Analytic Model for IEEE 802.11e EDCA

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ABSTRACT

This paper investigates the analytic performance of IEEE 802.11e enhanced distributed channel access (EDCA) under saturated traffic load. Compared with the existing analytical models of EDCA, we obtain transmission probability τ_i by applying the renewal theory and provide simple but accurate delay model for IEEE 802.11e EDCA by considering the possibility that a station's backoff procedure may be suspended due to transmission from other stations, which is inherent to the difference of $AIFS$ value. We derive several performance measures such as the probability generating function of HoL-delay(MAC delay) and throughput.

INTRODUCTION

IEEE 802.11e is designed to support multimedia applications. The main and mandatory scheme of IEEE 802.11e standard is the enhanced distributed channel access (EDCA), which adopts service differentiation in configuration.

IEEE802.11e standard[1] classifies traffic into four access categories (ACs), i.e., voice, video, best effort and background. AC based traffic prioritization is implemented by using a combination of AC specific parameters, which include arbitration interframe space (AIFS), the minimum contention window size (CWmin) and the maximum contention window size (CW-max).

To investigate the performance of EDCA, an accurate analytical model considering the effect of using different $CWmin$ and $AIFS$ values is necessary. Moreover, the analytical model would be better to provide the closed-form solution on the performance metrics. In particular, the possibility of *backoff suspension*[10] inherent to different $AIFS$ value should be analyzed. The term of *Backoff suspension* is introduced in [10], which refers to the procedure that a station's normal backoff procedure is interrupted by transmission from other stations, and the station must sense the channel idle for a complete AIFS before it can start a new backoff procedure or resume the suspended backoff procedure[10]. Most of analytical work on EDCA [5–10] use the Markov chain approach in order to obtain HoL-delay or throughput, but they ignore the possibility of backoff suspension or not clearly analyzed in their Markov chain model except [10].

In this paper, we investigate the analytic performance of IEEE 802.11e EDCA under the saturated traffic load. We provide simple but accurate delay model for EDCA by considering the effect of using different $CWmin$ and $AIFS$ values. We derive the several performance measures such as HoL-delay (MAC delay) and throughput.

MATHEMATICAL MODEL AND ANALYSIS

We assume that only two ACs are considered: AC[0] and AC[1]. AC[0] has higher priority than

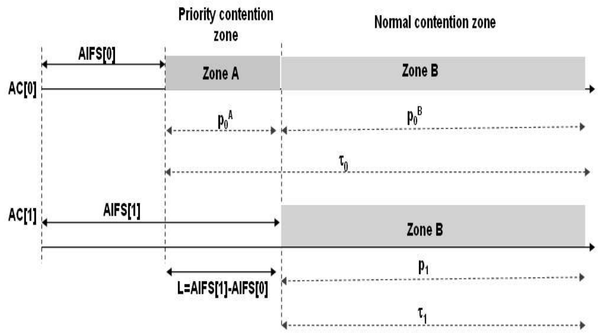

Figure 1. Differentiation of AIFS

AC[1] and $AIFS[0] < AIFS[1]$. We assume that each station carries the traffic from one AC only. Thus a station may be referred as a AC[0] station or a AC[1] station. We assume that there is N_1 and N_2 number of AC[0] stations and AC[1] stations, respectively. Also, we assume that the maximum backoff stage for each AC[i], $i = 0, 1$, is m_i and the retry limit for each AC, the number of allowable transmissions for HoL-packet, is infinite.

Stations can be classified into different sets based on their $AIFS$ value and CW_{min}. The difference of $AIFS$ creates different contention zones for AC to differentiate the access probability. We assume that for each AC[i], the probabilities p_i^A and p_i^B that any transmission experiences a collision are constant within a each contention zone, regardless of the number of retransmissions suffered. This is the key assumption to approximate the EDCA to p-persistent CSMA, which is already adopted for DCF in Bianchi's work[12]. As shown in Fig. 1, in contention zone A, only high priority AC[0] stations contend for the channel access; while in contention zone B, high priority AC[0] stations contend with the low priority AC[1] stations. Let τ_i be the transmission probability of AC[i], for $i = 0, 1$. For the analysis, we define the several probabilities depending on zone as follows:

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