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Modeling and Simulation of a Wireless LAN (WLAN) connected to an Etherent using Riverbed Modeler Academic Edition 17.5

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Abstract

Wireless LAN has gained its popularity due to the mobility support that it provides in comparison to the secure and faster connection provided by the Wired LAN. In most of the cases wired and wireless LAN are deployed together to give the required services to an organization or enterprise. In such cases, it is mandatory to consider the performance optimization of the wired and wireless LAN together. A specific networking model of a wireless LAN (IEEE802.11g) connected to an Ethernet (IEEE 803.2) through a Wireless LAN router and an Ethernet Gateway (backbone of the wired LAN) is built and simulated using the simulation software RIVERBED MODELAR ACADEMIC EDITION 17.5. We have shown the performance of the WLAN router and the Ethernet Gateway with the help of the different performance parameters such as the Utilization, Packet sent, Packet received, Queuing delay and Throughput.

Keywords: WLAN, Ethernet, RIVERBED MODELER ACADEMIC EDITION.

I. Introduction

The increased demand for mobility and flexibility in our daily life has led to the development of Wireless LAN (WLAN) tremendously. Often this WLAN is connected to a high speed Ethernet backbone through the wireless access point or router and a gateway to the Ethernet. While the workstations in the WLAN communicate with each other, they also may need to communicate with any of the workstations of the Ethernet (wired LAN). In such scenario, the wireless router and the gateway play the vital roles for the communication in the network. Our objective is to evaluate the performance of the router and the gateway in the network for Video Conferencing application which places stringent demand on the delivery of the video traffic and delay experienced by it. (Dr. R K Bansal *et al.*, 2010 and Prof. Dr. Alfons *et al.*,2010) Several researchers have modeled and investigated their proposed network model by different simulation techniques. Among the various network simulators available like NetSim, NS-2, GloMoSim etc., OPNET provides the industry's leading environment for network modeling and simulation. The Riverbed Modeler Academic Edition 17.5 is the new name for the OPNET and it allows to design and study communication networks, devices, protocols, and applications with flexibility and scalability. It provides object oriented modeling approach and graphical editors that mirror the structure of actual networks and network components (Riverbed Modeler Academic Edition)

In our research work we have simulated our model for various performance parameters such as point-to-point utilization, throughput, queuing delay, packet sent, and packet received at the wireless LAN access point, Ethernet gateway and the link used in between them.

The paper is organized as follows: Part I gives Introduction, part II focuses on the Literature Overview, part III sheds light on the Riverbed Modeler Academic Edition, part IV is about the network simulation model used in our work. Part V deals with the simulation results of the performance metrics and in the VI section the paper has been concluded.

II. Literature Review

Many works have been carried out to simulate the performance of the Wired and Wireless LAN separately or combined WLAN and wired LAN (e.g. Ethernet) together using the OPNET simulation software. So, we have organized our discussion according to that .

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A. Combined Wired and Wireless LAN

(Dr Adnan Hussein and *et al*., 2013) have done performance optimization of an office LAN with 20 work stations connected to a Access Point with 6 wireless work stations. In (Alfons Eisenhofer *et al*., 2010) we can find the network scenario of a wired LAN connected to three Access points through a wireless LAN controller where the AP are connected to few wireless work stations. Table 1 shows different important design & research issues of these papers. A Qualitative comparison of our work with other 'combined Wired and wireless network model using OPNET' is also presented in the table.

Table 1: Features of the combined Wired and Wireless LAN together

Author	Network Scenario	WLAN technology used	Application Traffic model	Parameters varied	Evaluated Performance parameter	Concluding remarks
Dr Adnan Hussein and et al	A WLAN subnetwork deployed within an enterprise WAN framework.	802.11g	Web Browsing, File Transfer, Email, Database, print, talent session and video conference	Data rate, and the physical characteristics	load data, Packet Delay, Medium Access Delay, overall throughput of the WLAN	The performance optimization of a wireless LAN subnet connected to a wired LAN within normal limits of 802.11g standard
Prof. Dr. Alfons Eisenhofer et al	A Wired LAN with 3 Access Points connected through a WLAN controller	802.11n	Not specified	Number of wireless work stations connected to each of the Access Points	Total & Avg. throughput of the WLANs, Media Access Delay, Data dropped, Data received, S/N ratio & received power of the mobile nodes	The performance of a next generation wireless LAN degrades as the number of workstations increases
Anika Aziz & Shahriar Ahemd	A 10 node wireless LAN connected to a wireless router which is connected to an Ethernet via a gateway	802.11g	Video Conferencing	The performance parameters were observed with the advancement of time within the simulation period	% utilization of the router and gateway, throughput, traffic sent and received by different nodes of the network, point-to-point utilization and throughput of the links, delay of the links.	Although other works mentioned here have used a model with combined wired and wireless network, their focuses were to improve the performance of the wireless LAN part. Whereas we wanted to focus on the fact that how the gateway connected in between these two types of networks influences the performance of the total network

B. Wired and Wireless LAN

We have reviewed few papers which have focused on different aspects of the Wired and Wireless LAN separately. These two types of LAN are then simulated and comparisons are made on the basis of different performance parameters. (Er. Ishu Gupta *et al.*, 2010) have simulated Ethernet and WLAN for different number of workstations and it was found that the WLAN at 10 Mbps can have better throughput than the Ethernet when there are sufficient number of users within the range. (Prof. Satish K. Shah *et al.*, 2013) have evaluated the performance of wireless and wired network with simulation tool. In this paper, performance of wireless and wired networks as well as comparison is evaluated using OPNET simulation tool. For wired network, collision count, traffic received, delay, throughput is studied while for wireless network, data dropped, traffic received, media access delay, and throughput is studied. For comparison of both wired and wireless networks, the performance parameters throughput is investigated. (Dr. R K Bansal *et al.*, 2010) is a review paper on the performance analysis of wired and wireless LAN obtained from different works using OPNET simulation software

C. Review papers on Wireless LAN

The wireless LAN technology and IEEE standards have different attributes and performance variations. In order to catch up with that we mentioned two useful papers here. (Vijay Chandramouli, 2003) has presented detail study on different wireless LAN technologies in his paper. The white paper by U.S Robotics (Wireless LAN networking white paper) on Wireless LAN networking is also very informative. J. Song and et al., have implemented three methods for performance improvement of a WLAN: by changing the physical layer characteristics, by properly chosen the WLAN parameters and finally by using the adaptive back-off algorithm of MAC layer.

III. Riverbed Modeler Academic Edition 17.5

Riverbed Modeler provides you with a modeling and simulation environment for designing communication protocols and network equipment. Riverbed Modeler Academic Edition incorporates tools for all phases of a study, including model design, simulation, data collection, and data analysis.

Simulations in Modeler are run by representing real world devices as nodes and links. Modeler provides an environment on which attributes of these nodes and links can be configured and used as inputs in the simulation run, after which results are analyzed (Riverbed Modeler Academic Edition).

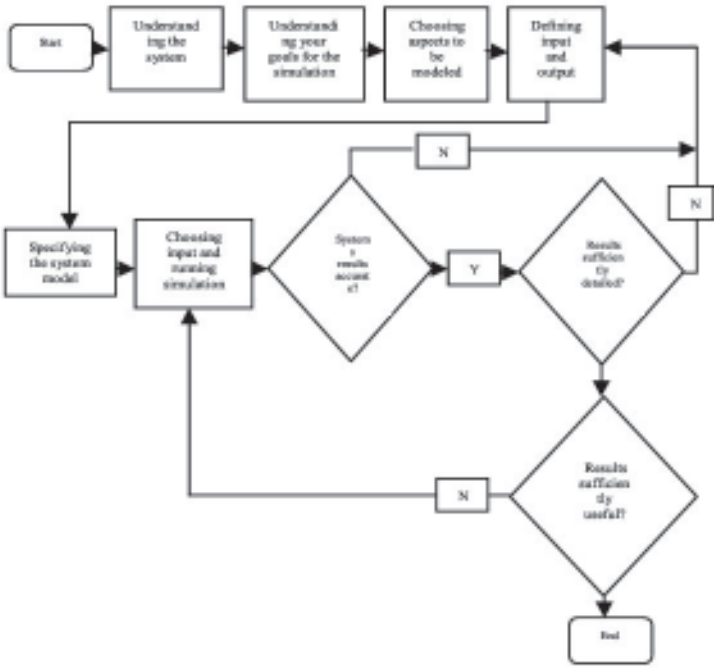

Figure1: Simulation Methodology

IV. Network simulation model

We have modeled a Wireless LAN with a LAN network as its backbone which acts as a gateway to the Internet. This is basically a bridge wireless LAN network where two networks are connected to function as one.

Figure 2: Simulation model of the Wireless LAN connected to the Ethernet which act as a gateway to the Internet

Table 2 : shows the parameters used in the simulation. The reasons behind choosing each of these parameters are explained in the table.

Table 2: Performance parameters

Parameters	Description (values)
Node type	Wireless LAN router -1 Wireless LAN workstation-10 Ethernet workstation-2 Ethernet Gateway (LAN backbone)-1
Communication Link type	10BaseT Link-2 1000BaseT Link-1
Wireless LAN parameters	BSS identifier is set to 1
Data rate	24 Mbps
Simulation area	200 m
Transmitting power of the nodes	.005 watt
Application configuration	The Application: Video Conferencing with VCR quality video
Profile configuration	The Profile: uniform distribution with [5,10]
Simulation time	2 mins

V. Simulation Results

We have used VCR quality Video Conference as our application scenario. The Application type and Profile of the Application are set to each of the nodes of our network model. As we can see from figure2, all the wireless workstations communicate with each other through the wireless router and the traffic intended for the Ethernet passes to the Ethernet Gateway from the wireless router. We have shown two Ethernet workstations connected to the Gateway which can be scaled up to any number of stations or connected to the Internet.

A. Utilization (%)

We wanted to investigate the utilization of the wireless LAN router and the Ethernet gateway as these two are responsible for carrying out the data of the wireless LAN to outside.

- The figure shows the Utilization% Overlaid Statistics graph of both Ethernet gateway(blue) and the WLAN Router (red)
- As it was anticipated the Ethernet Gateway is more utilized than the Wireless LAN router. Because the total traffic of the wireless LAN passes through the Gateway to both the Ethernet workstations, the Gateway is more utilized.

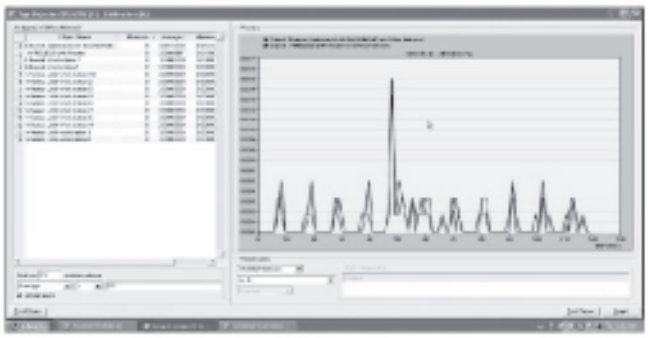

Figure 3: Utilization of the Wireless LAN router and the Ethernet Gateway.

- Over the whole simulation period, the Gateway has .005% and the Wireless router has about .003% of utilizations. Although we received a peak of .015% and .014% respectively at 50 sec.

B. Traffic sent (packets/second)

We have studied how much Traffic is sent by the different nodes of the wired and wireless LAN to understand how much load (Traffic sent in packets/sec) the nodes of the network are dealing with.

Figure 4: Traffic sent by different nodes of the network

- The above Figure shows the Overlaid statistics graph of traffic sent between every object in the network (WLAN Router, WLAN workstations, Ethernet workstations, Ethernet gateway).
- The Wireless LAN router sends more packets than any other node in the network because all the traffics (packets) from the wireless nodes have to pass through the wireless router. The Ethernet Gateway is in the 2nd position in handling the packets as not all the packets are destined for the wired LAN.

- While the Wireless router sends on the average 2.5 packets/ sec, the Ethernet Gateway sends 1.5 packets/sec and the wireless work stations sends less than .5 packets/sec.

C. Traffic Received (packets /seconds)

Traffic received by the different nodes of the wired and wireless LAN are studied.

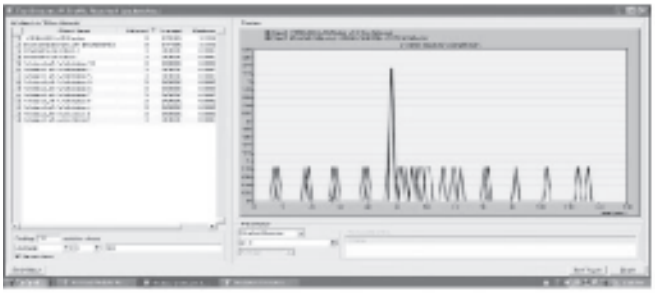

Figure 5: Traffic received by different nodes of the network

- The above Figure shows the Overlaid statistics graph of traffic received between every object in the network (WLAN Router, WLAN workstations, Ethernet workstations, Ethernet gateway).
- For the same reason as stated earlier the WLAN Router receives more packets than the other nodes of the network.
- In case of received packets/sec. the Wireless router and Ethernet Gateway received almost same number of packets.

D. Point to Point Throughput (bits/seconds)

Throughput is a measure of how much data is flowing through a part or whole of the network. Here we have studied the throughput of the links between the Wireless router, Ethernet Gateway and the Ethernet workstations.

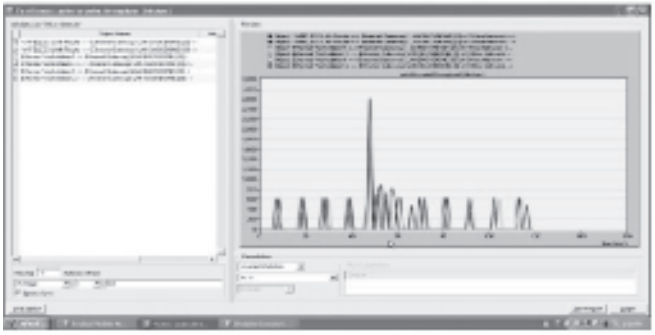

Figure 6: Throughput of the different links of the network.

- Most of the traffic of our network model passes through the Router and the Gateway. So, as we can find in the graph that the Throughput is highest between these two points.
- The performance will vary if we use different link objects. In our simulation model we have used both the 10BaseT and 100BsaeT and have found changes in the throughput of the links.

E. Point to point Utilization

It is very important to measure how much each of the links are utilized between different nodes of the network.

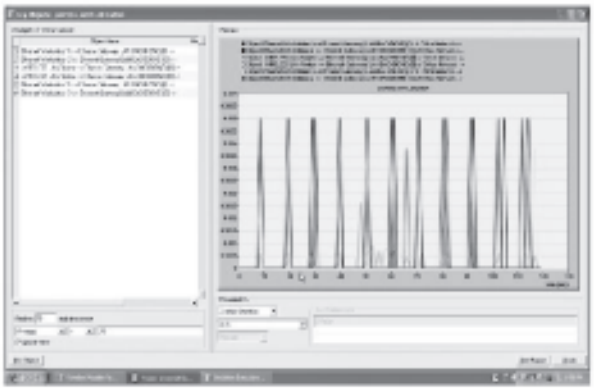

Figure 7: Utilization of the links between different nodes of the network

- As we can found from the above chart that Links between the Ethernet Workstations and Ethernet Gateway are mostly used.
- The traffic that flows between the Ethernet Gateway and any of the Ethernet workstations are accumulated traffic from different wireless workstations. As a result these two links are heavily utilized comapre to the other links.

F. Point to point queuing delay (sec)

We have also studied the queuing delay at different links of the network.

- Since the traffic flow from the Ethernet Gateway to any of the Ethernet workstations is large in number, the queuing delay for these two links increases linearly with time and gains a higher value as it is shown in Fig 8.

Figure 8: Queuing Delay at different links of the network.

- The queuing delay of the link between the Ethernet Gateway and the Wireless router has much lower value which is in favor of a faster communication between two nodes in the wired and wireless LAN.

VI. Conclusion

A wireless LAN of 10 nodes connected to an Ethernet through a wireless router/Access Point and an Ethernet Gateway is simulated using Riverbed Modeler Academic Edition 17.5. We have found that the Ethernet gateway is the most utilized node in the network as it forwarded all the traffic from the wireless LAN to the outside world. The wireless router is in 2nd position as traffic from a wireless workstation may end up in another wireless workstation passing through the router only. But when we think of in terms of traffic load handled then the wireless router is the mostly used node in the network because any two or more wireless stations must be communicating with each other all the time. We have also shown that the link between the gateway and the router has the highest throughput. And as a consequence this link is the most utilized link in our network. So, we have concluded that during a video conference application running between a wireless workstation and another workstation in the Ethernet, the gateway will play the main role for a good performance to carry out. Because this gateway is the most utilized node with highest throughput achieved at the links connected in between the router and it. The queuing delay at the link between the router and the Ethernet gateway is also of low value which is required for a faster response.

In future we would like to vary the number of the wireless workstations to see how it affects the performance of the throughput and utilization of the gateway and the queuing delay of the link between the router and the gateway. We opt to simulate our model for other applications such as Web browsing, FTP and Email.

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