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Wired and WLAN Optimal Design

Using OPNET™ IT GURU

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Abstract

This paper presents an evaluation study of wired and IEEE 802.11b wireless LAN (WLAN) applied in a small business computer networks. The simulation is conducted using OPNET IT Guru. Various scenarios have been designed and analyzed on different users, services and cases. Also, this paper presents a simulation study to ensure maximum network performance with different statistics of global, node and links. Our simulation results measured at multi background utilization such as 0%25%, %50% and 70% and performance measures show the limitations for IEEE 802.11b WLAN to be taking in consideration through design operation.

Keywords: Wireless Local Area Network (WLAN), Hyper Text Transfer Protocol (HTTP), background utilization, Global Statistics

1. Introduction and 2. Related Works

Designing a computer network in optimal performance and meeting the requirements for all the users in an organization is very important decision. Before purchasing and deploying the equipment, it is beneficial if the network can be simulated quickly with ease and without much expense. The OPNET Technologies, Inc. offers simulation software for the enterprise and the uni-

versities [1]. The OPNET™ IT Guru Academic edition software, is very useful for creating a simulated network and learning the fundamentals of networking technologies. The software has a toolbox, which allows a user to simulate any network with a variety of equipment, including workstations, routers, switches, servers, and links between the devices. It also enables users to make modifications to the network for latency, bandwidth, utilization, and, then, to study their impact**.** LAN are now commonplace on many areas such as: homes, airports, university campuses [1, 2, 3, 4]. Technologies such as Ethernet and IEEE 802.11b wireless LANs (WLANs) have changed the way people think about networks. In this paper, we explore four different traffic in LAN to observe and analyze the performance difference and to outline the limitations. Our work is based on measurements of a proposed computer network experiment. We use the OPNET IT Guru 9.1 simulation environment with its detailed models of IEEE 802.11b, TCP/IP, and HTTP…etc. We parameterize the simulation model based on four levels of utilization measurements. We then build our recommendation regarding the results achieved in all proposed level of utilization and use these results in a simulation to study addressing the scalability of the LAN for a small business area network. Our experiments focus on the end-to-end throughput, Wireless Access point delay, and the impacts of factors such as number of clients, HTTP transaction rate, FTP download send and receive which can be achievable in the four different utilization network environment. We used an infrastructure networks as shown in Figure.1. The parameters must be set in order to configure the simulation, Duration: 300 seconds, Speed: 128 and Values per statistic: 100. The network consists of four subnets. Each of these subnets represents one of the following Offices or Rooms: Meeting Room, Commercial Office, Management Office and Engineering Office Each of these subnets is connected to the switch (ethernet16_switch) with 100BaseT link. For the purpose of the Internet connection, an IP cloud is connected to the router. Additionally, firewalls are used for the security of the FTP and HTTP Ethernet servers and the security of the employer's computers [6]. The connections between the router and the IP cloud, as well as the IP cloud and firewall are implemented by using PPP_DS1 link (1.53Mbps) ADSL connection.

3. Simulation Scenarios

This section of the paper describes the implementation of the LAN Scenario by using the OPNET simulation tool, as seen in Figure (1). The general format of the OPNET scenario consists of the following four rooms:

a) The Engineering Office
b) The Boss Office
c) The Meeting Room and
d) The Commercial Office

3.1 Results and Discussion of Results:

In this section, the results and the discussion of them are described.

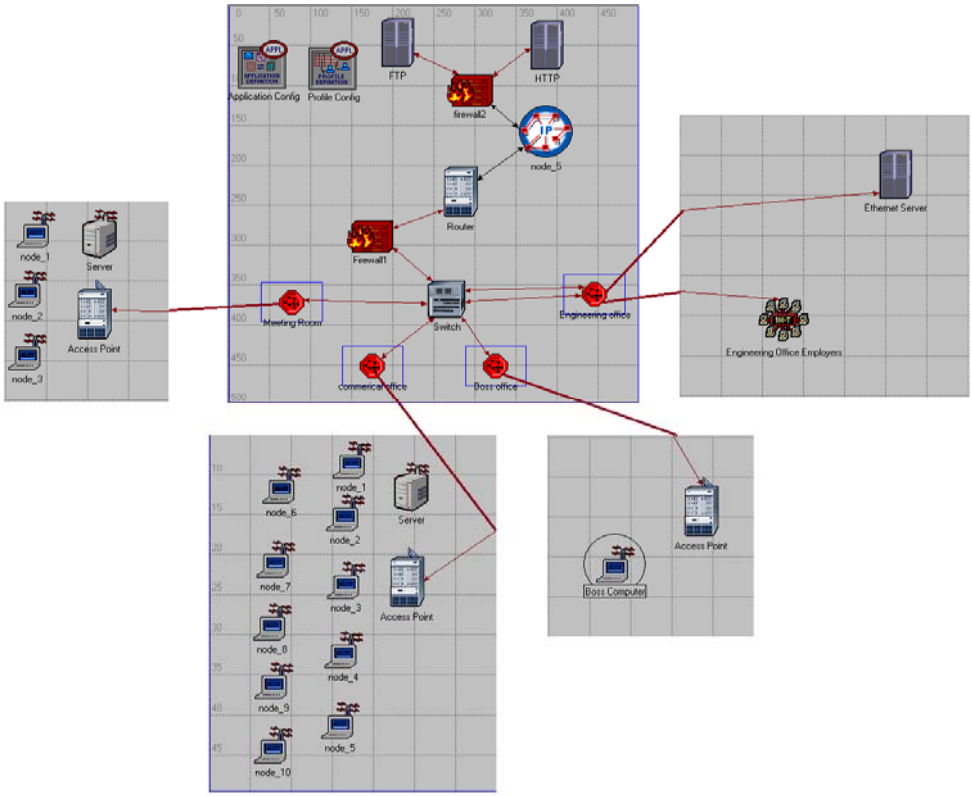

Figure1: The proposed overall network

3.1.1 Ethernet Delay

This section describes the concept of the Ethernet delay of the whole Network (Global Statistics). Ethernet delay is the statistic, which represents the end-to-end delay of all packets received by all stations [6]. In table 1, the time average Ethernet delay of the whole network (Global Statistics), for different values-percentages of background utilization can be observed. it is obvious that the average time Ethernet Delay increases as the background utilization increases. This relationship illustrated very well as show in the same table.

Table.1: Background Utilization and Average Time Ethernet Delay.

Background Utilization (%)	Average Time Ethernet Delay (second)	
	Minimum	Maximum
0%	0.000025 sec	0.000092 sec
25%	0.00003 sec	0.00012 sec
50%	0.0000375 sec	0.00015 sec
70%	0.000048 sec	0.0002125 sec

The average time Ethernet delay for different values of background utilization can be observed. Furthermore, the average Ethernet delay increases as the background utilization increases. This contribution can be detected in table 2.

Table.2: Background Utilization and Increment of Average Time Ethernet Delay.

	Background Utilization (%)		
	0% - 25%	25% -50%	50% -70%
	0%: Min:0.000025 Max:0.000092 25%: Min:0.00003 Max:0.00012	25%: Min:0.00003 Max:0.00012 50%: Min:0.0000357 Max:0.00015	50%: Min:0.0000357 Max:0.00015 70%: Min:0.000048 Max:0.0002125
Increment of average time Ethernet delay	Min:20% Max:30.4%	Min:25% Max:25%	Min:28% Max:41.7%

3.2 Email Traffic Statistics

This section describe the average time of email traffic for the whole Network (Global Statistics). In Figures 2,3,4 and 5, the email traffic sent and the email traffic received can be observed for different values of the background utilization. The email traffic sent (bytes/sec) represents the average number of bytes per second traffic submitted to the transport layers by all email applications in the network. Moreover, the email traffic received (bytes/sec) represents the average number of bytes per second forwarded to all email applications by the transport layers in the network.

3.3. FTP Traffic

This section describes the concept of the FTP traffic of the whole network (Global Statistics). The statistics for the FTP traffic of the network include the FTP download response time (sec), the FTP upload response time (sec), the FTP traffic sent (bytes/sec) and the FTP traffic received (bytes/sec).First of all, the FTP download response time (sec) describes the time elapsed between sending a request and receiving the response packet. Measured from the time a client application sends a request to the server to the time it receives a response packet. Every response packet sent from a server to an FTP application is included in this statistic. In addition, the FTP uploads response time (sec) represents the time elapsed between sending a file and receiving the response. The response time for responses sent from any server to an FTP application is included in this statistic. Furthermore, the FTP traffic sent (bytes/sec) represents the average bytes per second submitted to the transport layers by all FTP applications in the network. Moreover, the FTP traffic received (bytes/sec) describes the average bytes per second forwarded to all FTP applications by the transport layers in the network. In the following Figures, the FTP traffic is described and analyzed for different values of the background utilization.

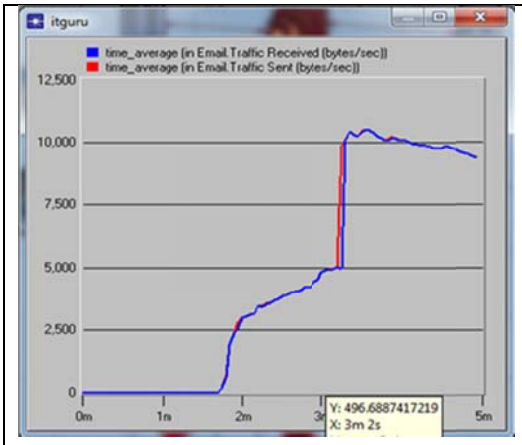

Figure.2: Time Average of Email Traffic Sent vs. Received for 0% Background Utilization.

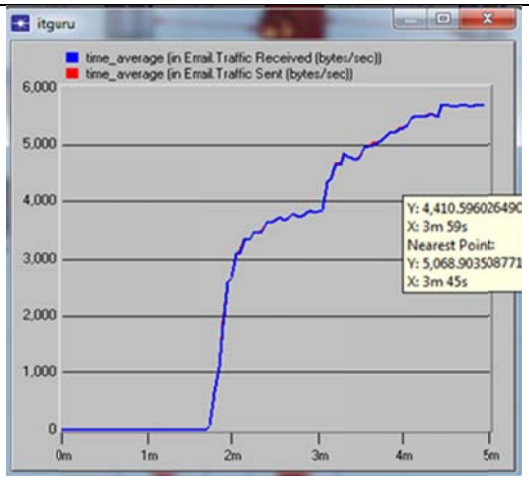

Figure.3: Time Average of Email Traffic Sent vs. Received for 25% Background Utilization.

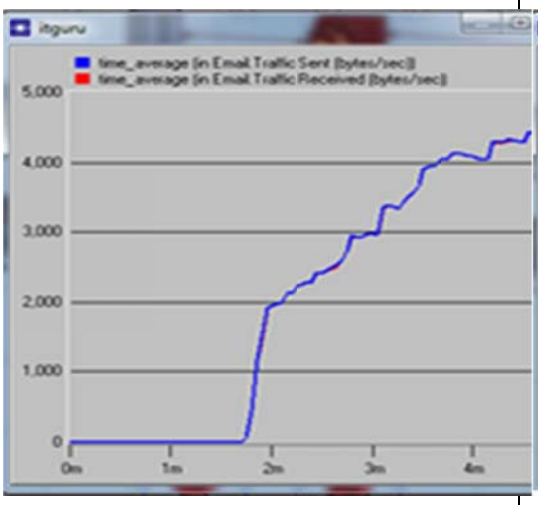

Figure.4: Time Average of Email Traffic Sent vs. Received for 50% Background Utilization.

Figure.5: Time Average of Email Traffic Sent vs. Received for 70% Background Utilization.

From Figures 2, 3, 4 and 5, it is obvious that the time average of email traffic sent and the time average of email traffic received are exactly the same.

3.3.1. FTP Traffic Sent and FTP Traffic Received

This section describes the FTP traffic sent and the FTP traffic Received for different values-percentages of background utilization. Figure 5 represents the FTP traffic for downloading response time in four different background utilization. For FTP download response time as mentioned in table 3, it is obvious

that the FTP download response time increases as the background utilization increases. In addition, the percentages of these increments are described in this table. Finally, the same conclusions can be made for the FTP upload response time.

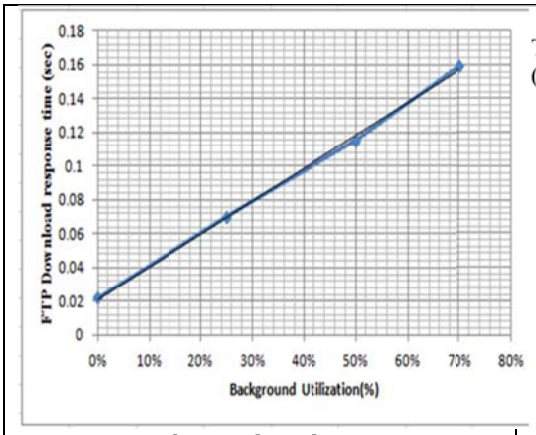

Figure.5: Background Utilization vs. FTP Download Response time (sec)

Table.3: Summary of FTP Download Response Time (sec).

Statistic	Avr	Max	Min
FTP Download response time (sec)	**0%** : 0.02217	**0%** : 0.044	**0%** :0.00034
	25% : 0.07017	**25%** : 0.2300	**25%** :0.0035
	50% : 0.11517	**50%** : 0.1400	**50%** :0.0004
	70% : 0.15978	**70%** : 0.1018	**70%** :0.0005

The Figure6 represent the FTP traffic sent for different percentages of the background utilization. Table 4 describes the average, maximum and minimum values of the FTP traffic sent (bytes/sec) for different values of the background utilization.

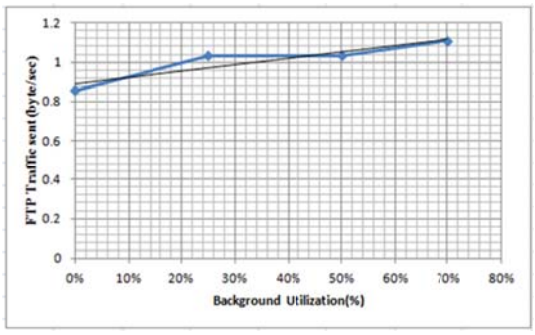

Figure 6: Background Utilization vs. FTP Traffic Sent (Byte/sec)

Table.4: Average-Maximum-Minimum values of the FTP Traffic Sent.

statistic	Avg.	Max	Min
FTP Traffic sent(byte/sec)	0%: 0.8578	0%: 1.7156	0%: 0
	25%: 1.0336	25%: 2.0672	25%: 0
	50%: 1.0320	50%: 2.0640	50%: 0
	70%: 1.1092	70%: 2.2184	70%: 0

From table 4, which describes the average of maximum and minimum values of the FTP traffic sent (bytes/sec) for different values of background utilization. The statistics in Figure 6 can be summarized in the table 5 ,which describes the summary of average maximum and minimum values of the FTP traffic received (bytes/sec) for different four values of the background utilization. FTP traffic sent (bytes/sec) appears for the maximum value of the background utilization. Furthermore, the FTP traffic received (bytes/sec) for different values of background utilization are shown in Figure 6.

Table 5: Summary of average maximum and minimum values of the FTP traffic received (bytes/sec)

Statistic	Avg.	Maximum	Minimum
FTP Traffic Received (byte/sec)	0%: 0.8566	0%: 1.7132	0%: 0
	25%: 1.0264	25%: 2.0529	25%: 0
	50%: 1.0306	50%: 2.0612	50%: 0
	70%: 1.1041	70%: 2.2082	70%: 0

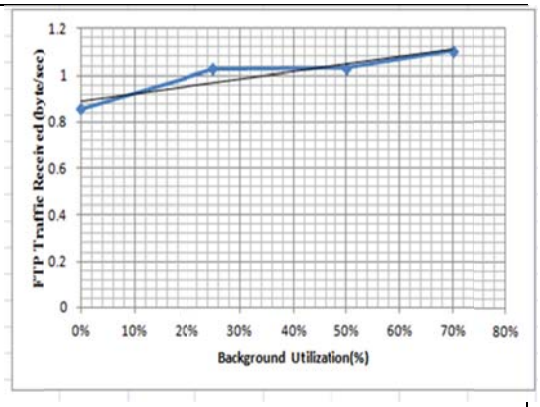

Figure.7: Background utilization vs. FTP Traffic response (Byte/sec).

From table 5, it is obvious that the lowest value of the average FTP traffic received (bytes/sec) appears for the maximum value of the background utilization. This result was expected. Moreover, the FTP traffic received (bytes/sec) is slightly different (lower) than the FTP traffic sent (bytes/sec). This is due to possible delays and retransmissions.

3.4. HTTP Traffic

This section describes the HTTP traffic of the whole network (Global Statistics). The statistics for the HTTP traffic of the network include the HTTP object response time (sec), the HTTP traffic sent (bytes/sec) and the HTTP traffic received (bytes/sec). The HTTP page response time (sec) specifies the time required to retrieve the entire page with all the contained in line objects. In addition, the HTTP object response time (sec) specifies the response time for each in lined object from the HTML page. Furthermore, the HTTP traffic sent (bytes/sec) describes the average bytes per second submitted to the transport layer by all HTTP applications in the whole network, the HTTP traffic received represents the average bytes per second forwarded to the HTTP application by the transport layer in this mode. Also regarding to the statistics for HTTP page response time (sec) and HTTP object response time (sec) for a different values back ground utilization which can be summarized in Table 6.

Table 6: Average -Maximum- Minimum values of the HTTP page Response time (sec) and HTTP object response time (sec).

Statistic	Average	Min	Max
HTTP page response time (sec)	0%:0.027	0%:0.01	0%:0.044
	25%:0.034	25%:0.012	25%:0.056
	50%:0.027	50%:0.014	50%:0.040
	70%:0.110	70%:0.1	70%:0.119
HTTP object response time (sec)	0%:0.021	0%:0.009	0%:0.033
	25%:0.026	25%:0.01	25%:0.043
	50%:0.019	50%:0.012	50%:0.026
	70%:0.062	70%:0.008	70%:0.116

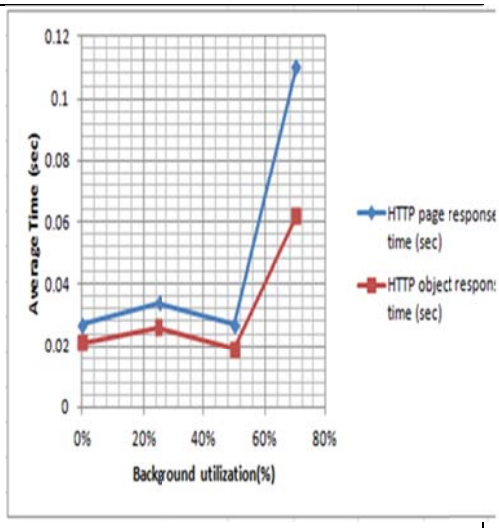

Figure.8: Background Utilization vs. Average Time of the HTTP page response time (sec) and HTTP object response time (sec).

As seen in table 6 the HTTP page and object response time increase as the background utilization increases. The Maximum values for the page and object response time increase rapidly as utilization increases. In Figure (8) HTTP traffic sent (byte/sec) and HTTP traffic received (byte/sec) different values for background utilization. The statistics of the HTTP traffic sent and the HTTP traffic received (byte/sec) in different values for background utilization which illustrated in Figure 8. The statistics of the average-Maximum-Minimum values of HTTP traffic sent (byte/sec) and HTTP traffic received (byte/sec) can be summarized in Table 7. Using table (7) Figure 9 can be drawn. Summary for Statistics of the HTTP Traffic sent and the HTTP Traffic received. Maximum amount of byte per second for HTTP traffic sent and received appears for highest value of background utilization. HTTP traffic sent (byte/sec) is slightly higher than HTTP traffic received (byte/sec) due to the delay &possible retransmission. It is obvious that the HTTP page and object response time increases as the background utilization increases. Furthermore, the maximum values for the page and object response time increases rapidly as the utilization increases. Moreover, the maximum amount of bytes per second for the HTTP traffic sent and Received appears for the highest value of the background utilization.

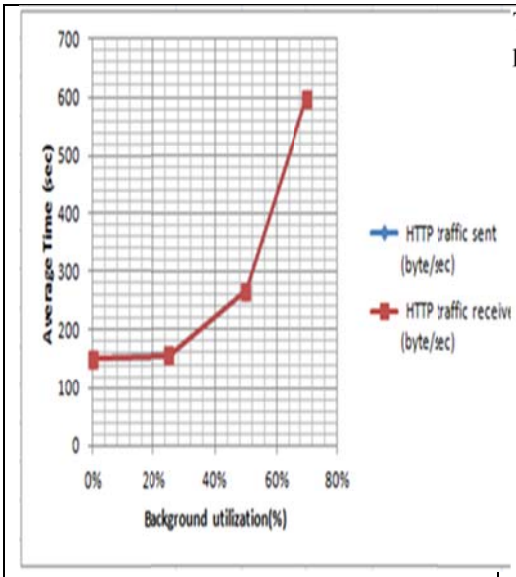

Figure.9: Background Utilization vs. Average Time (sec) of HTTP traffic sent (byte/sec) and HTTP traffic received (byte/sec)

Table 7: summarized for Statistics of the HTTP page response time

Statistic	Average	Min	Max
HTTP traffic sent (byte/sec)	0%: 151.62	0%: 0	0%: 303.25
	25%: 155.62	25%: 0	25%: 311.25
	50%: 267.21	50%: 0	50%: 534.43
	70%: 597	70%: 0	70%: 1194
HTTP traffic received (byte/sec)	0%: 151.62	0%: 0	0%: 303.42
	25%: 155.62	25%: 0	25%: 311.25
	50%: 267.21	50%: 0	50%: 534.43
	70%: 597	70%: 0	70%: 1194

4. SUMMARY AND CONCLUSIONS

This paper presented a simulation study of optimal design for a LAN which includes wired and wireless in small business computer network by uses multi scenarios. The OPNET software was of great help during the simulations of different scenarios of the networks. To get better performance when designing a network, the faster Ethernet cabling is useful. The results also show that persistent HTTP connections can provide a significant performance advantage in a WLAN environment. Ongoing work focuses on extending our experimental shows that performance comparison of HTTP and FTP. HTTP is more responsive for request-response of small files, but FTP may be better for large files if tuned properly. FTP used to be generally considered faster. FTP requires a control channel and state be maintained besides the TCP state but HTTP does not. There are six packet transfers before data starts transferring in FTP but only four in HTTP. There are twelve references to FTP and the very first section says "The HTTP protocol was originally developed to reduce the inefficiencies of the FTP." [7].To get better performance when designing a network, the faster Ethernet cabling is useful.

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