Chapter 27
Delay Constrained Admission Control and Scheduling Policy for IEEE 802.11e HCCA Method

Der-Jiunn Deng
National Changhua University of Education, Taiwan

Yueh-Ming Huang
Department of Engineering Science, National Cheng Kung University, Taiwan

Hsiao-Hwa Chen
Department of Engineering Science, National Cheng Kung University, Taiwan

ABSTRACT

In order to obtain better Quality-of-Service (QoS) requirements for multimedia traffic, the 802.11TGe has proposed HCF Controlled Channel Access (HCCA) method for the Controlled Access Period (CAP) in the HCF (Hybrid Coordination Function) to enhance the original IEEE 802.11 Medium Access Control (MAC) protocol, and it is expected to provide integrated traffic service to realize mobile multimedia communications. However, the reference design of admission control and scheduling policy in HCCA still can not provide stringent delay requirements to fulfill a hard QoS guarantee, a necessary feature for most multimedia applications. In this chapter, the authors propose a pragmatic admission control scheme with a novel polling based packet scheduling policy for multimedia transmission, such as Constant Bit Rate (CBR) and Variable Bit Rate (VBR) traffic, for IEEE 802.11e HCCA method. Our design is simple, it is compatible with the standard, it can guarantee delay constraint, and it utilizes bandwidth efficiently. A simple and accurate analytical model is carried out to study the average queueing delay estimation of the proposed scheme. In addition to theoretical analysis, simulations are conducted in NS2 network simulator to verify our analysis and to validate the promising performance of the proposed scheme.

DOI: 10.4018/978-1-4666-2136-7.ch027

INTRODUCTION

In the past, network designers had to contend with only one form of traffic, voice or data. Today, most new applications have become much richer in content than simply text, or strictly telephony, and require transmission of multitude of media. Hence, there is a strong economic and practical push to integrate all of these applications onto a single network. However, data, video and audio media have different transmission requirements, in terms of sustained data rates, acceptable latency, and tolerated error rates. Hence, the presence of QoS support in wireless networks is crucial since a global, ubiquitous wireless network will play a vital role in creating new user-centric communication service in the next generation Internet.

In Wireless Local Area Networks (WLANs), the MAC protocol is the key component that provides the efficiency in sharing the common radio channel while satisfying the QoS requirements for multimedia applications. That is, MAC protocols that aim to carry multimedia traffic must be able to meet the differing requirements of each of the different traffic classes. Time-bounded data are useless unless arrived in time. Such data usually have stringent delay constrains and in many cases they should be delivered exactly as they were generated. Examples of such traffic include voice and video. On the other hand, asynchronous data, such as email or file transfer, can be delayed without causing any inconvenience.

In general, there are two methods in wireless MAC protocols to facilitate the transmission of time-bounded data, reservation schemes and priority schemes. Reservation schemes allow time-bounded traffic to reserve a periodic time slot on the channel that they alone can access. When the time-bounded traffic being transmitted is voice or video, the reserved time is a periodic slot in time within a larger time frame. Once a slot is assigned, no other stations may contend for that portion of resources. All reservation schemes suffer from one drawback. When reserved and unused, the resource is simply wasted. This is where priority schemes come in. Priority schemes share resources and at the same time allow some stations to have a larger share of the pie. They assign higher priority to the time-bounded traffic and high priority traffic has precedence for using network resources. However, depending on the protocol design (for example, whether the resource usage is preemptive), performance can not be absolutely guaranteed.

The original IEEE 802.11 standard (Chen, Zhai, Tain & Fang, 2006) is designed for best effort service only. The lack of a built-in mechanism for support of real-time services makes it very difficult to provide quality-of-service guarantees for throughput-sensitive and delay-sensitive multimedia applications. Therefore, modification of existing standards is necessary. To expand support for applications with QoS requirements, the 802.11e Task Group (IEEE Draft Std. 802.11e/D8.0, 2004) was formed to enhance the original IEEE 802.11 MAC protocol and it is expected to provide integrated traffic service to realize mobile multimedia communications.

A simple admission control scheme and packet scheduling policy for IEEE 802.11e HCCA method has been developed as a reference in the IEEE 802.11e standard, where the mean data rate and the mean packet size are used to calculate the resource need by stream. However, a guaranteed stringent delay constrain for every single MAC Service Data Unit (MSDU) to provide multimedia traffic with their pledged QoS requirements still cannot be satisfied in WLANs since the instantaneous and fluctuating data rate generated by multimedia applications are usually quite different from the corresponding mean values.

This chapter aims to provide a comprehensive study of the limitations and merits of mechanisms that have been proposed toward the provision of hard QoS support to WLANs at MAC layer. First, we will give a brief introduction of the IEEE 802.11e HCCA method. We then explore various proposed admission control schemes and packet