PCF and DCF Performances Evaluation for a Non Transition 802.11 Wireless Network using OPNET Modular

Haeeder Munther Noman

***Abstract:** Wireless Local Area Networks (WLANs) take increased a percentage of acceptance as they can offer an access to independent site network among computing systems. IEEE 802.11 WLAN is the best organized wireless knowledge with probably show a key role in the wireless tele-communication networks for the next generation. Many access techniques have been utilized in Wireless Networks, mainly DCF in addition to PCF can be the essential access methods. Main features to the 802.11 WLAN technologies deal with simplicities, flexibilities, and effectiveness of cost. 802.11 standards specify Many _mechanisms of essential access: Distributed Coordination Function (DCF) and Point Coordination Function (PCF) present in the MAC layer of the OSI Protocol stack. This paper mainly deals with a performance presented at these mechanisms from where the end to end delay, throughput and average delays.*

***Keywords:** Wireless LAN, IEEE 802.11, DCF, PCF, Opnet Simulator.*

I. INTRODUCTION

The applications of WLAN- Wireless Local Area Network had been progressively utilized for both of data communications and a topical developments in digital communications in addition to advance technology of semiconductors and convenient computers. The technology of IEEE 802.11 uses any modulation spectrum system of FHSS – Frequency Hopping Spread or DSSS- Direct Sequence Systems composed with IR or radio medium at the physical layer [1]. Therefore, various data rates are provided by physical layer based upon modulation system. A technology of Radio Frequency (RF) be commonly chosen owing to the restrictions in IR propagations. WLANs can be utilized for many applications like health, military, and multimedia, where great system performances in addition to stable link connections are extremely desired.

The standards of IEEE 802.11 had realized two various access techniques so as to let several users for accessing a common channel, first is DCF (distributed coordination function), second is PCF (point coordination function) [2]. For DCF, data structures will be transmitted by simple access mechanism and RTS/CTS (request-to-send/clear-to-send) mechanism [3], and two uncomplicated mechanisms can be summarized for IEEE 802.11: the compulsory technique created on CSMA/CA, and noncompulsory technique to avoid hidden terminal difficult, while for PCF there is a contention-free polling technique for time bounded facilities. [3].

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IEEE 802.11 LANs can be considered as Wireless communication systems which use a techniques of spread spectrum RF for safe, credible and confident data delivery. Most characteristics of the main spread spectrum signals are:

1-The modulated signals have a greater bandwidth compared with the data to be transmitted.

2-The modulation of signal can be done with the transmitted data, so the transmitter and a proposed receiver utilize a confirmed spreading code which is not depend of the data to be transferred [2].

FHSS: is a modulation system, spread spectrum, which utilizes a narrowband carrier varying frequency with a form identified for transmitter and receiver together. FHSS offers transmission of data over channels which has interval of 1 MHz in 2.4 - 2.48 GHz bandwidth. An IEEE 802.11 standard assigns 78 series channels. These channels will be assembled with 3 dissimilar sets of 26 sequences channels for each [3]. While FHSSs are using within IEEE 802.11, so they are not chosen because of their many manufacturing disadvantages.

In **DSSS** technique each bit sent is represented with several bits. In addition, there are some other coding techniques such as DBPSK (Differential Binary Phase Shift Keying) for 1 Mbps data rates, DQPSK (Differential Quadrature Phase Shift Keying) for 2 Mbps data rates and CCK (Complementary Code Keying) for 5.5/11 Mbps, used in 802.11b. On the other hand 802.11a with higher data transmission rates uses BPSK for 6/9 Mbps data rates, QPSK (Quaternary Phase Shift Keying) for 12/18 Mbps data rates, 16 QAM (Quadrature Amplitude Modulation) for 24/36 Mbps data rates, and 64 QAM for 48/54 Mbps data rates [2], [3].

II. 2- 802.11 MAC MECHANISMS

The standards of IEEE 802.11 have specified mechanisms of two various access so as to permit several operators for accessing the mutual channel, they are distributing coordination function (DCF) and the centre controlling access mechanism named a Point Coordination Function (PCF). The 802.11 MAC (Medium Access Control) layer can be concerning to the wireless medium with a controlling access

2.1. Distributed Coordination Function (DCF):

Distributed Coordination Function can be considered as an elementary MAC protocols which uses listen before talks in addition to carrier sense multiple access with collision avoidance method (CSMA/CA) [4]. The property of network that be used DCF protocol is permanently sensing a medium earlier of transferring any data. The station performs Clear Channel Assessment (CCA) before directing any data then attends a channel for a DCF Inter Frame Space (DIFS) [5].

It starts a transmission once the stations discover the channel is free at period of the DIFS, else a station implements a Binary Exponential Backoff Algorithm [6].

In DCF mechanism, every station must be desired for sensing the medium before starting transmission and then achieve a binary exponential backoff [7]. A DCF interframe space (DIFS) can be obtained for the medium which would be sensed inactive at a period time, the station moves in a backoff process and a located backoff time can be produced randomly from a disagreement window. If there is unsuccessful transmission or may be collision happens, the station at that moment confirms a backoff counter with any randomly rate inside a predetermined dispute window named Backoff time.

As the medium is inactive, a counter will be decrementing and the station at any time discovers the idle medium; it is waiting for DIFS and constantly start to decrement one unit from a backoff timer. A new transmission takes place each time a counter terminates. The station will have to be waited before transmission and with any station there is a contention window informs how the amount of slot whiles it delays. So at destination if data arrived magnificently, the recognition packet will be sent after Short Inter Frame Space (SIFS). The ACK (recognition packet) inform transmitter that frames of transferred data had well received. Though, if the sender with no acknowledgement received form receiver, then assumption of frame has been lost and schemes retransmitted and a Backoff process will be started again. The contention window resets when a successful transmission is done, and backoff process will be achieved again via station even if no MSDU. Thus these processes are named "post backoff" and fig. 1 explained the DCF process [8].

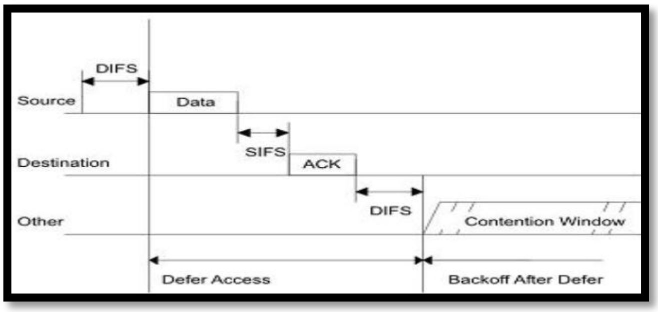

Fig. 1 Access Process of DCF

2.2. Point Coordination Function (PCF):

The standard of 802.11 contains a second management function called point coordination function (PCF) for supporting facilities which need proximate real-time applications, and can be built on the top of DCF. The standard of 802.11 describes PCF as Media Access Control MAC function optionally due to the hardware employment of PCF is too complicated and goes on infrastructure-based networks.

In access technique of PCF , stations totally access media over a solitary Access Point (AP) which considers to be Point Coordinators (PC) [9]. This PC utilizes voting system to decide which station be for initiating data transmission. The network station as an option may be participated in PCF then react for polling received from PC. In PCF enabled BSS of a WLAN system, the time of channel access can be divided with beacon intervals, a Conflict Free Period (CFP) following with a Conflict Period (CP) that d inscribes in Fig. 2. Point Coordinator (PC) load a listed of stations that can polled by a mechanism of channel access and these stations may be transmitted data or received data from AP merely if they were polled. Similarly in network the duration of maximum CFP for all stations is identified and determined by PC entitled CFP_MX_Duration. Access Point sets and sustains CFP that occasionally transfers a Beacon (B). Each beacons comprise data of CFP and CP durations.

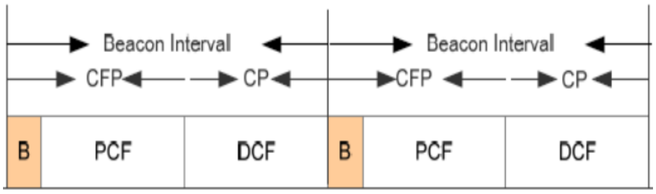

Fig. 2: Beacon Interval of 802.11

The first beacon is transmitted once a CP is transferred after a PCF Inter Frame Space. When AP sends a CF End control packet (CFE), CFP terminates. The transmission is permitted just for station that is polled by AP throughout CFP. This station can be transmitted data to AP or another station in the network. When a polling station doesn't contain any data, it replies by a NULL packet. From fig. 3, beacon is transmitted by AP to initiate CFP [9]. A poll packet and data both are combined to station 1 after SIFS. As station 1 receive this packet it acknowledges the reception of data packet and respond to the poll by transmitting a data packet to the AP. Now, AP combines a poll packet and data packet to station 2 after it acknowledges data packet received from station 1. Now station 2 acknowledges the packet to AP and transmits data to station 1 and after transmission of CE packet CFP is finished. Also after station 1 received the packet it acknowledged it and CFP ends with transmission of CE packet.

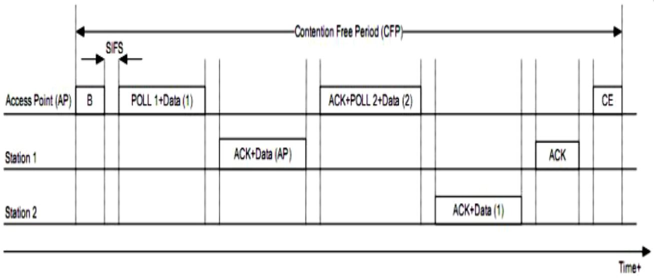

Fig. 3: The Access Method of PCF

2.3. The OPNET Simulator

OPNET stand for Optimization Networking Engineering Tool. It represents a tool for simulation that used to assess communication networks. A user which OPNET realistically defines the structure of any networks that deals with node and link. Every nodes involves queue, processor in addition to traffic originators. Another user's task to brief the flowing of data among components with a nodes. Lastly, the behavior of every node can be explained by utilizing states diagram. OPNET which get an understand enhancement situation for simulation, specifications with a performances analyses of networks [10].

III. SCENARIOS EXPERIMENTS AND SETTINGS

A network of WLAN comprises of specified nine WLAN stations. A simulated region has restricted to the small square area. Several networks had been selected for simulating with two scenarios:-

a) First scenario

Four experiments of an identical scenario were produced, with a first experiment,

A configuration of wireless stations for purposing. In type of DCF with inactivated of the mechanism RTS/CTS and AP of node (0). While the experiment 2 with a similar scenario, a configuration of wireless stations for purposing in type of DCF with enabling a mechanism of RTS/CTS. It's achieved with a set of RTS threshold by 256 bytes. The experiment 3, the setting of RTS threshold with 1024 bytes. Lastly, experiment 4 with a configuration of wireless stations is done at PCF approach with the node (0) as the AP.

All experiments are prepared with a setting Time of Inter-arrival at 0.025-0.05 s.

b) Second scenario:

Same experiments of the first scenario are created but with a varying of the inter- arrival time to high load (0.0125-0.025) seconds. The Network outline for the OPNET modeler can be shown in fig. 1, and the parameters of station that are used for these scenarios are listed in table 1.

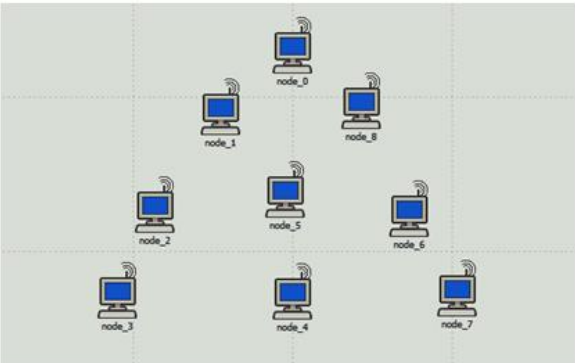

Fig 3: Simulation Network Outline

Table 1 DCF, PCF Station parameters

DCF Station Parameters	Values	PCF Station Parameters	Values
Type of Network	Infrastructure	Type of Network	Infrastructure
Length of Simulation	6000 seconds	Length of Simulation	6000 seconds
Packet Size Range	100 -2000 Bytes	Packet Size Range	100 -2000 Bytes
Inter-arrival Time (Low Load)	0.025-0.05 seconds	Inter-arrival Time (Low Load)	0.05-0.1 seconds
Inter-arrival Time (High Load)	0.0125-0.025 seconds	Inter-arrival Time (High Load)	0.025-0.05 seconds
RTS Threshold	256/1024 Bytes	RTS Threshold	256/1024 Bytes
Number of Stations	9	Number of Stations	9
AP Destination Address	Node_0	AP Destination Address	Node_0
Physical Characteristics	Direct Sequence DSSS	Physical Characteristics	Direct Sequence DSSS
Data Rate	11 Mbps	Data Rate	11 Mbps
PCF Functionality	Disabled	PCF Functionality	Enabled

IV. SIMULATION RESULTS

A. Low Load Time Inter-arrival 0.025-0.05 s:

A conditions of Low load are produced with a set time of the inter arrival at 0.025-0.05 Metrics that utilized to evaluate performances application like MAC delays, data drop rate (bps), the throughput, traffic sent and load.

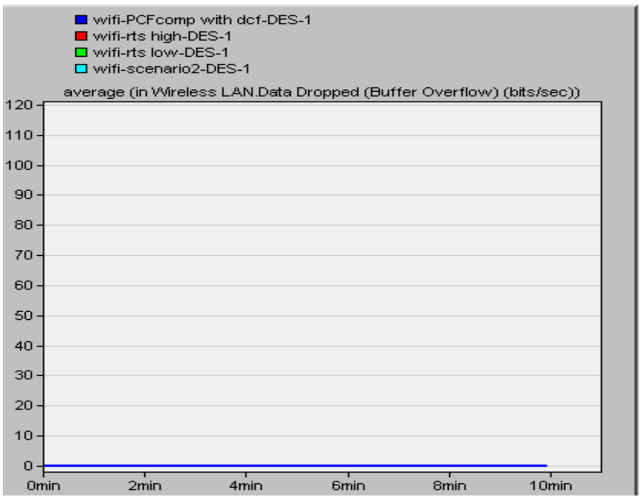

Fig - 4 the Drop Data (bps)

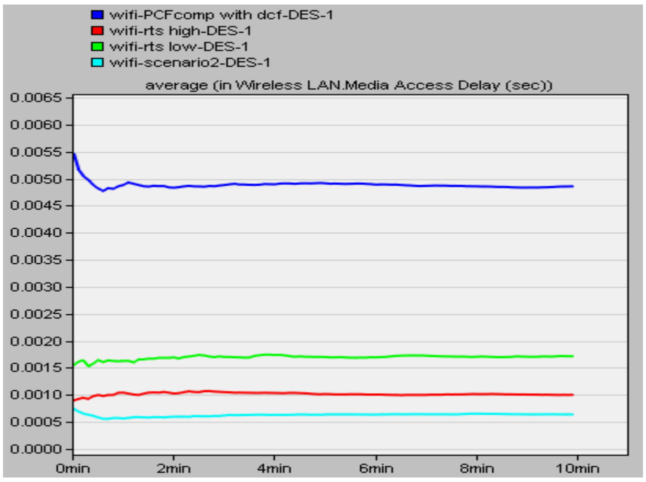

Fig -5 MAC Delay (sec)

From the simulations of low load scenario we can conclude that PCF records highest delay due to the stations have to waiting for polling just before station transmitted, while the Delay is smallest at DCF without RTS, here a fact of no frames above of an RTS/CTS concerned that doesn't an instance for DCF with RTS as shown in fig (5).

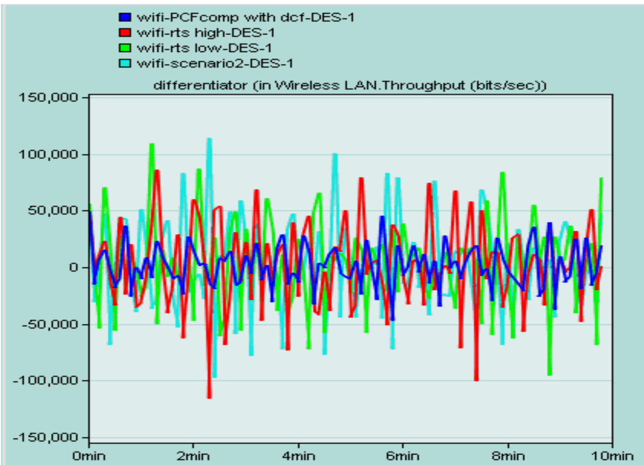

Fig-6 Throughput (bps)

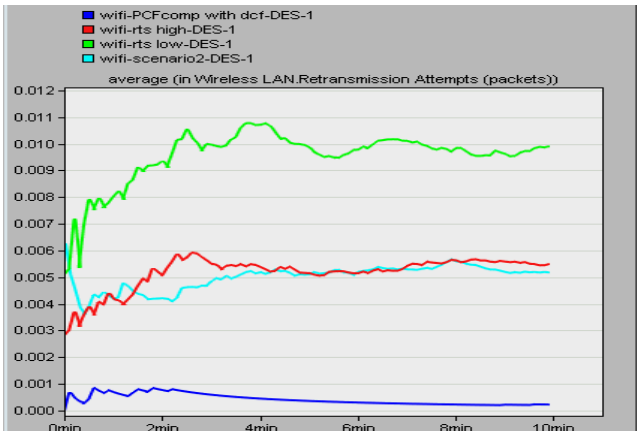

Fig-7 Retransmission attempts (packets)

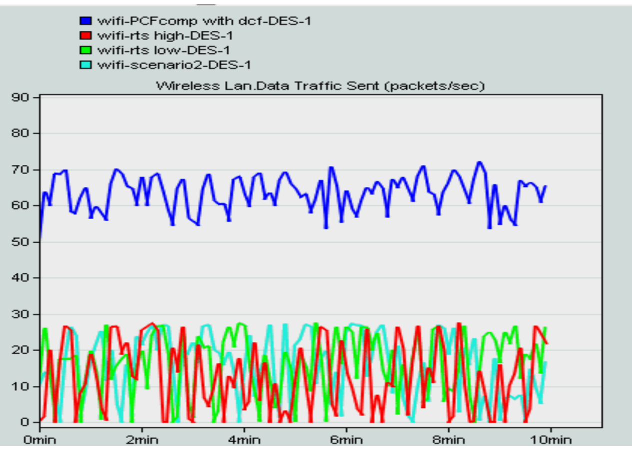

Fig-8 data traffic sent (packets)

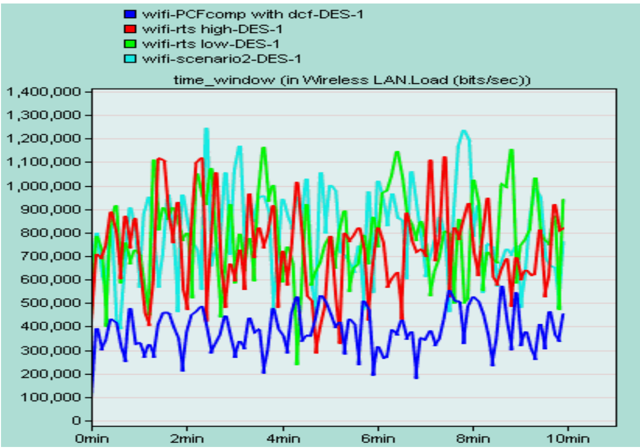

Fig-9 load (bit/sec)

Throughput is same for all the scenarios as no data packets dropped in any of the scenarios shown in fig (6). DCF with RTS 256 bytes records highest retransmission attempts as seen in fig (7). The PCF records highest data sent fig (8). Load is approximately the same for all DCF scenarios except with the PCF which records the lowest load as shown in fig (9).

B. Inter-arrival Time (heavy Loads) 0.025-0.05 seconds

The conditions of heavy loads are made with a set time of the inter arrival to be (0.025-0.05) Metrics utilized to evaluate the performances like MAC media access delay (fig.10), the rate of data drop (PLR) (fig. 10), the throughput (fig.12), retransmission attempt (packets) (fig.13), and finally traffic sent fig. 14 and load (fig.15).

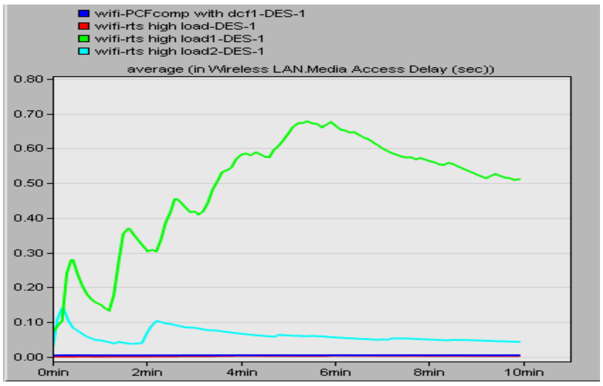

Fig-10 media access delay (sec)

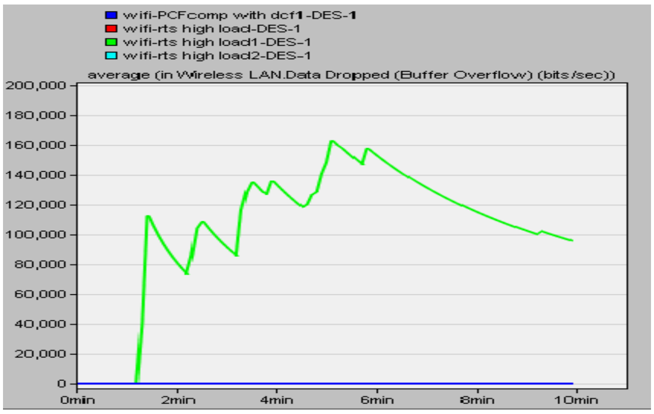

Fig-11 data dropped (bits/sec)

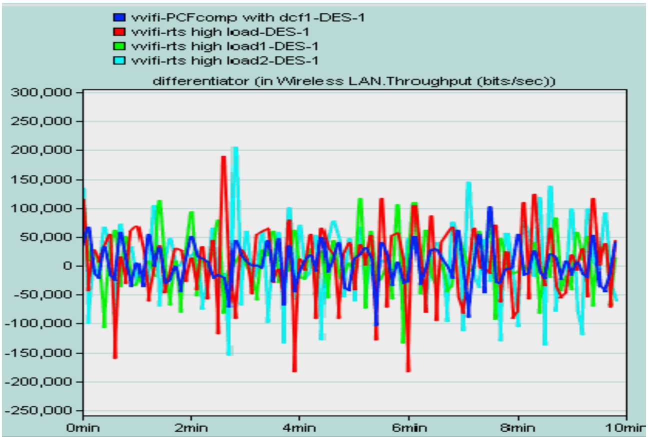

Fig-12 throughput (bits/sec)

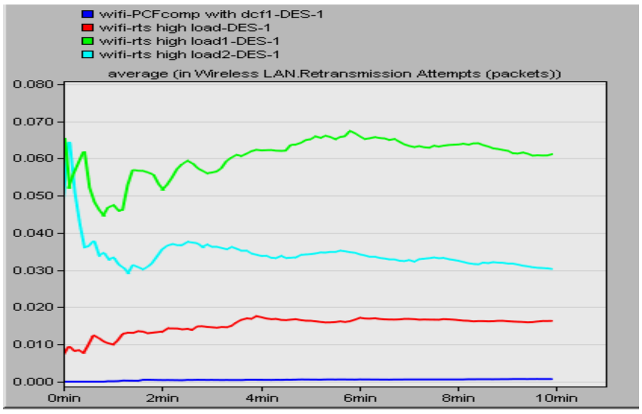

Fig-13 retransmission attempt (packets)

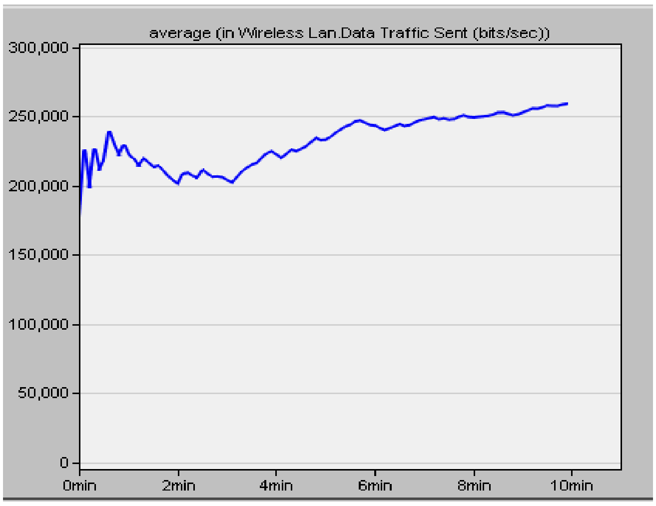

Fig-14 traffic sent (packets)

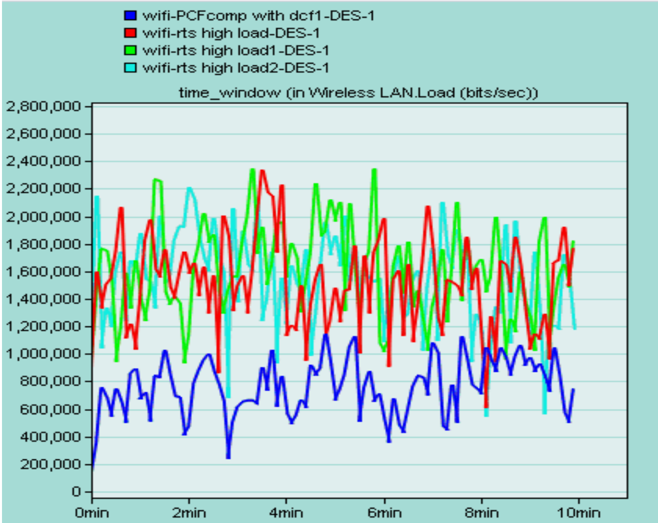

Fig -15 load (bits/sec)

The observation obtained by simulations offered that a delay for PCF with high Load conditions remaining stable, no effect on DCF with no RTS & DCF with RTS=1024, DCF with RTS=256 approaches criticality as shown in fig(10). The throughput can be considered equal for most Scenarios as shown in fig. (12), where load be equal to the throughput for PCF, DCF with no RTS and DCF with RTS=1024 whereas the load didn't equal to the throughput for DCF with RTS=256, fig (15). Packet dropped=0 for PCF, DCF with no RTS and DCF with RTS=1024, packet dropped =162 kbps in case of DCF with RTS =256 as explained in fig (10). PCF records the highest traffic sent in fig (14). Retransmission attempt is relatively high for DCF with RTS=256 in fig (13). Finally PCF has the lowest load for fig (15)

V. CONCLUSION

A two basic medium access mechanisms for wireless DCF and PCF is presented with low and high load conditions. DCF was observed to outperform PCF under low load and PCF outperform DCF under high load conditions. RTS/CTS offered no advantage, but there were no hidden terminals. The observations were done for many performances like Media Access Delay, Throughput, retransmission attempt (packets), traffic sent (packets) & load metrics.

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