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Comparative Analysis of PCF, DCF and EDCF over IEEE 802.11 WLANs

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Abstract*— with the enhancement of wireless network, QoS has become major researcher area. IEEE802.11 standard has two sub layers MAC protocols like as Distribution Coordination Function (DCF), Point Coordination Function (PCF). Medium access coordination function basically implements the Distribution Coordination Function (DCF) and Point Coordination Function (PCF) which support just to best effort service but have limited to QoS services. A new standard, Enhanced Distribution Coordination Function (EDCF) is reported .The IEEE 802.11e (EDCF) which defines the MAC procedures to support QoS requirements and that specifies distribution based access scheme to access the shared wireless media. In this paper, Protocols are tested under realistic conditions to perform evaluation of the coordination functions. Various parameters such as load, network load, media access delay, data dropped are tested in wireless network. Furthermore, the simulative observation is reported at data rate of 66Mbps using a physical layer protocols such as IEEE 802.11n to stumble the best one to implement with EDCF to achieved improved QoS.

Keywords*— PCF, DCF, EDCF, Load, Network Load and Data Dropped, Media Access Delay Attempts.

I. Introduction

The wireless technologies which are important role in the entire internet infrastructure. NowdaysIEEE802.11 is spread and rapidly use standard for its simplicity robustness. As wireless medium which is a shared medium, therefore more and more station demand the bandwidth, performance is become main issue of concern [1]. Medium Access Control (MAC) packet transmission and controls through a common channel in a distributed manner, with minimum possible overhead included [2]. The IEEE 802.11 standard that specifies the two access mechanisms, Distributed Coordination Function (DCF) as well as a centralized solution called Point Coordination Function (PCF). Medium access control (MAC) and physical (PHY) of IEEE 802.11 standard are implemented for only best effort data transmissions. The original 802.11standard do not taken QoS into account. Improved to obtain the QoS support IEEE802.11 standard group has specified a new IEEE 802.11e standard [3]. DCF has two mechanisms: Access mechanism and RTS/CTS mechanism. In access mechanism, DCF is basic of legacy of IEEE802.11 WLANs and based on carrier sense multiple access with collision avoidance (CSMA/CA).The 802.11 tasks with a single first- in- first- out transmission queue [4].CSMA/CA which constitutes a distributed MAC and also based on a local assessment of channel status, i.e. whether channel is idle or busy. MAC will be waiting when the channel is busy until the medium is idle, then defer for an extra time interval, known as the DCF Inter-frame Space (DIFS).During the DIFS deference, when channel stays idle and the MAC then begin the back off process continuous by selecting a random back-off counter. If a certain node or station which does not get access the medium in first cycle, then it stop the back off process, as well as wail for channel to be idle again for DIFS and initiate the back off counter again. In RTS/CTS

mechanism, Request to Send (RTS) frame firstly transmits and after this process transmit the data frame to destination. Acknowledgement transmits to source and clear to send (CTS) frame transmit to source .With this technique, to reduce probability of collisions. Point Coordination Function which is based on infrastructure- base networks the all nodes or stations access medium by single access point (AP). The Point Coordinator (PC) use polling scheme to find which node or station can begin the data transmission. Station or nodes which have option to take participate in network and response to poll from Point Coordinator(PC) .Enable Basic Service Set(BSS) , the channel access time is quotient into beacons intervals , contention free period follow by contention period. Point Coordinator holds the list of all registered stations or nodes to be poll. EDCF is analysed to get prioritized QoS by enhancing the contention based DCF. This is provides differentiated distributed access to the wireless medium for QoS stations(QSTA) following 8 different user priorities (UPs).Each data packet received from upper layer is assigned a specific user priority value ,before entering the MAC layer. It has new kind of Interframe space known as Arbitration Interframe Space (AIFS) in EDCF [6]. EDCF mechanism which defines four different first in first out (FIFO) , known as access categories(ACs) that access support for reach of traffic with Ups at QoS stations.

TABLE .1

Priority	**Access Categories**	**Description**
1	0	Background
2	0	Standard
0	1	Best Effort
3	1	Excellent Multimedia
4	2	Streaming Multimedia
5	2	Interactive
6	3	Interactive Voice
7	5	Reserved

A single station may analyse up to eight transmission queues realized as virtual station inside a station with QoS parameters that find the their priorities. In a station, counters of two or more parallel Access Categories approach at zero at same time a manner that inside the station escapes the virtual collision.

After the introduction, literature survey is given in second section. In third section, a brief introduction to OPNET simulator is given. Our Experimental scenarios as well as setting are discuss, in forth section. We have analysed the results and finally in section five, conclude the paper.

II. RELATED WORK

Choi S.et al [2002] that describes the contention-based channel access technique for QoS support, known as EDCF as emerging 802.11e MAC. Based on simulation, author that compare legacy 802.11 DCF as well as the 802.11e EDCF. It represent that EDCF which provides the differentiate channel access among different priority traffic. An optional feature evaluated called CFB. Contention Free Burst (CFB) allows a node to transmit multiple MPDUs with the SIFS. The CFB (Contention Free Burst) is indicated to improve the global performance at the cost of a delay increase for certain traffic types [7].Romdhani L. et al [2003] that have been extend basic 802.11 e EDCF scheme by dynamically varying contention window of each active class of service. Simulation results indicated

that achieve better performance of throughput, delay and jitter. It validate the results by analysed the impact of sources and networks motion on the performance metrics as well as relatives the results with EDCF [8]. Wang X.et al [2004] that have been analyse an adaptive continuous transmit EDCF protocol based on IEEE 802.11e EDCF. Author concluded that the distributed protocol can not only enhance the total system throughput and channel utilization, but also provides better service differentiation than EDCF [9]. Tao Z. et al [2004] that have been proposed analytical results which represent the numerical values of QoS specific parameters can separate the channel access for packets of different priorities [10]. Sengupta J. et al [2010] that describes the EDCF provides the efficient mechanism for service differentiation. The acquisition of the radio channel by higher priority traffic is more aggressive than for lower priority. DCF perform marginally better as compare to EDCF. Due to this cause, this happens that in EDCF mechanism, each AC function like a virtual station that for medium access, therefore more collision will be hoped for EDCF scenario. But in terms of Quality of Service, EDCF (Enhanced Distributed Coordination Function) outperformed DCF (Distributed Coordination Function) [11]. Battula B. et al [2011] that have been proposed the transmit the packet condition throughput and delay of the IEEE802.11 DCF protocol since the standards which have been proposed. The number of active stations has packets that ready for transmission is huge. for protocol capacity of IEEE 802.11 Medium Access Control and they have deliberate some extensions to model proposed to test the packet drop probability, packet delay, as long as the packet drop time [12]. Singh N. et al [2012] that have been analysed the impact of DCF mode of Wireless LAN topology as well as compared with EDCF which is Enhanced DCF by OPNET Modeller. DCF which do not provides services differentiation to different types of traffic. Therefore, higher priority traffics like voice application and video flowing applications with greater delay suffer. EDCF offer service differentiation on basis of priority and hence the performance as compared to DCF [13]. Sharma V. et al [2012] that have been describes the protocol capability of IEEE802.11 e which enhances the QoS support in deliberated WLAN for delay sensitive applications due to its differentiation mechanism over DCF based WLAN [14]. Kaur I. et al [2012] that have been checked performance of wireless network by PCF, DCF and EDCF co-ordination functions for different parameters such Data Traffic Sent, Channel Reservation, Dropped Data packet, Retransmission Attempts and Load which improves the Quality of Service [15]. Kaur S. et al [2013] that proposed a comparison between DCF and PCF and the result is DCF based WLAN support better throughput for the tested voice and FTP traffic rates as compared to PCF. PCF degrades the overall throughput due to the adopted polling mechanism which tends to decrease end to end delay, channel utilization, is more for voice and video in comparison to FTP. Further PCF based WLAN are found to offer less delay than DCF for real time or bound traffic applications for tested network set up as chances of contention and centralized overhead are lesser in it [16]. Dhaliwal A. et al [2013] that have been proposed the collision of PCF and DCF access mechanism and it is based of different parameters such as throughput, end to end delay, load and retransmission etc on performance of IEEE802.11g WLAN standards on numerous scenarios. The performance obtained that WLAN 802.11g outperformed and can used for high bandwidth data with lower delay to 802.11 a and b network standards when using only DCF access mechanism. Author concluded that lower retransmission attempt and load achieved when DCF is using PCF compare to WLAN when DCF is using PCF compared to WLAN network using only DCF [17]. Hassan M.et al [2013] that analysed the overall performance of IEEE802.11g wireless local area networks has been analysed with the help of the OPNET Modeler and performance describes with help of parameters. Author concluded that have been obtained the different methods to optimize the performance of wireless local area network through limited time. WLAN sub network operates within normal limits of IEEE802.11g standards [18]. Sarmah S. et al [2016] that describes the performance of wireless network for different parameters like load, retransmission data traffic received, data traffic sent and data dropped attempts and throughput using DCF, PCF and EDCF coordination functions. EDCF coordination function is useful to improve Quality of Service (QOS) because EDCF provide differentiation on basis of priorities and improvement over DCF [19].

III. Opnet Simulator

OPNET stand for Optimized Networking Engineering Tool. It is a simulation tool that for auditing communication networks. The user which OPNET graphically defines the topology of his network that consists of nodes and link. Every node involves queue, processors and traffic generators. The user also has to brief the data flow between components in a node. Finally, behaviour of every node is explained by using state diagram. OPNET which get a understand enhancement environment for simulation, specification and performance analysis of communication networks [20].

IV. Experiment Scenario and setting

4.1 Scenario

The IEEE standard 802.11n is used in DCF, PCF and EDCF protocols. An infrastructure of area 200 x 200 m2 is attended which consists of eight nodes at different locations dedicated for different data traffic in Basic Service Set (BSS) infrastructure. The buffer size of data is keep to 2024 Kbps for each mobile workstation and data traffic is set to 60Mbps according to requirements. The traffic

flows between different DCF, PCF and EDCF placed at the numerous locations for different scenarios have been appearance as: Best Effort1 to Best Effort2; Background3 to Background4, voice5 to Voice6, are indicated in fig.1.The infrastructure BSS based mechanism requires the presence of a base station that act as access point for implement of DCF, PCF and EDCF.

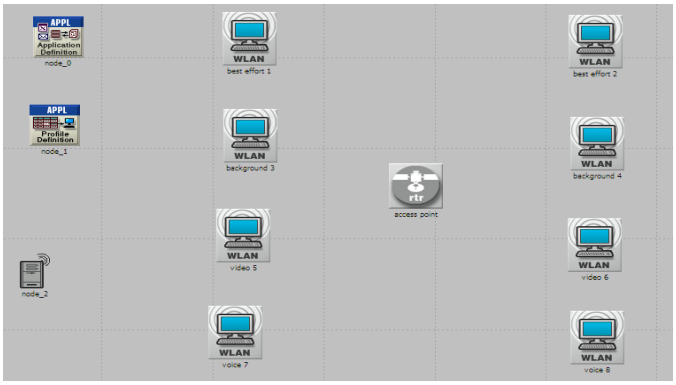

Fig.1 Model of WLAN network using
OPNET Modeler 17.5

4.2 Simulation Parameter

Applications	Parameters	Units
WLAN	Media Access Delay	Sec
	Data Dropped	Bits/Sec
	Load	Bits/Sec
	Network Load	Bits/Sec

V. Result Analysis

We have simulated model of WLAN and plotted graphs on different parameters are selected for analysis. Graphs are different of DCF, PCF and EDCF protocols. Graphs are explained below

5.1 Media Access Delay

In shown in fig. 2 firstly, 104 seconds of simulation the Medium Access Delay three protocols constant at equal pace and then after EDCF is lesser delay than PCF as long as EDCF is higher delay than DCF. DCF is lesser delay as compare to PCF, EDCF protocols.

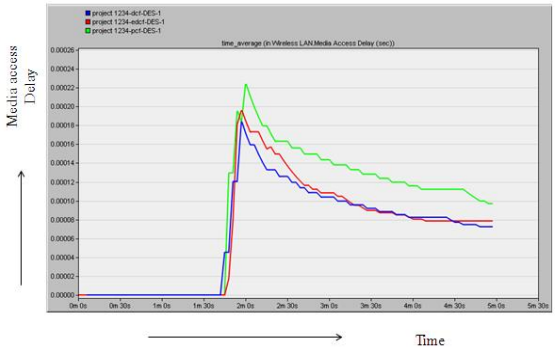

Fig.2 Media Access Delay comparison of PCF, DCF and EDCF

TABLE.2 Media Access Delay

S.No	Time(sec)	DCF	EDCF	PCF
1	105	0.0000453	0.0000176	0
2	108	0.0000453	0.0000793	0.000129
3	111	0.00012	0.000181	0.00013
4	114	0.00012	0.000196	0.000195
5	117	0.000184	0.000184	0.000182
6	120	0.000171	0.000184	0.000224
7	123	0.000159	0.000173	0.000211
8	126	0.000159	0.000173	0.000199
9	129	0.000149	0.000173	0.000189
10	132	0.000141	0.000164	0.000179

5.2 Data Dropped

In shown in fig.3 after 104 seconds of simulation, Data Drop in EDCF flourish suddenly. The cause of varying Data Dropped increasing suddenly in EDCF is a service differentiation that provides the priority based scheme to handle numerous kinds of data. EDCF is higher Data Dropped as compare to DCF and PCF.

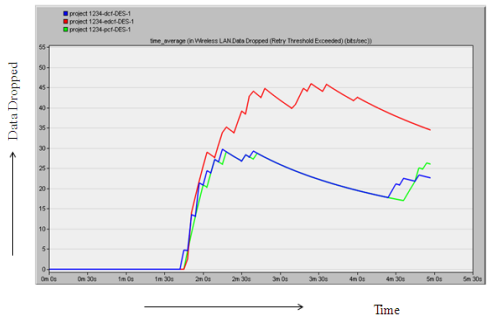

Fig.3 Data Dropped comparison of PCF, DCF and EDCF

TABLE.3 Data Dropped

S.No	Time(sec)	DCF	EDCF	PCF
1	105	4.740741	0	0
2	108	4.612613	2.544595	4.612613
3	111	13.47368	14.03509	8.982456
4	114	13.12821	18.05128	13.12821
5	117	21.33333	21.86667	17.06667
6	120	20.81301	25.49593	20.81301

7	123	24.38095	28.95238	23.81395
8	126	23.81395	28.27907	23.81395
9	129	27.15152	27.63636	27.15152
10	132	26.0495	30.81481	26.54815

5.3 Load

In shown in fig. 4, Firstly DCF and PCF increasing the load as long as EDCF load is increases gradually EDCF load is high as compare to DCF and PCF.

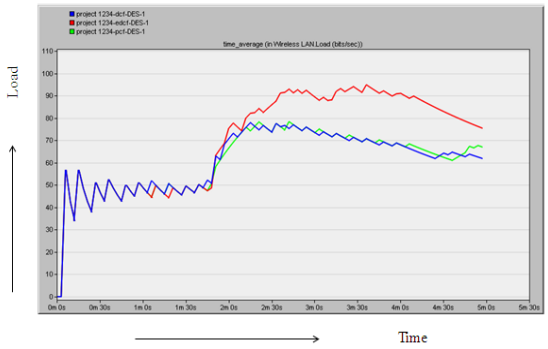

Fig. 4 Load comparison of PCF, DCF and EDCF

TABLE.4 Load

S.No	Time(sec)	DCF	EDCF	PCF
1	0	0	0	0
2	3	0	0	0
3	6	56.88889	56.88889	56.88889
4	9	42.66667	42.66667	42.66667
5	12	34.13333	34.13333	34.13333
6	15	56.88889	56.88889	56.88889
7	18	48.7619	48.66667	48.66667
8	21	42..66667	42.66667	42.66667
9	24	37.92593	37.92593	37.92593
10	27	5.12	5.12	5.12

5.4 Network Load

In shown in fig. 5 firstly at simulation time DCF network load is increasing and after this, EDCF flourish the network with time. EDCF is higher network load as compare to DCF and PCF.

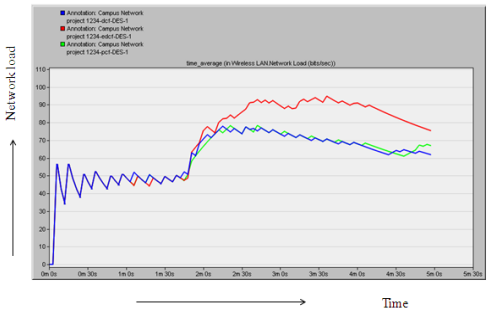

Fig.5 Network Load comparison of DCF, EDCF and PCF

TABLE.5Network Load

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S.No.	Time(sec)	DCF	EDCF	PCF
1	0	0	0	0
2	3	0	0	0
3	6	56.88889	56.88889	56.88889
4	9	42.66667	42.66667	42.66667
5	12	34.13333	34.13333	34.13333
6	15	56.88889	56.88889	56.88889
7	18	48.7619	48.7619	48.7619
8	21	42.66667	42.66667	42.66667
9	24	37.92593	37.92593	37.92593
10	27	5.12	5.12	5.12

VI. Conclusion

The results get from simulation shows that EDCF (Enhanced Distributed Coordination Function) that provide efficient mechanism for service differentiation and hence provide quality of service (QoS) in WLAN. We checked the performance of wireless network like Media Access Delay, Data Dropped, Load and Network Load attempts by DCF, PCF and EDCF. DCF is marginally better than PCF and EDCF. Each AC function acts like a virtual station for access to medium so, no of bakeoffs have that a lot of collision will be expected for EDCF scenarios. Finally, EDCF outperforms of DCF and PCF in terms of Quality of Service for delay sensitive applications (such Video conferencing).

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