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# Scheme to improve the QoS of MPEG4 over WLAN

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**Abstract**

IEEE 802.11e is put forward to improve the quality of service (QoS) of WLAN. But how to apply it to different applications is still a problem. This paper focus on apply EDCA to improve the QoS of MPEG4 service over WLAN. The scheme use cross-layer design to map different type of MPEG4 frames to different EDCA AC in order to get better QoS and also proposed an IAEDCF to further improve the QoS. From the NS-2 simulation results, it is proven efficient. This article puts forward two novel user-grouping algorithms for grouped multi-carrier (MC)-code division multiple access (CDMA) systems.

**Keywords** cross-layer design, streaming service QoS, WLAN

## 1 Introduction

As more and more wireless LAN networks are used as the popular method to access the internet, it is more attractive to provide streaming service over WLAN. But the QoS of streaming service is still a problem. Although IEEE 802.11e gives some enhanced schemes to improve the system's capability to support the QoS requirements, but how to apply them to different services is still an open issue.

IEEE 802.11e [1,2] QoS framework defines a new coordination function called the hybrid coordination function (HCF), which multiplexes between two medium access modes: a distributed scheme called enhanced distributed channel access (EDCA), and a centralized scheme called HCF controlled channel access (HCCA). Both access schemes enhance or extend functionality of the original access methods, distributed coordination function (DCF) and point coordination function (PCF), specified in IEEE 802.11a/b/g. EDCA, is a parameterized version of DCF defined in IEEE 802.11b. To provide prioritized QoS, IEEE 802.11e enhances the original DCF by classifying traffic through the introduction of access categories (ACs). Each AC has its own transmission queue and its own set of channel access parameters. Then different service priority can be guaranteed. HCCA provides a centralized polling scheme to allocate guaranteed channel access to traffic flows based on their QoS requirements, for example, HCCA can be used to support CBR service.

There are a lot works have been done related to improve the QoS capability of IEEE 802.11e [2], some are focused on improving EDCA to adapt the time-varying network conditions [3–5], some are focused on improve HCF to adapt the varying application profiles [6,7]. Based on analyzing all these works, this paper put emphasis on applying and improving EDCA to streaming service because of its simplicity and efficiency.

In this paper, we propose a cross-layer scheme to effectively support QoS of streaming services which are encoded by MPEG4 over the IEEE 802.11e EDCA. The rest of this paper is organized as follows: Section 2 describes the proposed scheme. Section 3 will introduce the simulation models and Sect. 4 shows the simulation results. Finally, the conclusions are drawn in Sect. 5.

## 2 Proposed scheme description

The end-to-end transmission of a streaming video in the WLAN system is depicted in Fig. 1. As shown, the IEEE 802.11e is used as the access network which consists of acess point (AP) and mobile nodes (MN). The streaming server is located in MN's application layer belong to WLAN subsystem. And the receiver is located in another IP network. The streaming service in this study is encoded by MPEG4. In the proposed scheme, the MN will periodically report the network condition to the streaming server (application layer of MN) and MAC layer. The following subsections will describe the details of the scheme, including the functions of every layer.

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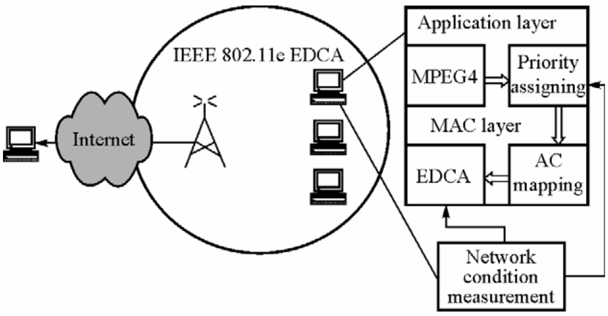


**Fig. 1** The E2E wireless streaming service over WLAN

### 2.1 The network condition measurement

When EDCA is used in WLAN, the network condition can be measured by the mobile node. From the mechanism of EDCA, it is clear that a mobile node can get sufficient bandwidth when the network is in a light load status and the wireless channel is in a good condition. When the network's load increases, the packet collision probability increases. And when the channel condition is poor, the retransmission times increase. In the worst case of network condition, many packets are failed to transmit because it has been retransmitted for too many times.

In Ref. [5], the packet collision probability is used to as an indicator of the WLAN's conditions.

The packet collision probability of the $j$th period is $f_{\text{curr}}^{j}$,

$$f_{\text{curr}}^{j} = \frac{E(\text{collision}_j[p])}{E(\text{data\_sent}_j[p])} \tag{1}$$

where $E(\text{collision}_j[p])$ and $E(\text{data\_sent}_j[p])$ are the number of packet collided and the number of packet sent of the $p$th MN in the $j$th period.

But as we analyzed before, Eq. (1) ignored the condition when the packets loss by the poor channel condition. So we change Eq. (1) to Eq. (2)

$$f_{\text{curr}}^{j} = 1 - \frac{E(\text{data\_ack}_j[p])}{E(\text{data\_sent}_j[p])} \tag{2}$$

where $E(\text{data\_ack}_j[p])$ is the number of packets which have ACK received by the $p$th MN in the $j$th period.

### 2.2 The controls in application layer

The application layer tries to use the advantages of EDCA, so it will classify its encoded frames into different priority when necessary. In our system, MPEG4 is used as coding algorithms, and in a MPEG4 GOP (group of picture), the I-frame is the most important, because an error I-frame affects the following P-frame and B-frame. And the P-frame is less important, because an error P-frame only affects the related P-frame and B-frame. An error B-frame won't affect others, so it is not important compared with I-frame and P-frame. Then we designed our control policy as follows:

1) When the network is in good condition, all the frames will use the same priority.

2) When the network is in bad condition, different priority of frames is assigned.

Table 1 gives an example of the policy.

**Table 1** Example of MPEG4 frame priority

| | In good network conditions | | | In bad network conditions | | |
|---|---|---|---|---|---|---|
| Encoded frame | I-frame | P-frame | B-frame | I-frame | P-frame | B-frame |
| Priority (assigned by application layer) | Middle | Middle | Middle | High | Middle | Low |
| AC (defined in EDCA) | 1 | 1 | 1 | 0 | 1 | 2 |

### 2.3 The controls of MAC layer

#### 2.3.1 Apply basic EDCA to streaming service

EDCA use AC to classify different services' priority, and each AC is realized by setting different values for the channel access parameters. The following are the most important additional parameters:

1) Arbitrary interframe space number (AIFSN): the minimum time interval for the medium to remain idle before starting backoff.

2) Contention window (CWmin and CWmax): a random number is drawn from this interval for the backoff mechanism.

3) Transmission opportunity (TXOP) limit: the maximum duration for which a node can transmit after obtaining access to the channel.

With these parameters, EDCA channel access prioritization works as follows. When data arrives from higher layers, the data is classified and placed in the appropriate AC queue. To determine the next packet to be sent by the node, an internal contention algorithm is used to calculate the total backoff time for each AC. This backoff time includes the time spent waiting for the medium to be idle, which is based on AIFSN, and the estimated backoff time within the contention window range, CWmin and CWmax. The AC with the smallest backoff wins the internal contention and uses this backoff value to contend externally for the wireless medium [2].

When a MPEG4 service flow arrives at MAC layer, the AC mapping function assign the prioritized streaming flow to different AC.

Under our control policy in Fig. 2, when the network is carrying heavy load, the error probability of I-frame will get better while that of P-frame and B-frame will get worse. But the total QoS of MPEG4 will increase.