An Evaluation of "Quality of Service" Schemes for IEEE 802.11 Wireless LANs Using OPNET Modeler

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Abstract **: In the era of information and communication technology, WLANs are being used for military, multimedia and health application, where high system performance and the ability to stay in link is extremely required. WLAN supports best-effort service at lower investment and cost. Apart from low cost ,IEEE 802.11 technology is relatively easy, quick to install , and operating on a unlicensed frequency of 2.4 GHz which can be built independently by the individual or organization without reliance on operator. With the increasing demand and penetration of wireless services, users now expect good Quality of Services (QoS), in terms of delay; media access delay, throughput, and retransmission attempts.**

In this Paper, the performance optimization methods have been presented using a networks simulator, OPNET modeler 14.5. Various physical parameter such as Number of Nodes, Data Rates, Transmission Technology, Buffer Size etc. have been varied for the infrastructure wireless network. The effects of these variation on QoS characteristics like delay, media access delay, throughput, etc have been studied. It was found that there is trade off among the QoS parameters. Thus for a particular application the QoS requirements change and accordingly those parameters are being selected.

Keywords: **Quality of Service, wireless LANs, performance evaluation, MAC protocol.**

I INTRODUCTION

WLAN standard is IEEE 802.11 become top priority in remote area development or installation of wireless technology-based information infrastructure because of its economic feasibility and high ability over several wireless technologies available today such as microwave, WiFi or IEEE 802.11 and WiMAX. Apart from the low cost, IEEE 802.11 technology is relatively easy, quick to install, and operating on an unlicensed frequency of 2.4 GHz which can be built independently by the individual or organization without reliance on operator. A Wireless LAN always uses the electromagnetic waves to transmit the data signals from one end to another end in the network and it is implemented on the physical layer. IEEE 802.11 wireless LAN has two types of network architectures:

A) Ad-Hoc Network
B) Infrastructure Network

II BRIEF INTRODUCTION OF IEEE 802.11

IEEE group started work on IEEE 802.11 project in year 1997, in order to design a Medium Access

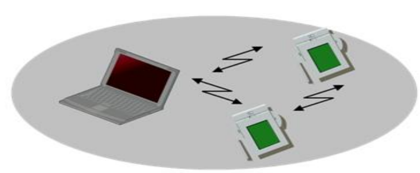

Figure 2. : Ad-Hoc Network

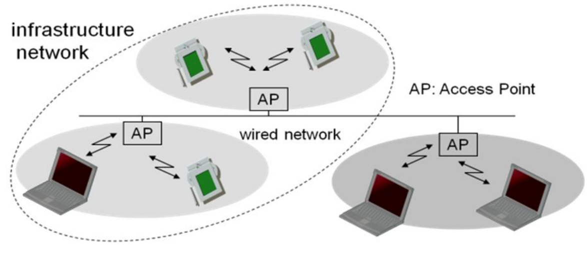

Figure 3 : Infrastructure Network

Control (MAC) and Physical layer (PHY) which provides benefits to wireless connectivity to fixed stations, portable stations and moving station within the specific boundary of the network.

The initial standard includes three Physical layers, FHSS (Frequency Hopping Spread Spectrum), DSSS (Direct Sequence Spread Spectrum) and Infrared. Later on two other transmission technologies were included OFDM (Orthogonal Frequency Division Multiplexing) and HR-DSSS (High Rate Direct Sequence Spread Spectrum).

IEEE802.11 MAC layer consists of Channel Access Mechanism. IEEE802.11 MAC provides two channel access controls, DCF (Distributed Coordination Function) and PCF (Point Coordination Function). PCF provides contention-free channel access and aims at supporting real-time traffic. DCF works based on CSMA/CA (Carrier- sense Multiple Access with Collision Avoidance) with the consideration of the complexity in wireless environment; for example, stations can not listen to the channel for collisions while transmitting. Because PCF is seldom implemented, let's take DCF for example to introduce IEEE 802.11 MAC Layer.

A. Distributed coordination function

The DCF is the basic access mechanism of IEEE 802.11. It uses a Carrier Sense Multiple Access with Collision Avoid- ance (CSMA/CA) algorithm to mediate the access to the shared medium. Before a data frame is sent, the station senses the medium. If it is idle for at least a DCF interframe space 1 (DIFS) period of time, the frame is transmitted. Otherwise, a backoff time B (measured in time slots) is chosen randomly in the interval [0, CW], where CW is the so called Contention Window. After the medium has been detected idle for at least a DIFS, the backoff timer is decremented by one for each time slot the medium remains idle. If the medium becomes busy during the backoff process, the backoff timer is paused, and is restarted when the medium has been sensed idle for a DIFS again. When the backoff timer reaches zero, the frame is transmitted. Upon detection of a collision (which is detected by the absence of an acknowledgment frame to the data frame), the contention window is doubled.

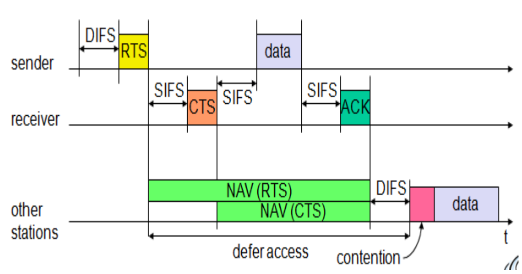

Figure 1: IEEE 802.11 (DCF) Data Transfer mechanisms

In addition, IEEE 802.11 defines RTS/CTS system, source STA will send out a short RTS frame before it transmits a data frame, and then receiver will send back a CTS frame immediately when it receives the RTS, RTS and CTS frames contain the information of the time how long the channel will be occupied to transmit the next data frame, so that other STAs nearby won't send out data in the time declared by setting their NAV timer.

III QUALITY OF SERVICE IN IEEE 802.11

Quality of Service (QoS) is a measure of network performance that reflects the network's transmission quality and service availability. For each flow of network traffic, QoS can be characterized by many parameters. Some of important parameters are: Retransmission Attempts, Delay, Throughput and Medium Access Delay.

QoS is of particular concern for the continuous transmission of high-bandwidth video and multimedia information. QoS is a guarantee by the network to satisfy a set of predetermined service performance constraints for the user in terms of the end-to-end delay statistics available bandwidth, probability of packet loss, and so on.

A).Throughput (bits/sec): determined by the needed data rate of the application and also depending on the size of the data packets.

B).Delay (sec): distinguished into local (at the resource) and global (end-to-end) delay.

C).Medium Access Delay (sec): Represents the total of queuing and contention delays of data for each frame.

D).Retransmission attempts: Total number of retransmission attempts by WLAN MAC in the network until either packet is successfully transmitted or it is discarded.

IV SIMULATION SCENARIO

In our work, we use OPNET Modeler 14.5 to model a WLAN. We have taken three different scenarios to study the performance of WLAN.

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.

TABLE1:- PARAMETERS SETTING OF INFRASTRUCTURE WLAN BY INCREASING NUMBER OF NODES

ATTRIBUTE	SCENARIO
RTS Threshold	None
Fragmentation	None
PHY Characteristic	DSSS
DATA Rate	11Mbps
Buffer Size (bits)	256000

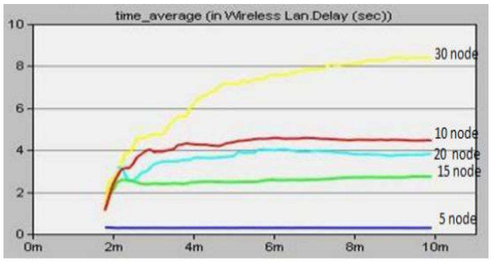

Fig 4: Effects of no. of nodes on delay

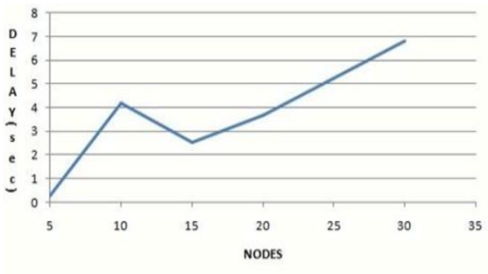

Figure 5: Effects of no. of nodes on delay

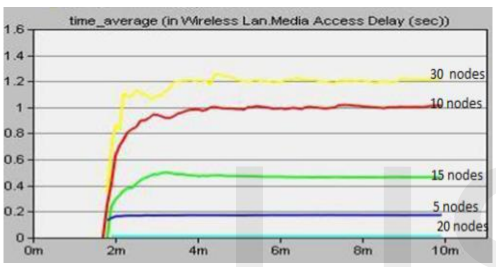

Fig 6

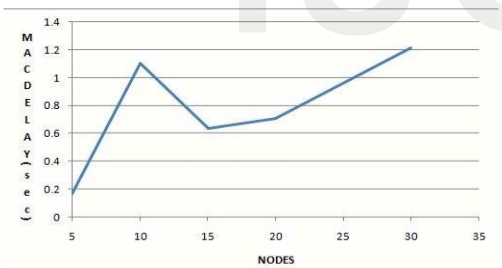

Fig 7

Figure (6, 7): Effects of no. of nodes on Medium Access Delay

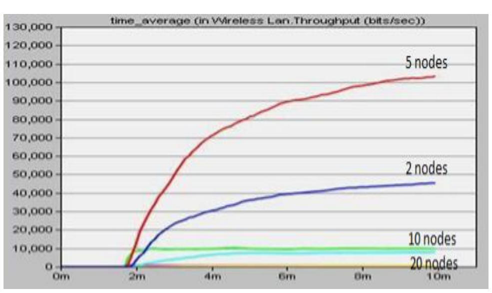

Fig 8

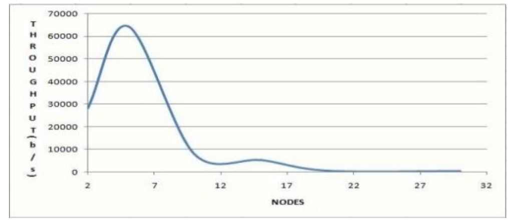

Fig 9

Figure (8, 9): Effects of no. of nodes on Throughput

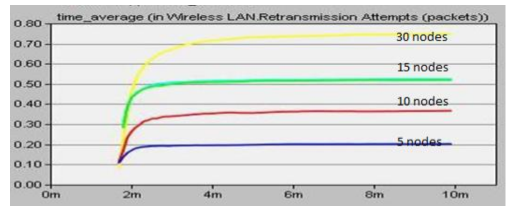

Fig 10

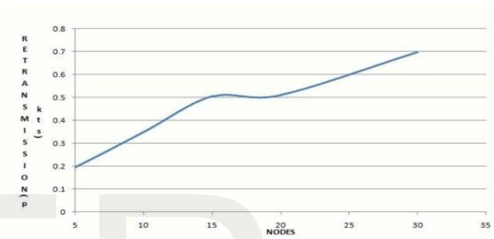

Fig 11

Figure (10, 11): Effects of no. of nodes on Retransmission

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. Retransmission Attempts increases with the no of nodes.

Scenario 2: Ad-hoc N/W with varying Data rates

The data transfer rate (DTR) can be viewed as the amount of digital data that is moved from one place to another in a given time. In this model four scenarios are created, and each has varying data rate 1 Mbps, 2 Mbps, 5 Mbps, and 11 Mbps.

TABLE 2:- PARAMETERS SETTING OF INFRASTRUCTURE WLAN BY CHANGING DATA RATE

Attribute	Scenario
RTS Threshold	None
Fragmentation	None
Phy Char act eristic	DSSS
Buffer Size (bits)	256000

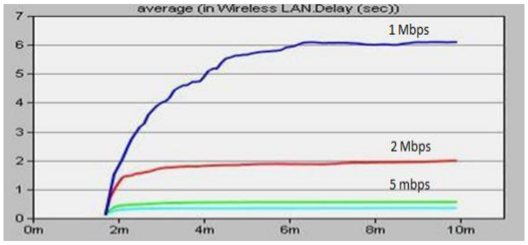

Fig 12: Effect on Delay by changing data Rate

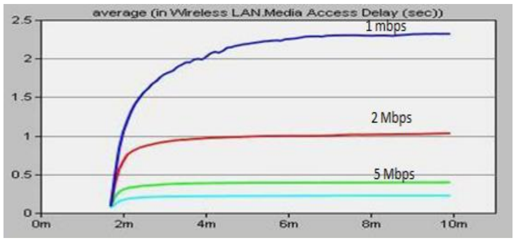

Fig 13: Effect on Medium Access Delay by Changing data Rate

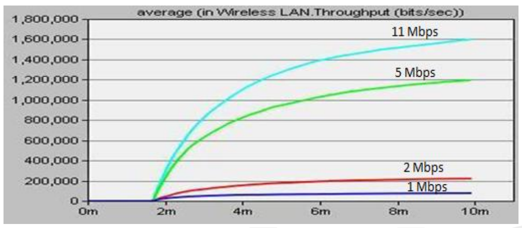

Fig 14: Effect on Throughput by changing data Rate

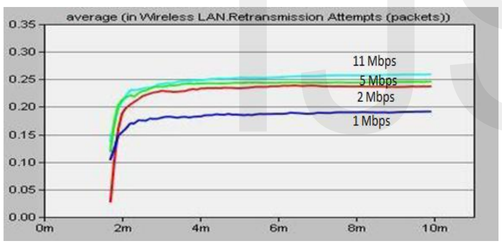

Fig 15: Effect on Retransmission Attempts by Changing data Rate

Analysis of scenario 2 simulation results:

1. By increasing the data rate, delay and Media Access delay in transmission will reduces.
2. By increasing the data rate from 5 Mbps to 11 Mbps, Throughput increases by 30%.
3. By increasing the data rate from 1 Mbps to 11Mbps, Retransmission Attempts increases by 35%.

Scenario 3: Ad-hoc N/W with varying Transmission Technology

The Physical Layer defines the means of transmitting raw bits. The OPNET supports three pre-defined physical Layer characteristics that is “Direct-sequence”, “Frequency-hopping” and “Infrared”.

TABLE3:- PARAMETERS SETTING OF INFRASTRUCTURE WLAN BY CHANGING TRANSMISSION TECHNOLOGY

Attribute	Scenario
RTS Threshold	None
Fragmentation	None
Data rate	2 Mbps
Buffer Size (bits)	256000

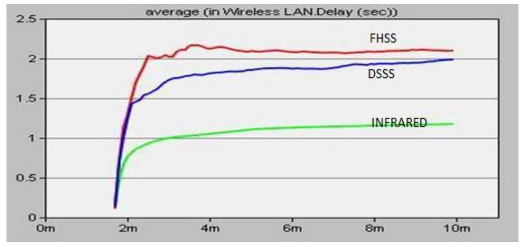

Fig 16: Effect on Delay (sec) by Changing Transmission Technology

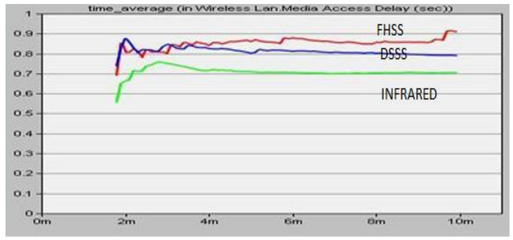

Fig 17: Effect on Medium Access Delay (sec) by Changing Transmission Technology

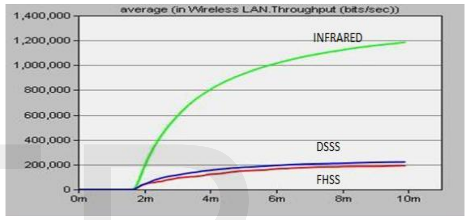

Fig 18: Effect on Throughput (bits/sec) by Changing Transmission Technology

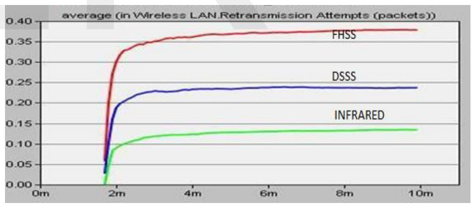

Fig19: Retransmission Attempts (packets) on Changing Transmission Technology

Analysis of scenario 3 simulation results for entire simulation duration of 600 sec:

1. Infrared technology proved to the best for the parameters that are Delay, MAC Delay, Retransmission Attempts and throughput.
2. FHSS hopping method proves to be the worst for the parameters that are Delay, MAC Delay, Retransmission Attempts and throughput.
3. DSSS technology proves to be lying b/w Infrared and FHSS technology.

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

We have classified over simulation in 3 different scenarios and their conclusion is as follows:
[1] In adhoc networks, delay and throughput obtained for 8 users is optimum.
[2] In adhoc networks, delay and medium access delay decreases with increase in data. And for Data Rate 10 Mbps, throughput is optimum.
[3] In adhoc networks, delay and medium access delay are highest for FHSS, least for Infrared and Intermediate for DSSS, due to their individual properties.

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