QUALITY OF SERVICE OPTIMIZATION IN IEEE 802.11e NETWORKS USING ENHANCED DISTRIBUTED CHANNEL ACCESS TECHNIQUE

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***Abstract*- Quality of Service (QoS) is an ability to guarantee a certain level of performance to data flow in a wireless network. IEEE 802.11 a/b/g networks do not provide QoS for multimedia traffic. Where as providing QoS for IEEE802.11e is difficult. EDCA technique enhances the QoS service in IEEE802.11e. Enhanced Distributed Channel Access (EDCA) which is a contention-based channel access mode. With EDCA, high-priority traffic has a higher chance of being sent than low-priority traffic. EDCA provides contention-free access to the channel for a period called a Transmit Opportunity (TXOP). The TXOP works on the basis of four Access Categories (AC) of EDCA. By varying the TXOP value and MAC parameters among the ACs we can get the Qos optimization. In this work ,the QoS parameters such as minimum delay, maximum throughput is achieved.**

Index Terms- EDCA, MAC parameters, IEEE 802.11e, QoS optimization, TXOP limit.

I.INTRODUCTION

A.IEEE 802.11e

IEEE 802.11e-2005 or 802.11e is an approved amendment to the IEEE 802.11 standard that defines a set of Quality of Service enhancements for wireless LAN applications through modifications to the Media Access Control (MAC) layer. 802.11 is an IEEE standard that allows devices such as laptop computers or cellular phones to join a wireless LAN widely used in the home, office and some commercial establishments. [5]

Application				
Presentation				
Session				
Transport				
Network				
Logic Link Control				
PCF			HCCA	
DCF			EDCA	
802.11-1997	802.11a	802.11b	802.11g	80211n

Figure 1 OSI model of IEEE 802.11e

The 802.11e QoS facility defines a new coordination function called hybrid coordination function (HCF) used only in QoS . HCF has two modes of operation such as EDCA and HCCA. [6]

B. Enhanced distributed channel access (EDCA):

The EDCA uses Distributed coordination function DCF. Distributed coordination function (DCF) shares the medium between multiple stations. DCF relies on CSMA/CA and optional 802.11 RTS/CTS to share the medium between stations**.** In the DCF mode all the station is allowed to contend for shared medium simultaneously [6]. With EDCA, high-priority traffic has a higher chance of being sent than low-priority traffic. A station with high priority traffic waits a little less before it sends its packet, on average, than a station with low priority traffic. The IEEE 802.11e EDCA defines the four Access Categories.

C.TXOP:

The basic concept of the channel access function is the transmission opportunity (TXOP). A TXOP is a bounded time interval in which the QSTA is allowed to transmit a series of frames. A TXOP is defined by the start time and a maximum duration.

II.RELATED WORKS

Bellalta. B.et al investigated the basic values of EDCA parameters which should be changed to perform the QoS optimization [3]. Their work is mainly based on the frequency of acquiring transmission opportunities parameters and they have concentrated to maximize the elastic (BE) throughput while assuring the bandwidth-delay requirements of the rigid flows(VO).

Zhen-ning, Kong et al. analyzed the performance of contention-based channel access in IEEE 802.11e [7] and t have produced the markov chain model of one Access Category per station. They have

ACCESS CATEGORIES	DESCRIPTION
AC_VO(Voice)	Voice traffic and network control belong to AC_VO
AC_VO(Video)	Video and video/controlled load belong to AC_VI
AC_BE(Best Effort)	Best effort (E-mail) and video/excellent effort belong to AC_BE
AC_BK(Background)	Background (Uninvited) traffic will come under AC_BK

Table I Access Categories

concentrated on AIFS in the Enhanced Distributed Channel Access.

In this paper we propose a new optimization algorithm which is the modification of EDCA and the new algorithm provides per stream QoS which is not available in EDCA [1] and it is achieved by tuning the duration of transmission opportunity parameter called TXOP limit.

III.PROPOSED WORK

A.EDCA:

With EDCA, high-priority traffic has a higher chance of being sent than low-priority traffic: a station with high priority traffic waits a little less before it sends its packet, on average, than a station with low priority traffic. This is accomplished by using a shorter contention window (CW) and shorter arbitration inter-frame space (AIFS) for higher priority packets. The levels of priority in EDCA are called access categories (ACs), where each AC has its own MAC parameters and behaves independently of others. Arbitration Inter frame Space (AIFSj), Minimum Contention Window (CWmin;j), Maximum Contention Window (CWmax;j) and Transmission Opportunity (TXOPj) uses the Distributed Coordinate function (DCF).

The basic 802.11 MAC layer uses the distributed coordination function (DCF) to share the medium between multiple stations. DCF relies on CSMA/CA and optional 802.11 RTS/CTS to share the medium between stations. This has several limitations:

1) If many stations attempt to communicate at the same time, many collisions will occur which will lower the available bandwidth and possibly lead to congestive collapse.
2) There are no Quality of Service (QoS) guarantees. In particular, there is no notion of high or low priority traffic.
3) Once a station "wins" access to the medium, it may keep the medium for as long as it chooses.

The IEEE 802.11e EDCA defines the four Access Categories are listed below:

B.MAC PARAMETERS:

MAC parameters are Arbitration Inter frame Space (AIFSj), Minimum Contention Window (CWmin;j), Maximum Contention Window (CWmax;j) and Transmission Opportunity (TXOPj) are frequency dependent parameters.

1) *Arbitrary inter-frame space number (AIFSN):* The minimum time interval between the wireless medium becoming idle and the start of transmission of a frame.
2) *Contention Window (CW):* A random number is drawn from this interval, or window, for the back off mechanism.
3) *TXOP Limit:* The maximum duration for which a QSTA can transmit after obtaining a TXOP.

The Table II specifies the values of MAC parameters which belong to different access categories of IEEE 802.11e.The parameter values are fixed in our project and is given below.

Table II Default MAC Parameter Value

AC	**AIFSN**	**CWmin**	**CWmax**
AC[3]– VO	7	CWmin	CWmax
AC[2] – VI	3	CWmin	CWmax
AC[1]– BE	2	CWmin/2	CWmin
AC[0]– BK	2	CWmin/4	CWmin/2

Each AIFS is an IFS interval with arbitrary length as follows. In EDCA a new type of IFS is introduced, the arbitrary IFS (AIFS), in place of DIFS in DCF. This is calculated by using the formula:

$$AIFS=SIFS +AIFSN * a\ Slot\ Time \quad (1)$$

Where AIFSN is AIFS Number and a Slot Time is the duration of a time slot [1]. The AC with the smallest AIFS has the highest priority. The timing relationship of EDCA is given below:

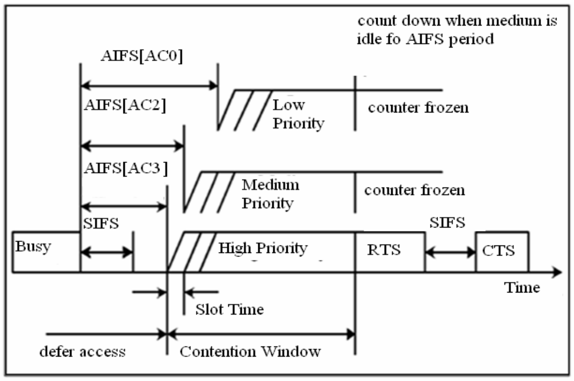

Figure 2 Shows the Timing Relation of EDCA

C. QOS OPTIMIZATION IN IEEE 802.11e USING EDCA:

In our projet QoS optimization is the three step process and this is described below. Initially heterogeneous traffic reaches the MAC layer including voice, video, best effort, background and they are mapped to the corresponding Access Categories. Then all frequency-related parameters of various Access Categories including AIFS, CWmin, and CWmax are fixed by controlling the Transmission Opportunity Limit parameter the higher priority traffic has a higher chance of being sent and waits a little less before it sends its packet, on average, than a station with low priority traffic.

STEP1: Mapping to access categories.

STEP2: Fixing Frequency-related parameters.

STEP3: Controlling TXOP limit based on frequency related parameters. Finally transmission will be takes place.

D.TXOP LIMIT:

A TXOP is a time period when a station has the right to initiate transmissions onto the wireless medium. This is a bounded time interval during which a station can send as many frames as possible (as long as the duration of the transmissions does not extend beyond the maximum duration of the TXOP). If a frame is too large to be transmitted in a single TXOP, it should be fragmented into smaller frames and the effect of TXOP Limit differentiation parameter on the global performance is studied thoroughly in the paper [10].

Consider wireless stations compete for the shared air medium of a wireless LAN using the IEEE 802.11e EDCA protocol. These wireless stations transmit data to/from the base station at different bitrates, and the rate differentiation is achieved by varying the TXOP limits for individual wireless stations. In optimization problem, it is a need to determine the total effective airtime (EA) of the wireless medium so that it can be divided among stations, and to avoid over/under allocation of the wireless medium. The virtual transmission time vj as the time duration between the jth and the (j + 1)th successful transmissions is defined.

Each virtual transmission consists of three periods:

- Idle
- Collision
- Transmission

Let us consider E[x] to denote the average transmission opportunity limit for all wireless stations, and E[v] to denote the average virtual transmission time. Then, the effective airtime can be given by:

$$EA = E[x]/E[v] \quad (2)$$

Let us denote the number of collisions in a virtual transmission time by C, define ik to be the duration of the k-th idle period, and similarly, ck to be the duration of the k-th collision period. Then E[v] is given by:

$$E[v] = E[C](E[c] + td + ts + ta) + (E[C] + 1) E[i] + E[x] + td \quad (3)$$

Where,

t_d is the distributed inter-frame space (DIFS),

t_s is the short inter-frame space (SIFS),

t_a is the average time of sending an acknowledgment.

From the equation (3) it is found that optimal solution for airtime differentiation comes from controlling the TXOP limit and by fixing the frequency of of transmissions opportunities parameters.

E. SCHEDULING ALGORITHMS:

Scheduling algorithm is the method by which threads, processes or data flows are given access to system resources (e.g. processor time, communications bandwidth). This is usually done to load balance a system effectively or achieve a target quality of service. The scheduler is concerned mainly with throughput, Latency, Fairness / Waiting Time. The main purposes of scheduling algorithms are to minimize resource starvation.

They are many Scheduling Algorithms are there as follows:

1) First in First out
2) Random Early Detection(RED)
3) Weighted Random Early Detection(WRED)
4) Round Robin scheduling.

In our project FIFO scheduling algorithm is used.

FIRST IN FIRST OUT*:*

It is also known as First Come, First Served (FCFS), the simplest scheduling algorithm. Figure 4 shows the FIFO scheduling algorithm. FIFO simply queues processes in the order that they arrive in the ready queue.

1) Since context switches only occur upon process termination, and no reorganization of the process queue is required, scheduling overhead is minimal.

2) Throughput can be low, since long processes can hog the CPU.

3) Turnaround time, waiting time and response time can be high for the same reasons above.

4) No prioritization occurs, thus this system has trouble meeting process deadlines
5) The lack of prioritization means that as long as every process eventually completes, there is no starvation. In an environment where some processes might not complete, there can be starvation. It is based on Queuing.

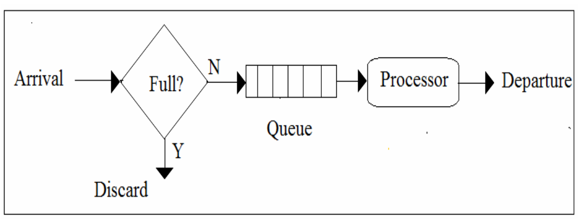

Figure 3 Shows the FIFO scheduling algorithm

IV.EXPERIMENTAL RESULT

Scenario consists of 1 Access Point and 24 wireless stations as shown the figure 4. The simulation of created scenario, its progress and the simulation parameters are given below:

Simulation tool	Qualnet-5.0.2 version
PHY layer model	IEEE 802.11 b
Antenna height	1.5meters
Terrain Space	1000*1000 meters
Simulation time	100 seconds
Scheduling algorithm used to select service classes	Strict Priority
Scheduling algorithm used inside the service class	FIFO

Table III Simulation Parameter

The scenario is given below,

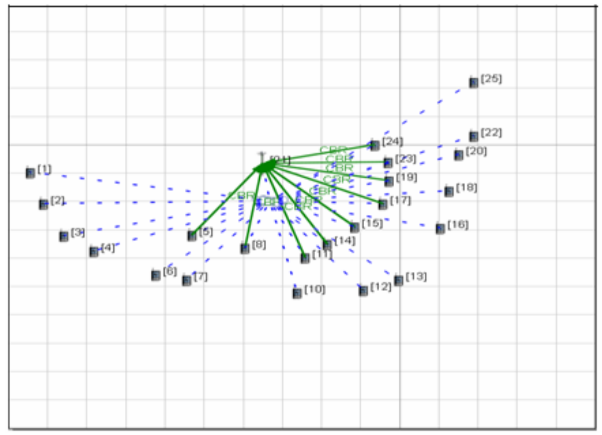

Figure 4 Scenario of IEEE 802.11e

A. Throughput analysis

Throughput is calculated for both Access point and wireless stations using the following formula:

- Access Point Throughput= ((Total no. of bytes received * 8)/Session Duration)

- Wireless Stations Throughput= ((Total no. of bytes sent * 8) / Session Duration)

The throughput for Wireless Stations or client is shown in Figure 5 and throughput for Access Point is shown in Figure 6.

Analysis says that the throughput of nodes which generates high priority traffic (17, 19, and 23) is very high because of the TXOP variation.

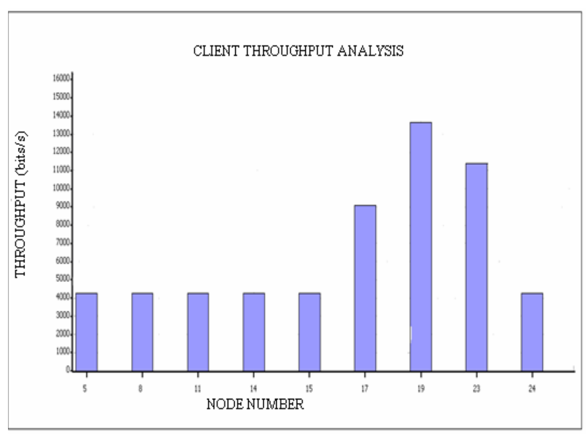

Figure 5 Shows Client Throughput

Node 21 is act as access point or server whose throughput is high because of reception of high priority traffic due to TXOP transmission.

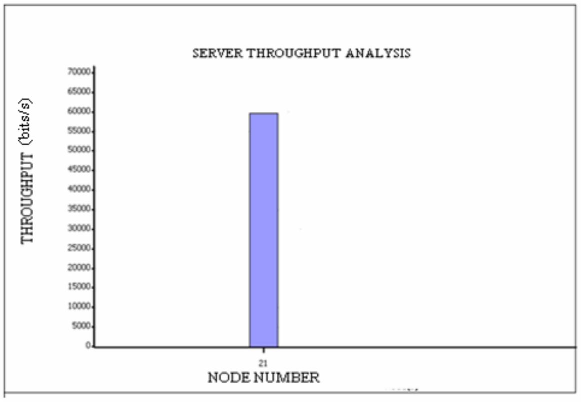

Figure 6 Shows Server Throughput

B. End to End delays analysis:

Average end-to-end delay of the server can be defined as the ratio of Sum of the delays of each CBR packet received to the no. of CBR packets received. Figure 8 shows the average end to end analysis for access point or server.

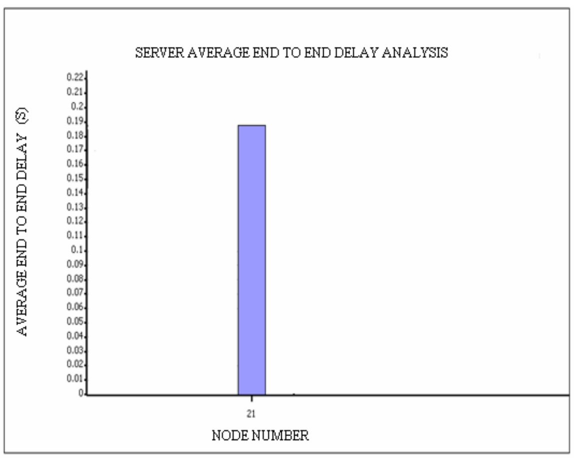

Figure 7 Shows Server Average End-to-End Delay

C.TXOP variation:

TXOP variation can also be defined in terms of starting time and maximum duration. A TXOP is a time period when a station has the right to initiate transmissions onto the wireless medium. Throughput for client should be high because of small TXOP variation and the delay should be low.

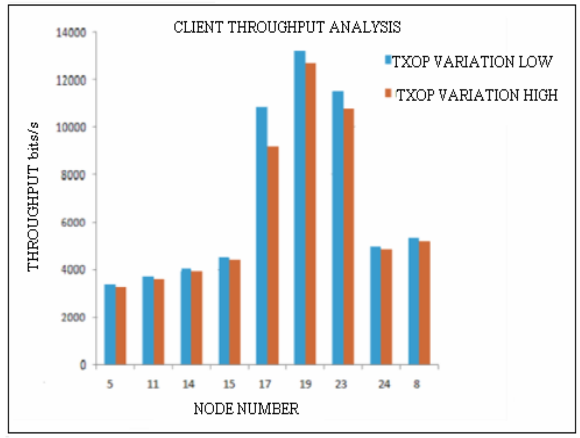

Figure 8 Shows the TXOP variation

Server End to End Delay is given below,

TXOP VARIATION LOW - 0.13025S
TXOP VARIATION HIGH - 0.13113S

V.CONCLUSION

The QoS optimization is provided by Enhanced Distributed Channel Access mode in IEEE802.11e based Networks. Using EDCA, the quality improvement comes at negligible cost, because the optimal solution is computed using simple equations. Finally maximum throughput and minimum delay can be achieved by low TXOP variation with fixed MAC parameters. In future, HCCA technique can be implemented for same scenario and also compare the both EDCA and HCCA technique performance.

VI. REFERENCES

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