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WLAN 802.11e evaluation performance using OPNET

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ABSTRACT

The low cost and easy deployment of Wireless LAN 802.11 standard means it becomes more and more popular, but it has a vital drawback with regard to Quality of Service (QoS). QoS defines the ability of network to introduce consistent services for data transmission, and is evaluated in terms of specific parameters such as jitter, delay, and packet loss. These parameters describe data traffic quality over a network. Service differentiation should be offered to let higher priority multimedia traffic to get a preferred treatment. This deficiency of Wireless LAN 802.11 MAC mechanisms in offering QoS support is a major obstacle in the adaptation of modern multimedia applications in Wireless LAN 802.11 networks. This paper aims to build different scenarios to evaluate QoS characteristics and to examine the effect of enhancement on the QoS. The evaluation, implemented using the OPNET simulator, will contain the different parameters of Wireless LAN 802.11e to see how this enhancement in distributed channel access increases the performance over the Wireless LAN 802.11 standard. The results gives a clear picture that the enhanced standard offers a very effective service mechanism to provide QoS support.

INTRODUCTION

With the continuing advancement of both computer and internet technology, optimized data (multimedia technology) is being used more and more in applications such as entertainment, medical science, video conferencing, etc. These applications demand exchange of sensitive information over the internet and will become more popular as time progresses [1].

The internet architecture has been successful in boosting the traditional data applications like textual applications, news, and file transfer. But it is not able to fulfil the demands of real time applications like video conferencing. When data transfers, it may experience varying time delay (jitter) and may also experience data loss. This especially appearswhen a wireless local area network (WLAN) is considered.

Generally, optimized data applications occasionally require much higher bandwidth compared to traditional text based applications. Optimized data means extremely high density of data and very heavy traffic so the hardware must provide enough bandwidth. In the optimized data packets, one of the most critical tasks is to transfer these packets in time to reconstruct the original data at the receiving end. So it is very important for the optimized data to be transferred within certain delay bounds. Also, the optimized data require ensured bandwidth along the transmission path and this is addressed in this paper[2].

Voice over Internet Protocol (VoIP) is a technology used to transfer voice over the network. The idea of VoIP started in the 1970s because of the shortage in internet protocol (IP). Nowadays, VoIP is become the alternative of the public switch telephone network (PSTN[3]).

Wireless LAN 802.11e Medium Access Control Layer: The Wireless LAN 802.11 MAC layer consists of a group of protocols, which are responsible for controlling medium access, support for roaming, and authentication and it is divided into two types, centralized and distributed. The Point Coordination Function (PCF) is an example of centralized protocols where the access point or base station regulates access to the wireless medium. The centralized types are considered as a contention free mechanism. The Distributed Coordination Function (DCF) and Enhanced Distributed Coordination Function (EDCF) are examples of distributed protocols since each station independently determines whether to send a packet or not. This mechanism is considered as a contention base since each node should contend for the medium if it needs to send data. The last one is Hybrid Coordination function (HCF), which takes features of both centralized and distributed MAC protocols [4].

PCF: PCF uses the pooling scheme to handle the real time applications. Point Coordinator (PC) which implements the polling access method is used to assign the medium for communication and periodically send a beacon frame to network identification. With PCF, a Contention Free Period (CFP) and a Contention Period (CP) form a super-frame. Only stations polled by the point coordinator may send during the CFP while during the CP the stations contend among themselves using the DCF method. The CFP ends by a CF-End control frame. However, The PCF has higher priority than the DCF since it may begin sending after a shorter period PCF Inter Frame Space (PIFS) than the DCF Inter Frame Space (DIFS)[5].

DCF: Asynchronous service is only provided with DCF in an Ad-Hoc network. With DCF, when there is no other station transmitting, the stations contend for access and attempt to send frames. But all stations will wait if there is another station sending a frame.DCF is also known as Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) protocol. Distributed Inter Frame Spacing (DIFS) and Short Inter Frame Spacing (SIFS) are two modes of DCF and prioritizing the traffic is done through this. In this protocol the station listens to the medium before sending any packet. If the medium is clear then it sends the packet. Otherwise it determines the amount of time the station must wait until it is permitted to send its packet which named as a random back off factor. Using back off factor the collisions between packets are decreased since the probability that two stations will choose the same back off factor is small [5].

EDCF: EDCF is an extension of DCF. Wireless LAN 802.11 MAC does not provide prioritization and differentiating between data frames. Channel access to all stations in DCF is provided without prioritizing them and all stations in the system have equal chance to receive data. However, in real time applications this is not a suitable procedure for its functions. The solution is provided by EDCF. For QoS stations (QSTAs) EDCF provide differentiated and distributed access to the wireless medium using eight priorities that are from Lowest (0) to Highest (7). Further, EDCA provides contention free access to the channel for a period called a Transmit Opportunity (TXOP). Using EDCF, stations must do two things before trying to send data; first detect the medium to see if it is idle or not, second wait a specific period of time defined by the corresponding traffic category called the Arbitration Inter Frame Space (AIFS) as shown in Fig. 1 [6].

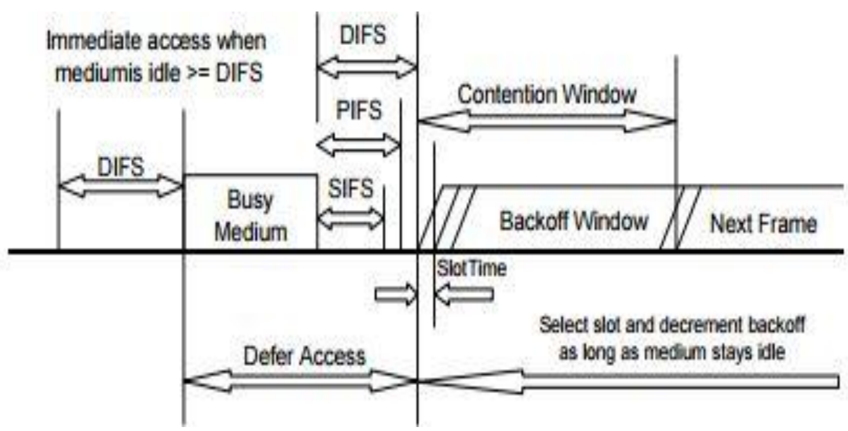


Fig. 1Arbitration Inter frame Space (AIFS)[8]

A shorter AIFS will be given a higher priority traffic category than a bigger AIFS. Thus stations with higher priority traffic must wait shorter period than those with low priority traffic before trying to access the medium.

HCF: By using HCF the PCF scheme is extended in Wireless LAN 802.11e. There are two methods for channel access: Enhanced Distributed Channel Access (EDCA) and HCF Controlled Channel Access (HCCA).Depending on their features, this combination will achieve a suitable level of QoS. It could be said this is the Enhancement of both DCF and PCF. Hybrid coordinator (HC) which is usually co-located with the access point may allocate TXOPs to itself to begin frame sending after waiting for a specific time equal to PIFS which is shorter than DIFS and any AIFS. So the HC gets priority over other stations to send frames [7].

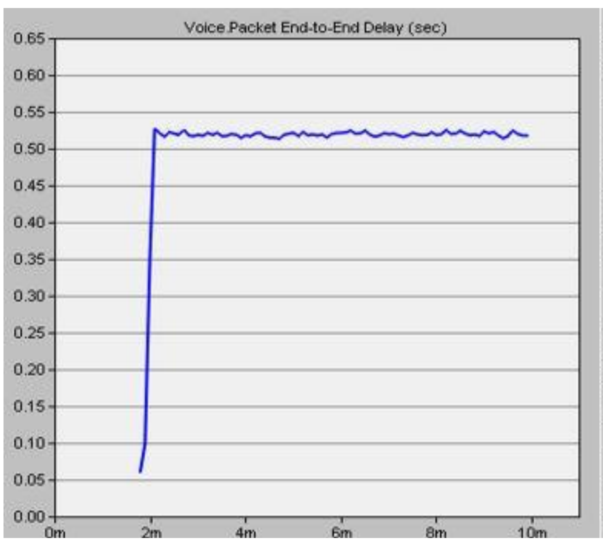
HCF operates during both the CP and CFP durations. DCF rules are applied in CP and the TXOP is initiated. On the other hand, stations in CFP are pooled considering the priority which is done by HC. For QoS, there are two terminologies used here; one is CFP-Pool and CF-End. During CFP, CFP-Poll initiates and the communication is through by allocation of the channel. CF-End is the end of CFP [5].

Network Design: In this paper, the scenarios are built for testing the performance of basic Wireless LAN 802.11 standard and the enhanced Wireless LAN 802.11e standard. This scenario is a network design that evaluates QoS parameters for both IEEE 802.11 and IEEE 802.11e, when using VoIP and HTTP applications. During constructing the networks, several scenarios are built by implementing the OPNET equipment.

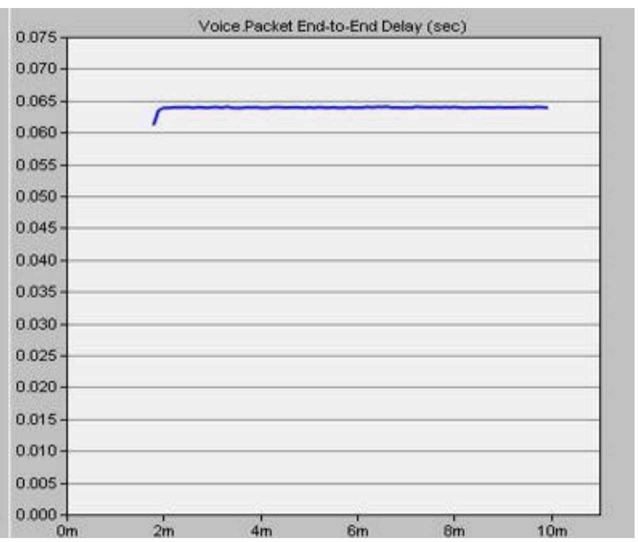
RESULTS AND DISCUSSION

The objective here is to study the enhancement effects when using Wireless LAN 802.11e over Wireless LAN 802.11 for VoIP and HTTP applications. Also it's important to notice the QoS parameters such as bandwidth, delay and packet sent.

Delay: In Wireless LAN 802.11 the delay reaches up to 0.52 s, as shown in Fig. 2a. This value is reduced to 0.064s when using Wireless LAN 802.11e as shown in Fig. 2b. This is considered a reasonable value for VoIP applications.



(a)



(b)

Fig. 2Delay of WLAN for both standards (a) Delay of Wireless LAN 802.11(b) Delay of Wireless LAN 802.11e

Traffic Sent by VoIP: Considered as delay sensitive traffic, VoIP gets priority over the network. Number of clients and servers supporting VoIP type of service are two. The traffic is generated in a great amount sending almost 600 packets/sec, and after some time the traffic flow becomes constant. The performance of VoIP traffic sent over WLAN 802.11e is equal to the WLAN 802.11 standard.

Table 1 summarized the results that obtained from the scenario for different QoS parameters.

Table 1: Summary of scenario results

Standard	Delay (sec)	Packet send (packets/sec)
WLAN 802.11	0.52	600
WLAN 802.11e	0.064	600

CONCLUSION

The main concern in the WLAN 802.11 field is to provide good and suitable services. The WLAN 802.11e standard has been recently released, which is an extension to WLAN 802.11 standard to provide QoS support. Further, this work implemented the two basic access mechanisms of Wireless LAN 802.11e standard, EDCA and HCF in OPNET Modeler, and evaluated its performance in introducing QoS support in 802.11 networks.

The evaluation of this study based on a simulation scenario has been introduced. Performance parameters considered are delay and packets send. From the results, it is concluded that WLAN 802.11e offers a very effective service mechanism to provide QoS support. An enhancement to WLAN 802.11e to further increase the performance of packets sent, will be studied.

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