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ANALYSIS OF QOS PARAMETERS USING DIFFERENT BACK OFF WINDOW ALGORITHM IN THE IEEE 802.11E NETWORKS

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Abstract

The IEEE 802.11e task group adopted the enhanced distributed channel access (EDCA) protocol as a complement to IEEE 802.11 medium access control (MAC) to fulfil quality of service (QoS) needs of both data and real-time applications. DCF is a carrier sense multiple access with collision avoidance (CSMA/CA) scheme with binary exponential backoff algorithm (BEB). To increase the performance of congested situations, construct an adaptive backoff algorithm for the IEEE 802.11 DCF that enhances system throughput is improved, the collision probability is reduced, and good fairness is maintained in congested network conditions. This paper deals with the utilization of networks for different back off strategies for different network conditions. The results obtained were comparatively much better than the existing methods.

1. Introduction

IEEE 802.11 [1] is the most commonly used wireless local area network (WLAN) standard. The distributed coordination function (DCF) and a centrally controlled access mechanism called the point coordination function are defined in the IEEE 802.11 standard to allow multiple users to access a common channel (PCF). The BEB algorithm is used to implement Carrier Sense Multiple Access (CSMA) with Collision Avoidance (CA). When a station listens to the medium before transmitting and detects an ongoing transmission, it enters a deferral period determined by the binary

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exponential back off algorithm.

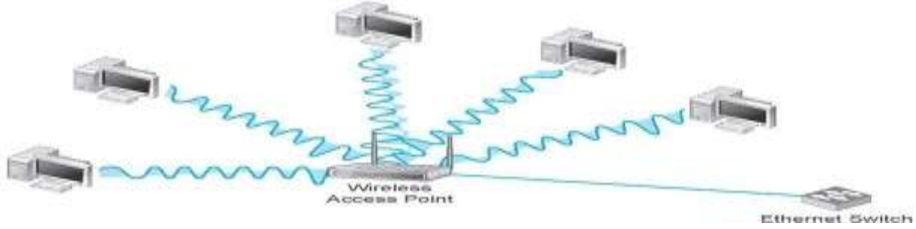

Figure 1. Wireless access points.

Throughout many instances, wireless local area networks are operated in two modes: infrastructure and ad hoc. The channel capture effect occurs when the node that transmits the packet most recently resets its contention window to the smallest value and may always gain access to the channel in the present DCF protocol. To reduce the number of collisions and to improve network performance, backoff algorithms are used in MAC protocol. Ikram Syed (2016) states that the proposed algorithm improves the performance of the EDCA algorithm in dense scenarios by distinguishing the CW size and calculating the ideal CW based on network load [10] Estefanía Coronado, José Villalón (2017) states that improvement in the system can be accomplished by separating the AIFSN values properly and selecting the right CW size for each AC. In addition, this strategy reduces the amount of retransmission attempts and helps the network's overall throughput [13]. Oran Sharon states that there is just one TCP connection in the system, which is a circumstance that can happen in small systems like the Home environment. The performance of reverse direction and aggregation when the AP maintains many TCP connections at the same time. [11] Waqar Aslam etall says that with the goal of making accurate predictions, the performance analysis must be precise and based on reasonable speculations. We refer to the following system elements as reasonable conjectures: After a transmission, the probability of winning channel arbitration varies over slotted time; - the probability of collision varies over different retry attempts; -Each back off process has a finite number of retries [12].

In IEEE 802.11e WLANs, there is an unfairness problem when different data rates are employed. The reason for this is that each station is given the same TXOP, or transmission opportunity, regardless of data rate. In comparison to stations with lower data rates, stations with greater data rates can send more traffic across the network was stated by Marjan Yazdan [12].

DCF are briefly reviewed in Section II. Section III describes a mathematical analysis that uses a constant backoff window to improve energy efficiency for ideal channel conditions.

1.1 Mac Layer. This layer is in control of data transmission and is the most important data link layer. It is in control of the medium and has access to and control over data transmission from the sender to the receiver. This system uses an access control mechanism and provides a full-duplex configuration for wireless transmission.

1.2 DCF Mechanism. The physical and virtual carrier sensing mechanisms are inspected when the MAC receives a request to transmit a frame. The MAC transmits the frame if both mechanisms reveal that the medium is not in use for a DIFS interval. If the physical or virtual carrier sense mechanisms indicate that the medium is in use during the DIFS interval, the MAC will choose a backoff interval and increment the appropriate retry counter using the binary exponential backoff mechanism. For an interval of one slot time, the MAC will decrement the backoff value each time the medium is detected as idle by both the physical and virtual carrier sense mechanisms.

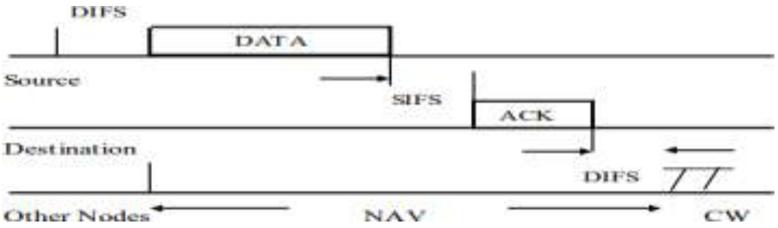

Figure 2. MAC layer CSMA/CA operation.

Figure 3 depicts the RTS/CTS access mechanism. A station that wants to send a packet waits until the channel is sensed idle for a DIFS, then follows the backoff rules explained above, and then, instead of the packet, sends a preliminary message.

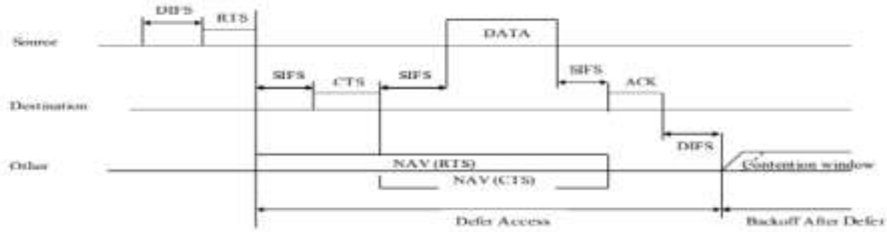

Figure 3. RTS/CTS access mechanism.

2. QoS Analysis

The primary goal of this paper is to investigate the Energy Efficiency and Throughput of IEEE 802.11 DCF under ideal channel conditions using the CW and BEB algorithms. This section analyses energy efficiency, and the following section analyses throughput.

3. Data Analysis

Let $b(t)$ denote the process that represents a station's backoff timer. The time scale is discrete and integer, with t and $t+1$ being two consecutive slot times, and each station's backoff time counter decrements at the start of each slot time. When a collision occurs in BEB [3], the backoff stage increases, the contention window doubles in size, and the station choose a new backoff interval from the contention window. Figure 4 depicts the Markov Chain model [4]. For each packet, the backoff slot is chosen at random from (0, CW-1) (just arriving or retransmitted). The backoff timer value decreases as the channel is detected as idle, and when it reaches zero, the station transmits the packet. When the retry limit reaches its maximum value [5], the packet is dropped.

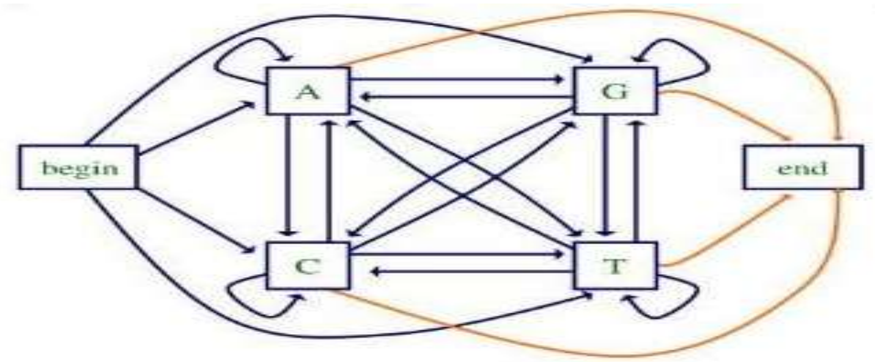

Figure 4. The model.

$$\begin{cases} P\{b(t+1) = k \mid b(t) = k+1\} = 1 & k \in (0.CW-2) \\ P\{b(t+1) = k \mid b(t) = 0\} = 1/CW & k \in (0.CW-1) \end{cases} \tag{1}$$

The first equation in (1) accounts for the fact that the backoff time is decremented at the start of each slot time and the second equation is telling about the range

$$b_k = \lim\nolimits_{t\to\infty} \mu\{b(t) = k\} \cdot k \in (0.CW-1) \tag{2}$$

$$b_k = \frac{CW-k}{CW} b_0 \cdot k \in (0.CW-1) \tag{3}$$

$$1 = \sum_{k=0}^{CW-1} b_k = \sum_{k=0}^{CW-1} b_0 \frac{CW-k}{CW} = b_0 \sum_{k=0}^{CW-1}\left(1 - \frac{k}{CW}\right) \tag{4}$$

$$= b_0 \frac{CW+1}{2}.$$

Analysis of the ideal channel's energy efficiency. To determine the energy efficiency of 802.11 using a constant backoff window, consider the probability that a station will transmit packets, the probability of collision, and the probability of successfully transmitting packets in a random slot time.

$$P_n = (1-t)^n \tag{5}$$

n is the nodes and τ is the probability of data sent.

$$P_c = P_{cr} = 1 - (1-t)^{n-1} \tag{6}$$

$$\tau = \frac{2(1-2P_{tr})}{(1-2P_{tr})(CW+1)+P_{tr}CW(1-(2P_{tr})^{m})} \tag{7}$$

$$E_{\text{total}} = E_{\text{backoff}} + E_{\text{listen}} + E_{\text{collision}} + E_{\text{success}} \tag{8}$$

Let E_{backoff} be the amount of energy utilized by the station, and E_{listen} be the amount of energy utilized when the station overhears other transmissions.

$$\eta = \frac{L+8}{E_{\text{total}}} \tag{9}$$

The equation is used to calculate the Energy Efficiency (9).

$$S = \frac{E[\text{time used for successful tr ansunnission in an interval}]}{E[\text{length between two consecutive transmissions}]} \tag{10}$$

$$= \frac{P_{tr}P_3E[P]}{P_{tr}P_3T_{\text{success}} + P_{tr}(1-P_S)T_{\text{collion}} + (1-P_{tr})\text{ slottime}}$$

Let S stand for the system throughput. The throughput of RTS/CTS mechanisms can be calculated using equations (1), (2), (7), (8), (9) and (10).

To evaluate the system's performance, we'll utilize two metrics: efficiency and fairness and efficiency as the percentage of time spent on reached transmissions, which is influenced by the duration of successful, collision, and empty slots. We'll use IEEE 802.11b's default parameter values and a frame length. The main goal is to test the system using a contention-based window whose size and variance are dependent on the bit error rate and the number of users in the channel or medium. In this article, various comparisons were made concerning the number of stations, simulation time frame size with the successful transmission of the frame along with efficiency.

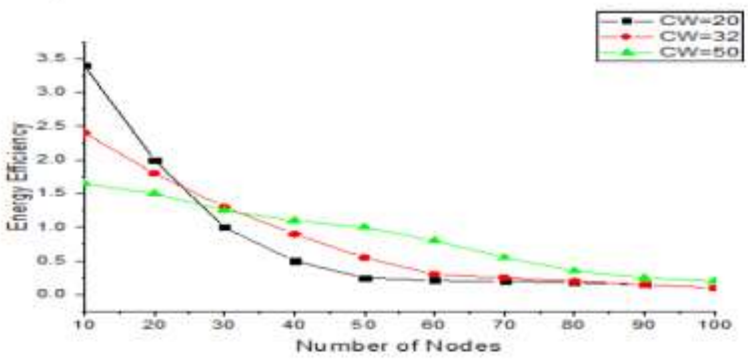

Figure 5. Energy Efficiency of Basic access with several nodes.

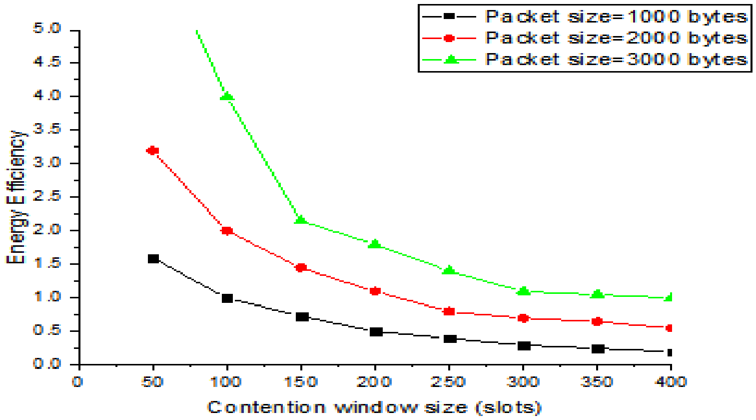

Figure 6. Energy Efficiency of Basic access with Contention window for 25 nodes.

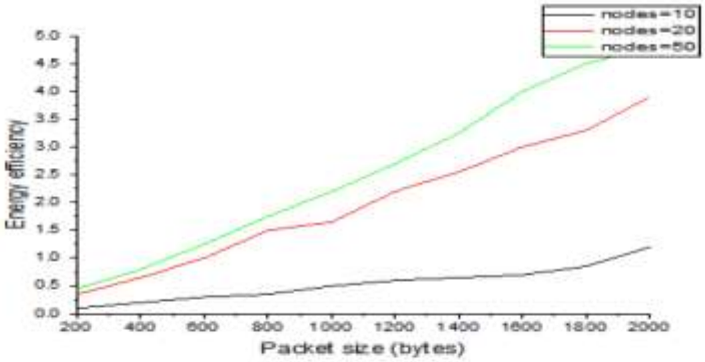

Figure 7. Energy Efficiency of Basic access with Packet size for $CW = 32$.

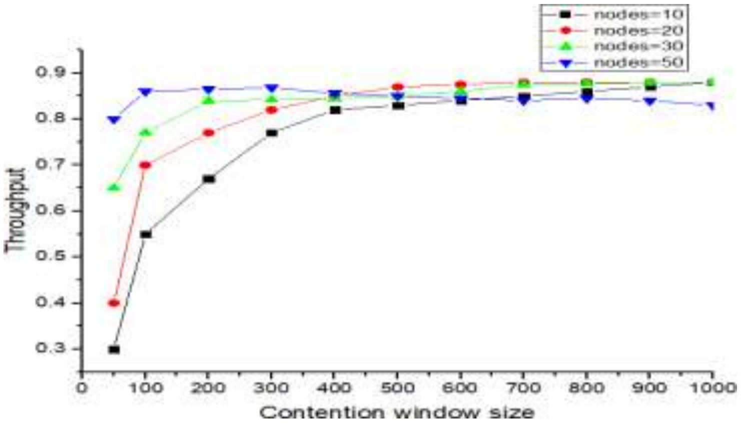

Figure 8. Saturation throughput with contention window for various nodes.

From Figure 8, it is seen that as the value of CW increases, the throughput firstly increases and then decreases. Hence the maximum throughput can be obtained if the size of the contention window is properly selected.

Results

The QoS parameters of 802.11 DCF for ideal channel conditions are discussed in this section. Matlab has been used to run all simulations. QoS parameters are analyzed in terms of the CW and the nodes. The performance of CWA is compared to that of IEEE 802.11's original backoff scheme. The Constant back off Window Algorithm (CWA) is the modification of the IEEE 802.11 BEB algorithm, which is used to control the contention window in the case of collisions, to provide a better Throughput and Energy efficiency. The IEEE 802.11e task group adopted the enhanced distributed channel access (EDCA) protocol as a complement to IEEE 802.11 medium access control (MAC) to fulfil quality of service (QoS) needs of both data and real-time applications. As the number of contending stations increases, the energy efficiency decreases because the collision increases. From Figure 6 and Figure 7, it is observed that the energy efficiency decreases with an increase in contention window size. The number of nodes is fixed at 25. Figure 8 show the variation of Energy efficiency and it increases with the Packet size and decreases with the number of nodes. In this, the contention window is fixed at 32.

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