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Original Article

A Performance Evaluation of E-Learning Model over Wireless Network using Opnet

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***Abstract* - *Today, e-learning mainly takes the form of online courses, e-learning is revolutionizing the education sector. Education not only a kind of learning, but practices in education, teaching, design and research "can be defined as the use of information and communication technologies (ICTs) to facilitate and enhance learning and teaching" . In this paper, Performance Evaluation Of E-Learning Model has been presented using an advanced network simulator, OPNET MODELER 14.5 simulation tool, then we used technology Wireless Local Area Network(WLAN) and IEEE802.11b protocol applied in E-learning classroom. Here performance optimization has been shown via a series of simulation tests with parameters such as Data rate and the physical characteristics. The simulation results show that an IEEE 802.11b WLAN can support up to 100 clients with modest E-learning and Web browsing activities. Also in this paper we implemented different types of Multimedia Application with respect to the quality of service(QoS)parameters, such as network load, throughput and media access delay. Then the results are compiled toimproved andanalysis the performance of wireless local area networks.*

***Keywords* - *E-learning,WLAN, Access Points(AP), IEEE802.11b, OPNETMODELER14.5,QoS*.**

I. INTRODUCTION

E-learning is a fast and efficient way to spread knowledge to learners in different parts of the world that provides the following definition of e-learning: "E-Learning uses the Internet or other digital content for learning and teaching activities".E-Learning is the use of technology to enable people to learn anytime and anywhere[14]. E-learning activities can be synchronous or asynchronous[1].In our research we present the modelling and implementation of a wireless LAN (WLAN) applied in E-learning classroom based on OPNET. Further, presents a simulation study to estimate the appropriate number of E-learning clients that can be supported in the WLAN as well as the user-perceived Web response time as a function of network load[5]. Two of the most exciting and fastest-growing Internet technologies in recent years are the World Wide Web and wireless networks[6].The Web has made the Internet available to the masses, through its TCP/IP protocol stack and the principle of layering: Web users do not need to know the details of the underlying communication protocols in order to use network applications.

Wireless technologies have revolutionized the way people think about networks, by offering users freedom from the constraints of physical wires[6].WLAN market is increasing every day. Dueto its convenience, mobility, and high-speed access,WLAN represents an important future for Internetaccess. Growing use of multimedia applications intoday life and time bounded services motivated the WLAN in the market[25].Wireless access points are now commonplace on many areas such as: homes, airports, university campuses [4],[5] and [7]. One of the popular technologies in the wireless LAN market is the Institute of Electrical and Electronics Engineers IEEE 802.11b standard. This popular "Wi-Fi" (Wireless Fidelity) technology provides low-cost wireless Internet capability for end users,with up to 11 Mbps data transmission rate at the physical layer. The IEEE 802.11b standard defines the channel access protocol used at the MAC layer, namely Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)[4].

II. PRELIMINARIES

Basic components of a WLAN are access points (APs) and Network Interface Cards (NIC)/client adapters and these discussed as follows [3]:

Access point (AP) is the wireless equivalent of a LAN hub. It is connected with the wired backbone through a standard Ethernet cable[3]. IEEE 802.11b defines two pieces of equipment, a wireless station, which is usually a PC or a Laptop with a wireless network interface card (NIC), and an Access Point (AP),which acts as a bridge between the wireless stations and Distribution System (DS) or wired networks. There are two operation modes in IEEE 802.11b, Infrastructure Mode and Ad Hoc Mode[8] in Figure.1 .In our model we use Infrastructure Mode Infrastructure: Mode consists of at least one Access Point connected to the Distribution System.

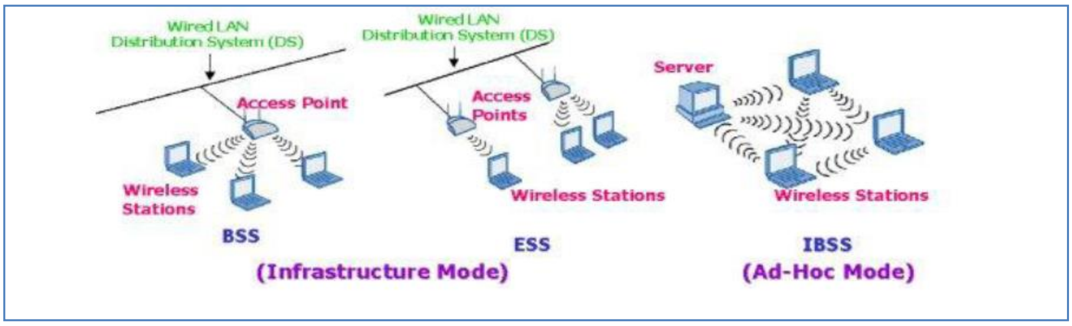

Fig. 1 Operation Modes

Wireless Internet and IEEE 802.11b WLANsIEEE 802.11b standard expands the original IEEE 802.11 with Direct Sequence Spread Spectrum (DSSS) to operate up to 11 Mbps data rate in the 2.4-GHz unlicensed spectrum using complementary code keying (CCK) modulation technique. With the recent adoption of new standards for high-rate wireless LANs, mobile users can realize levels of performance, throughput, and availability comparable to those of traditional wired Ethernet. As a result, WLANs are on the verge of becoming a mainstream connectivity solution for a broad range of business customers. This research describes the new IEEE 802.11b standard for wireless transmission at rates up to 11 Mbps, which promises to open new markets for WLANs. It describes 802.11 and 802.11b technology and discusses the key considerations for selecting a reliable, high-performance wireless LAN[9].

III. RELATED WORK

There is a growing literature on wireless traffic measurement and Internet protocol performance over wireless networks[10],[11] and [12]. But in this paper we are viewing some research works were done on performance evaluation of IEEE 802.11b WLAN for e-learning classroom network and QoS[4],[5],[9],[20],[22],[23]and [24].

First, Salam A. Najim et al[4] presented a simulation study of an IEEE 802.11b wireless LAN in an E-Learning classroom network scenario. The simulations, conducted using OPNET IT Guru 9.1.Their simulation results of this paper show that an IEEE 802.11b WLAN can easily support up to 50 clients with modest ELearning and Web browsing behavior. Furthermore, HTTP protocol features such as persistent connections provide a significant performance advantage in a WLAN environment.Ongoing work focuses on extending our E-Learning and Web browsing model to represent more realistic Web workloads and simulating larger network models.

Also , Sonam Dung and Deepak Malik[5] presented a simulation study of an IEEE 802.11b wireless LAN in an E-Learning classroom network scenario using OPNET IT Guru 9.1. The simulation results show that an IEEE 802.11b WLAN can easily support up to 50 clients doing modest E-learning and Web browsing. The results also show that persistent HTTP connections can provide a significant performance advantage in a WLAN environment.

Then Khaled Ahmed [23] presented an improved E-learning wireless network using IEEE 802.11b LAN for a classroom. He consider the maximum number of wireless clients equal to 100 to be used in this E-learning classroom wireless network. He has evaluated the performance of the proposed ELearning wireless network using OPNET IT GURU simulator. This proposed E-learning wireless network uses web browsing, database, email, and ftp servers The experimental results show that the proposed E-learning wireless network performs better than the web browsing based E-learning network in terms of high throughput and small delay.

Antonis Athanasopoulos ,Stavros Koubias et al [22]presented a paper, a comprehensive evaluation analysis of the IEEE 802.11b and IEEE 802.11g has been carried out, examining the performance of both standards at the MAC sub-layer, in terms of QoS, using two different simulation tools. Thus, generally speaking, 802.11b networks would have both more stable performance and QoS characteristics, independent of both network topology and data traffic, while 802.11g networks seem to be vulnerable when exposed to hidden node problem.

H.S.Mewara, Mukesh Kumar Saini and Rakesh Kumar[20] analyzed the throughput and Delay performance of IEEE 802.11b Wireless Local Area Network (WLAN) with one access point. OPNET IT Guru Simulator (Academic edition) was used to simulate the entire network. In this paperthey considered the effects of varying the data-rate were observed on the throughput and Delay performance metric. Some points are to be noted from the results of this simulation:
(1) When the data-rate in a wireless network is increased, the Delay decreases; and packets are

delivered more accurately, hence less requirement for retransmission.
(2) When the data-rate in a wireless network is increased, the throughput increases; and packets are delivered more accurately, hence less requirement for retransmission.

Finally,Navdeep Singh Chauhan, ,LoveljeetKaurSLIET,Longowa[24] presented paper of implementation of QoSof Different Multimedia Applications in WLAN that used twenty fixed nodes and a single WLAN server to make a perfect network model. All nodes communicate with each other through WLAN sever. The simulation experiments are carried out using OPNET (version 14.0) on windows platform. The results show that the real time application like (video conferencing, video streaming) the QoS parameters such as Network Load, throughput are increased. Over all we see that the high priority channel benefited, while low priority**.**

IV. NETWORK MODEL /BASELINE SCENARIO

The IEEE 802.11 standard defines a set of wireless LAN protocols that deliver services similar to those found in wired Ethernet LAN environments.In this paper we modelled the network, and consists of a WLAN workstation fixed node , a wireless Access Point (AP), an Ethernet-based E-learning Web server, and an Ethernet Switch. The Web server is located on a 100 Mbps Ethernet LAN segment. The fixed client accesses content from the E-learning and Web server via the AP1, using the IEEE 802.11b protocol and the type of Modulation Method, a DSSS. We can choose the access mechanism to the centre Medium Access Mechanism. (Additional clients are considered in later experiments.)

V. SIMULATION RESULTS AND DISCUSSION

➤ *PART 1*

A. *Experiment 1: 50 Clients*

This first experiment contains from 3 scenarioswhich we adjustment some factors like number of users to see if there are fairness problems between 50 clients on a shared WLAN, web browsing http/1.0 and We consider different loads in experiment FTP transfer (low, med, high).

50 clients	Web-browsing http/1.0	FTP transfer (low, med, high).

We see that 50-clients share the channel fairly, and experience similar user-level Web performance, and similar numbers of TCP resets. Also 3 scenarios completed simulation in 9min and small differences in time (delay) y axis

scenario1 :50 clients_http1.0_low

scenario2 :50 clients_http1.0_med

scenario3 :50 clients_http1.0_high

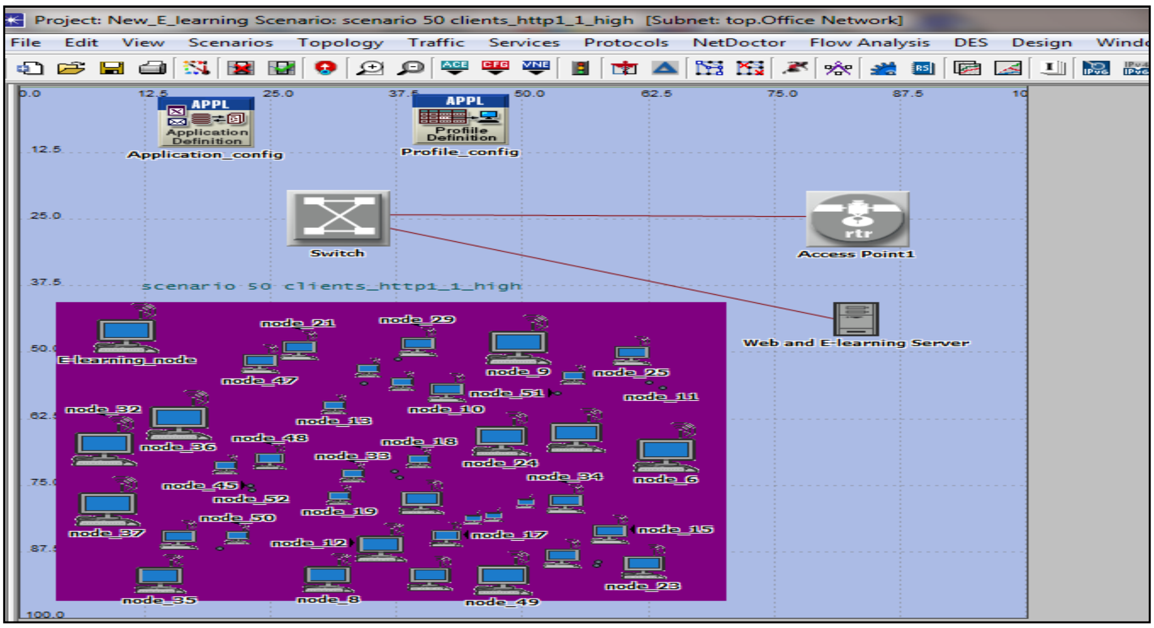

Fig. 2 Scenario1 :50 clients_http1.0_low

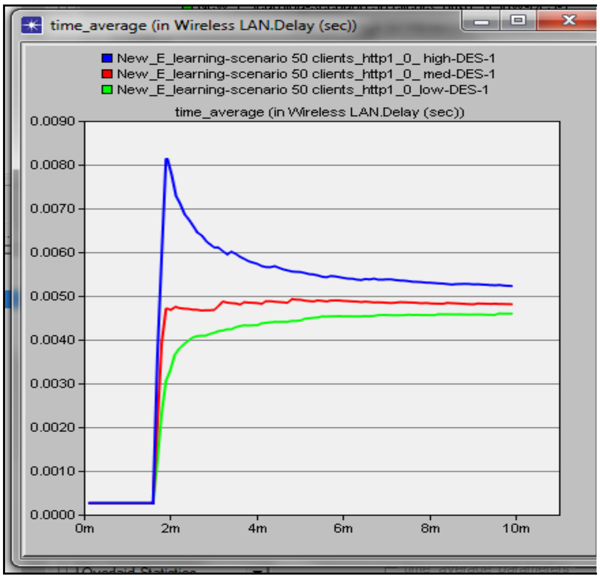

Fig. 3a Time_average (in WirelessLAN.Delay (sec))

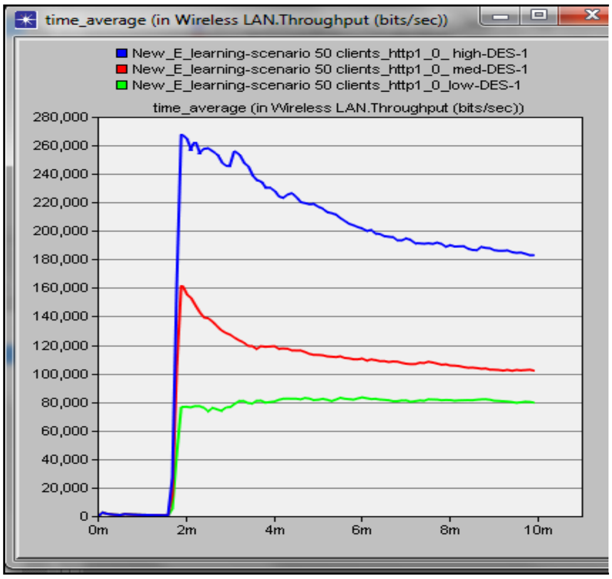

Fig. 3bTime_average (in WirelessLAN.Throughput (bits/sec))

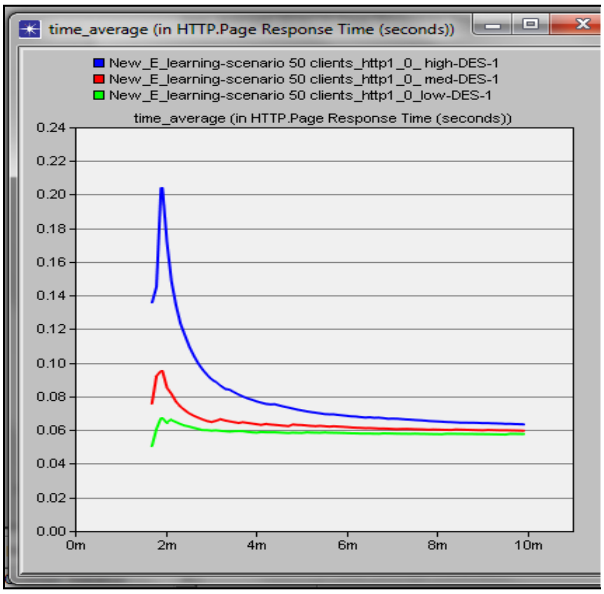

Fig. 3cTime_average (in HTTP.Page Response Time (sec))

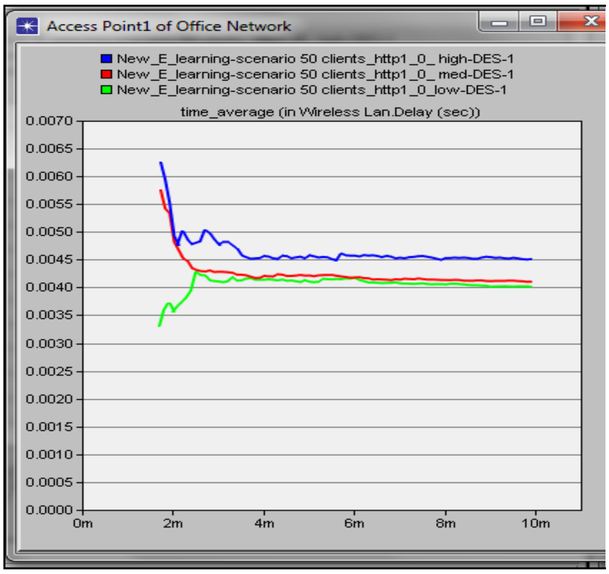

Fig. 3dTime_average (in Wireless LAN.Delay (sec))

B. Experiment Persistent Connections

This experiment is the same of experiment1 but here we change the protocol HTTP 1.0 to HTTP 1.1.

50 clients	web browsing http/1.1	FTP transfer (low,med,high).

The term HTTP refers to Hyper Text Transfer Protocol. This acts as both the client and server protocol of which defines how messages within the worldwide web are transmitted and formatted. HTTP 1.0 could only define up to 16 status codes which was a reserved number. The main limitation of using the 16 status codes was that there was poor resolution reporting that was noticed and thus there was the need to come up with the HTTP 1.1. HTTP 1.1 came with 24 status codes that were able to solve the previous limitations that HTTP 1.1 faced. Error reporting was done faster and there was easy detection of errors when they occurred, also HTTP 1.0 design needed a new TCP connection for every request that was made through it. This caused a challenge as there was the cost and time of setting up a new TCP connection with every request, making the connection very slow. To deal with this HTTP1.1 came up with the use of persistent connections and also the use of pipeline requests to work on the persistent connections.When using non-persistent connections in HTTP/1.0 TCP connection handshaking adds a lot of overhead (and latency) to an HTTP transaction. only two of the packets in Fig4carry "useful" data; the others are control packets to establish, update, andreleaseTCP connection state information. The overhead is particularly painful in a WLAN environment where each TCP packet must contend for access to the shared WLAN using the MAC channel access protocol.The purpose of the this experiment is to demonstrate the performance advantages of persistent connections in a WLAN environment, In the OPNET simulation model, we changed HTTP/1.0 to HTTP/1.1, and set a 9-second persistent connection timeout. With these settings, we simulated three different HTTP/1.1 transactions take place using the same (single) TCP connection. Each of the individual HTTP transactions takes about 1.5- milliseconds to complete, These transactions are about 1.5 times faster than with HTTP/1.0.

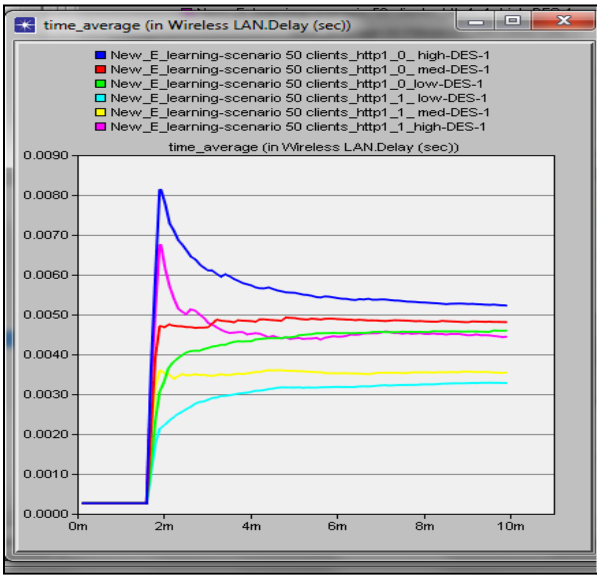

Fig. 4aTime_average (in Wireless LAN.Delay (sec))

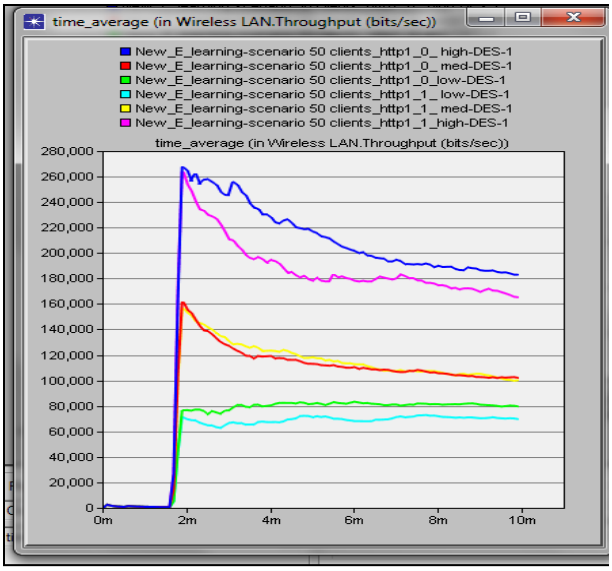

Fig. 4bTime_average (in Wireless LAN.Throughput (bits/sec))

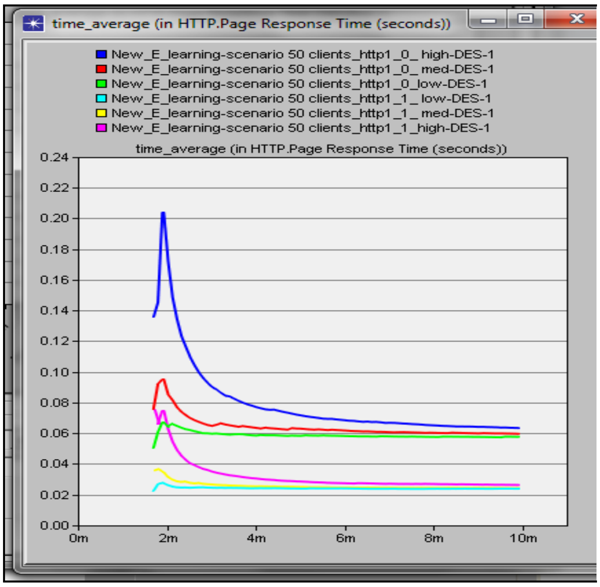

Fig. 4cTime_average (in HTTP.Page Response Time (sec))

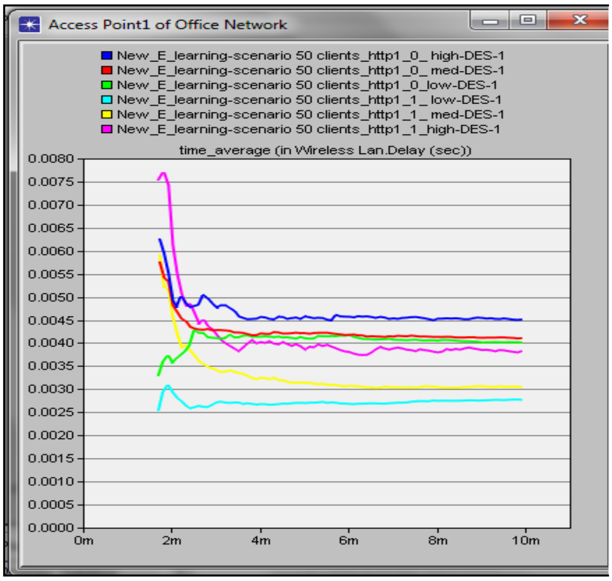

Fig. 4d Wireless Access Point (AP1) Delay (sec)

C. Experiment 3: Large Classroom Network

Our aim here is in the scalability of classroom area networks (i.e., how many clients can be supported in the WLAN, and how does user-perceived browsing performance degrade with network load), so we increase number of user from 50 to 100.

scenario1 :100 clients_http1.0_low
scenario2 :100 clients_http1.0_med
scenario3 :100 clients_http1.0_high

scenario1 :100 clients_http1.1_low
scenario2 :100 clients_http1.1_med
scenario3 :100 clients_http1.1_high

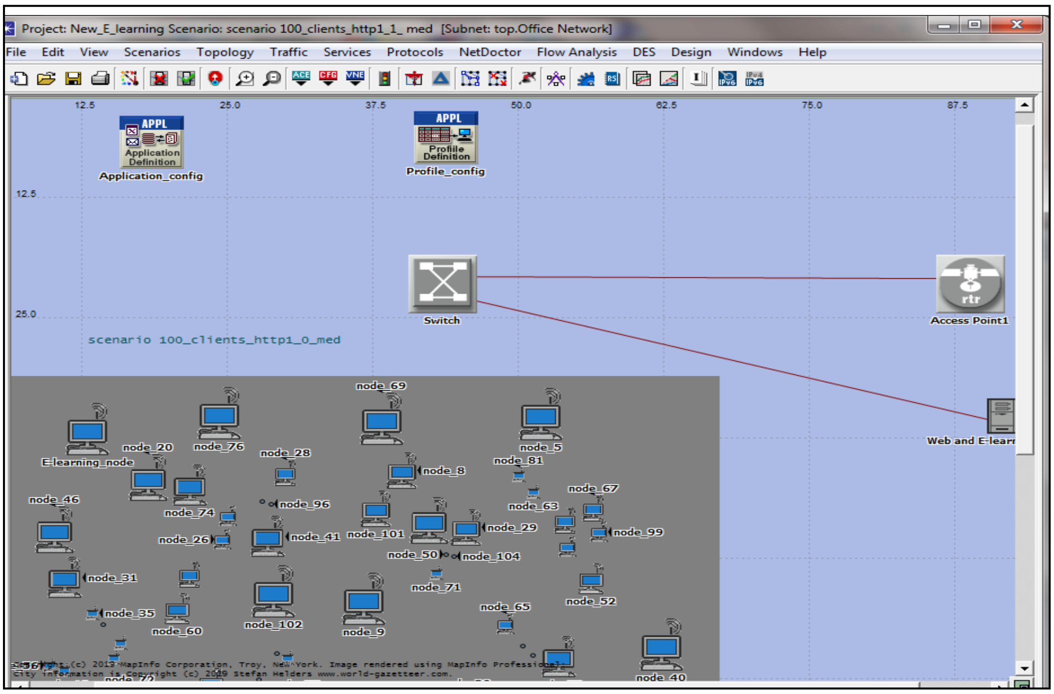

Fig. 5Scenario1 :100 clients_http1.1_high

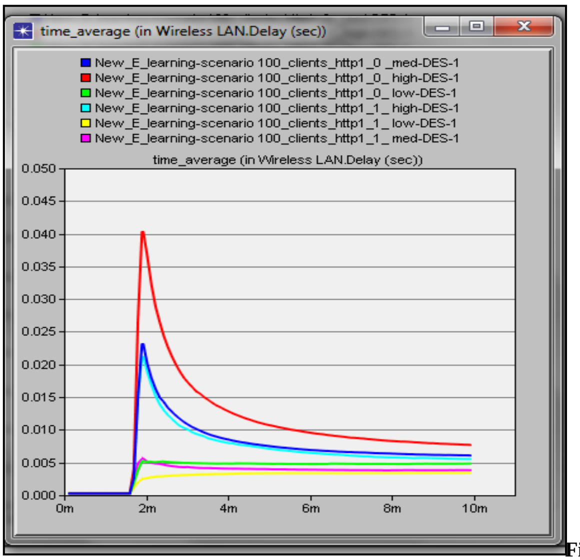

Fig. 6aTime_average (in Wireless LAN.Delay (sec))

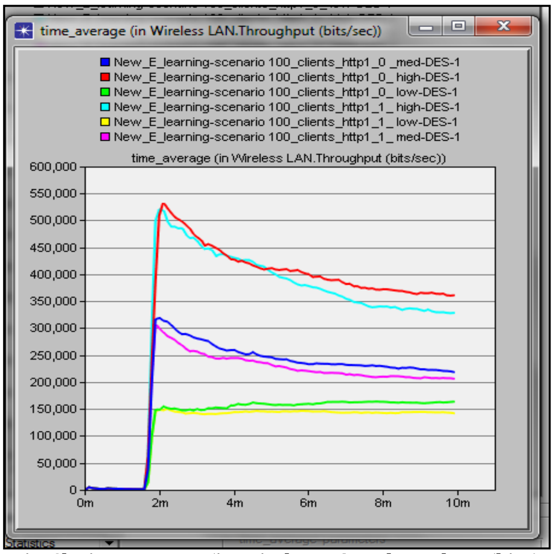

Fig. 6bTime_average (in Wireless LAN.Throughput (bits/sec))

Fig6ashows the wireless delay for the Web clients, averaged over the simulated 10 minutes period. This delay is primarily a function of the number of clients, reaching almost 0.04042 (sec.) with 100 clients when HTTP/1.0 ; while HTTP/1.1 reaching almost 0.02136 (sec.) this has a good advantage over HTTP/1.0; this advantage would increase significantly with more efficient TCP DATA/ACK packetzation..

Fig6b shows the network-level throughput results. The network throughput is higher than the application-layer throughput because of protocol overhead (e.g., TCP, IP, headers, retransmissions). Again, this load is a direct function of the number of clients.

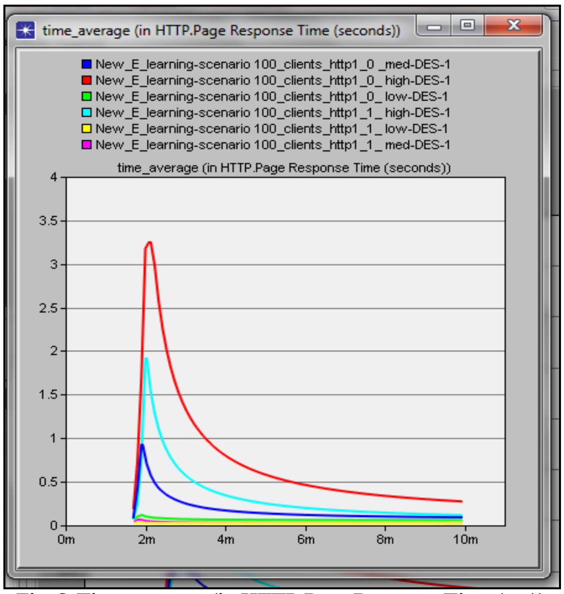

Fig. 6cTime_average (in HTTP.Page Response Time (sec))

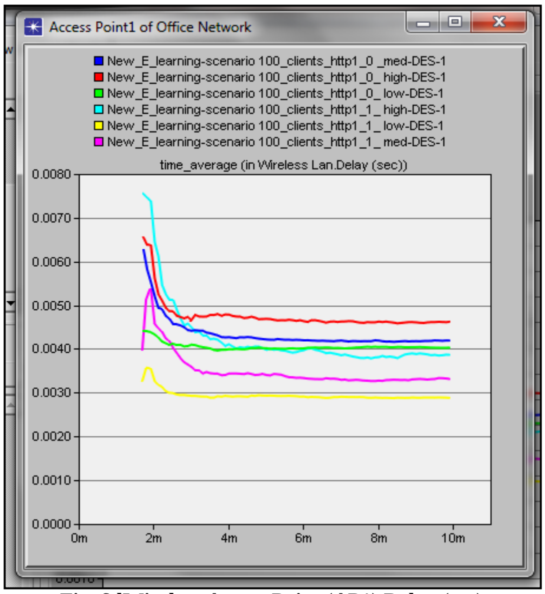

Fig. 6dWireless Access Point (AP1) Delay (sec)

Fig6c shows the mean HTTP transfer time, averaged across all transfers by all clients. The mean HTTP transfer time increases slightly with the number of simulated clients, because of contention for use of the shared WLAN, and perhaps queuing delay at the server.

Finally, Fig 6d plots the mean channel access delay for the shared WLAN channel. This graph shows an increase in channel access delay with the number of competing clients, as expected.

PART 2

D. Experiment : WLAN QoS

QoSis an advanced feature that prioritizes internet traffic for applications, online gaming, Ethernet LAN ports, or specified MAC addresses to minimize the impact of busy bandwidth.QoS is the set of techniques to manage network resources.

This scenario a single fixed Access Point , thirty clients fixed nodes were chosen as the WLAN configuration for the model. All fixed nodes are the same distance from the AP in Fig7.The WLAN 802.11b baseline network model is configured to generate three types of application traffic: web browsing,Voice over IP Call (PCM Quality) and video conference. However, all the applications defined in OPNET Modeler are enabled for future use. Table1. shows the nodes and the applications commonly used, also shows the profile configuration, which defines how the applications are run at the OPNET network level. Every profile contains many number of applications, configured as shown in Table.1which runs throughout the simulation.

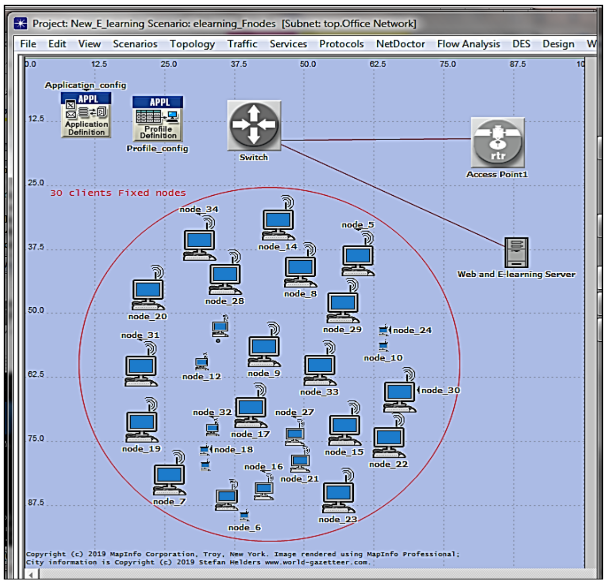

Fig. 7 WLAN QoS , 30 Clients different application and Profile .

Table 1.User Profiles and Applications

Profile /nodes	Applications		
	Web browsing	Video Conferencing	Voice
30 Fixed nodes	Heavy HTTP1/1	High resolution video	Voice (PCM)

A. Load

Represents the total load (in bits/sec) submitted to wireless LAN layers by all higher layers in all WLAN nodes of the network. The overall WLAN load data is displayed in fixed nodes showing an average value of 14358.97Kbps on the 10 minute mark in Fig8.

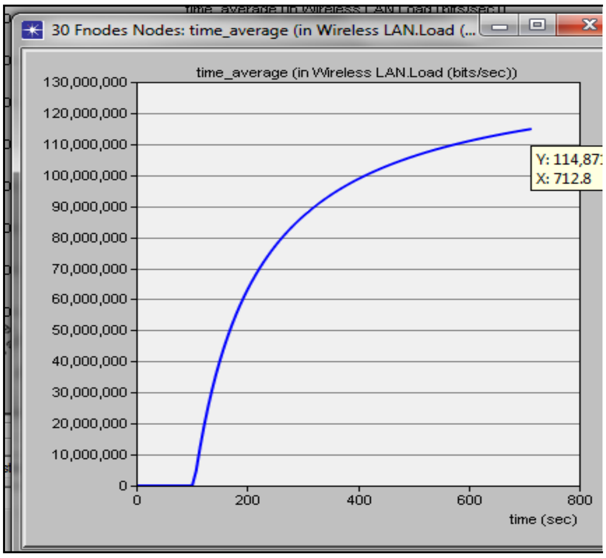

Fig. 8 Total Load of WLAN

B. Throughput

Throughput is a measure of successful delivery of packets in a given interval of time. The throughput of the WLAN in fixed nodes is shown in Fig 9.

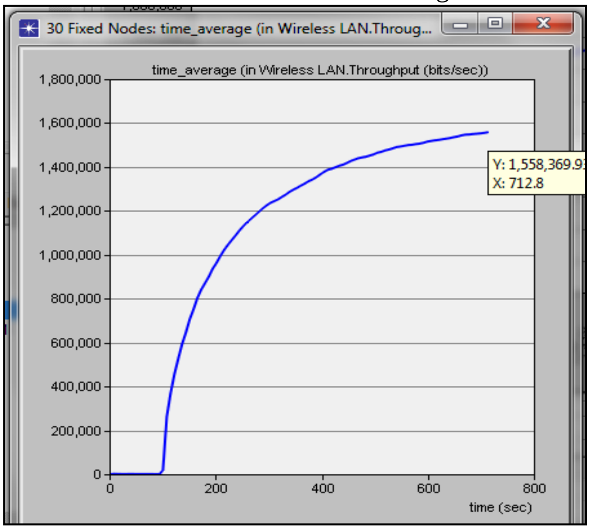

Fig. 9 The Throughput of the WLAN

C. Media Access Delay

Delay is a technical term that can have a different meaning depending on the context. It can relate to networking, electronics or physics. In general it is the length of time taken for the quantity of interest to reach its destination. In computer networks, media access delay is the amount of time it takes for the head of thesignal to access a medium.

According the simulation result in Fig 10 we findminimum delay 0.12s and maximum delay 5.2s.

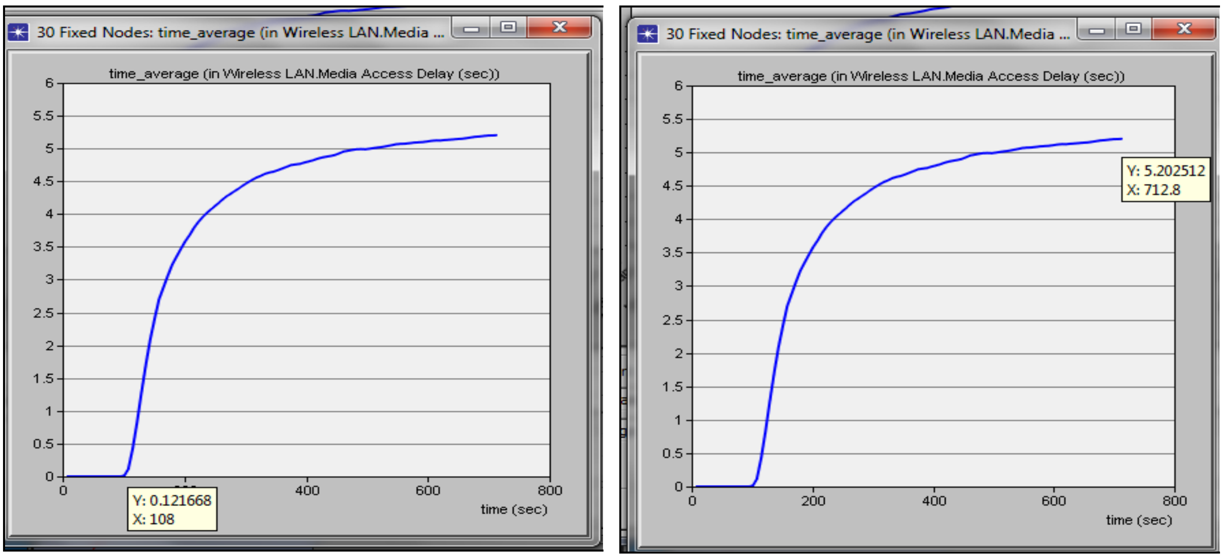

Fig. 10 Media Access Delay of the WLAN

VI. COMPARISON WITH RELATED WORKS

In order to compare our model with other works focusing on the same subject, We have made some improvements like:

1. Increase number of clients, which simulation can easily support up to 100 clients ,but in previous study can supported up to 50. IEEE 802.11b (often called Wi-Fi) the ability to serve up to four to five times more users now do. It also opens the possibility for using IEEE 802.11 networks in more demanding applications.
2. Also our paper focus toimplemented of QoS of Different Multimedia Applications in WLAN ,the previous study used 20 nodes and two application (Video Conferencing and voice) used,also this applications divided in categories.In our paper we increased the number of nodes to 30 and we used 3 Applications: Web browsing , Video Conferencing and voice.Then we used all this applications in simulation as a serial order .

Table 2. Users Applications

Web browsing	Video Conferencing	Voice
Heavy HTTP1/1	Heavy	(PCM)

Table 3. Comparison Result

Factor	Previous Study	Our Study
No.Clients	20	30
Applications	2	3
Time(sec)	300	720

From the result of simulation WLAN 802.11b baseline network model is good to support applications with number of clients during 12 minutes .

VII. CONCLUSION

We presented a simulation study by using technology WLAN network and IEEE802.11b protocol applied in E-learning classroom scenarios. The simulations, conducted using OPNET modeller 14.5. The simulation results show that an IEEE 802.11b WLAN can easily support up to 100 clients doing modest E-learning, and IEEE 802.11b which Sharing of a single channel among multiple users. The 802.11b seems to have the good performance.

Also from the results show that the real time application like (video conferencing, voice) the QoS parameters such as Network Load, throughput , media access delay are increased. Over all we see that the high priority channel benefited, while low priority channel suffered.

VIII. FUTURE WORK

After the completion the Model Of E-Learning Over Wireless Network Using Opnet that God willing I aspire to a wider area of research in the following:

1. We may be done by using moveable Infrastructure of wireless LAN.,and we are comparing the performance betweenfixed nodes and mobile nodes.
2. In Yemen we will attempt to create web site for E-learning project which is a different educational experiment , which improves the way of learning to a modern technological learning by using model MOOCs depended on model which we were created by Opnet.
3. Using Cloud Computing in E-learning Systems.

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