Distributed Approach for QoS Guarantee to Wireless Multimedia

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INTRODUCTION

Providing support for QoS at the MAC layer in the IEEE 802.11 is one of the very active research areas. There are various methods that are being worked out to achieve QoS at MAC level. In this article we describe a proposed enhancement to the DCF (distributed coordination function) access method to provide QoS guarantee for wireless multimedia applications.

Wireless Multimedia Applications

With the advancement in wireless communication networks and portable computing technologies, the transport of real-time multimedia traffic over the wireless channel provides new services to the users. Transport is challenging due to the severe resource constraints of the wireless link and mobility. Key characteristics of multimedia-type application service are that they require different quality of service (QoS) guarantees.

The following characteristics of WLAN add to the design challenge:

- Low bandwidth of a few Mbps compared to wired LANs bandwidth of tens or hundreds Mbps.
- Communication range is limited to a few hundred feet.
- Noisy environment that leads to high probability of message loss.
- Co-existence with other potential WLANs competing on the same communication channel.

Successful launching of multimedia applications requires satisfying the application's QoS requirements.

The main metrics (or constraints) mentioned in such guidelines and that eventually influence the MAC design are: time delay, time delay variation and data rate. We develop a scheme to provide guaranteed data rate for different applications in WLAN environment.

PROPOSED ENHANCEMENT OF DCF TO PROVIDE QoS

The proposed enhancement is developed as a modular system, which integrates with DCF MAC of 802.11b wireless LAN.

Salient Features of the Modular System

- Provides throughput guarantee for traffic flow between a pair of mobile stations.
- Works in distributed mode.
- Provides MAC level admission control for traffic flow.
- Applications on the mobile stations can send resource reservations request for each call (session).
- Works with backward compatibility, on hosts that do not support QoS enhancements.

Based on the basic principle of DCF access mode, each mobile station transmits data independent of other mobile station. Also, the AP (access point) has no role to play during the data transmission. Under this scenario, the throughput control (and guarantee) has to be achieved in a distributed manner.

One has to restrain a station from accessing the medium if there are other stations in the BSS that has requested for higher resource. If there is no such other station, the station is allowed to access the medium. We propose to use eight different priority flows. The queue manager at mobile stations maintains queues for these flows. Also, the state of these queues (if there are applications that are using this flow) is synchronized across all the mobile station via the beacon messages sent by AP. The scheduler transmits the

Figure 1. Block schematic of proposed system at AP

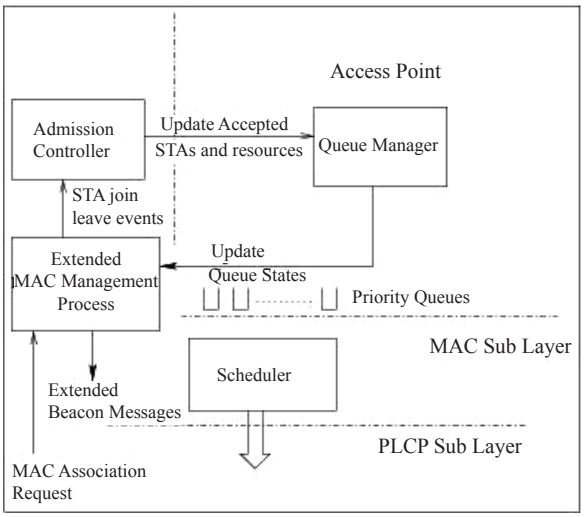
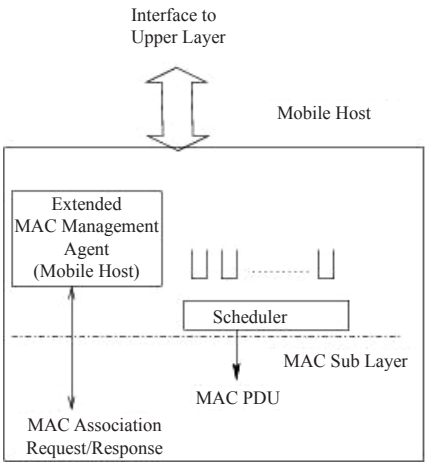


Figure 2. Block schematic of proposed system at mobile station



packets from these priority queues using a priority algorithm. The admission controller admits a call to particular flow, if the acceptance of call to the flow do not over-shoot the throughput for that flow.

ARCHITECTURE OF THE MODULAR SYSTEM

The block schematics of the proposed system are given in Figures 1 and 2, for AP and mobile station respectively. The system has four major components:

1. Extended MAC management process
2. Admission controller
3. Queue manager
4. Scheduler

The detailed functioning of each of the components is explained in the following subsections.

Enhanced MAC Management Process

To signal the QoS messages, we propose an extension to MAC layer management messages to carry the resource request and responses.

To signal mobile host resource requirements to AP, we propose extension to the existing MAC management frames. This approach does not need any changes in the core MAC layer. The SME (station management entity), which is normally residing in a separate management plane, needs modifications, which can be easily incorporated.

We incorporate enhanced MAC management with two segments.

MAC Management Process at AP

Apart from receiving and transmitting extended management frames to signal QoS, here the AP also broadcasts the queue states as an extension to beacon message.

MAC Management agent at Mobile Host

Apart from normal functionalities, the agent also receives the extended beacon message with queue states and passes this information to QM.

Management Message Modified

The beacon message is extended to include the queue states in a bit mask format. The queue state is an eight-bit field with each field representing a priority queue state. The queue is considered active if the bit is set, else inactive.

Admission Controller

The admission controller gets triggered by the extended MAC management process. The admission controller is a parameter based admission controller. However the decision process is modified to suit the distributed nature of DCF functionalities. While working in DCF mode each mobile station transmits/receives PDUs independent of AP and independent of other mobile stations. However the queue