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Performance Analysis of Ethernet LAN Network Connection under Different Network Devices

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ABSTRACT

This paper studies the performance of different network devices in an Ethernet based network environment. That is the performance of Hub, Switch and Bridge in a local area network (LANs) in order to know which among these three network devices mentioned above performs best in terms of packet transfer, collision count and delay. The simulation was carried out using OPNET IT Guru Academic Edition 9.1. To observe the performance of these devices, three scenarios were presented. In the first scenario, the network was connected with one hub and 16 nodes; the second scenario was connected with two hubs and a switch while the third scenario was connected with two hubs and a bridge. These entire scenarios were observed under different Packet sizes 1500 bytes, 1024 bytes and 512 bytes. But it was observed that the higher the packet size the higher the value of some of the performance metrics such as traffic received and delay. On the other hand some performance such as collision count was improving as the packet size reduces from 1500 bytes, 1024 bytes e.t.c. but in some situation the packet size has no significant impact on some performance metric such as traffic sent. The simulation results displayed the level of data traffic observed in the three scenarios.

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1. INTRODUCTION

As its name implies, a local area network is a computer network that interconnects computers in a limited area such as a home, school, computer laboratory, or office building using network media [1]. The defining characteristics of LANs, in contrast to wide area networks (WANs), include their usually higher data-transfer rates, smaller geographic area, and lack of a need for leased telecommunication lines. ARCNET, Token Ring and other technology standards have been used in the past, but Ethernet over twisted pair cabling, and Wi-Fi are the two most common technologies currently used to build LANs [2].

Today, most networks use some form of Ethernet [2]. The aim of this paper is to evaluate the performance of network in different Ethernet LANs connected by hubs, switch and bridge which includes measuring performance metrics like traffic sent, traffic received, delay and utilization in the Ethernet environment. The simulation was carried out using OPNET IT GURU ACADEMIC EDITION 9.1, because it has originally been developed for network simulation and it is fully usable as a robust simulation tool with higher investment. OPNET also provides a comprehensive development environment for specification, simulation and performance analysis of communication networks [3][4][5]. Heavy load in the network that generates high traffic, may contribute to the congestion of network interfaces [1]. Therefore, this research is significant in order to study the performance of different network devices in Ethernet based network

environment. Also, we want to find out an optimum packet size in which an Ethernet standard will work best. For this research we created an office LAN with 16 nodes, one hub under 10BaseT for scenario one, two hubs and one switch under 10BaseT for scenario two and two hubs and one bridge under 10BaseT for the third scenario Ethernet LAN.

In the work done in [6], [7] and [8] two scenarios were tested. In the first scenario a network connected with hub only, 10BaseT wiring standard under packet size of 1500bytes and in second scenario a network connected with two hubs and one switch, 10BaseT wiring standard under packet size of 1500bytes was analyzed. But the work in [6], [7] only considered packet size of 1500bytes and did not considered under which packet size would this devices perform optimally in terms of packet received, packet size, delay and collision count. The work in [8] also considered two scenarios with first scenario connected with hub only, 10BaseT wiring standard and under two different packet sizes 1500bytes and 250bytes. While the second scenario was connected with two hubs and a switch, 10BaseT wiring standard and under two different packet sizes 1500bytes and 250bytes. The work in [8] shows that by reducing the packet size from 1500bytes to 250bytes the throughput (received traffic) is far better, while the traffic sent in both cases is almost identical and the delay also decreased considerably. But the work in [8] only considered two network connection devices which are hub and switch. The main contribution of this paper is to consider another network connection device which is the bridge and we also observe the behavior of these devices under different packet sizes 1500bytes, 1024bytes and 512bytes. The rest of this paper is organized as follows: In section 2, the simulation design and configuration was described. Section 3 presents and analyses the results. Section 5 concludes the research work.

2. SIMULATION DESIGN AND CONFIGURATION

2.1. Simulation Designs

To execute all the experimental works the following network design has been taken into consideration. At the first step different network devices was used for connecting all the nodes together as shown in Figure. 1, 2 and 3.

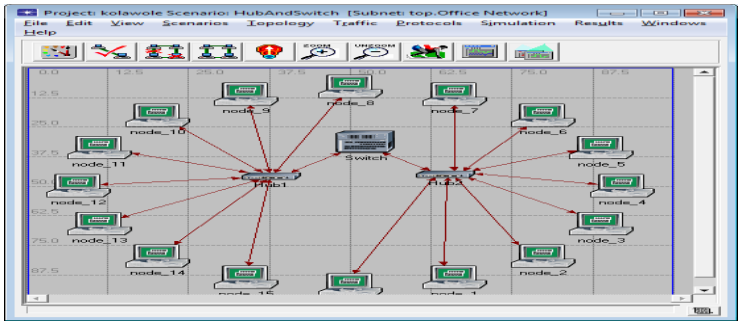

Figure 1. Office Network connected with one Hub only

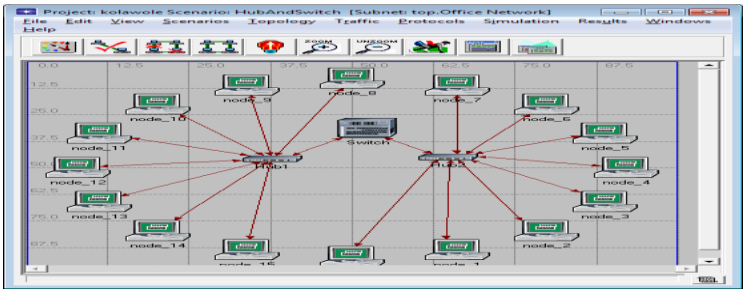

Figure 2. Office Network connected with two Hubs and one Switch

Figure 1 shows the first network scenario connecting all the 16 nodes together with a hub. Figure 2 shows the second network scenario where all the 16 workstations or nodes are connected together with two hubs and one switch.

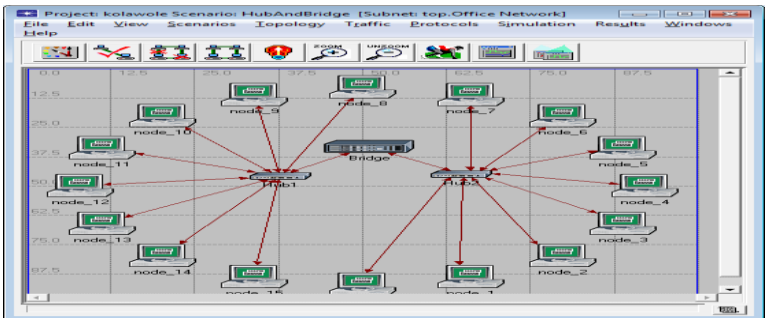

Figure 3. Office Network connected with two Hubs and one Bridge

Meanwhile, Figure 3 shows the third network scenario where all the 16 nodes were connected together with two hubs and a bridge.

2.2. Simulation Configuration

Firstly we configure the traffic generated by the stations. Right-click on any of the 16 stations (node_0 to node_15) and selects similar Nodes and Right-click on any of the 16 stations and select Edit Attributes. Check the Apply Changes to Selected Objects check box. To avoid reconfiguring each node individually. Expand the hierarchies of the Traffic Generation Parameters attribute and the Packet Generation Arguments attribute and Set the following four value

a. Start Time (seconds) to Constant (5.0)
b. On State Time (seconds) to exponential (100.0)
c. Inter arrival Time (seconds) to exponential (0.02)
d. Packet size (bytes) to Constant (1500),(1024) and (512) as shown in Figure 4, 5 and 6

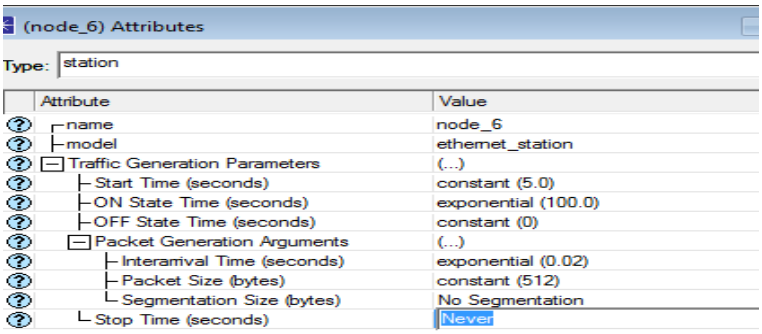

Figure 4. Configuration with packet size of 1500bytes

Figure 4 shows the interface of an Opnet software environment where the packet size was configured with value of 1500bytes.

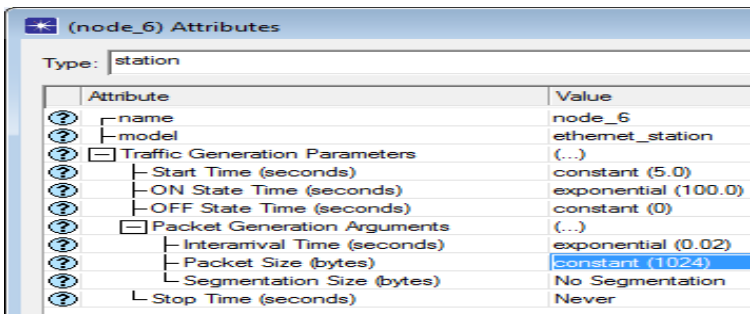

Figure 5. Configuration with packet sizes of 1024bytes

Figure 5 shows the interface of an Opnet software environment where the packet size was configured with value of 1024 bytes.

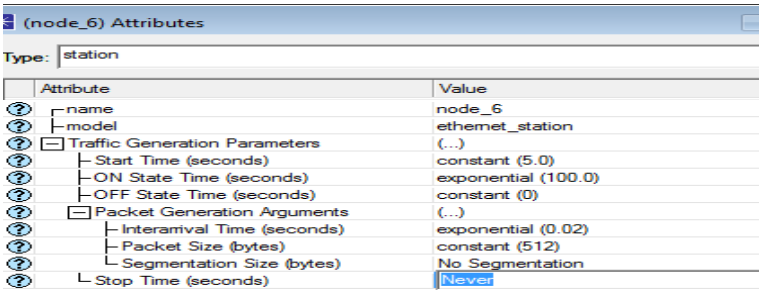

Figure 6. Configuration with packet sizes of 512 bytes

Figure 6 shows the interface of an Opnet software environment where the packet size was configured with value of 512 bytes.

3. SIMULATING THE DESIGN AND RESULT ANALYSIS

3.1 Traffic Sent

Three simulations have been executed using OPNET software for every network devices under different packet sizes (1500, 1024 and 512 bytes).

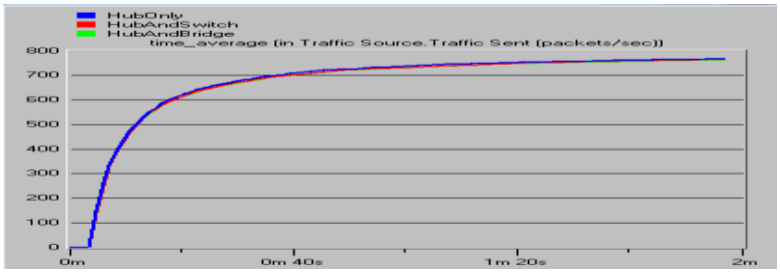

Figure 7. Traffic sent while pack size is 1500 bytes

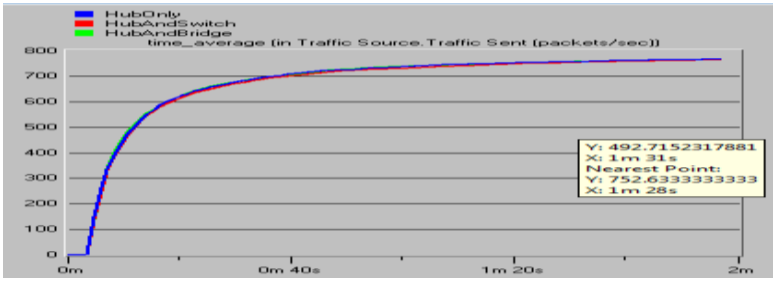

Figure 8. Traffic sent while packet size is 1024 bytes

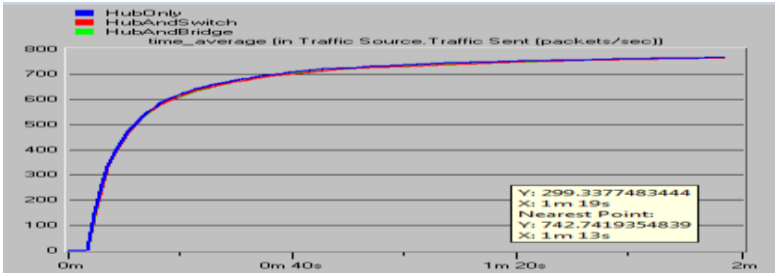

Figure 9. Traffic sent while packet size is 512 bytes

From figure 7, 8 and 9 it was observed that by reducing the packet size from 1500bytes to 1024bytes and 512 byte the traffic sent is almost identical. The simulation was able to establish that packet size has a very minor effect on the three network connection devices in terms of traffic sent.

3.2 Traffic Received

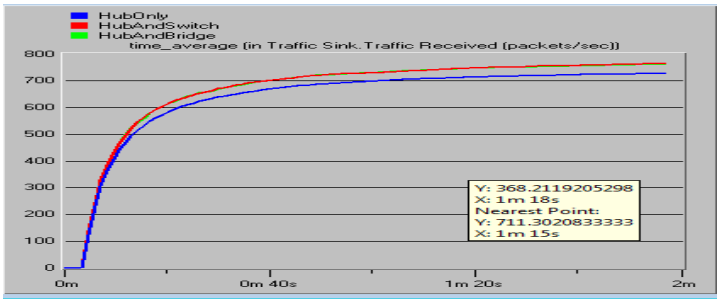

Figure 10. Traffic received while packet size is 1500 bytes

Figure 10 shows the simulation result under packet size of 1500 bytes. The result shows that with packet size of 1500 bytes scenario 2 and 3 has the same level of performance while the performance of scenario 1 is lower.

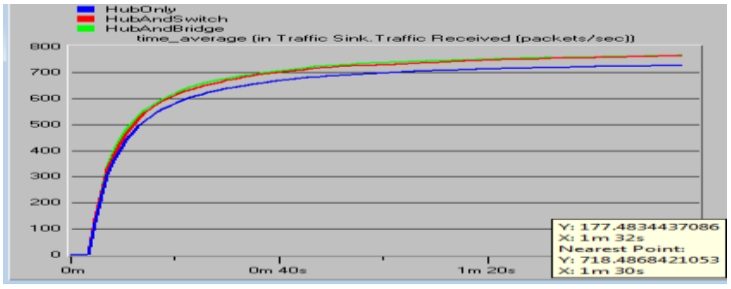

Figure 11. Traffic received while packet size is 1024 bytes

Figure 11 shows the simulation result under packet size of 1024 bytes. The result shows that with packet size of 1024 bytes scenario 2 and 3 has the same level of performance while the performance of scenario 1 is lower.

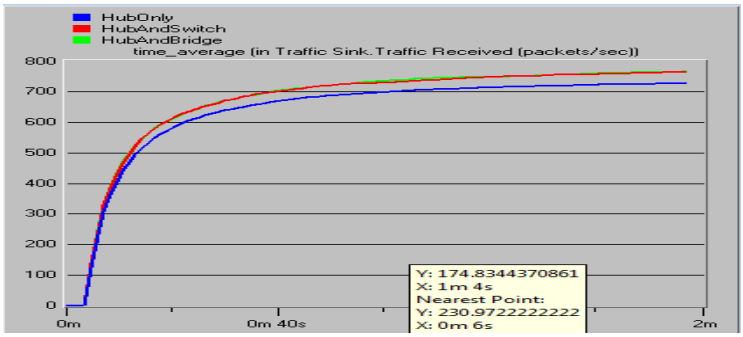

Figure 12. Traffic received while packet size is 512bytes

Figure 12 shows the simulation result under packet size of 512 bytes. The result shows that with packet size of 512 bytes scenario 2 and 3 has the same level of performance while the performance of scenario 1 is lower. Form figure 11 it was observed that by reducing the packet size from 1500bytes to 1024bytes hubs and bridge performs better than the other two scenarios. While figure 11 and 12 shows that by reducing the packet size from 1024bytes to 512bytes the traffic received is almost identical.

3.3 Collision Delay

The use of a switch and a bridge makes it possible to reduce collisions on the network. In Ethernet, the collision is increased as the network is loaded, and this causes retransmissions and increases in load that produce even more collisions. The resulting network overload slows traffic considerably [8]. But decreasing the size of the frame can differently reduce the collision. The results are shown in figure 13, 14 and 15 respectively.

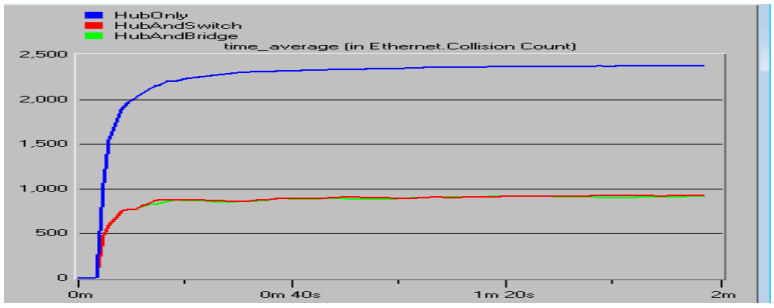

Figure 13. Average Collision count when packet size is 1500 bytes

From figure 13 the first scenario has a high collision count while the second and the third scenario perform better in terms of collision reduction.

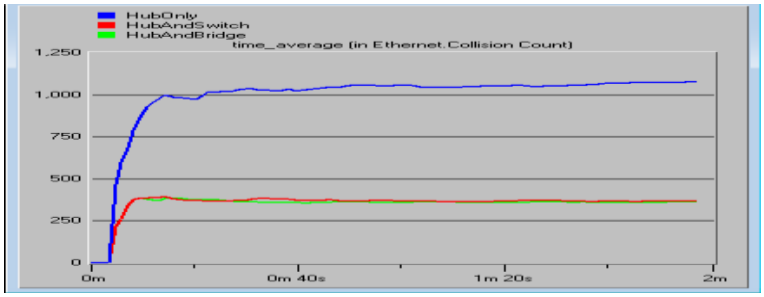

Figure 14. Average Collision count when packet size is 1024 bytes

From figure 14 simulations shows that by reducing the packet size from 1500 to 1024 bytes the collision count in the first scenario reduced greatly while that second and third scenario also reduced from 900 to 400.

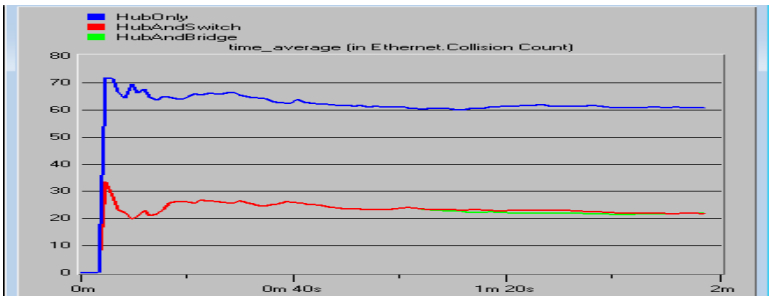

Figure 15. Average Collision count when packet size is 512 bytes

From figure 15 the simulation shows that by reducing the packet size from 1024 to 512 bytes the collision count also reduces but the graph was not stable. This shows that the packet size has a great impact on the network devices performance.

3.4 Average Delay Analysis

The delay shows the end to end delay of all frames received by all nodes. Figure 16, 17 and 18 shows the behavior of different network devices under different frame sizes.

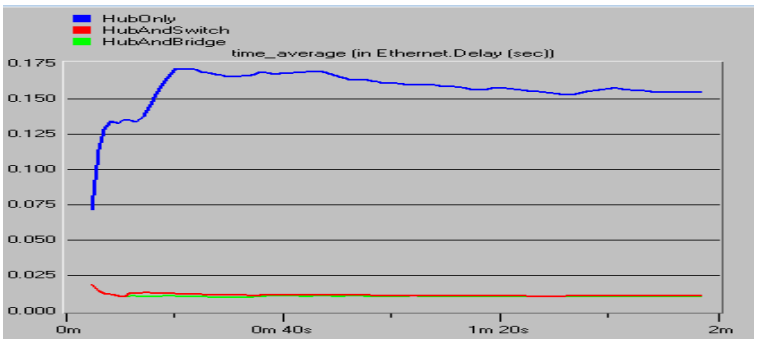

Figure 16. Average Delay when packet size is 1500 bytes

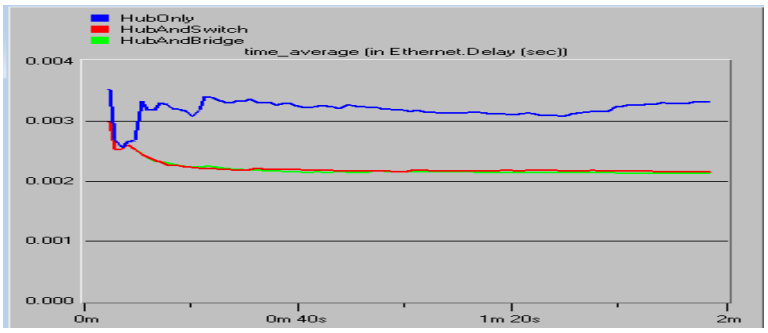

Figure 17. Average Delay when packet size is 1024 bytes

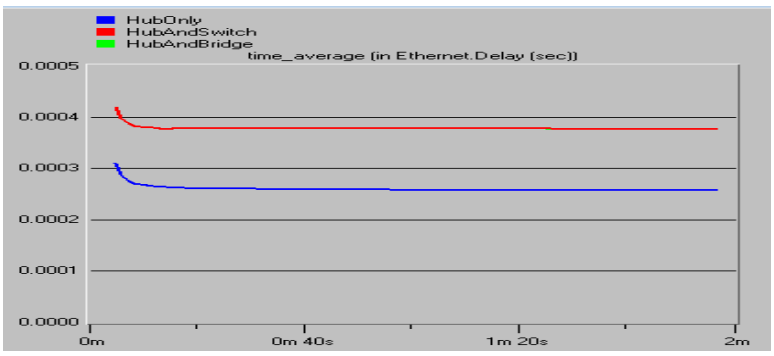

Figure 18. Average Delay when packet size is 512 bytes

From figure 16 the graph shows the average delay, we observed that the delay is high and it is not stable in case of Hub only scenario. In figure 17 where frame size was reduced from 1500 to 1024 the Hub only scenario is still not stable but the delay value reduced from about 0.175 to 0.0035. In figure 18 where frame size is reduced from 1024 to 512 the Hub only performance was stable but the delay value of switch and bridge increased. So it was observed that when the packet size reduce the delay value of Switch and Bridge increases while in the case of Hub scenario the delay value reduces.

3.5 Average Utilization Analysis

Figure 19 shows that the first scenario has a high CPU utilization where the second and the third shows equal level of CPU utilization under packet size of 1500 bytes. Figure 20 shows that by reducing the packet size from 1500 bytes to 1024 bytes the CPU utilization drops from 0.9 to 0.65 likewise that of second and third scenario. Figure 21 shows that by reducing the packet size from 1024 to 512 bytes all the scenario CPU utilization reduced greatly. So this research shows that the lower the packet size the lower the CPU utilization.

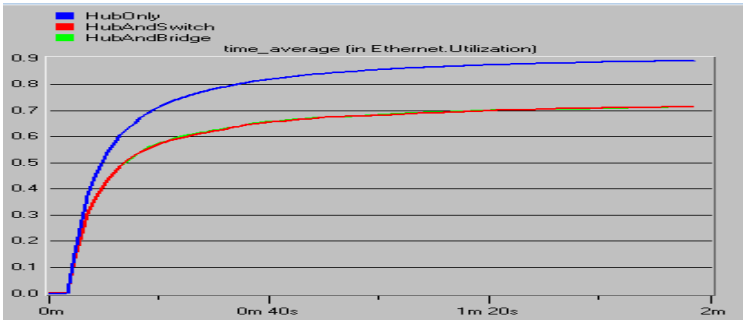

Figure 19. Average Delay when packet size is 1500 bytes

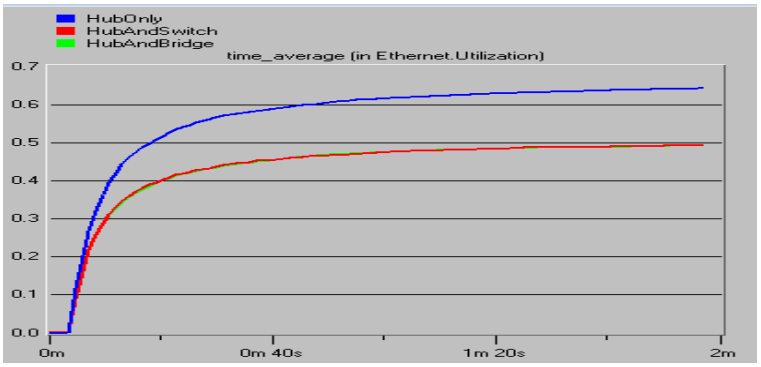

Figure 20. Average Delay when packet size is 1024 bytes

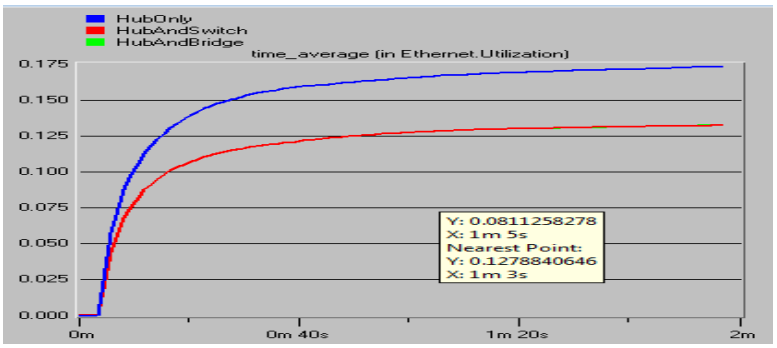

Figure 21. Average Delay when packet size is 512 bytes

4. CONCLUSION

In this study three network deployments have been considered using OPNET: one with a hub and the others with two hubs and a switch, as well as with two hubs and a bridge. In the three network deployments the delay and collisions have been inspected. We have compared the performance and effect of the three networks in case of sending and receiving frames. Delay, Traffic Sink, Traffic Sources, Collision and Frame Size are the performance parameters. The throughput was improved and collision was decreased as the frame size reduces from 1500, 1024 and 256 respectively. The compared simulation results show a good approximation of data traffic analyzed in the Ethernet environment and the researcher demonstrated that the lower the packet size better some of Ethernet network performance metric like Average utilization, collision count and delay but in some cases the packet size has no significant impact on the network performance.

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