to multi-rate applications with different communications requirements. This implies that the protocol must be able to handle a wide range of information bit rates as well as various types of real-time and non-real-time service classes with different traffic characteristics and QoS guarantees. In addition, the protocol must operate under different constraints of moving users, dynamic traffic load variations, and highly sensitive wireless links.

Within the next generation wireless network architecture, radio resource management (RRM) entity is responsible for utilization of the air interface resources, covering, call admission control (CAC), packet scheduling, and handoff. This chapter investigates the CAC and packet scheduling techniques for next generation wireless networks.

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