Chapter 6

Delay-Based Admission Control to Sustain QoS in a Managed IEEE 802.11 Wireless LANs

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1. ABSTRACT

In this chapter, we present a delay-sensitive MAC adaptation scheme combined with an admission control mechanism. The proposed solution is based on thorough analysis of the trade-off existing between high network utilization and achieving bounded QoS metrics in operated 802.11-based networks. First, we derive an accurate delay estimation model to adjust the contention window size in real-time basis by considering key net-work factors, MAC queue dynamics, and application-level QoS requirements. Second, we use the abovementioned delay-based CW size adaptation scheme to derive a fully distributed admission control model that provides protection for existing flows in terms of QoS guarantees.

2. INTRODUCTION

During the last decade, multimedia services such as VoIP and Video have gained an increased success in the 802.11-based wireless network as this latter continuously adds capacity to support more and more bandwidth-hungry services. This has, in turn, opened new business opportunities for Network Operators (NOs) that are now offering new multimedia services over IEEE 802.11-based wireless networks (IEEE 802.11, 1999). The deployment of this kind of application is facilitated by the promise of both new 802.11's physical layers that provides high data rate (100 Mbps), and the new IEEE 802.11 QoS-based standard (IEEE 802.11e, 2005). In fact, the IEEE 802.11e standard is designed to support different sensitive multimedia applications (such as: Voice over IP, Video streaming), besides the classical best effort traffics. Still, the current version of the IEEE 802.11e standard doesn't provide firm QoS guarantees with efficient Admission Control (AC) protocol, the way traditional wired networks do. In fact, it is difficult to maintain QoS for admitted multimedia flows in 802.11-based networks without using an AC protocol. This poses tremendous viability problems on any carrier-grade multimedia services

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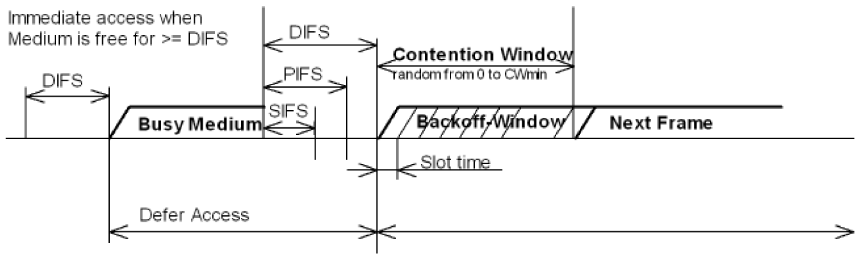
Figure 1. DCF access mechanism



provisioning over 802.11-based networks.

This chapter is organised as follows: section 3 reviews existing works on QoS support and admission control in IEEE 802.11. In section 4, we introduce our Delay-based Admission Control. Simulation results covering the performance of the proposed AC are given in section 5. Finally, we conclude in section 6.

3. QUALITY OF SERVICE SUPPORT AND ADMISSION CONTROL IN IEEE 802.11

In this section, we provide background material on the 802.11 MAC and QoS enhancements. Related works on AC algorithms in 802.11 networks are also reviewed in this section.

3.1. IEEE 802.11 Basic Access Mechanism: DCF

The IEEE 802.11 MAC defines two transmission modes for data packets: the Distributed Coordination Function (DCF) based on Carrier Sense with Multiple Access (CSMA/CA) and the contention-free Point Coordination Function (PCF), where the Access Point (AP) controls all transmissions based on a polling mechanism. The popularity of IEEE 802.11 wireless LAN (WLAN) is mainly due to DCF, whereas the PCF is barely implemented in today's products due to its complexity and inefficiency in common network deployment setup, despites its limited QoS support. PCF may cause unpredictable beacon delays and unbounded transmission latencies (Mangold, 2002). On the other hand, DCF is the basic mechanism for IEEE 802.11 that employs a CSMA/CA algorithm (see Figure 1) and allow for a fully distributed wireless medium sharing. Before sending a packet, a wireless station first senses the medium for a duration equivalent to Distributed Inter-Frame Space (DIFS). If the medium is idle for that duration, the wireless station starts sending immediately. Otherwise, if the wireless station senses the medium as busy, the wireless station backs off for a certain number of time slots (see eq. 1).

$$Backoff = Random\ (0,\ CW\text{-}1)\ *\ SlotTime \qquad (1)$$

Collisions can only occur in the case where two terminals start transmitting on the same slot. For each unsuccessful transmission the Contention Window (CW) is exponentially increased as follows:

$$CW_{new} = \left(CW_{\min} \times 2^{i}\right) \qquad (2)$$

where i is the number of unsuccessful transmission attempts usually referred to as the backoff stage.

Note that, after each successful transmission the CW is initialised with the CWmin.

In order to guarantee undisturbed transmission even in presence of hidden wireless stations, an RTS/CTS (Request to Send/Clear to Send) mechanism is used. When this sender/receiver synchronization mechanism is enforced, the contention