

Performance of LAN under Different Ethernet Wiring Standard and Different Frame Size

Ashraf A.M. Khalaf *, Mostafa S.A. Mokadem **, Khalil A. Ahmad *

**Department of Electronics & Communications Engineering, Faculty of Engineering, Minia University, Minia, Egypt*

***Egyptian Electricity Holding Company, Cairo, Egypt*

ashkhalaf@yahoo.com, mostafashokry0@gmail.com

Abstract— Commonly abbreviated Local Area Network LAN is a computer network that covers only a small area networks, such as campus computer networks, buildings, offices, in homes, schools or smaller. Currently, most LANs based on the IEEE 802.3 Ethernet technology using devices such as hubs and switches devices, which have a data transfer speed of 10, 100, or 1000 Mega bit per second (Mbps). In this paper, we will evaluate the performance of LAN under different Ethernet wiring standards (10BaseT, 100Base and 1000BaseT) with different frame size.

Keywords— Frame size, 10BaseT, 100BaseT, LAN performance, Switch, Hub.

I. INTRODUCTION

A local area network (LAN) is a computer network that interconnects computers within limited area as computer laboratory or office building by using network media. In the implementation of LAN we use different types of devices as repeaters, switches, hubs, connectors and different cables.

LAN is found in many business environments, that links a workgroup of task-related personal computers (PCs), for example, engineering workstations or accounting PCs. One of the computers is given a large capacity disk drive and become a server to all other PCs. Software can be stored on this server and used by the whole clients of the group .

LAN covers only a small area networks (a few kilometres), such as campus computer networks, buildings, offices, in homes, schools or smaller. Currently, most LANs based on the IEEE 802.3 Ethernet technology using devices such as hubs and switches, which have a data transfer speed of 10, 100, or 1000 Mega bit /s (Mbps).

In the work done in [2], they are measuring the LAN performance. Their work depends on variation of the time of simulation and the number of hubs and making the frame size fixed value of (46, 2000 bytes) with segmentation (1500 bytes).

The aim of this paper is to evaluate the performance of LANs in different Ethernet wiring standards (10BaseT and 100baseT) under different frame size (1500, 1024, 512, 128 and 64 bytes). Simulations are performed using IT Guru OPNET.

II. LAN COMPONENTS

A. Network Media

Network media, sometimes called Network medium, is the physical channel that used for transmission in network. There are two types of mediums used in the implementation of computer networks. One is guided medium and another in unguided medium.

1) **Guided Media (wired):** In guided medium electrical/optical signals are passed through a solid medium such as Copper Unshielded Twisted Pair (UTP), Copper shielded Twisted Pair (STP), Copper co-axial cables and fiber optics cables. In guided mediums, the signals are confined within the wire and do not propagate outside of the cables.

2) **Unguided Media (wireless):** In unguided medium the data is transmitted by sending electromagnetic signals through free space and hence the signals are not guided in any specific direction. All unguided transmission mediums are classified as wireless transmission.

The following table shows the comparison between the guided cables (Twisted pair, Co-axial cables and optical fiber)

TABLE I. COMPARISON BETWEEN GUIDED CABLES

Media	Frequency range	Typical attenuation	Repeaters
Twisted pair	0 - 3.5 kHz	0.2 dB/Km at 1KHz	2 km
Coaxial cable	0 -500MHz	7 dB/km at 10MHz	1 - 9 km
Optical fiber	186 - 370THz	0.2 to 0.5 dB/km	40m

3) **10BaseT cables:** It is a twisted pair Ethernet wiring standard for LAN implementation that support 10Mbps data rate. The maximum transmission length is 100 meters.

4) **100BaseT cables:** It is another twisted pair Ethernet wiring standard for LAN implementation that supports 100Mbps data rate. The 100BaseT Ethernet wiring standard is the most commonly used in LAN creation due to its high speed, robustness and low cost. It is also called fast Ethernet because it is ten times faster than 10BaseT.

B. Hub

Hub is the simplest component in any local area network (LAN). Any data packet coming from one port is sent to all other ports it is then up to the receiving computer to decide if the packet is for it or not. Since every packet is sent out to every computer on the network there is a lot of wasted transmission, so the network can be easily become bogged down. Hubs are typically used on small networks where the amount of data going across the network is not very high.

C. Switch

Switch has multiple ports. When the packet comes through a switch it is read to determine which computer to send the data to. This leads to increase the efficiency and the performance of the device because the packets are not going to computers that do not require them.

III. SIMULATION SOFTWARE AND PARAMETERS

The simulation will be done by using Riverbed Modeler Academic Edition 17.5. For this work we will create an office LAN which consists of hubs, switch, twenty Ethernet stations, 10 devices per each hub, under 10baseT (for scenario 1) and 100baseT (for scenario 2) Ethernet wiring standard.

A. Riverbed Modeler Academic Edition 17.5

Riverbed modeler is software that is specialized for network research and development. This release replaced OPNET IT guru academic edition. I used that software to implement the office LAN because it offers relatively much powerful visual or graphical support for the users.

B. Parameters of nodes

1) **Traffic Generation Parameters:** start time in seconds will be constant (5.0), ON state Time in seconds will be constant (1000), OFF state Time in seconds will be constant (0).

2) **Packet generation arguments:** Inter-arrival Time in seconds will be exponential (0.02), Packet size in bytes will be varied according to the frame size in each case which will be (1500, 1024, 512, 128, 64), segmentation size in bytes will be No segmentation.

C. Performance Parameters

1) **For hub:** Number of collision count, Utilization Traffic forwarded (bits/sec) and Traffic received (bits/sec).

2) **For Switch:** Traffic forwarded (bits/sec), Traffic received (bits/sec), Traffic filtered (bits/sec).

D. Running Time parameter

The duration of the simulation will be 4 min

IV. SIMULATION SCENARIOS

In our simulation we used two different scenarios for implementation of LANs with two different wiring Ethernet standard. At each scenario we changed the frame size to calculate some parameters of the network, then we evaluate the performance of the network.

A. Scenario 1

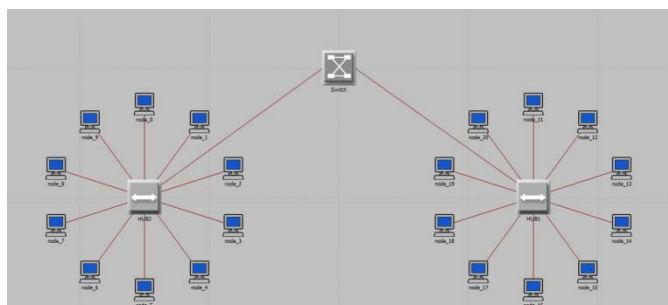


Figure 1. Office LAN under 10BaseT wiring standard

The previous figure illustrate scenario 1 which contains connection of 20 Ethernet stations to hubs, each hub connected to 10 Ethernet stations, and the hubs connected to Ethernet switch. 10BaseT Ethernet wiring standard will be used in that scenario.

B. Scenario 2

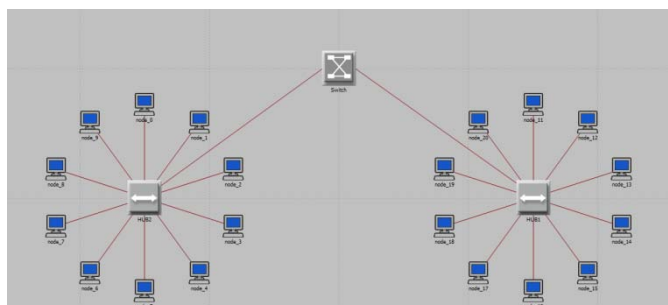


Figure 2. Office LAN under 100BaseT wiring standard

Figure 2 illustrates scenario 2 which contains connection of 20 Ethernet stations to hubs, each hub connected to 10 Ethernet stations, and the hubs connected to Ethernet switch. 100BaseT Ethernet wiring standard will be used in that scenario.

V. SIMULATION RESULTS

After we made the simulation we took the results that measure and evaluate the performance of LAN under different Ethernet wiring standard with different frame size as following:

A. Number of collision counts at Hub 1

TABLE2. NUMBER OF COLLISION COUNTS AT HUB1 (AVG)

Time duration	4 minutes	
	Collision count	
Devices	Hub 1	
standards	10BaseT (scenario1)	100BaseT (scenario2)
1500 bytes	3,456.19	24.24
1024 bytes	1,558.101	14.051
512 bytes	333.03	7.753
128 bytes	26.292	5.589
64 bytes	13.54	4.7

The previous table shows the comparison between the collision count number at hub 1 under 10BaseT (scenario 1) and 100BaseT (scenario 2) for 1500, 1024, 512, 128 and 64 bytes of frame size.

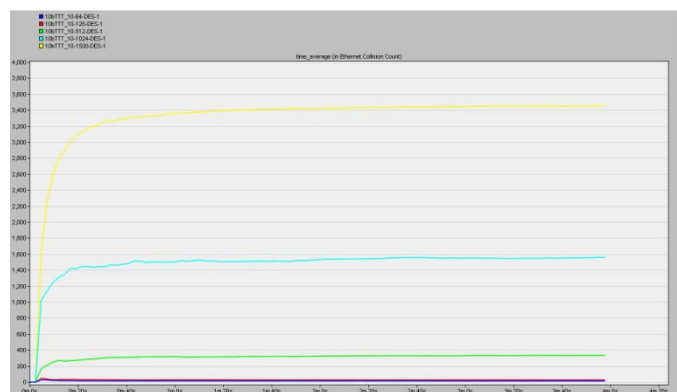


Figure 3. Comparison between number of collision count at Hub1 under different frame size at 10BaseT Ethernet wiring standard.

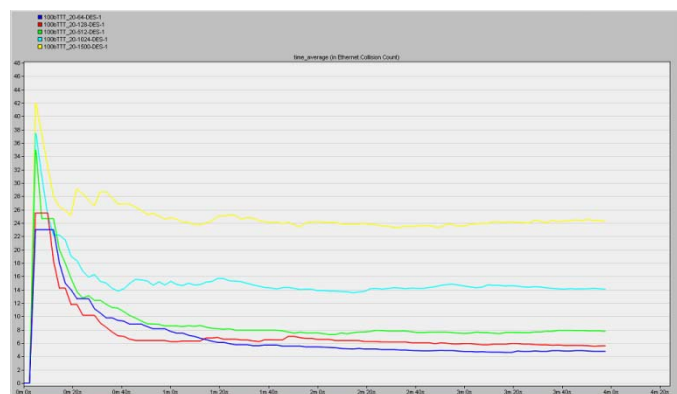


Figure 4. Comparison between number of collision count at Hub1 under different frame size at 100BaseT Ethernet wiring standard.

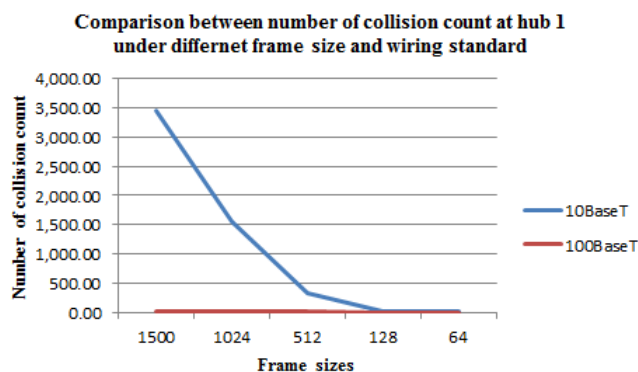


Figure 5. Graphs for number of collision count at Hub1

It is obvious from the previous figures that the number of collision counts in 10BaseT is more than 100BaseT for all frame sizes.

B. Utilization of Hub 1

TABLE3. UTILIZATION OF HUB1 (AVG)

Time duration	4 minutes	
	Utilization	
Devices	Hub 1	
standards	10BaseT (scenario1)	100BaseT (scenario2)
1500 bytes	0.883	0.091
1024 bytes	0.627	0.062
512 bytes	0.321	0.032
128 bytes	0.092	0.009
64 bytes	0.053	0.005

The previous table shows the comparison between the utilization of hub 1 under 10BaseT (scenario1) and 100BaseT (scenario2) for 1500, 1024, 512, 128 and 64 bytes of frame size.

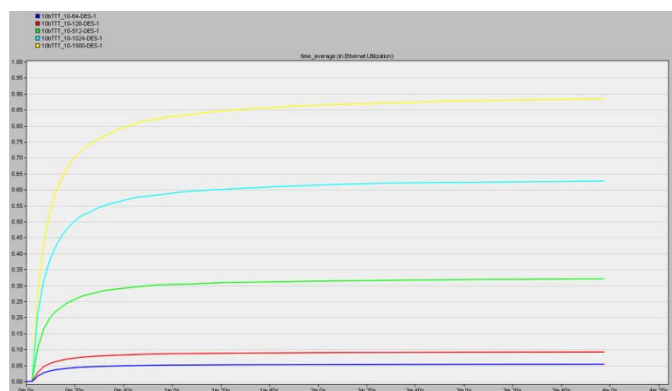


Figure 6. Comparison between utilization at Hub1 under different frame size at 10BaseT Ethernet wiring standard

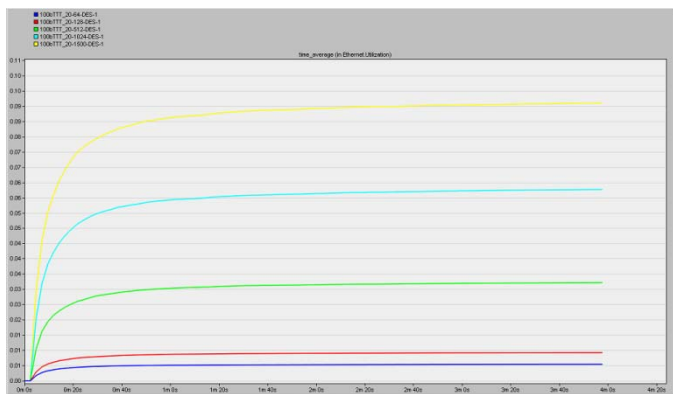


Figure 7. Comparison between utilization at Hub1 under different frame size at 100BaseT Ethernet wiring standard

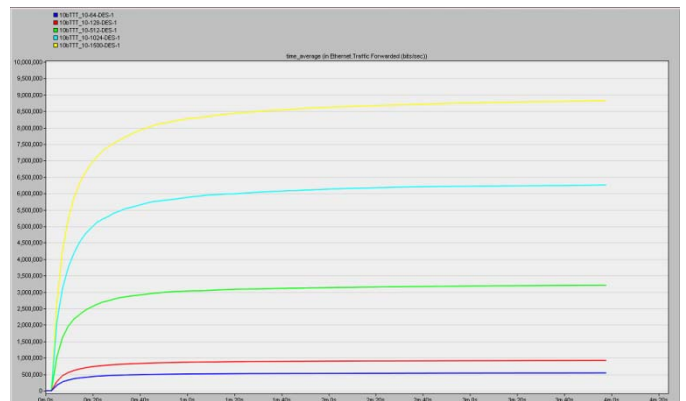


Figure 9. Comparison between traffic forwarded (bps) at Hub1 under different frame size at 10BaseT Ethernet wiring standard.

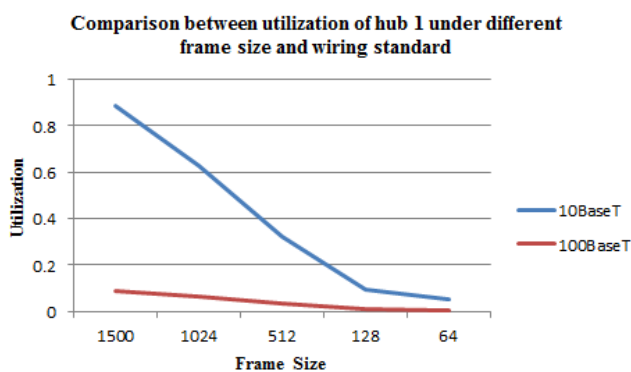


Figure 8. Graphs for Utilization of Hub1

It is obvious from the previous figures that the utilization in 10BaseT is more than 100BaseT for all frame sizes.

C. Traffic forwarded (bits/sec) at Hub1

TABLE4. TRAFFIC FORWARDED (BITS/SEC) AT HUB1 (AVG)

Time duration	4 minutes	
	Traffic Forwarded (bps)	
Devices	Hub 1	
Standards	10BaseT (scenario1)	100BaseT (scenario2)
1500 bytes	8,815,602	9,100,506
1024 bytes	6,259,192	6,263,042
512 bytes	3,209,531	3,214,534
128 bytes	919,988	918,550
64 bytes	538,601	538,967

The previous table shows the comparison between the traffic forwarded to Hub 1 under 10BaseT (scenario1) and 100BaseT (scenario2) for 1500, 1024, 512, 128 and 64 bytes of frame size.

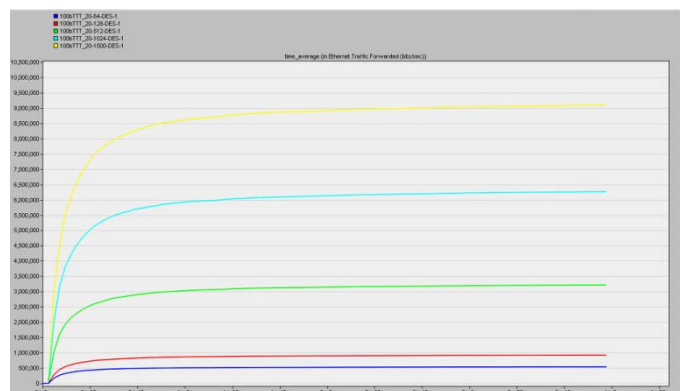


Figure 10. Comparison between traffic forwarded (bps) at Hub1 under different frame size at 100BaseT Ethernet wiring standard.

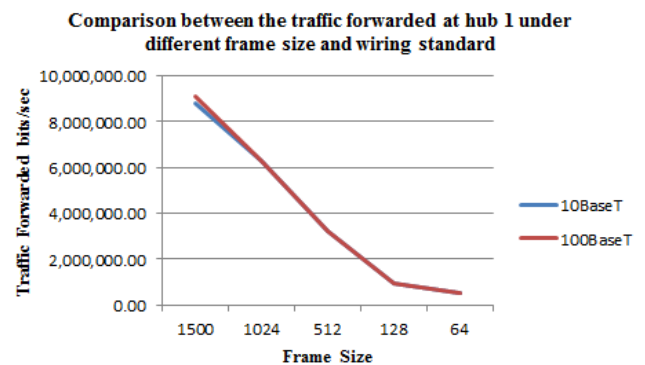


Figure 11. Graphs of traffic forwarded at hub1 (bit/sec)

It is obvious from the previous figures that at some points both curves overlap to each other; it means that traffic forwarded to hub1 is approximately same at these points.

D. Traffic received (bits/sec) at hub 1

TABLE5. TRAFFIC RECEIVED (BITS/SEC) AT HUB1 (AVG)

Time duration	4 minutes	
	Traffic Received (bps)	
Devices	Hub 1	
Standards	10BaseT (scenario1)	100BaseT (scenario2)
1500 bytes	8,815,602	9,100,506
1024 bytes	6,259,192	6,263,042
512 bytes	3,209,531	3,214,534
128 bytes	919,988	918,550
64 bytes	538,601	538,967

The previous table shows the comparison between the traffic received to Hub 1 under 10BaseT (scenario1) and 100BaseT (scenario2) for 1500, 1024, 512, 128 and 64 bytes of frame size.

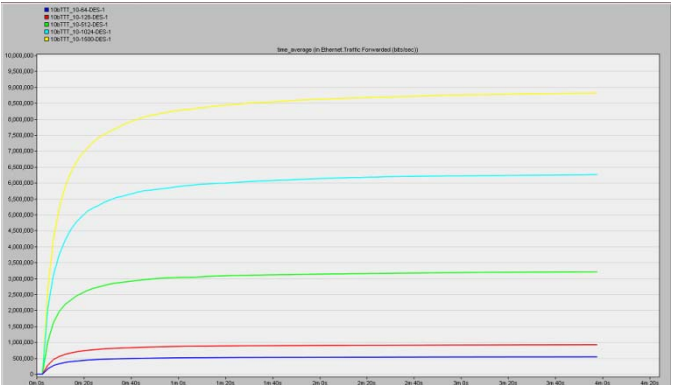


Figure 12. Comparison between traffic received (bps) at Hub1 under different frame size at 10BaseT Ethernet wiring standard

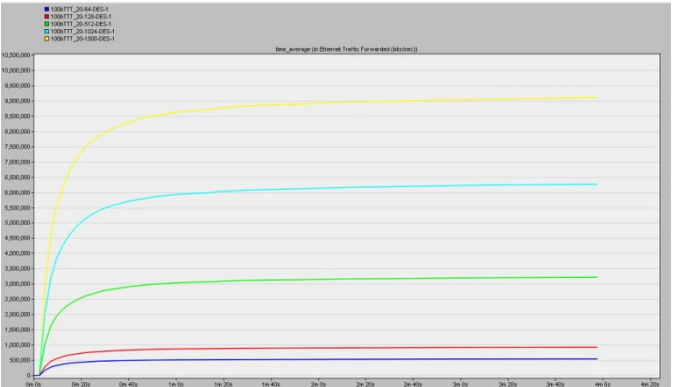


Figure 13. Comparison between traffic forwarded (bps) at Hub1 under different frame size at 100BaseT Ethernet wiring standard

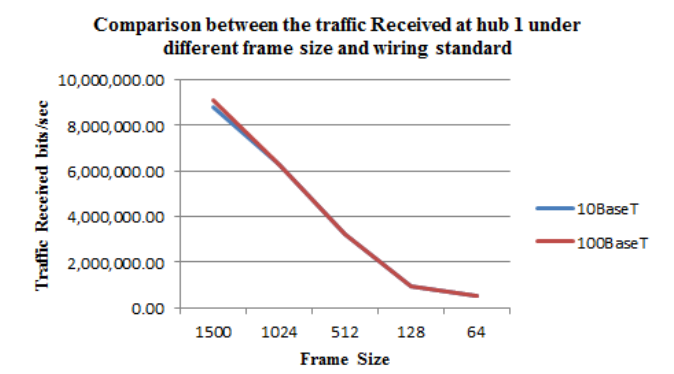


Figure 14. Graphs of traffic received at hub1 (bit/sec)

It is obvious from the previous figures that at some points both curves overlap to each other; it means that traffic received to hub1 is approximately same at these points.

E. Number of collision counts at Hub 2

TABLE6. NUMBER OF COLLISION COUNTS AT HUB2 (AVG)

Time duration	4 minutes	
	Collision count	
Devices	Hub 2	
Standards	10BaseT (scenario1)	100BaseT (scenario2)
1500 bytes	3,435.919	27.70
1024 bytes	1,572.666	14.877
512 bytes	340.3	7.626
128 bytes	29.4	5.29
64 bytes	12.4	5.13

The previous table shows the comparison between the collision count number at hub 2 under 10BaseT (scenario 1) and 100BaseT (scenario 2) for 1500, 1024, 512, 128 and 64 bytes of frame size.

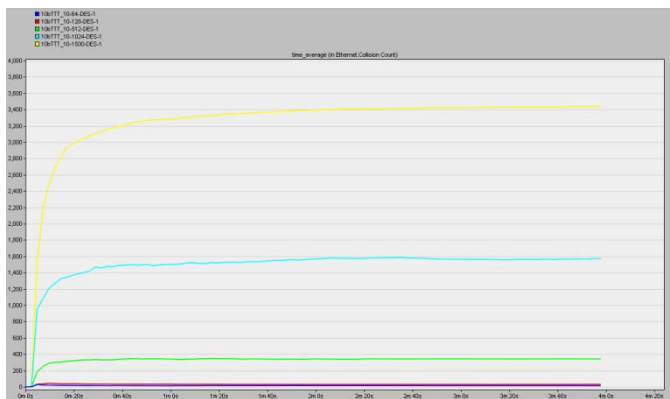


Figure 15. Comparison between number of collision count at Hub2 under different frame size at 10BaseT Ethernet wiring standard.

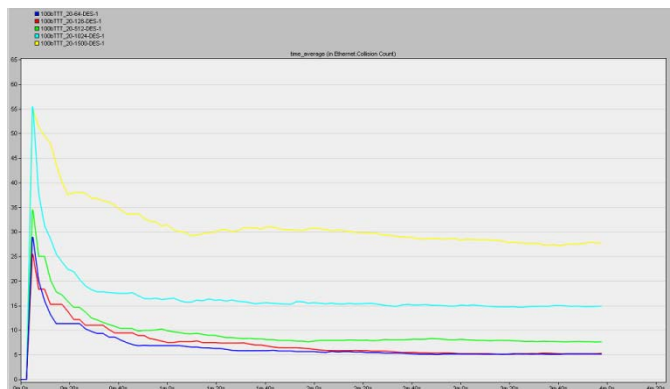


Figure 16. Comparison between number of collision count at Hub2 under different frame size at 100BaseT Ethernet wiring standard.

Time duration	4 minutes	
	Utilization	
Devices	Hub 2	
Standards	10BaseT (scenario1)	100BaseT (scenario2)
1500 bytes	0.8836	0.0910
1024 bytes	0.6288	0.0626
512 bytes	0.3217	0.0321
128 bytes	0.092	0.009
64 bytes	0.053	0.005

The previous table shows the comparison between the collision count number at hub 2 under 10BaseT (scenario 1) and 100BaseT (scenario 2) for 1500, 1024, 512, 128 and 64 bytes of frame size.

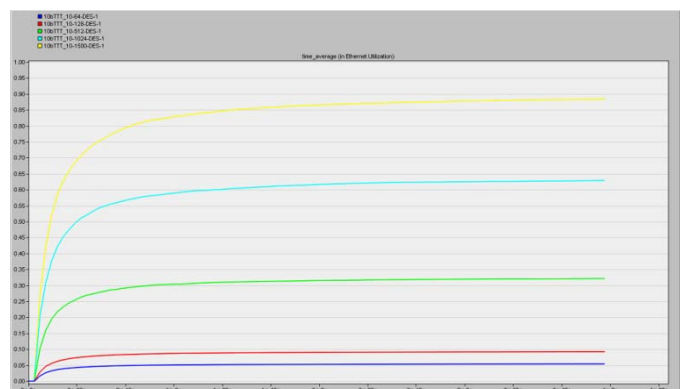


Figure 18. Comparison between utilization at Hub2 under different frame size at 10BaseT Ethernet wiring standard

Comparison between number of collision counts at hub 2 under different frame size and wiring standard

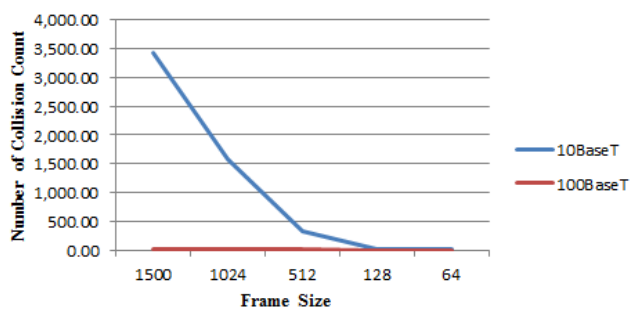


Figure 17. Graphs for number of collision count at Hub2

It is obvious from the previous figures that the number of collision count in 10BaseT is more than 100BaseT for all frame sizes.

F. Utilization of Hub 2

TABLE 7. UTILIZATION OF HUB2 (AVG)

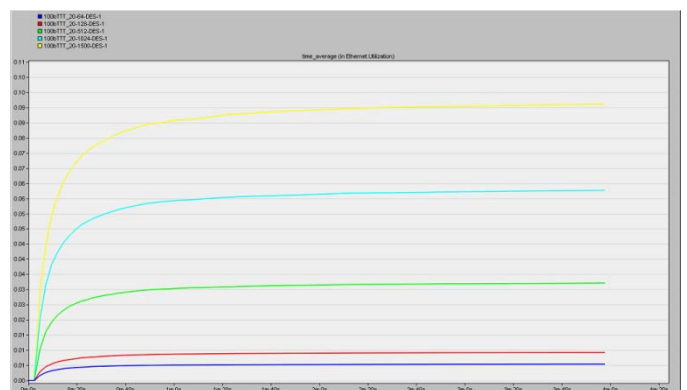


Figure 19. Comparison between utilization at Hub2 under different frame size at 100BaseT Ethernet wiring standard

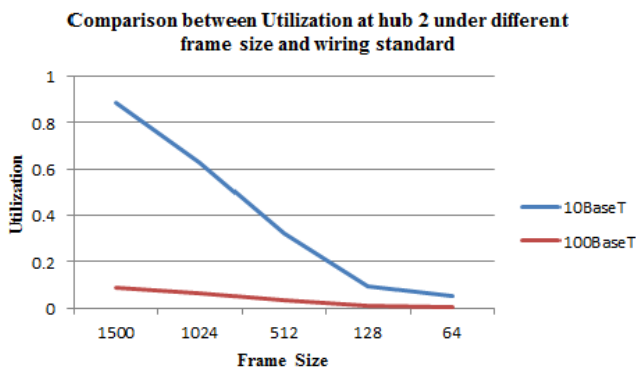


Figure 20. Graphs for Utilization of Hub2

It is obvious from the previous figures that the utilization in 10BaseT is more than 100BaseT for all frame sizes.

G. Traffic forwarded (bits/sec) at Hub2

TABLE8. TRAFFIC FORWARDED (BITS/SEC) AT HUB2 (AVG)

Time duration	4 minutes	
	Traffic Forwarded (bps)	
Devices	Hub 2	
Standards	10BaseT (scenario1)	100BaseT (scenario2)
1500 bytes	8,813,873	9,105,746.133
1024 bytes	6,276,727	6,266,542.4
512 bytes	3,214,211	3,212,418.33
128 bytes	920,963.466	918,889.6
64 bytes	538,082.4	539,042.4

The previous table shows the comparison between the traffic forwarded to Hub 2 under 10BaseT (scenario1) and 100BaseT (scenario2) for 1500, 1024, 512, 128 and 64 bytes of frame size.

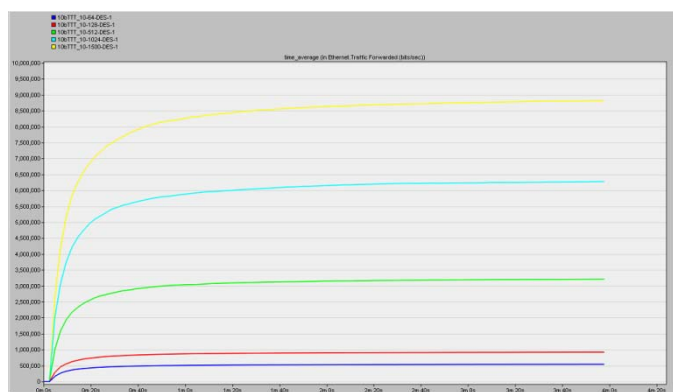


Figure 21. Comparison between traffic forwarded (bps) at Hub2 under different frame size at 10BaseT Ethernet wiring standard.

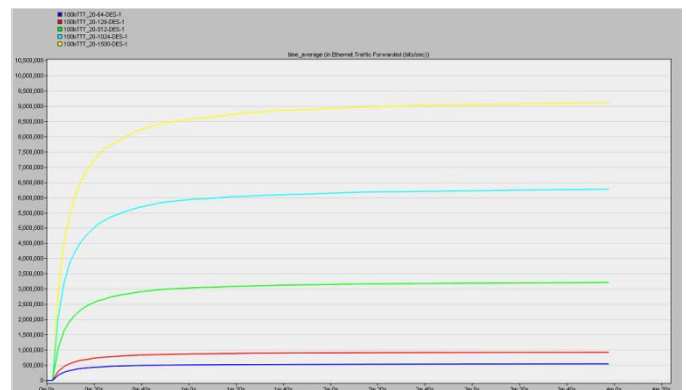


Figure 22. Comparison between traffic forwarded (bps) at Hub2 under different frame size at 100BaseT Ethernet wiring standard.

Comparison between traffic forwarded at hub 2 under different frame size and wiring standard

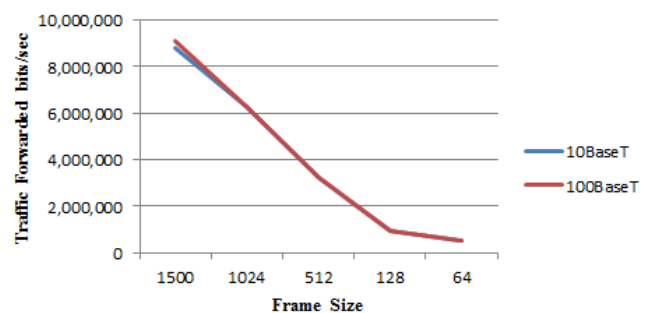


Figure 23. Graphs of traffic forwarded to hub2 (bit/sec)

It is obvious from the previous figures that at some points both curves overlap to each other, it means that traffic forwarded to hub2 is approximately same at these points.

H. Traffic received (bits/sec) at hub 2

TABLE9. TRAFFIC RECEIVED (BITS/SEC) AT HUB2 (AVG)

Time duration	4 minutes	
	Traffic Received (bps)	
Devices	Hub 2	
Standards	10BaseT (scenario1)	100BaseT (scenario2)
1500 bytes	8,813,873	9,105,746.133
1024 bytes	6,276,727	6,266,542.4
512 bytes	3,214,211	3,212,418.33
128 bytes	920,963.466	918,889.6
64 bytes	538,082.4	539,042.4

The previous table shows the comparison between the traffic received to Hub 2 under 10BaseT (scenario1) and

100BaseT (scenario2) for 1500, 1024, 512, 128 and 64 bytes of frame size.

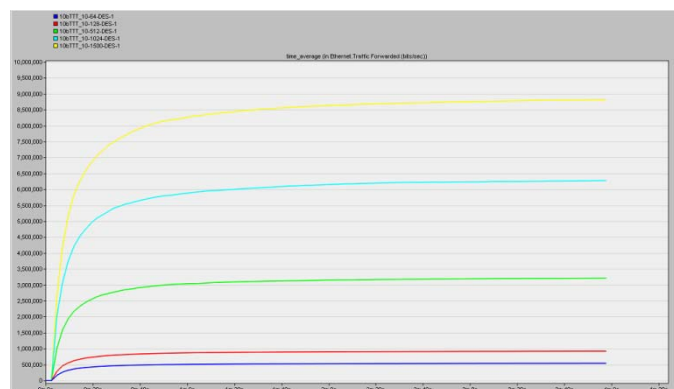


Figure 24. Comparison between traffic received (bps) at Hub2 under different frame size at 10BaseT Ethernet wiring standard.

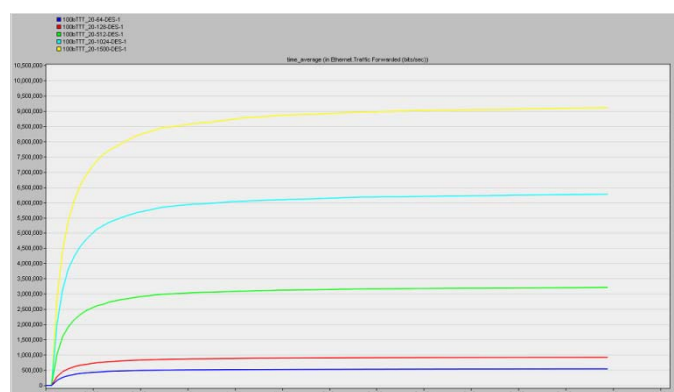


Figure 25. Comparison between traffic received (bps) at Hub2 under different frame size at 100BaseT Ethernet wiring standard.

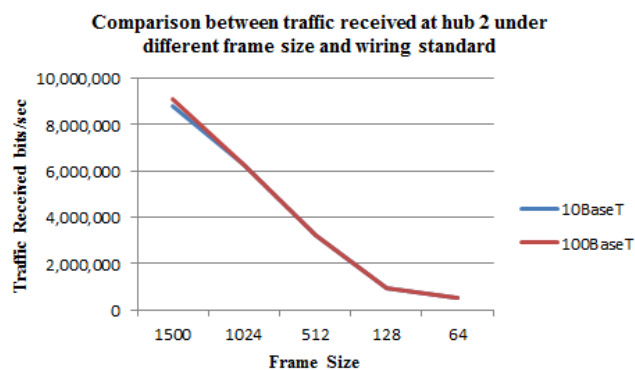


Figure 26. Graphs of traffic received to hub2 (bit/sec)

It is obvious from the previous figures that at some points both curves overlap to each other; it means that traffic received at hub2 is approximately same at these points.

I. Traffic forwarded (bits/sec) at switch

Table10. TRAFFIC FORWARDED (BITS/SEC) TO SWITCH (AVG)

Time duration	4 minutes	
	Traffic Forwarded (bps)	
Devices	Switch	
Standards	10BaseT (scenario1)	100BaseT (scenario2)
1500 bytes	6,091,588.533	6,281,372.066
1024 bytes	4,312,105	4,327,995
512 bytes	2,212,381.533	2,220,971.6
128 bytes	634,480	633,561.133
64 bytes	370,812	372,297

The previous table shows the comparison between the traffic forwarded to switch under 10BaseT (scenario1) and 100BaseT (scenario2) for 1500, 1024, 512, 128 and 64 bytes of frame size.

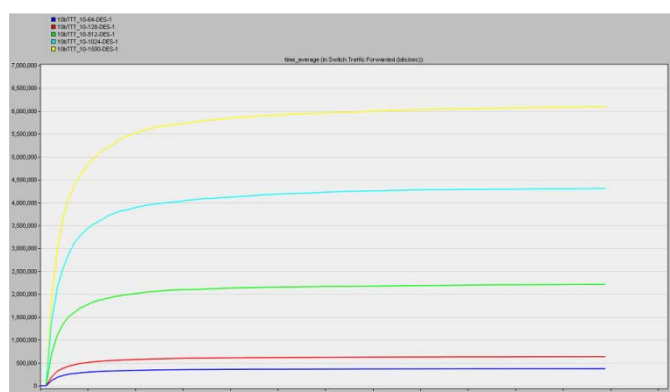


Figure 27. Comparison between traffic forwarded (bps) at Switch under different frame size at 10BaseT Ethernet wiring standard.

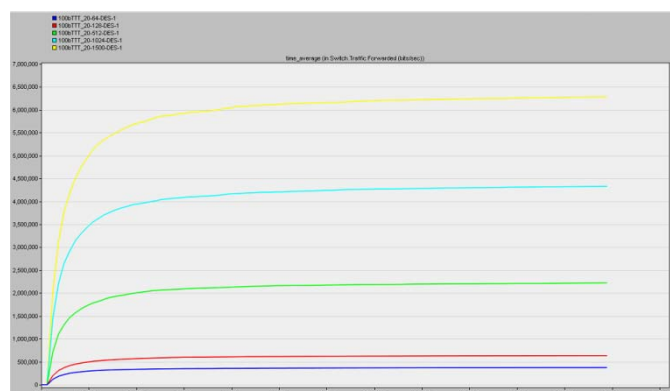


Figure 28. Comparison between traffic forwarded (bps) at Switch under different frame size at 100BaseT Ethernet wiring standard.

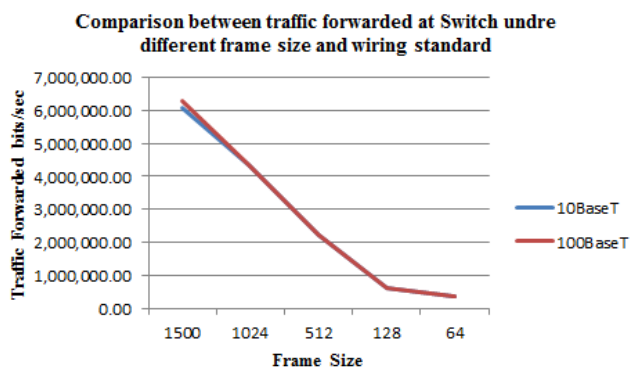


Figure 29. Graphs of traffic forwarded to switch (bit/sec)

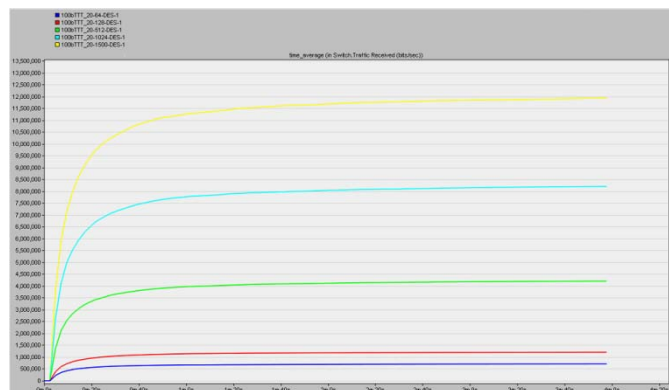


Figure 31. Comparison between traffic received (bps) at switch under different frame size at 100BaseT Ethernet wiring standard.

J. Traffic received (bits/sec) at switch

TABLE 11. TRAFFIC RECEIVED (BITS/SEC) TO SWITCH (AVG)

Time duration	4 minutes	
	Traffic Received (bps)	
Devices	Switch	
Standards	10BaseT (scenario1)	100BaseT (scenario2)
1500 bytes	11,559,450	11,924,876.13
1024 bytes	8,223,810	8,201,585
512 bytes	4,211,356	4,205,994.33
128 bytes	1,206,466.8	1,203,874.466
64 bytes	705,867	705,708

The previous table shows the comparison between the traffic received by switch under 10BaseT (scenario1) and 100BaseT (scenario2) for 1500, 1024, 512, 128 and 64 bytes of frame size.

Comparison between traffic received at Switch under different frame size and wiring standard

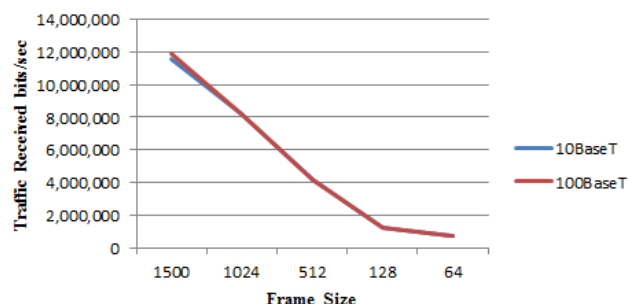


Figure 32. Graphs of traffic received at switch (bit/sec)

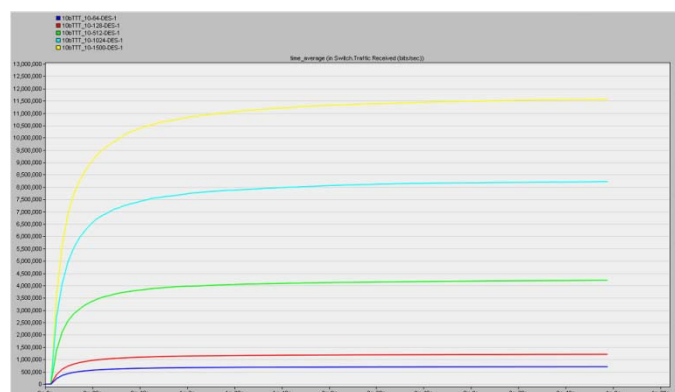


Figure 30. Comparison between traffic received (bps) at switch under different frame size at 10BaseT Ethernet wiring standard.

K. Traffic filtered (bits/sec) by switch

TABLE 12. TRAFFIC FILTERED (BITS/SEC) TO SWITCH (AVG)

Time duration	4 minutes	
	Traffic Filtered (bps)	
Devices	Switch	
Standards	10BaseT (scenario1)	100BaseT (scenario2)
1500 bytes	5,467,861.67	5,643,504.04
1024 bytes	3,911,705	3,873,590
512 bytes	1,998,974.8	1,985,022.7
128 bytes	571,986.8	570,313.33
64 bytes	335,055	333,411

The previous table shows the comparison between the traffic received by switch under 10BaseT (scenario1) and 100BaseT (scenario2) for 1500, 1024, 512, 128 and 64 bytes of frame size.



It is obvious from the previous figure that initially filtered traffic is more in case of 100BaseT for 1500 bytes frame size. For 1024, 512, 128 and 64 bytes frame size the switch under 10BaseT filtered more traffic than 100BaseT, it means that the performance of 10BaseT Ethernet wiring standard is become better at the case of low traffic data.

VI. CONCLUSIONS

The performance of LANs under different Ethernet wiring standard having different frame size are compared and the observations from our simulations outcomes are:

- A. The number of collision counts in 10BaseT is always more than 100BaseT for all the frame sizes because of the nature of 10BaseT.
- B. Hubs are more utilized in case of 10BaseT because of the large value of collision count so the more retransmission attempts will be required.
- C. The performance of a switch is better for 100BaseT wiring standard at the case of 1500 bytes frame size than that the case of 10BaseT because it filters more traffic. When the frame size is 1024 bytes, filtered traffic will be approximately the same for both 10BaseT and 100BaseT. When frame size is further reduced to 512, 128 and 64 the results show that the performance of 10BaseT becomes better than 100BaseT because the switch filtered more traffic than 100BaseT.
- D. If we have LAN in which high traffic is not required and the frame size will be fixed to 512, 128 or 64 bytes, 10BaseT will give us good result and performs better as compared to 100BaseT Ethernet wiring standard.
- E. At the case of small frame size we will not able to transfer more traffic per seconds (traffic receiving and forwarding is less) so we cannot use them in heavy traffic (refer tables 10 and 11).

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