Achieving Per-Stream QoS with Distributed Airtime Allocation and Admission Control in IEEE 802.11e Wireless LANs

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Outline

- Introduction
- Airtime-based Admission Control
- Allocation of Airtime in IEEE 802.11e Wireless LANs
- Parameter Negotiation Flow
- Performance Evaluation
- Conclusions

Introduction

- *To* support the transmission of (high-rate and often bursty) multimedia data with performance guarantees in an IEEE 802.11e WLAN, it is crucial to design judicious algorithms for admission control and resource allocation.

Introduction of 802.11e

- The MAC protocol in the 802.11e standard
  - Enhanced Distributed Channel Access
    - Contention-based channel access mechanism
    - Prioritized QoS service
  - HCF Controlled Channel Access
    - Polling-based channel access mechanism
    - Parameterized QoS service

Mechanism of EDCA

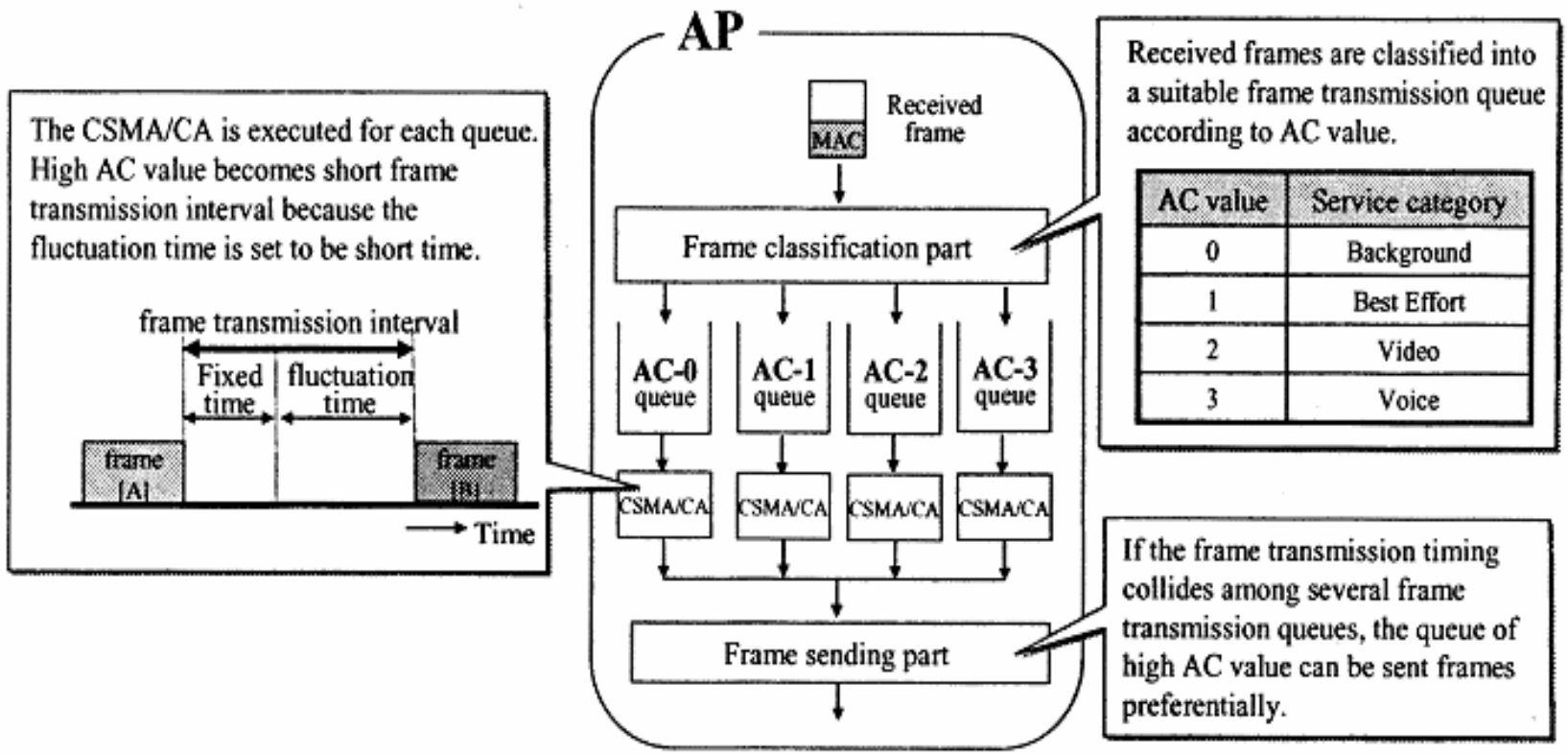


Figure 1. Mechanism of EDCA.

Mechanism of HCCA

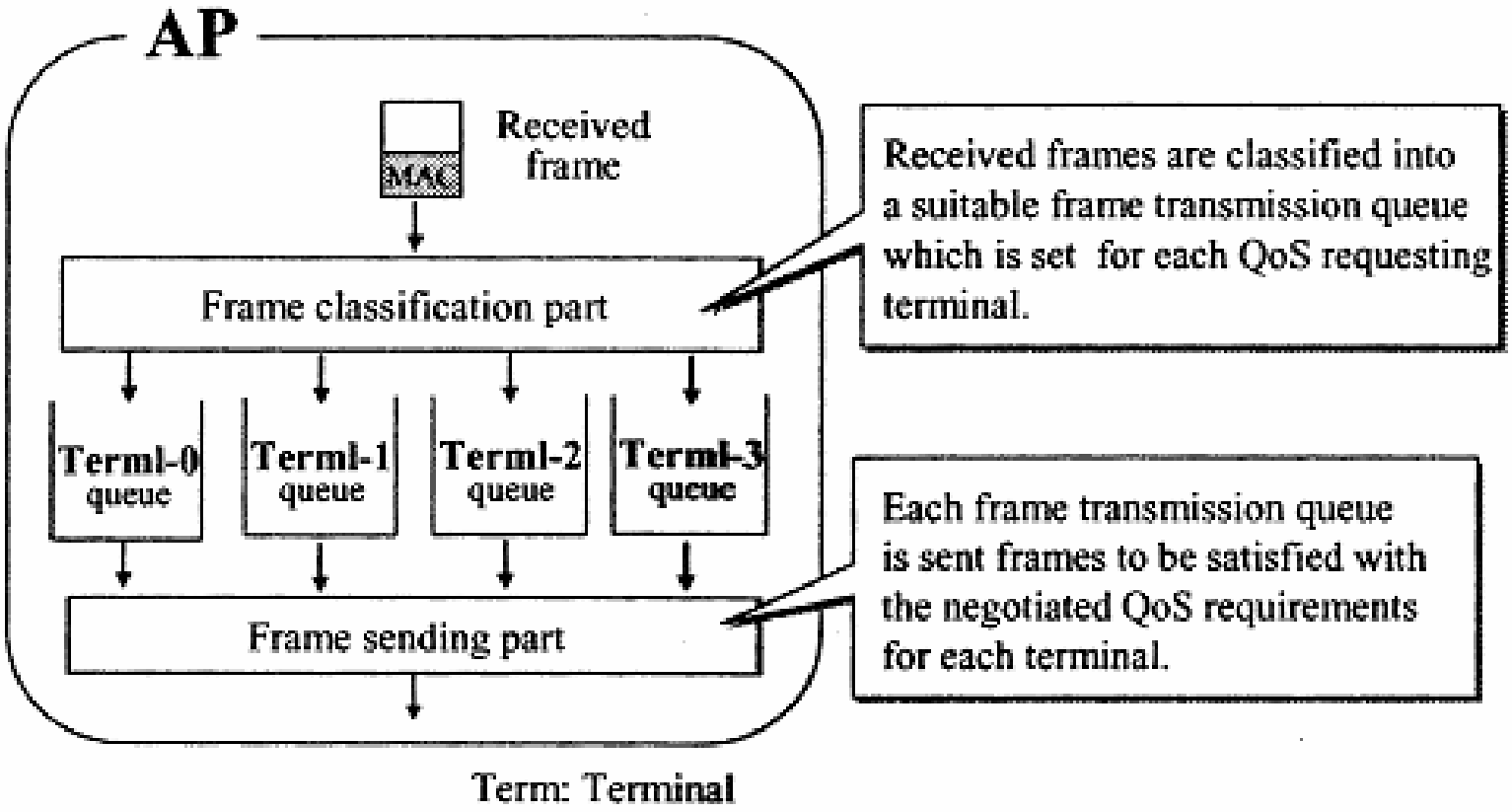


Figure 2. Mechanism of HCCA.

Airtime-based Admission Control

- EDCA need admission control to determine how much traffic a wireless LAN can handle so that the prescribed QoS for each traffic stream can be maintained
- Of course, an admission decision should be made according to both admission policies and QoS requirements supplied by a higher-layer entity of a wireless station, usually the application layer.

QoS Requirement

- These requirements are specified in the TSPEC element in the IEEE 802.11e standard and are submitted to the admission control unit (ACU) by stations carrying the streams.

Parameters of TSPEC

- The Mean Data Rate (p)
- The Peak Data Rare (P)
- The Maximum Burst Size (σ)
- The Minimun PHY TX Rare (R) field
- The Delay Bound (d)
- MSDU Size (L)

Admission Policies

- The ACU may decide to admit a stream only if its peak data rate can be supported (for the best QoS) or may simply admit the stream as long as the mean data rate is available.

Dual-Token Bucket

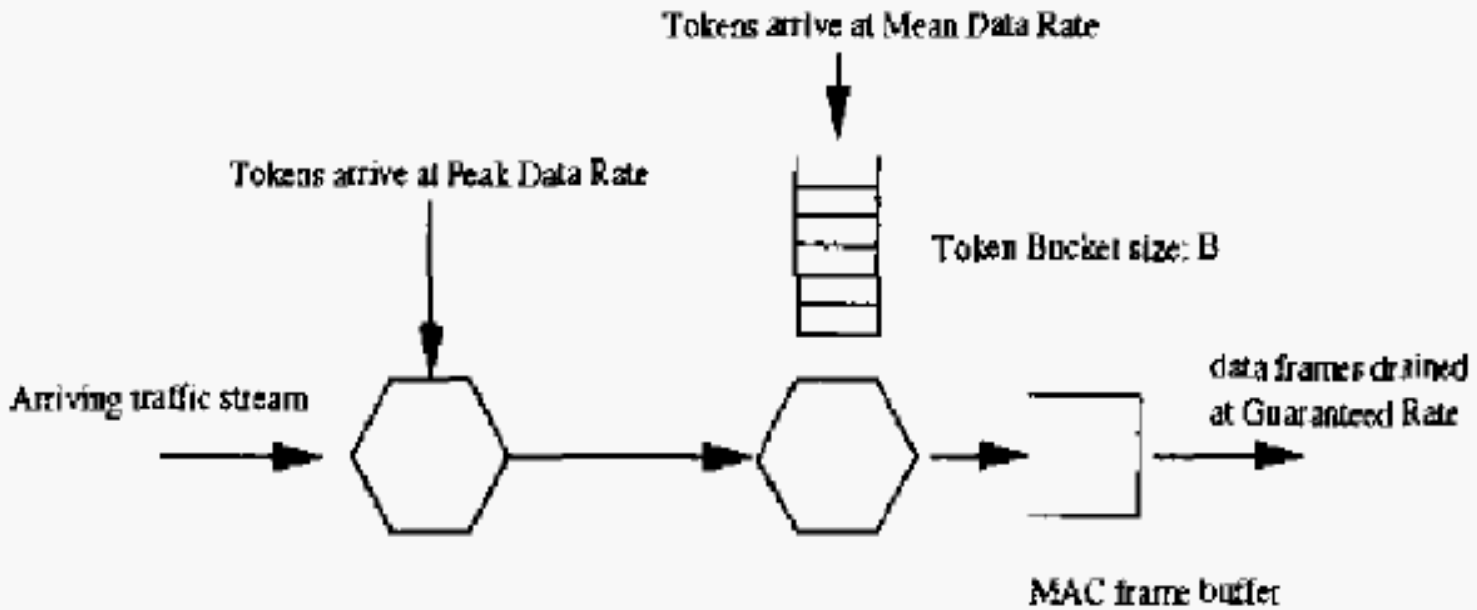


Fig. 3. The dual-token bucket filter for traffic policing.

Guaranteed Rate

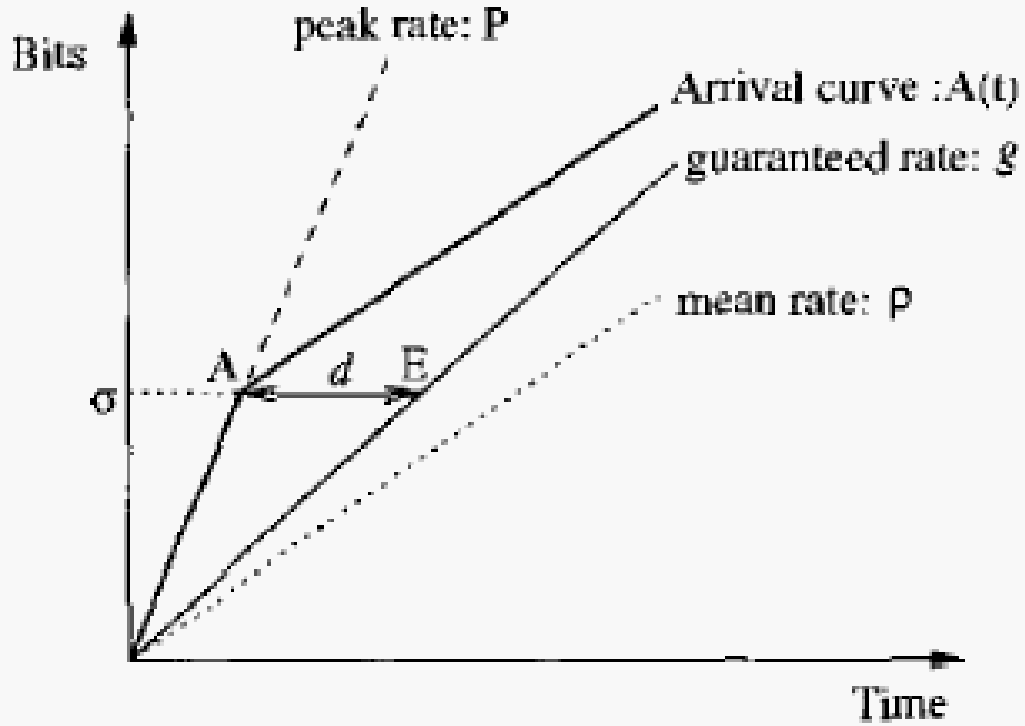
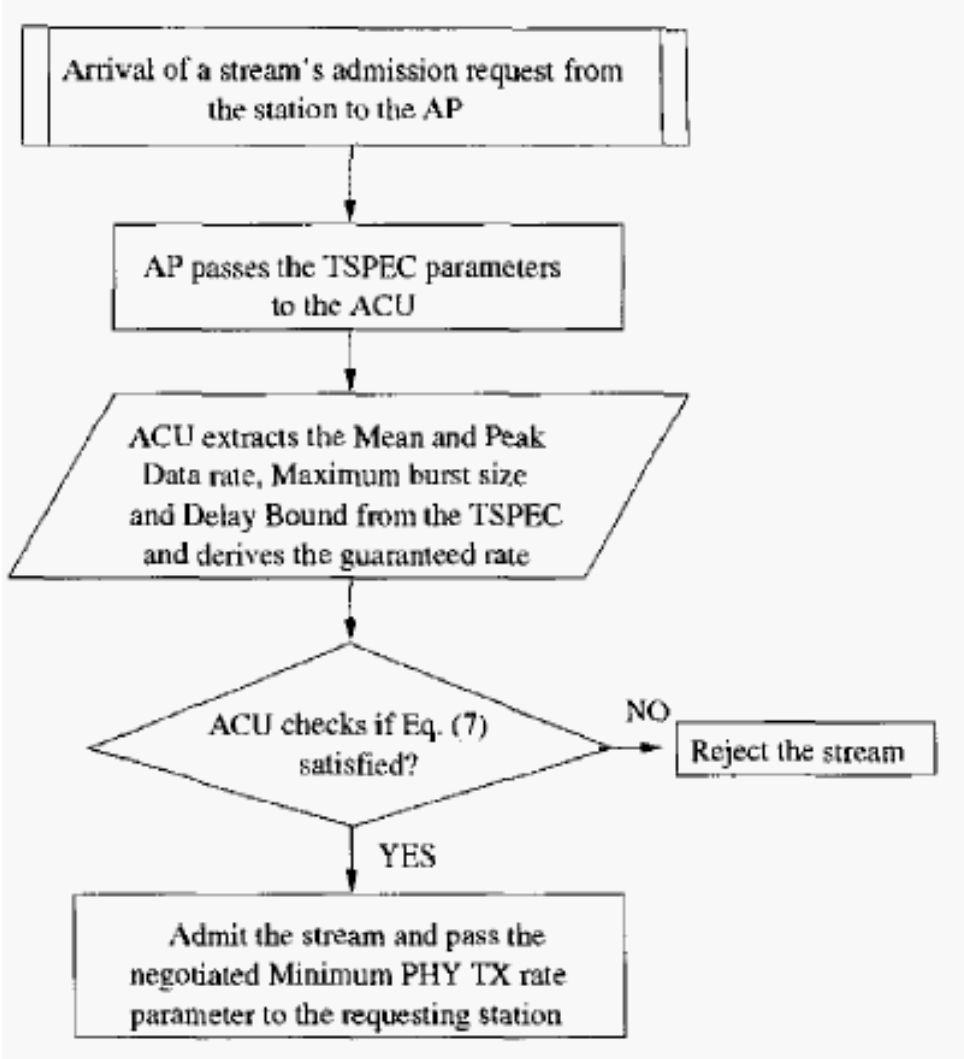


Fig. 4. Arrival curve at the entrance of MAC buffer and the guaranteed rate for a traffic stream.

Airtime-based admission control for EDCA



Controlled Airtime Usage in EDCA

- To control a station's airtime usage in EDCA, one may choose to control
  1. the TXOP limit of each station
  2. the frequency of a station's access to the wireless medium.

Controlling the Accessing Frequency

- Several EDCA parameters can be used for controlling *AF*, including minimum/maximum contention window size and arbitration inter-frame space *(AIFS)*

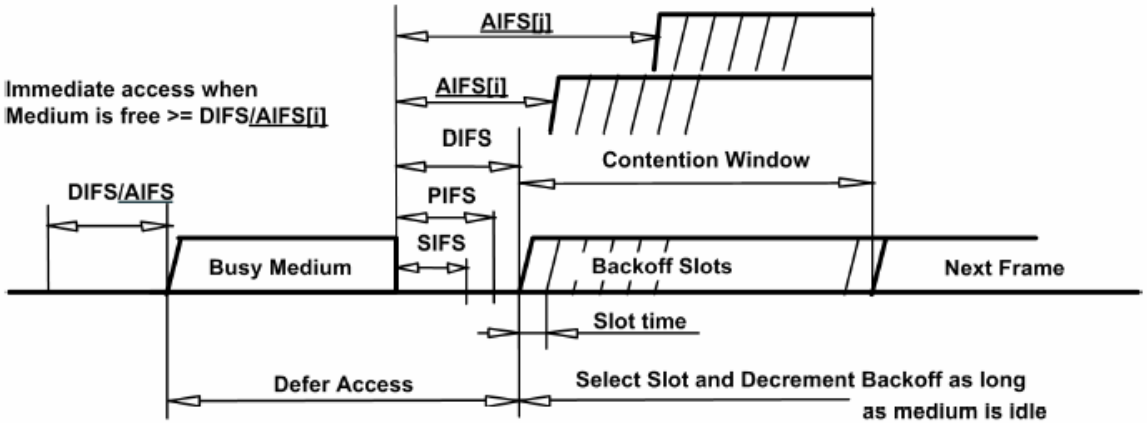


Figure 49—Some IFS relationships

Parameter Negotiation Flow

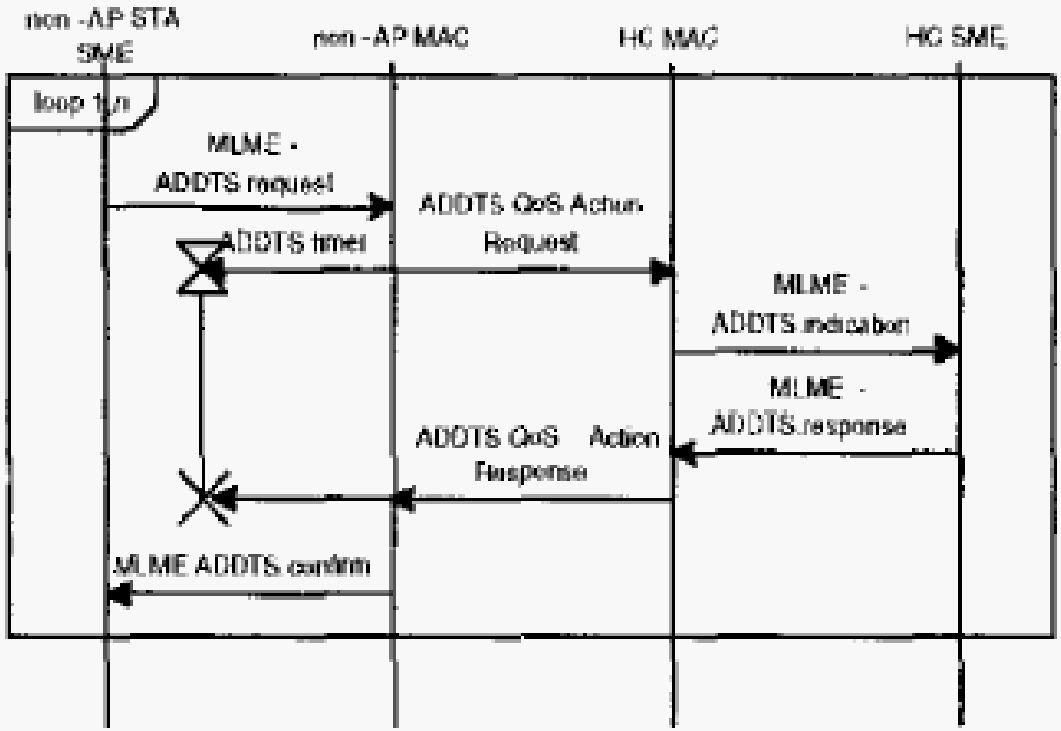


Fig. 9. Signaling and exchange of messages when a QoS traffic stream is added to an HC-coordinated 802.11 wireless LAN.

Performance Evaluation

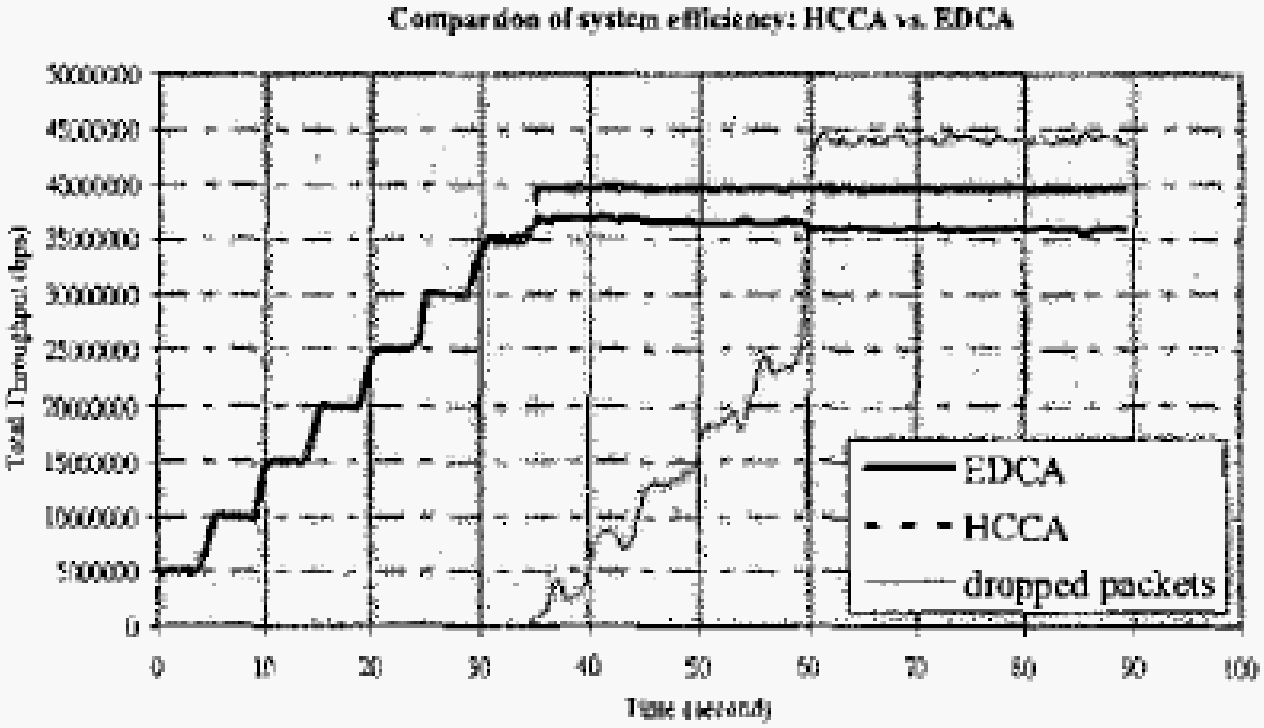


Fig. 11. Comparison of system efficiency, in terms of the total throughput, between HCCA and EDCA. *A new station carrying a single stream is added to the wireless LAN about every 5 seconds and transmits at 54 Mbps. The height of each "stair" in the figure is equal to a stream's guaranteed rate = 5 Mbps.

Throughput

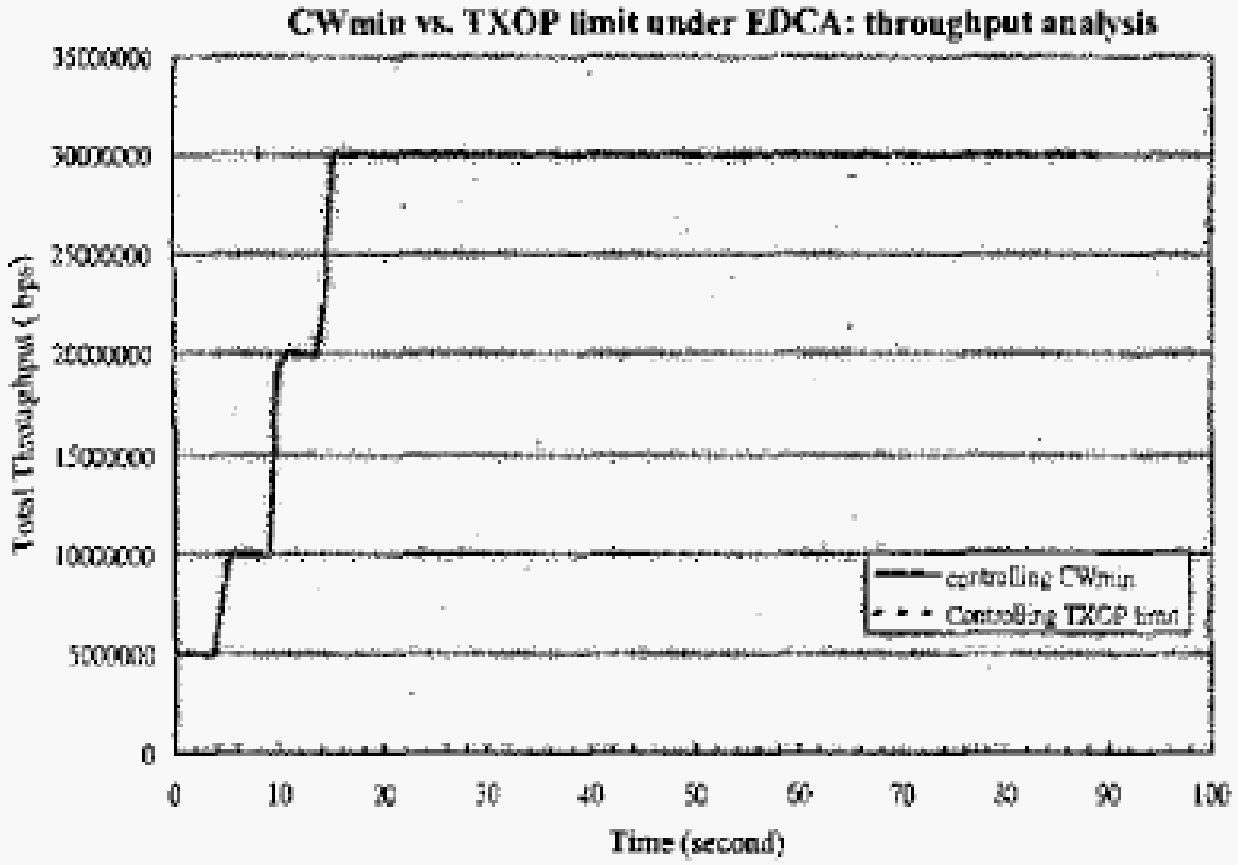


Fig. 12. Comparison of throughput between controlling stations' TXOP limits and CW_{min} values. *The figures shows that in EDCA, controlling stations' TXOP limits and controlling the CW_{min} values result in the same performance in terms of streams' throughput.

Delay analysis

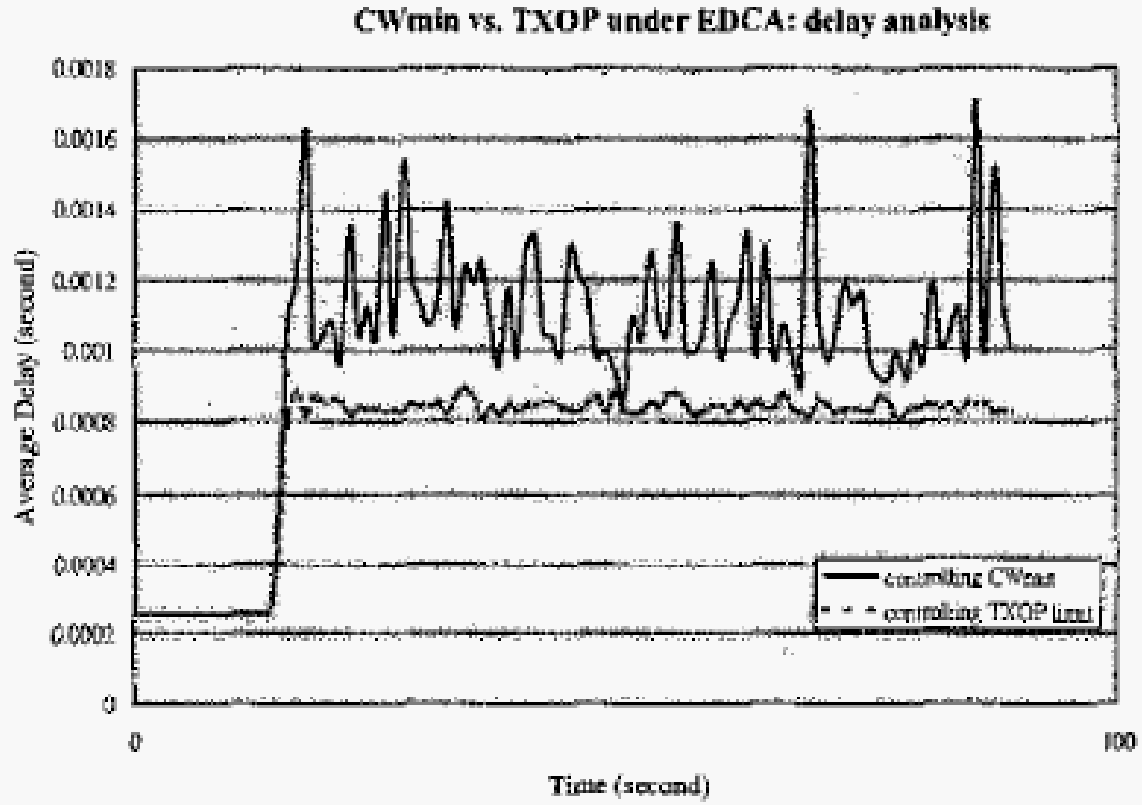


Fig. 13. Comparison of delay between controlling stations' TXOP limits and CW_{min} values. *The figures shows that in EDCA, controlling CW_{min} values may result in a large delay variance but still satisfy all stream's delay bound.

Conclusions

- Based on the traffic profile given in the TSPEC and the dual-token bucket regulation, a guaranteed rate is derived for our airtime-based admission control.
- The admission control is integrated with the contention-based Enhanced Distributed Channel Access (EDCA), which together can provide so-called “parameterized QoS”.