A QosBased Performance Evaluation of Wireless Networks using OPNET modeler

Vandana T. Bhatt and Abhishek Bhatt

Abstract- WLANs are being used for military, multimedia and health application, where high system performance and the ability to stay in link is extremely required. It can be considered the wireless version of Ethernet, which supports best-effort service. We have measured the performance of next generation wireless networks in terms of delay, media access delay, throughput, retransmission attempts. These are essential metrics which are used to identify the performance of a given wireless networks. Based on these measurement, the decision for networks selection is made i.e. Using vertical handover or alternate handover, user's call/connection is seamlessly transferred to good QoS enabled network.

In this paper the performance optimization methods have been presented using an advanced networks simulator, OPNET modeler 14.0. Further effect of segmentation on delay, throughput and mobility is analyzed. Finally a utility table is provided from calculation drawn from six different scenarios.

In adhoc networks, the throughput is increased when segmentation is enabled with a subsequent increase in delay. Thus this network will perform better for networks with high tele-density. ESS performs better than infrastructure BSS networks as throughput is increased and delay is reduced. This network can be recommended for video conferencing and high speed data transmission. For internet application in infrastructure BSS, PCF/DCF performs better than DCF. Throughput is increased and delay is increased. Finally the results are compiled in a utility measurement table.

Keywords-OPNET *MODELER 14.0,QoS.Throughput, WLAN*

I. INTRODUCTION

The best-known WLAN standard is IEEE 802.11, which has several supplementary standards. The legacy IEEE 802.11 was introduced with carrier sense multiple access/collision avoidance (CSMA/CA) MAC protocol and three different physical layer mechanism: direct sequence spread spectrum (DSSS), frequency hopping spread spectrum (FHSS), and infrared (IR). Since then, the standard has been enhanced with two physical layer standards: IEEE 802.11b and IEEE 802.11a. IEEE 802.11b uses High rate DSSS (HR/DSSS) and IEEE 802.11a uses orthogonal frequency division multiplexing (OFDM) [12]. The IEEE 802.11e MAC protocol is expected to be ratified for providing quality of access.

With state-of-the-art simulators (OPNET), throughput performance can be measured in MAC layer.

II. RELATED WORK

In [1], the overall performance of the IEEE 802.11 Wireless Local area networks has been analyzed in detail with the help of OPNET Modeler. the parameters like throughput, media access delay, the number of retransmission attempts, dropped data packets etc. for data rate, fragmentation threshold, RTS/CTS threshold, physical characteristics and the buffer size.

In [2], the performance of WLAN has been analyzed based on the parameters of response time, bandwidth,physical characteristics, roaming capability and theaccess methods.

In [3], the authors investigated how to improve voice and data service support in the cellular/WLAN integrated network by applying admission control. It is observed from the numerical results that the resource utilization can be maximized when a balance is achieved in distributing the voice and data traffic load to the overlaying cell and WLAN.

In [4], Kotz and Essein characterize campus-wide wireless network usage at Dartmouth college, focusing on infrastructure mode using access points.

In [5], Balachandran report on network performance and user behaviour for general internet access by San Diego. They find that for this set of technology-literate users a wide range of internet application are used, user behaviours are diverse, and overall bandwidth demands are moderate.

In [6], the authors have investigated some of the factors affecting throughput and delay performance of IEEE 802.11 WLANs in the PCF mode as compared to the DCF mode. and they agree that PCF behave better in terms of throughput when all nodes have data to send.

In [7] research is done to study, the Point Coordination Function (PCF) of IEEE 802.11, the Enhanced Distributed Coordination Function (EDCF) of the proposed IEEE 802.11e extension to IEEE 802.11. The metrics used were Throughput, Data Drop, Retransmission and Medium Access Delay.

The results showed that the performance of EDCF was better in providing QoS for real-time interactive services (likevideo conferencing) as compared to DCF Whereas the DCF's overall performance was marginally betterfor all

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kinds of services taken together.

In our own work the performance of WLAN has been analyzed. Throughput, Media Access Delay, Delay, Retransmission Attempts and Data Dropped are taken as performance metrics

III. SIMULATION SCENARIOS

In our work, we use OPNET Modeler 14.0 [8] to model a WLAN. We have taken five different scenarios to study the performance of WLAN. We have taken 300 simulation seconds to carry out the simulation.

Scenario 1 – Adhoc N/w with varying no. of users

We model an infrastructure WLAN. The network consists of a four fixed nodes without any access point. So all the workstation can directly communicate with each other.

Simulation results for scenario 1

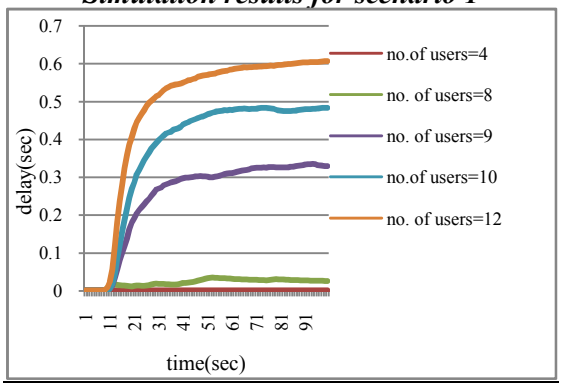

Figure 1. Delay Vs Time

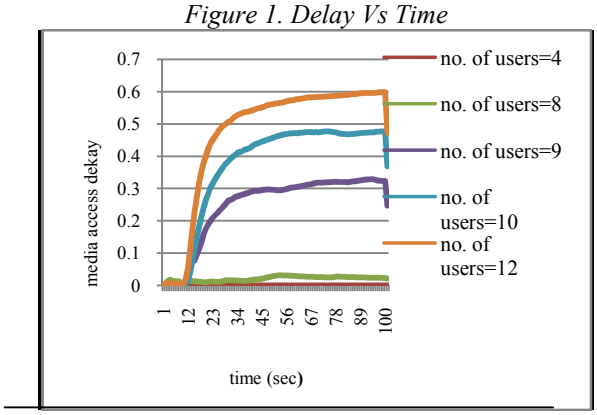

Figure 2. Media Access Delay

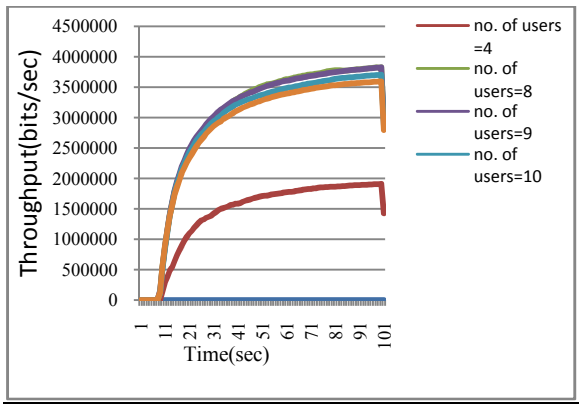

Figure 3. Throughput Vs Time

Scenario	Throughput (Mbps)	Delay (ms)	Media Access Delay (ms)	Data Dropped (Mbps)
Segmentation Disabled	1429485	0.00144	0.00065	743519 Mbps
Segmentation Enabled	2113434	0.0044	0.0034	Zero

TABLE 1
Analysis of scenario 1 simulation results

1. By increasing the no. of users beyond 8 reduces the throughput.
2. Media Access delay and Delay increases with the no. of nodes.
3. Throughput and load are exactly same for a particular scenario.
4. For a 100mX100m office, WLAN can afford max 8 no. of users effectively.

Scenario 2 – Independent BSS with segmentation Enabled

We model an infrastructure WLAN. The network consists of a four fixed nodes without any access point. Hero one attribute is "Packet Generation Argument" whose sub-attribute is "Segmentation size (bytes)". If set to "No Segmentation", then each generated packet is immediately sent to the lower layer whose size is determined based on the value of the "Packet Size" attribute. In this scenario, we have set the segmentation size to 1500.

Simulation results for scenario 2

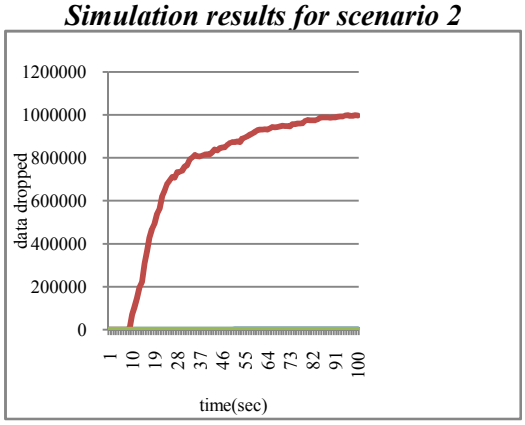

Figure 4. Data Dropped Vs Time

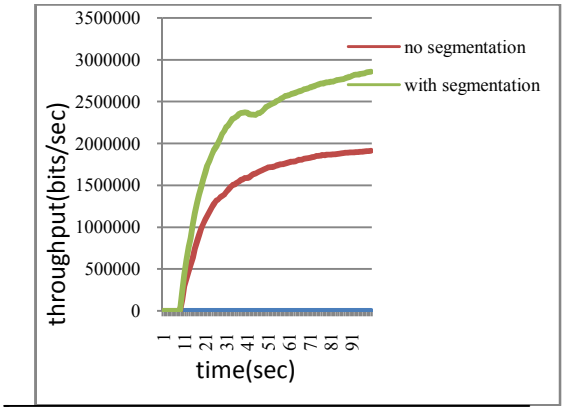

Figure 5. Throughput Vs Time

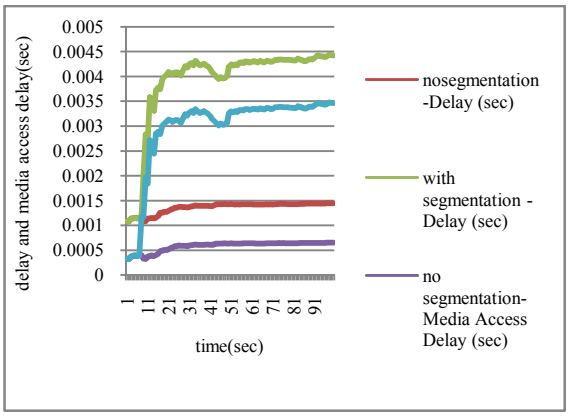

Figure 6. Delay and Media Access Delay Vs Time

TABLE 2
Analysis of scenario 2 simulation results

No. of Users	Throughput (Mbps)	Delay (Sec)	Media Access Delay (Sec)
4	1429485.512	0.00135	0.000580
8	2967878	0.02216	0.0206
10	2876350	0.37457	0.3688
12	2799374	0.47816	0.4716

1. Throughput is increased when segmentation is enabled.
2. Delay and Media Access Delay also increases up to 4 times.
3. Data Dropped is reduced to zero.

Scenario 3 –
In this scenario we have done the comparison b/w Adhoc and Infrastructure BSS
So far we have worked on ad hoc N/W. Now we will take an infrastructure BSS . Then comparison between these two modes is done.

Simulation results for scenario 3

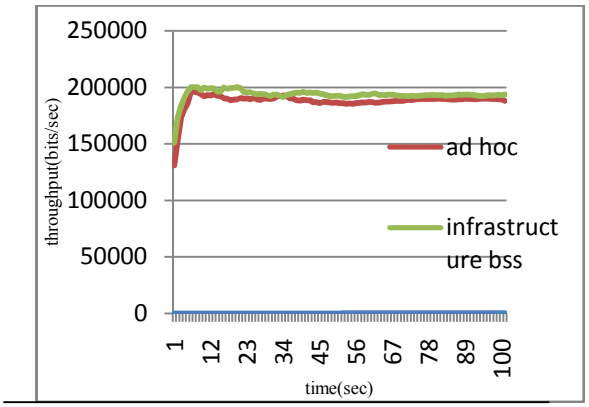

Figure 7. Throughput Vs Time

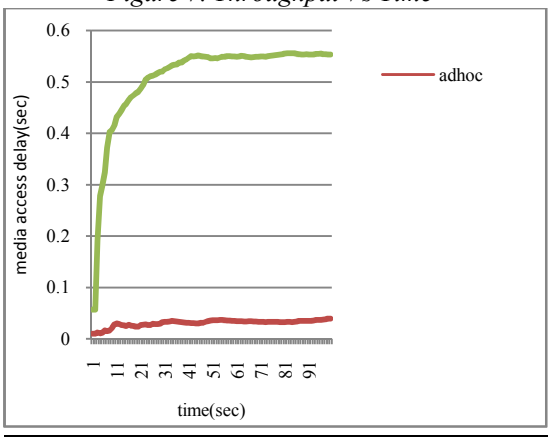

Figure 8. Media Access Delay Vs Time

TABLE 3
Analysis of scenario 3 simulation results

Scenario	Throughput (Mbps)	Delay (ms)	Media Access Delay (s)
Ad hoc mode	187986	0.027	0.0307
Infrastructure mode	193325	1.39 9	0.5

1. Throughput slightly increases with infrastructure BSS as compared to Adhoc N/W.
2. But Delay and Media Access Delay both increases largely as compared to ad hoc network.

Scenario-4
Infrastructure BSS With DCF/PCF Mode
This scenario has eight wireless LAN-based workstation in a simple network configuration (infrastructure BSS) which demonstrates the access method used by the wireless LAN [3].
PCF provides a contention-free (CF) frame transfer. The medium access during the CF is regulated by the point coordinator (PC) which resides in the access point (AP)..
Statistics Studied:
The number of retransmission for a PCF enabled station is very less compared to a non PCF node. Also, the throughput will be much higher for a PCF enabled compared to a non PCF node with a similar load. This is because PCF enabled

node will be able to transmit during both CFP and CP.

Simulation results for scenario 4

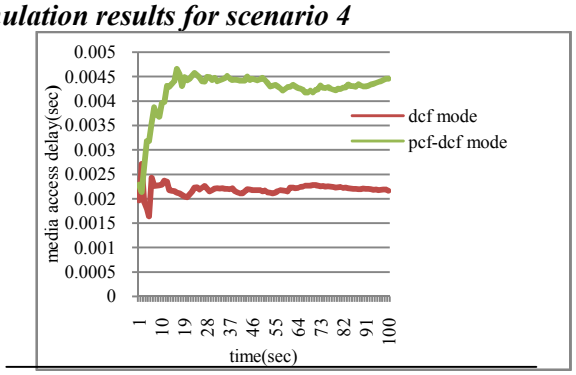

Figure 9. Media Access Delay Vs Time

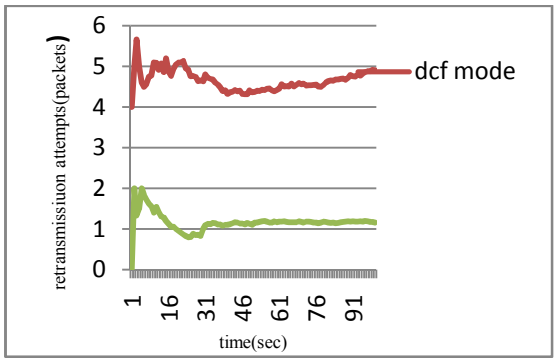

Figure 10Retransmission Attempts Vs Time

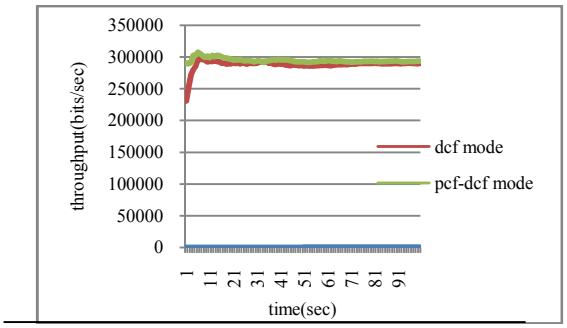

Figure 11.Throughput Vs Time

TABLE 4
Analysis of scenario 4 simulation results

Scenario	Throughput (kbps)	Media Access Delay (ms)	Retransmission Attempt (Packets)
DCF	287986	0.0021	4.656
DCF_PCF	294407	0.00424	1.165

Analysis of scenario 4 simulation results

1. Throughput is more in PCF than DCF mode due to contention mode and polling method alternatively.
2. But Delay and Media Access Delay is less in DCF mode by method of avoiding collision.

Scenario-5
Wireless LAN Developed With Internet In DCF/PCF Mode

The scenario consist of a wireless and a wireline network. The purpose of the scenario is to demonstrate the inter-communication between the wireless and wireline network through the internet back-bone.
The site_1 and site_2 subnet each contain 07 wireless station; all station comply with the wireless LAN (802.11) protocol. The access point nodes in site_1 and site_2 connect each subnet to the wireline network. The clients in the wireless LAN are trying to communicate with servers at the remote site via IP clouds.
Parameters configuration of WLAN station, others parameters are default. This paper take two types of access mechanism of DCF and DCF/PCF as scenery to simulate in order to compare and analysis results, the simulation time is 10 minutes.

Simulation results for scenario 5

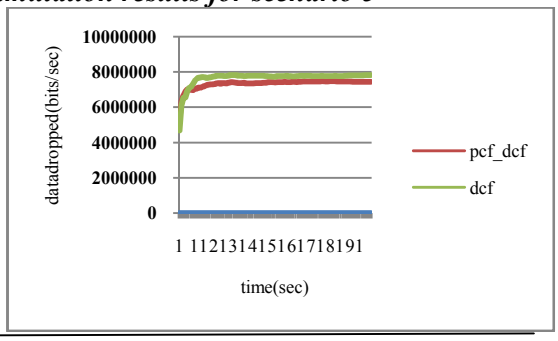

Figure 12. Data Dropped Vs Time

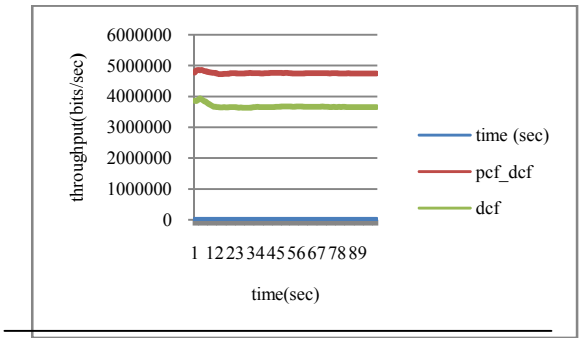

Figure 13. Throughput Vs Time

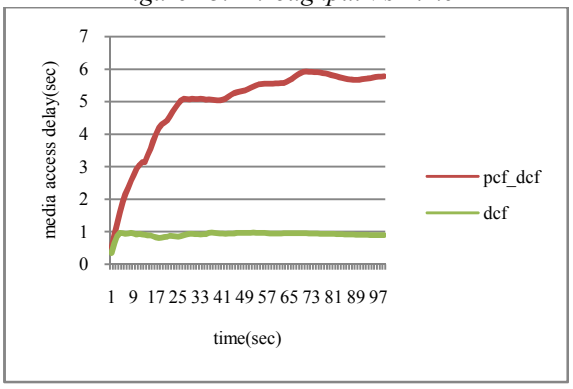

Figure 14. Media Access Delay Vs Time

TABLE 5
Analysis of scenario 5 simulation results

Scenario	Through put(kbps)	Delay (ms)	Media Access Delay (ms)	Data Dropped (kbps)
DCF mode	3678366	0.92	0.9138	7670728
PCF_ DCf mode	4754777	7.12	4.926	7325401

1. DCF access mechanism reduces the delay by method of avoiding collision because it uses the mechanism CSMA/CA
2. Throughput of WLAN is higher by using DCF/PCF access mode than DCf access mode because DCF/PCF access mode adopt contention mode and polling mode alternately whereas DCF mode uses only the contention mode.

IV. CONCLUSION

In this, several methods for improving WLAN performance were investigated. Using OPNET software tool for network management and capacity planning several network models were created, different scenarios were chosen, simulation were executed and results were viewed and analyzed. Our analysis indicates that tuning the MAC layer characteristics related parameters, such as DCF/PCF, Fragmentation threshold improves the network performance.

We have simulated throughput, media access delay, retransmission attempts, load, delay etc. as quality of service measures for WLAN and adhoc network.

We have classified over simulation in 5 different scenario and their conclusion are as follows:-

[1] In adhoc networks, delay and throughput obtained for 8 users is optimum.

[2] In adhoc networks the throughput is increase when segmentation is enabled with a subsequent increase in delay. Thus this network will perform better for networks with high tele-density.

[3] DCF perfoms better in infrastructure BSS networks as compared PCF/DCF mode.

[4] BSS performs better than adhoc network as throughput id increase and delay is reduced by 10 times. Thus this network can be recommended for video conferencing and high speed data transmission.

[5] For internet application in infrastructure BSS, PCF/DCF performs better than DCF. Throughput is increased an d delay is decreased thus this is recommended for large scale networks.

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