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Ethernet Wiring Standards with Different Frame Size to Enhance the Performance of LAN

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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 and 100BaseT) with different frame size.

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

1. 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 kilometers), 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 [1], 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).
In the work done in [2], they are evaluating the performance of the LAN by varying the frame size between (1500, 1024 and 512) only and the variation of the Ethernet wiring standard.
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 by using Riverbed Modeler Academic edition.

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2. 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 is unguided medium [3], [4] and [5].

I. 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.

II. 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.

Table 1 shows the comparison between the guided cables (Twisted pair, Co-axial cables and optical fiber) [4].

Table 1 Comparison between guided cables

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

III. 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 [5] and [7].

IV. 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 [5], [7] and [9].

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 [10].

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 [6].

3. Simulation software and parameters

The simulation will be done by using Riverbed Modeler Academic Edition 17.5 [8]. 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

I. Traffic Generation Parameters

Start time in seconds will be constant (5.0), ON State Time in second is constant (1000), OFF state Time is (0).

II. 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

I. For hub

Number of collision count, Utilization Traffic forwarded (bits/sec) and Traffic received (bits/sec).

II. For Switch

Traffic forwarded (bits/sec), Traffic received (bits/sec), Traffic filtered (bits/sec).

D. Running time parameters

The duration of the simulation will be 4 min.

4. 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

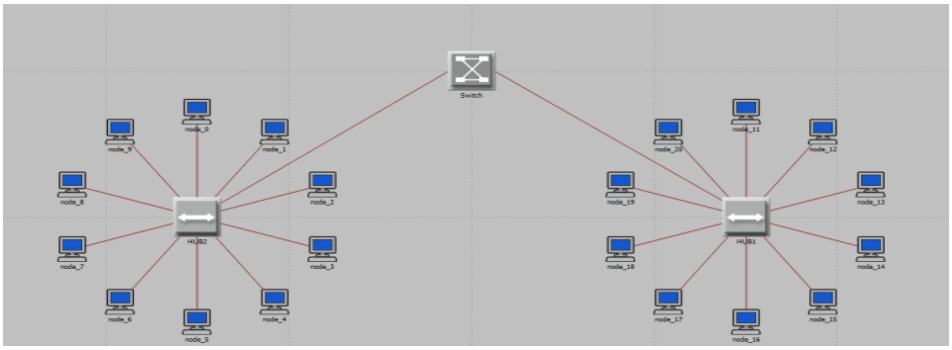

Fig. 1. Office LAN under 10BaseT wiring standard

Figure 1 illustrates 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

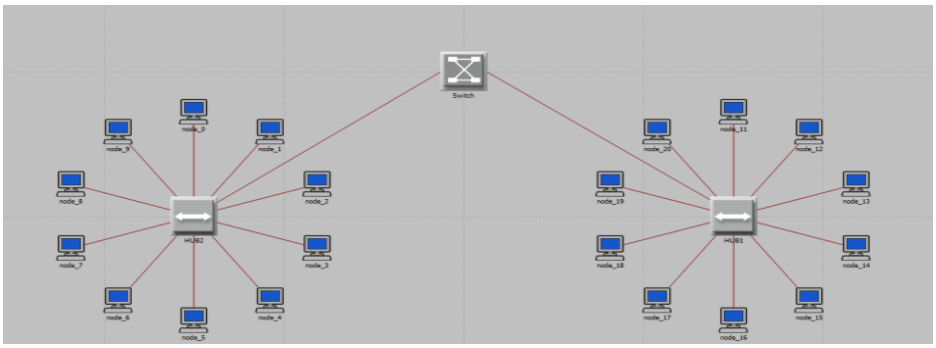

Fig. 2. Office LAN under 100BaseT wiring standard

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.

5. 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

Table 2 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

Table 2 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.

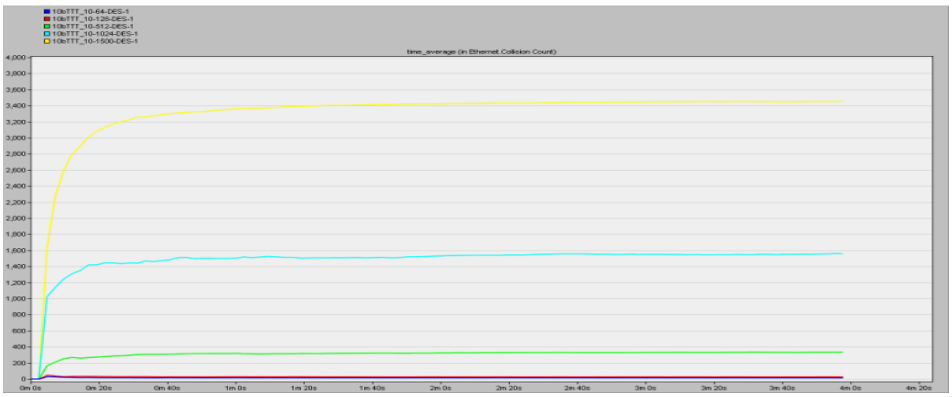

Fig. 3. Comparison between numbers of collision count at Hub1 under different frame size at 10BaseT Ethernet wiring standard.

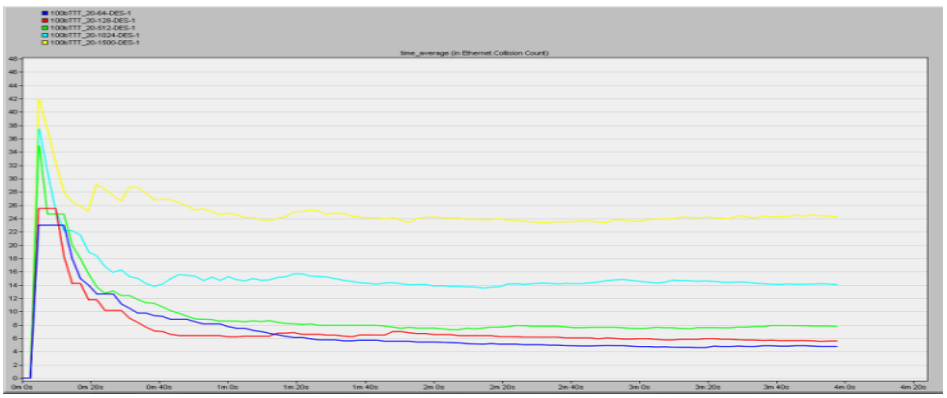

Fig. 4. Comparison between numbers of collision count at Hub1 under different frame size at 100BaseT Ethernet wiring standard

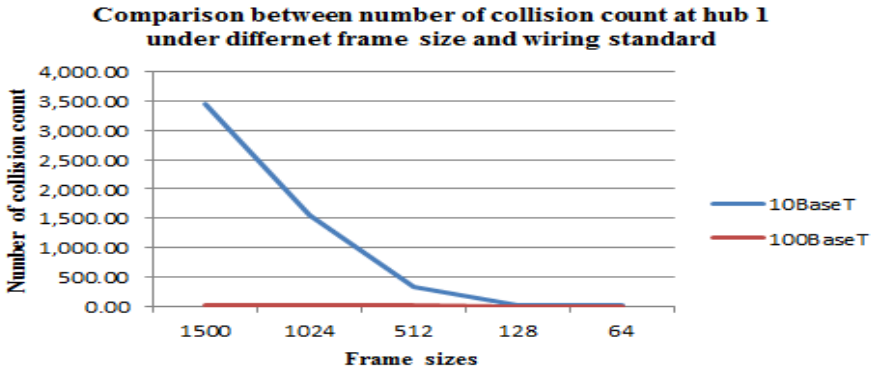

Fig. 5. Graphs for number of collision count at Hub1

Figures 3, 4 and 5 show that the number of collision counts in 10BaseT is more than 100BaseT for all frame sizes.

B. Utilization of Hub 1

Table 3 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

Table 3 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.

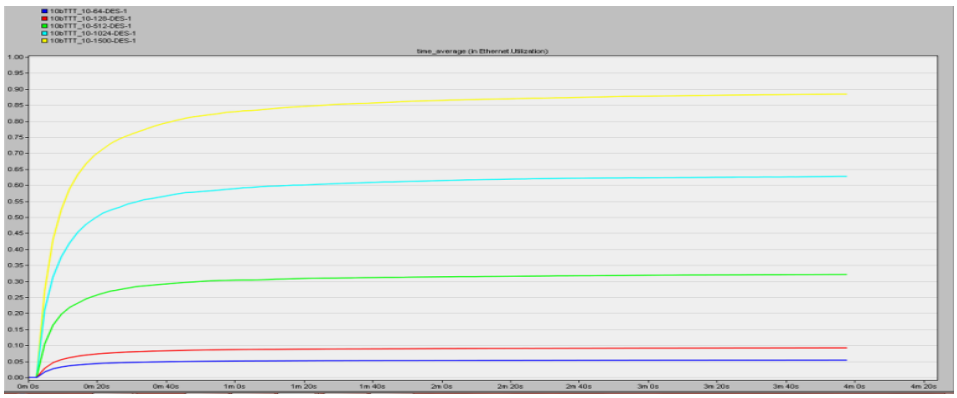

Fig. 6. Comparison between utilization at Hub1 under different frame size at 10BaseT Ethernet wiring standard.

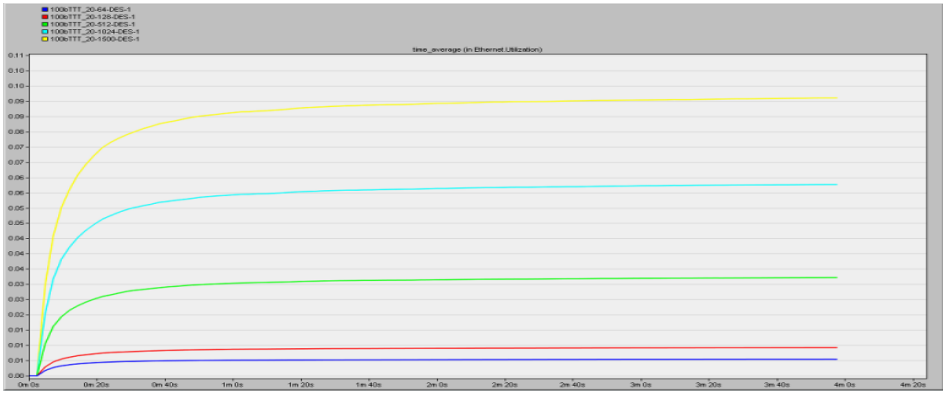

Fig. 7. Comparison between utilization at Hub1 under different frame size at 100BaseT Ethernet wiring standard

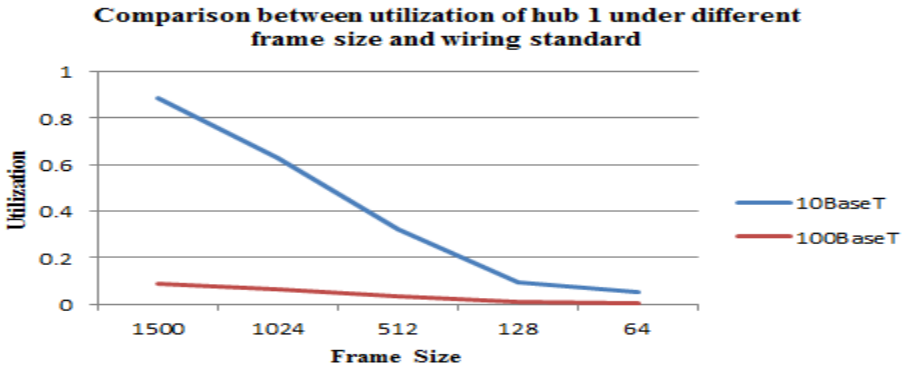

Fig. 8. Graphs for Utilization of Hub1

Figures 6, 7 and 8 demonstrate that the utilization in 10BaseT is more than 100BaseT for all frame sizes.

C. Traffic forwarded (bits/sec) at Hub1

Table 4 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

Table 4 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.

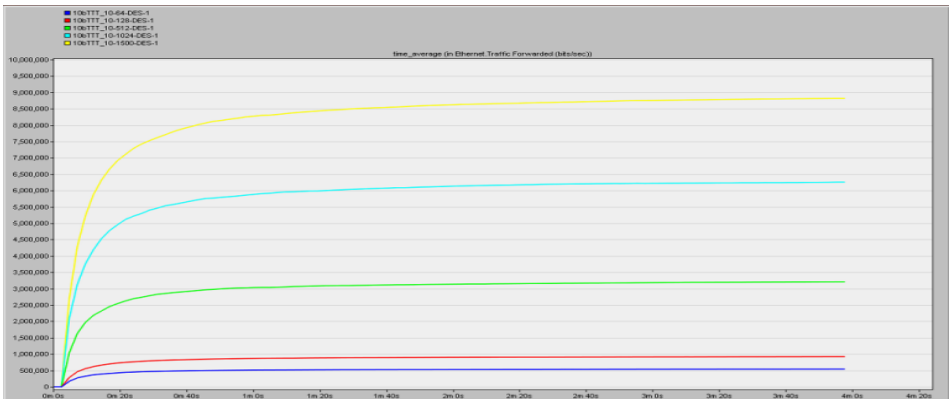

Fig. 9. Comparison between traffic forwarded (bps) at Hub1 under different frame size at 10BaseT Ethernet wiring standard

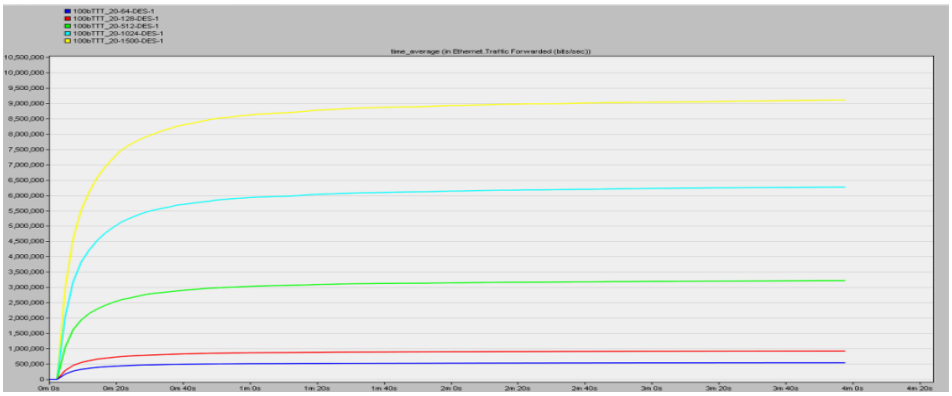

Fig. 10. Comparison between traffic forwarded (bps) at Hub1 under different frame size at 100BaseT Ethernet wiring standard

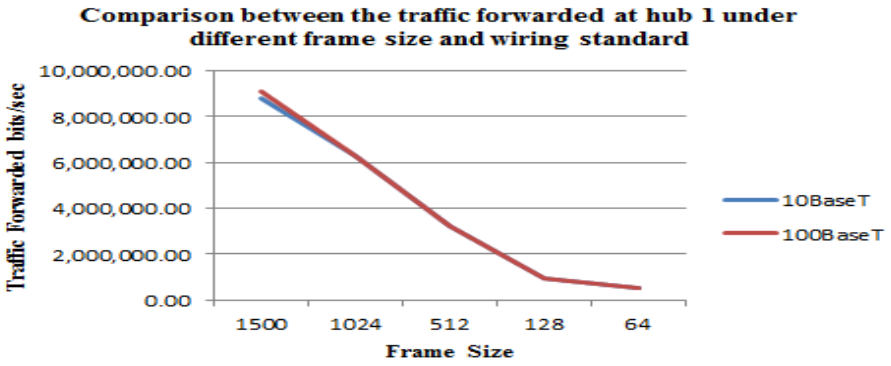

Fig. 11. Graphs of traffic forwarded at Hub1 (bit/sec)

Figures 9, 10 and 11 show 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

Table 5 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

Table 5 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.

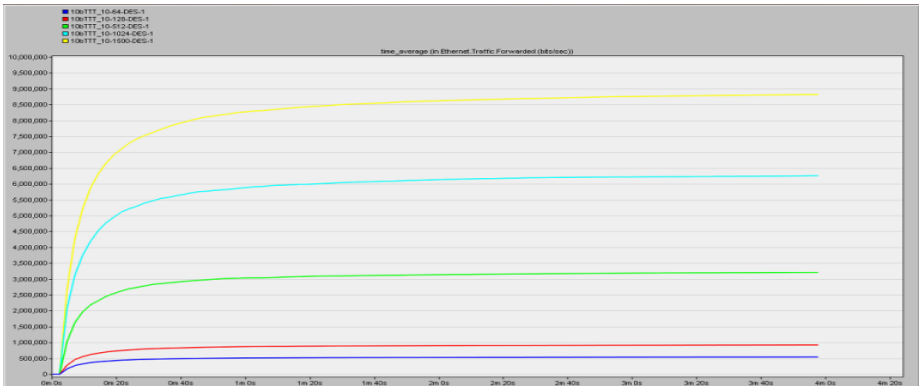

Fig. 12. Comparison between traffic received (bps) at Hub1 under different frame size at 10BaseT Ethernet wiring standard

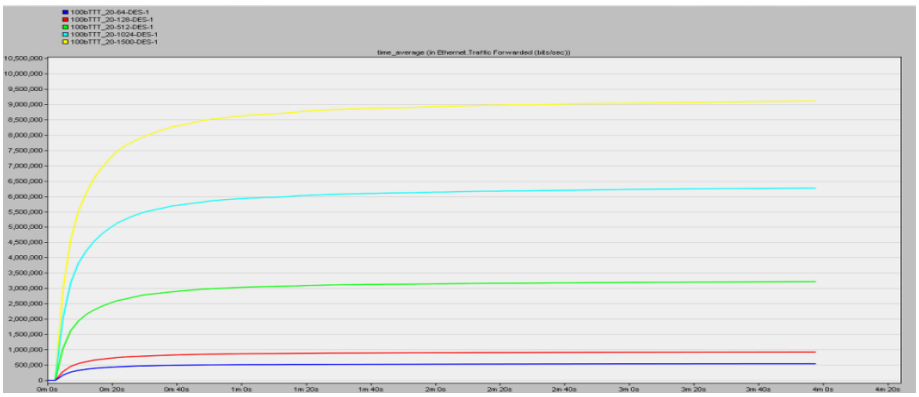

Fig. 13. Comparison between traffic forwarded (bps) at Hub1 under different frame size at 100BaseT Ethernet wiring standard

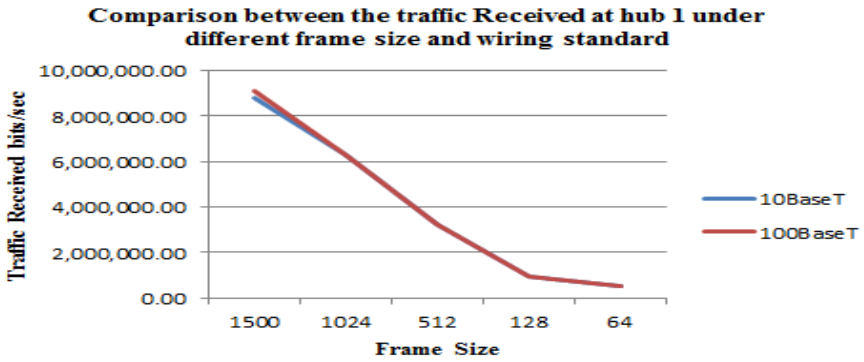

Fig. 14. Graphs of traffic received at hub1 (bit/sec)

Figures 12, 13 and 14 demonstrate 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

Table 6 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

Table 6 illustrates 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.

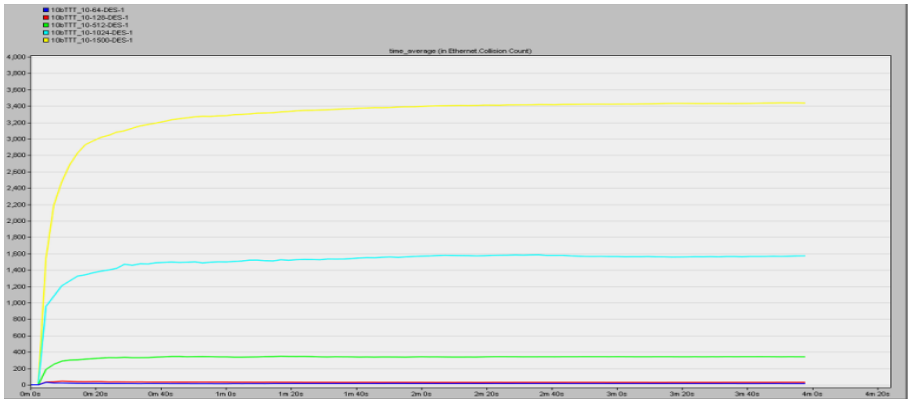

Fig. 15. Comparison between numbers of collision count at Hub2 under different frame size at 10BaseT Ethernet wiring standard

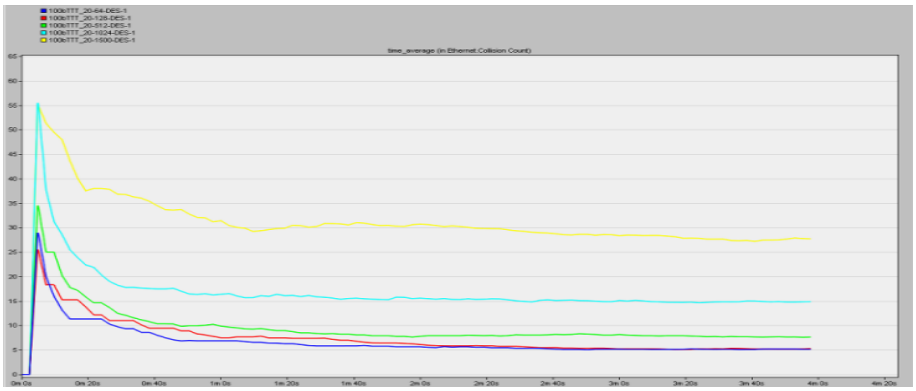

Fig. 16. Comparison between numbers of collision count at Hub2 under different frame size at 100BaseT Ethernet wiring standard

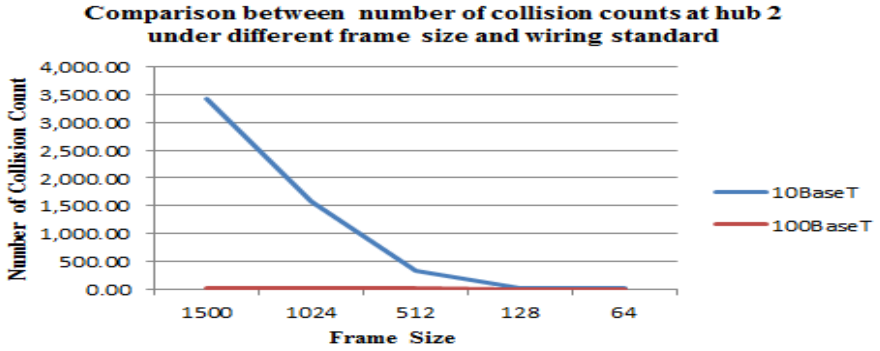

Fig. 17. Graphs for number of collision count at Hub2

Figures 15, 16 and 17 show 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.)

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

Table 7 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.

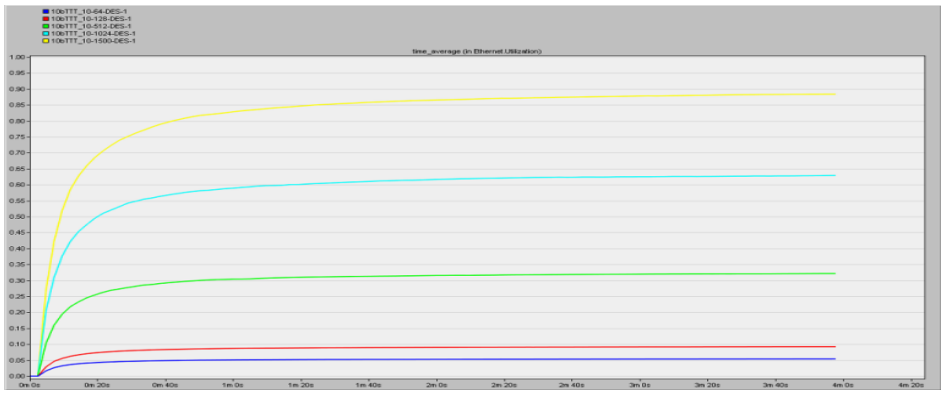

Fig. 18. Comparison between utilization at Hub2 under different frame size at 10BaseT Ethernet wiring standard

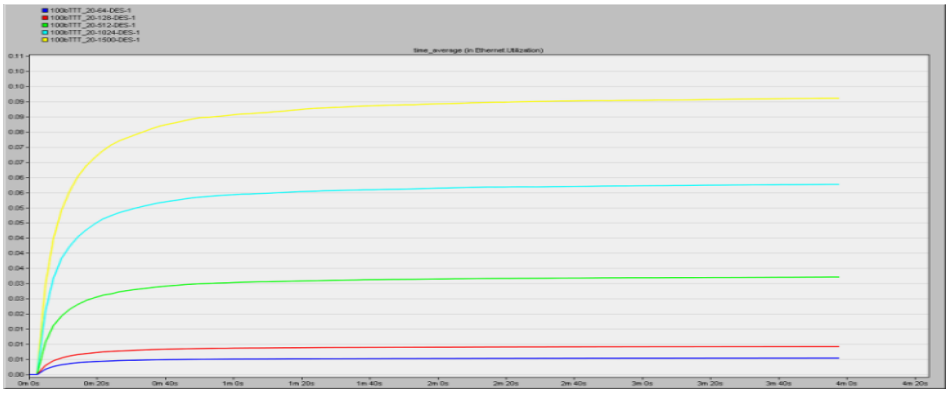

Fig. 19. Comparison between utilization at Hub2 under different frame size at 100BaseT Ethernet wiring standard

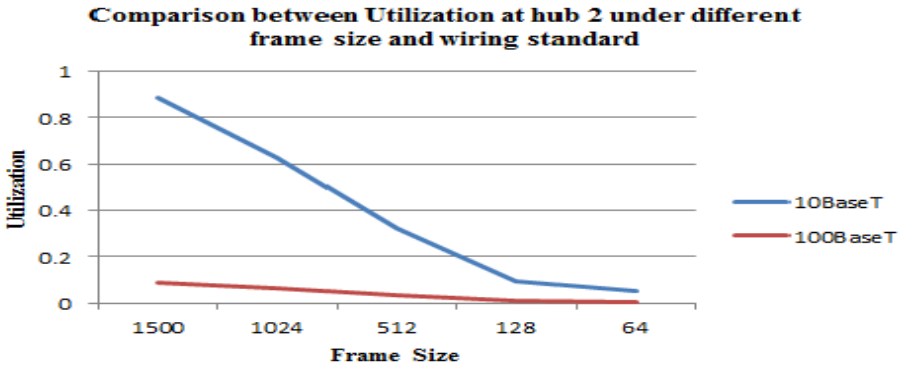

Fig. 20. Graphs for Utilization of Hub2

Figures 18, 19 and 20 illustrate that the utilization in 10BaseT is more than 100BaseT for all frame sizes.

G. Traffic forwarded (bits/sec) at Hub2

Table 8 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	920,963.46	918,889.6
64 bytes	538,082.4	539,042.4

Table 8 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.

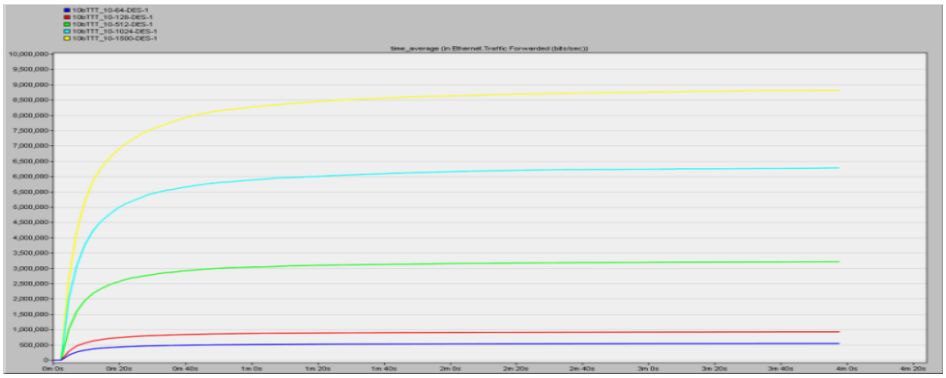

Fig. 21. Comparison between traffic forwarded (bps) at Hub2 under different frame size at 10BaseT Ethernet wiring standard.

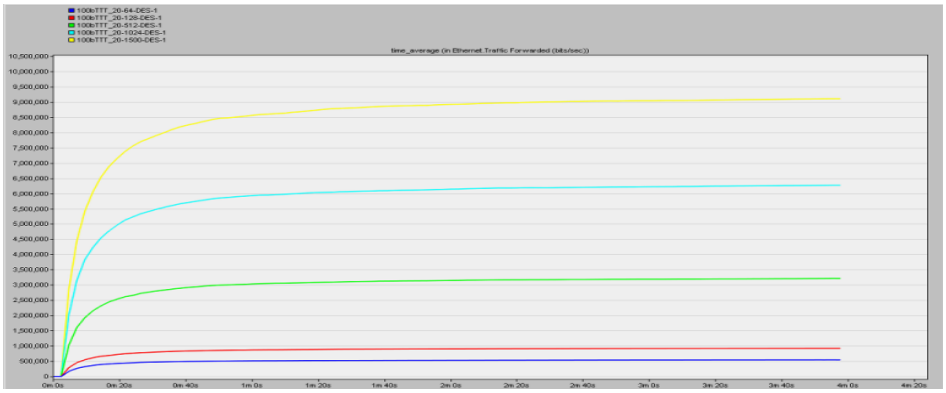

Fig. 22. Comparison between traffic forwarded (bps) at Hub2 under different frame size at 100BaseT Ethernet wiring standard

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

Figures 21, 22 and 23 demonstrate 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

Table 9 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

Table 9 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.

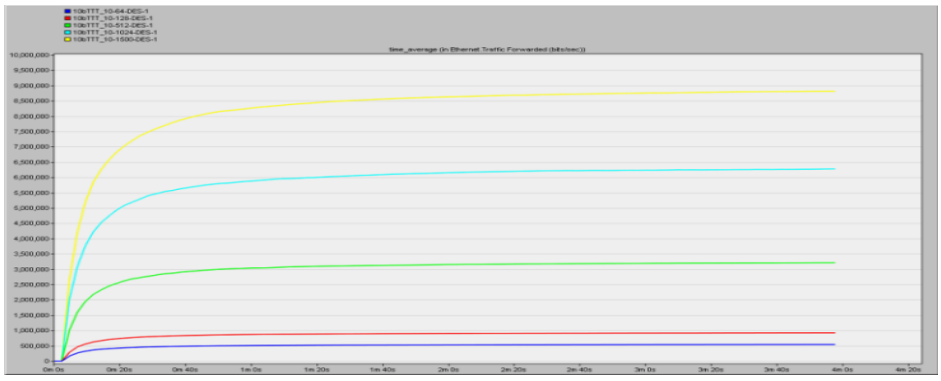

Fig. 24. Comparison between traffic received (bps) at Hub2 under different frame size at 10BaseT Ethernet wiring standard

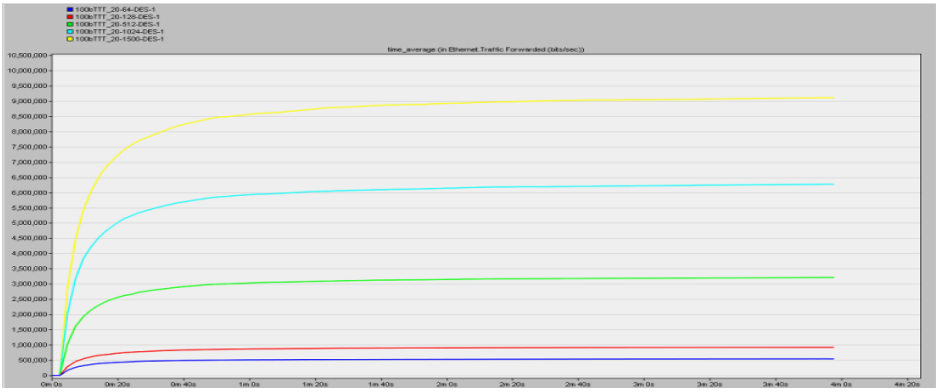

Fig. 25. Comparison between traffic received (bps) at Hub2 under different frame size at 100BaseT Ethernet wiring standard

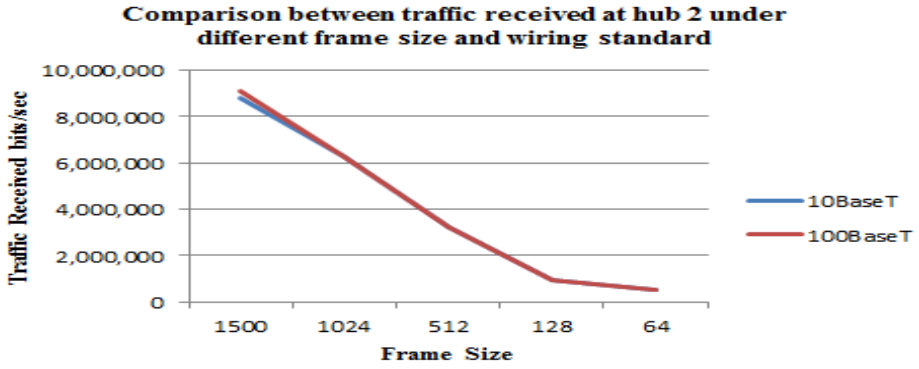

Fig. 26. Graphs of traffic received to hub2 (bit/sec)

Figures 24, 25 and 26 show 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

Table 10 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

Table 10 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.

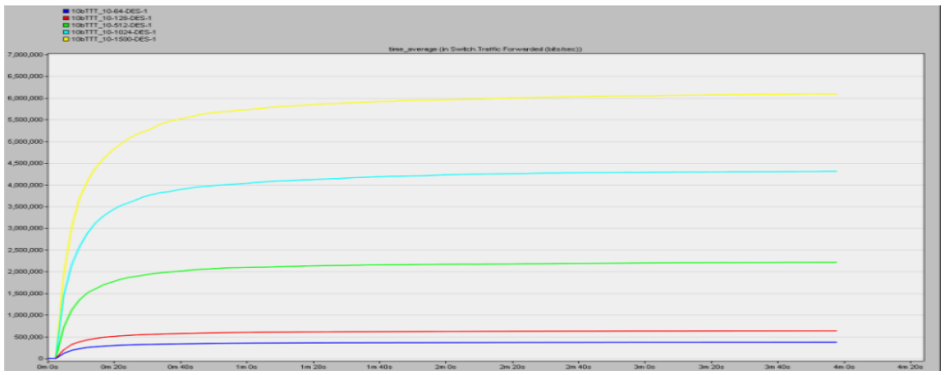

Fig. 27. Comparison between traffic forwarded (bps) at Switch under different frame size at 10BaseT Ethernet wiring standard

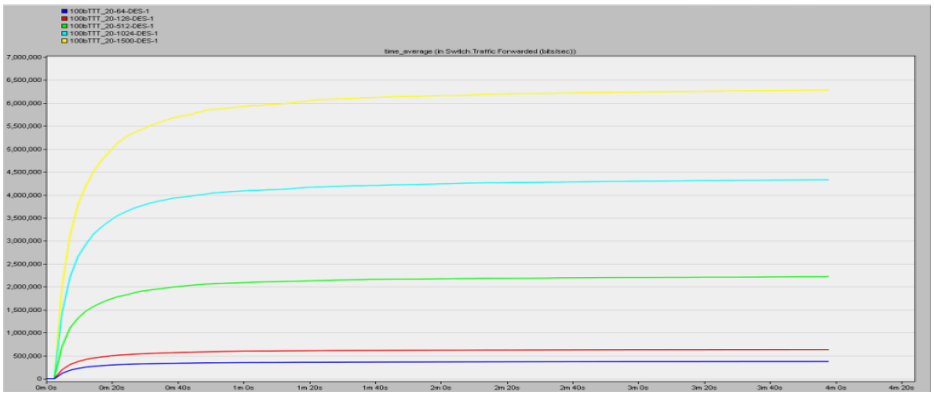

Fig. 28. Comparison between traffic forwarded (bps) at Switch under different frame size at 100BaseT Ethernet wiring standard

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

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

Table 11 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.

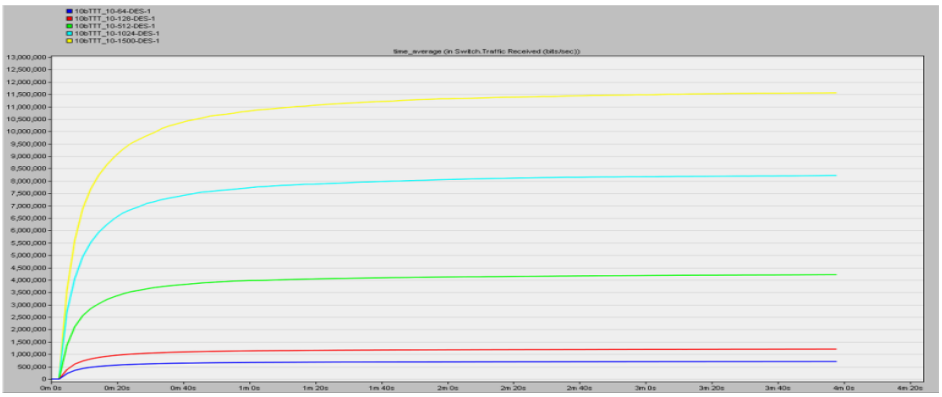

Fig. 30. Comparison between traffic received (bps) at switch under different frame size at 10BaseT Ethernet wiring standard

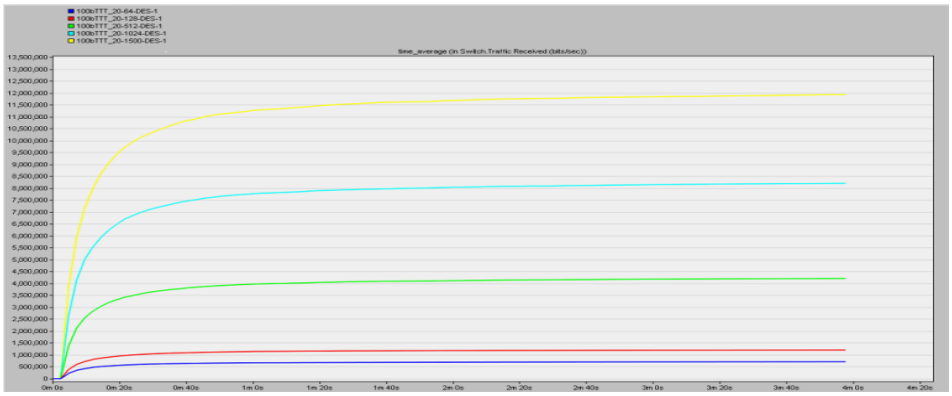

Fig. 31. Comparison between traffic received (bps) at switch under different frame size at 100BaseT Ethernet wiring standard

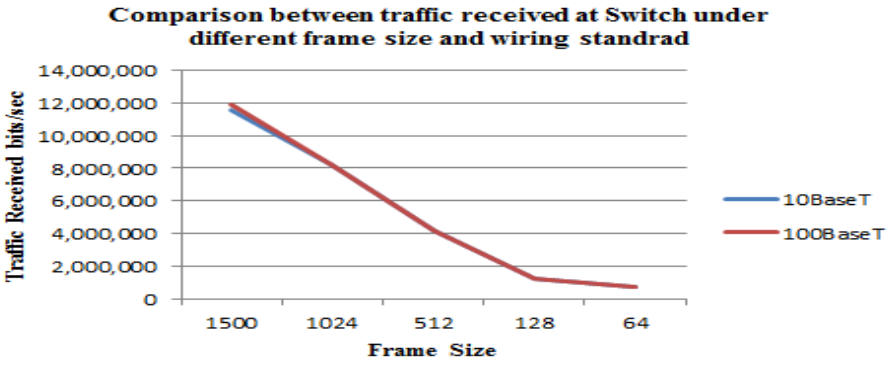

Fig. 32. Graphs of traffic received at switch (bit/sec)

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

Table 12 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.

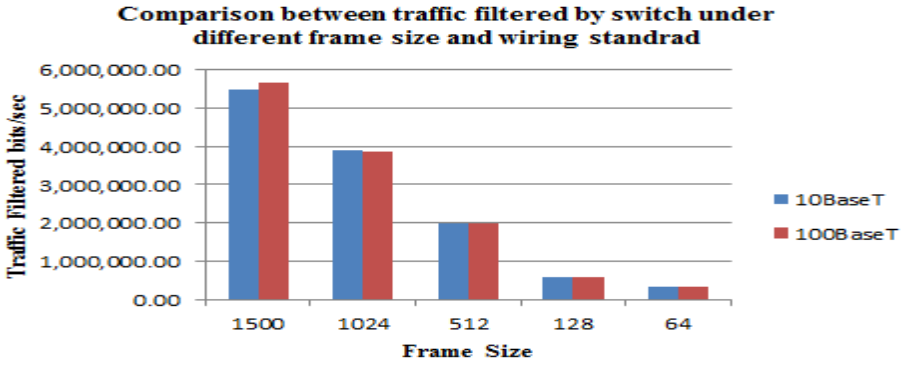

Fig. 33. Comparison between the traffic filtered by switch under different frame size and wiring standard

Figure 33 shows that the initially filtered traffic is better in case of 100BaseT for 1500 bytes frame size than 10BaseT. 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

6. 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 [5], [9] and [10]

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).

7. References

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