Analysis of a LAN under Different Ethernet Wiring Standards with Variation in Time and Components

Mohammad Wazid
Student, M. Tech Computer Network Engg. 1st Year
Graphic Era University
Dehradun, India
wazidkec2005@gmail.com

R. H. Goudar
Associate Professor
Department of CSE
Graphic Era University
Dehradun, India
rhgoudar@gmail.com

Vipin Kumar
Student, M. Tech Computer Science & Engg. 1st Year
Graphic Era University
Dehradun, India
vipinpundir88@gmail.com

***Abstract*— In this paper we simulate a campus LAN using IT Guru Opnet 9.1 and then we calculate the performance of this network under 10BaseT and 100BaseT Ethernet wiring standards with varying time and components (i.e. no. of hubs) and finally we compare the results i.e. which standard perform better for which time duration and for how many number of components. We find that numbers of collision counts at hubs are always more in 10BaseT, because of the nature of this standard. Hubs are always more utilized in 10BaseT, because of more retransmission attempts due to high number of collisions in 10BaseT. Hubs filter no traffic for 10BaseT but for 100BaseT they filter some traffic and perform well with increasing time. When we increase the time not the components the performance of switch is good under 100BaseT because it filter more traffic with increasing time as compare to 10BaseT. When we increase number of components and time period in 100BaseT, it also performs well. In this case when time is 2 minutes its performance with four components (hubs) is worst but if we start increasing time the performance is going to improve. Its improvement rate is greater than 10BaseT standard. So finally we come to a point that if number of components (hubs) are fixed and network is used for long time then we have to use 100BaseT standard in the implementation of LAN, it will give you good performance. But if more numbers of hubs are required and the network is used for long time, then in those situations always use 100BaseT standard, because it will give you good performance. In the same situation if the network is used for short time, then always prefer 10BaseT standard, it will give you better performance as compare to 100BaseT standard. To our best knowledge this is the first paper that analyzes the performance of a campus LAN under different Ethernet wiring standards with these assumptions.**

Keywords- Collision count; Utilization; Traffic Received; Traffic Forwarded; 10BaseT; 100BaseT

I. INTRODUCTION

A local area network (LAN) is a collection of different computers that interconnects computers in a limited area such as a company, college campus, office building etc. Usually a LAN has higher data transfer rates, smaller geographic coverage and lack of a need for leased lines as compare to a WAN. In the creation of a LAN we use different types of hardware such as repeaters, switches, hub, connectors and different cables. Our aim is to measure the performance of network in different Ethernet wiring (i.e. 10BaseT/100BaseT) environments. Simulations are done using IT Guru OPNET. For this work we create a local area network for a campus with stations (nodes), hubs, switch under 10BaseT and 100BaseT Ethernet wiring standards. Then we calculate the performance i.e. number of collision count, utilization, traffic received (bps), traffic forwarded (bps) for hubs and traffic received (bps), traffic forwarded (bps) for switch with varying time and increasing number of components.

A brief introduction about some related terms-

A. 10BaseT

10BaseT is an Ethernet wiring standard for LAN (Local Area Network) that runs at 10 Mbps. It uses twisted-pair cables. These cables have a maximum transmission length of 100 meters. They have two copper wires that are wrapped around each other, which reduce electromagnetic interference. Each workstation, containing a 10baseT network card connects to a 10baseT hub.

B. 100BaseT

100BaseT is an Ethernet wiring standard for LAN that supports data transfer rates up to 100Mbps over unshielded twisted pair copper wire cable. 100BaseT Ethernet wiring standard is the most commonly used LAN standard because of its high speed, robustness and low cost. It is also adaptable to new technologies. 100BaseT is based on 10BaseT Ethernet standard, which supports transfer rates of 10Mbps. It is also called as fast Ethernet because it is ten time faster than 10BaseT.

TABLE I. COMPARISONS 10BaseT & 100BaseT ETHERNET WIRING STANDARDS

	10BaseT	**100BaseT**
Media	UTP	UTP
No. of Wire	2	4
Max. Length	100 met	100 met
Topology	Star	Star
Data transmission rate	10 Mbps	100 Mbps
Line Encoding	Manchester	8B/6T
LAN access method	CSMA/CD	CSMA/CD

II. SIMULATION ENVIRONMENT

We have used following four simulation scenarios in our paper-

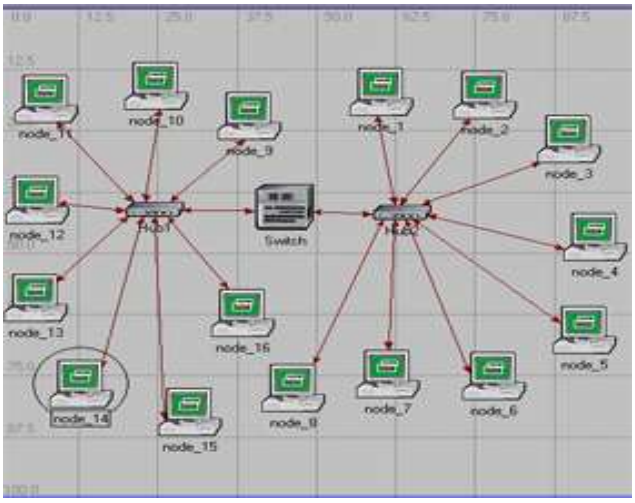

Figure 1. Campus network under 10BaseT with two hubs

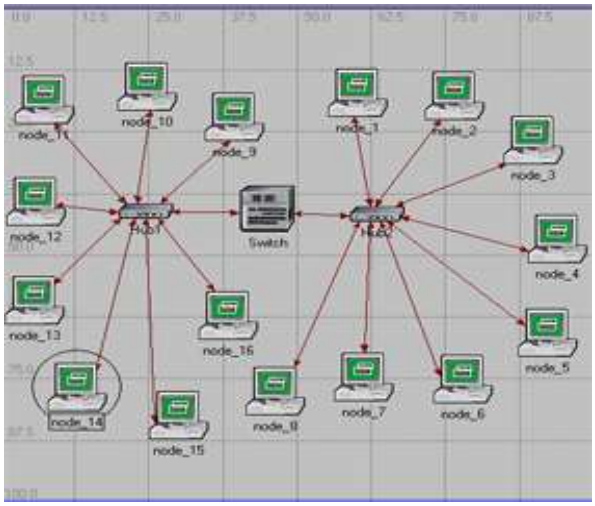

Figure 2. Campus network under 100BaseT with two hubs

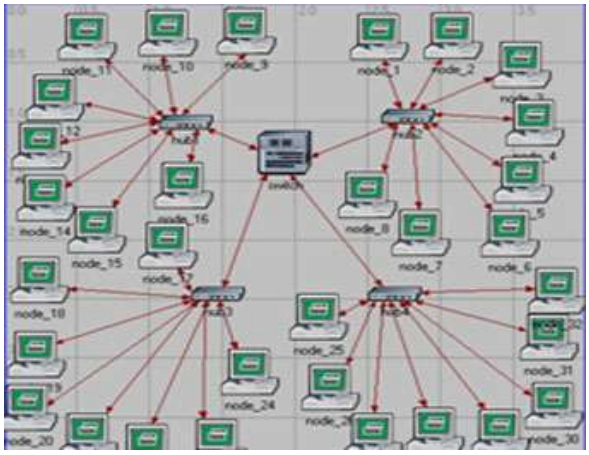

Figure 3. Campus network under 10BaseT with four hubs

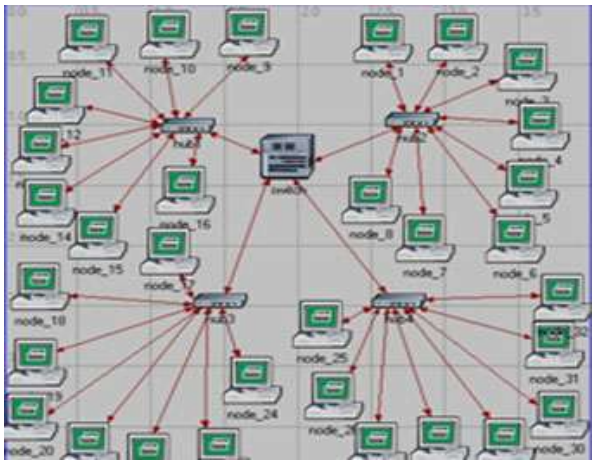

Figure 4. Campus network under 100BaseT with four hubs

In the figure 1 we use two hubs and a switch to connect 16 nodes. We use 10BaseT Ethernet wiring standard to simulate this network.

In the figure 2 we use two hubs and a switch to connect 16 nodes. We use 100BaseT Ethernet wiring standard to simulate this network.

In the figure 3 we use four hubs and a switch to connect 32 nodes. We use 10BaseT Ethernet wiring standard to simulate this network.

In the figure 4 we use four hubs and a switch to connect 32 nodes. We use 100BaseT Ethernet wiring standard to simulate this network.

III. OPNET SIMULATIONS FOR 10BASET & 100BASET

We are doing this work is to examine LAN's performance under different Ethernet wiring standards with varying time and components (number of hubs used) using OPNET simulator, the four Ethernet LANs were simulated.

Ethernet 10BaseT with 16 nodes connected by two hubs and a switch, Ethernet 100BaseT with 16 nodes connected by two hubs and a switch, Ethernet 10BaseT with 32 nodes connected by four hubs and a switch, other is Ethernet 100BaseT with 32 nodes connected by four hubs and a switch. All simulations are for 2 and 4 minutes.

A. Simulation Environment & Parameters

1) Common Parameters

Simulator- IT Guru Opnet
Version- 9.1
Platform- Windows XP SP2
Network Coverage- 4x4 km
No. of nodes- 16 and 32 systems.
Hub 1- It is an Ethernet hub supporting up to 16 Ethernet connections. All the ports should be operating at the same speed (set based on the connected link). The possible link model choices are 10BaseT, 100BaseT or 1000BaseX. Note that the hub handles deference and collision detection for all the stations connected to it. Packets received by the hub are broadcast to all the stations regardless of the destination address on the packet. There is no queuing of packets in the hub itself as the processing time is considered to be zero.
Hub 2, 3, 4 - Same as hub 1.
Switch- It represents a switch supporting up to 16 Ethernet interfaces. The switch implements the Spanning Tree algorithm in order to ensure a loop free network topology. Switches communicate with each other by sending Bridge Protocol Data Units (BPDU's). Packets are received and processed by the switch based on the current configuration of the spanning tree.
Ethernet wiring Standards- 10BaseT and 100BaseT.

2) Parameters for nodes

a) Traffic Generation Parameters

Start Time (Sec) - constant (2.0)
ON State Time (Sec) - exponential (50)
OFF State Time (Sec) - constant (0)

b) Packet Generation Arguments

Inter arrival Time (Sec) - exponential (0.02)
Packet Size (bytes) - uniform (46, 2000)
Segmentation Size (bytes) – Yes on 1500 Bytes

3) Running Time Parameters

Duration-2 and 4 Minutes
Speed- 128
Value per statistics-100
Update Interval-100000 Events

B. Simulation Results

In simulation we take following statistics for different components which are there performance parameters-
For Hub 1- Number of Collision Counts (should be less), Utilization (should be less depends upon collisions), Traffic Received (bps), Traffic Forwarded (bps), Filtered Traffic (bps) (should have high positive value).
For Hub 2, 3, 4 - Same as hub 1.
Switch- Traffic Received (bps), Traffic Forwarded (bps), Filtered Traffic (bps) (should have high positive value).
For a good performance of a standard (i.e. 100BaseT or 10BaseT) this filtered traffic should have high positive value.

C. Comparisons of performance under different Ethernet wiring standards

Case 1- When there are two hubs and time is 2 minutes.

TABLE II. SIMULATED RESULTS OF HUB1 AND HUB2, TIME IS 2 MIN

Time duration	**2 Minutes**			
	Hub1		***Hub2***	
Standards	***10BaseT***	***100BaseT***	***10BaseT***	***100BaseT***
Collision Count	5.64	1.32	10.12	2.67
Utilization	0.004800	0.000349	0.004829	0.000296
Traffic Received (bps)	47709.67	34415.53	47748.07	28665.80

Traffic Forwarded (bps)	47709.67	34355.67	47748.07	28504.93
Filtered Traffic (bps)	**0.00**	**59.86**	**0.00**	**160.87**

TABLE III. SIMULATED RESULTS OF SWITCH, TIME IS 2 MIN

Time duration	**2 Minutes**	
	Switch	
Standards	***10BaseT***	***100BaseT***
Traffic Received (bps)	62848.93	41105.80
Traffic Forwarded (bps)	32599.20	21767.53
Filtered Traffic (bps)	**30249.73**	**19338.27**

Case 2-When there are two hubs and time is 4 minutes.

TABLE IV. SIMULATED RESULTS OF HUB1 AND HUB2, TIME IS 4 MIN

Time duration	**4 Minutes**			
	Hub1		***Hub2***	
Standards	***10BaseT***	***100BaseT***	***10BaseT***	***100BaseT***
Collision Count	5.64	1.32	10.26	2.73
Utilization	0.004962	0.000417	0.005021	0.000398
Traffic Received (bps)	49471.50	41486.77	49930.93	39314.90
Traffic Forwarded (bps)	49471.50	41456.83	49930.93	39234.47
Filtered Traffic (bps)	**0.00**	**29.94**	**0.00**	**80.43**

TABLE V. SIMULATED RESULTS OF SWITCH, TIME IS 4 MIN

Time duration	**4 Minutes**	
	Switch	
Standards	***10BaseT***	***100BaseT***
Traffic Received (bps)	64921.80	52458.10
Traffic Forwarded (bps)	34475.83	28239.57
Filtered Traffic (bps)	**30445.97**	**24218.53**

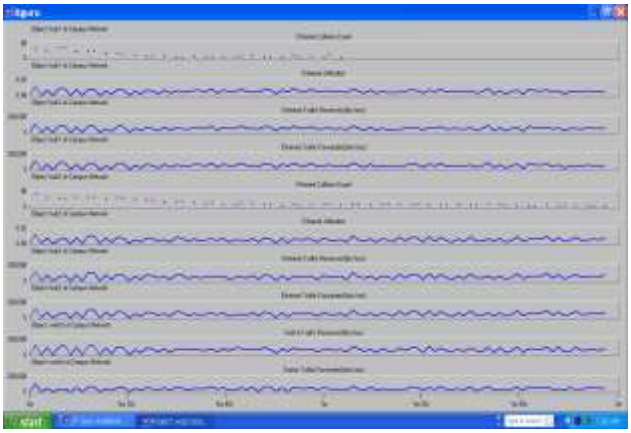

Figure 5. 10BaseT Standard with two hubs and time period is 2 min

These graphs show collision counts, utilization, traffic received (bps) and traffic forwarded (bps) for hub1 and hub2. Below two curves show results at switch, traffic received (bps) and traffic forwared (bps). All results are for 10BaseT Ethernet wiring standard for 2 minutes.

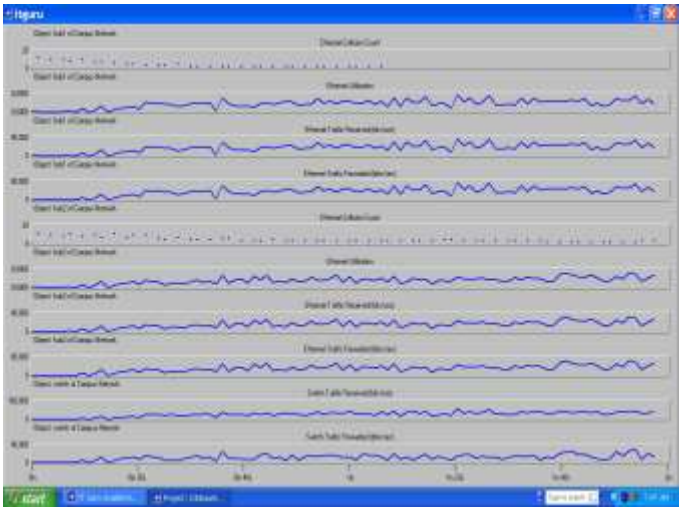

Figure 6. 100BaseT Standard with two hubs and time period is 2 min

These graphs show collision counts, utilization, traffic received (bps) and traffic forwarded (bps) for hub1 and hub2. Below two curves show results at switch, traffic

received (bps) and traffic forwared (bps). All results are for 100BaseT Ethernet wiring standard for 2 minutes.

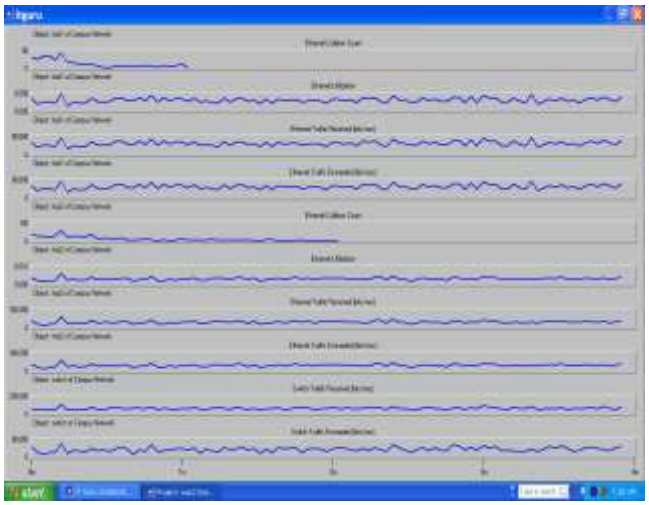

Figure 7. 10BaseT Standard with two hubs and time period is 4 min

These graphs show collision counts, utilization, traffic received (bps) and traffic forwarded (bps) for hub1 and hub2. Below two curves show results at switch, traffic received (bps) and traffic forwared (bps). All results are for 10BaseT Ethernet wiring standard for 4 minutes.

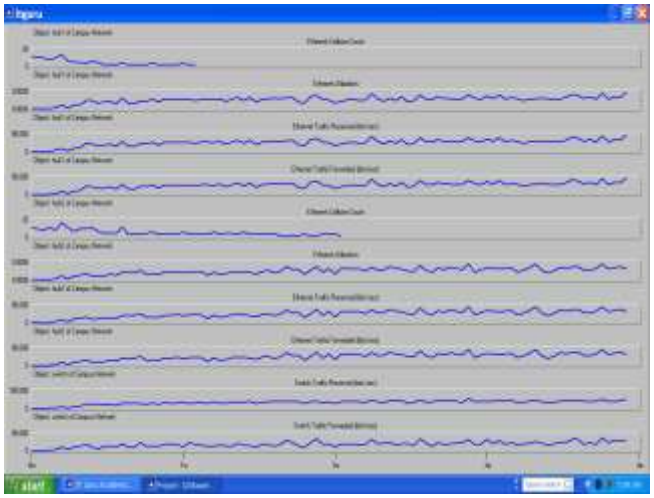

Figure 8. 100BaseT Standard with two hubs and time period is 4 min

These graphs show collision counts, utilization, traffic received (bps) and traffic forwarded (bps) for hub1 and hub2. Below two curves show results at switch, traffic received (bps) and traffic forwared (bps). All results are for 100BaseT Ethernet wiring standard for 4 minutes.

Case 3-When there are four hubs and time is 2 minutes.

TABLE VI. SIMULATED RESULTS OF HUB1, HUB2, HUB3 AND HUB4 TIME IS 2 MIN

Time duration	**2 Minutes**			
	Hub1		***Hub2***	
Standards	***10BaseT***	***100BaseT***	***10BaseT***	***100BaseT***
Collision Count	7.29	1.57	14.63	2.99
Utilization	0.005825	0.000423	0.006093	0.000339
Traffic Received (bps)	57951.53	41945.87	60385.67	33268.27
Traffic Forwarded (bps)	57951.53	41902.07	60385.67	33158.13
Filtered Traffic (bps)	**0.00**	**43.80**	**0.00**	**110.14**
	Hub3		***Hub4***	
Standards	***10BaseT***	***100BaseT***	***10BaseT***	***100BaseT***
Collision Count	10.76	2.12	17.81	3.74
Utilization	0.005983	0.000393	0.005635	0.000298
Traffic Received (bps)	59188.47	38698.40	55235.87	28723.80
Traffic Forwarded (bps)	59188.47	38455.60	55235.87	28486.87
Filtered Traffic (bps)	**0.00**	**242.80**	**0.00**	**236.93**

TABLE VII. SIMULATED RESULTS OF SWITCH, TIME IS 2 MIN

Time duration	**2 Minutes**	
	Switch	
Standards	***10BaseT***	***100BaseT***
Traffic Received (bps)	129827.07	70897.20
Traffic Forwarded (bps)	102915.27	71110.20

Filtered Traffic (bps)	**26911.80**	**-213.00**

Case 4-When there are four hubs and time is 4 minutes.

TABLE VIII. SIMULATED RESULTS OF HUB1, HUB2, HUB3 AND HUB4 TIME IS 4 MIN

Time duration	**4 Minutes**			
	Hub1		***Hub2***	
Standards	***10BaseT***	***100BaseT***	***10BaseT***	***100BaseT***
Collision Count	9.34	1.57	14.36	3.03
Utilization	0.005985	0.000500	0.005695	0.000450
Traffic Received (bps)	59649.97	49842.03	56677.93	44655.63
Traffic Forwarded (bps)	59649.97	49820.13	56677.93	44596.33
Filtered Traffic (bps)	**0.00**	**21.90**	**0.00**	**59.30**
	Hub3		***Hub4***	
Standards	***10BaseT***	***100BaseT***	***10BaseT***	***100BaseT***
Collision Count	10.48	2.12	19.19	4.50
Utilization	0.005726	0.000487	0.005830	0.000401
Traffic Received (bps)	56922.03	48460.03	57733.70	39297.07
Traffic Forwarded (bps)	56922.03	48338.63	57733.70	39157.73
Filtered Traffic (bps)	**0.00**	**121.40**	**0.00**	**139.34**

TABLE IX. SIMULATED RESULTS OF SWITCH, TIME IS 4 MIN

Time duration	**4 Minutes**	
	Switch	
Standards	***10BaseT***	***100BaseT***
Traffic Received (bps)	130067.10	97644.73
Traffic Forwarded (bps)	100906.93	84372.23
Filtered Traffic (bps)	**29160.17**	**13272.50**

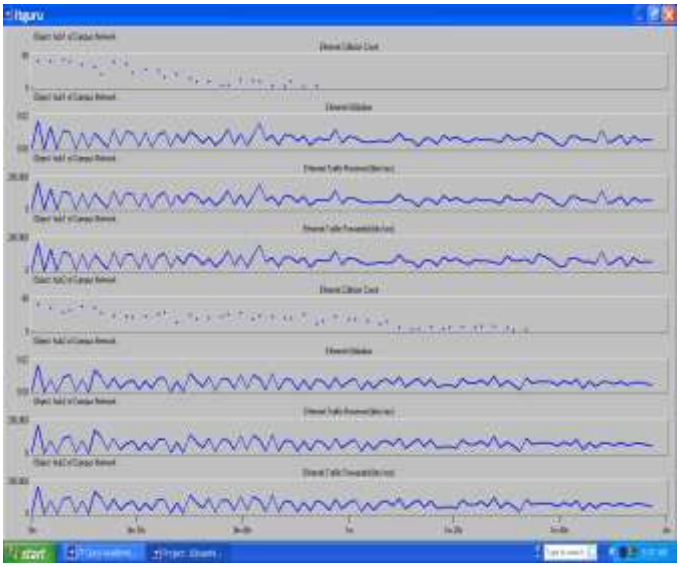

Figure 9. 10BaseT Standard with hub1 and hub2 and time period is 2 min

These graphs show collision counts, utilization, traffic received (bps) and traffic forwarded (bps) for hub1 and hub2. All results are for 10BaseT Ethernet wiring standard for 2 minutes.

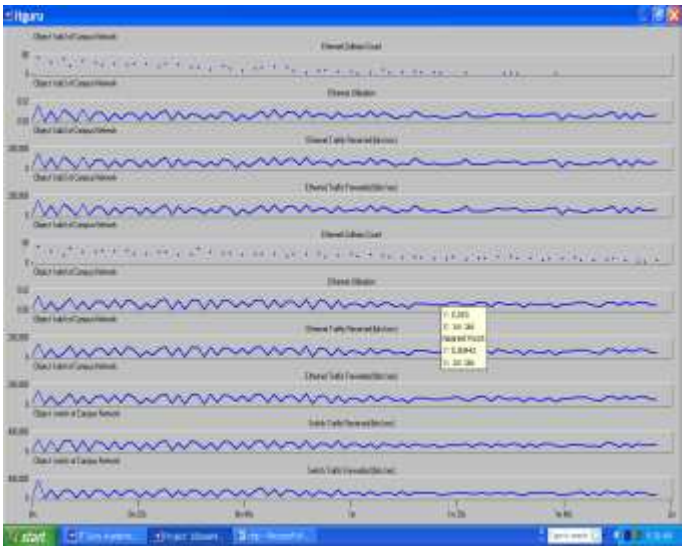

Figure 10. 10BaseT Standard with hub3, hub4 and switch , time period is 2 min

These graphs show collision counts, utilization, traffic received (bps) and traffic forwarded (bps) for hub3, hub4 and switch. Below two curves show results at switch, traffic received (bps) and traffic forwared (bps). All results are for 10BaseT Ethernet wiring standard for 2 minutes.

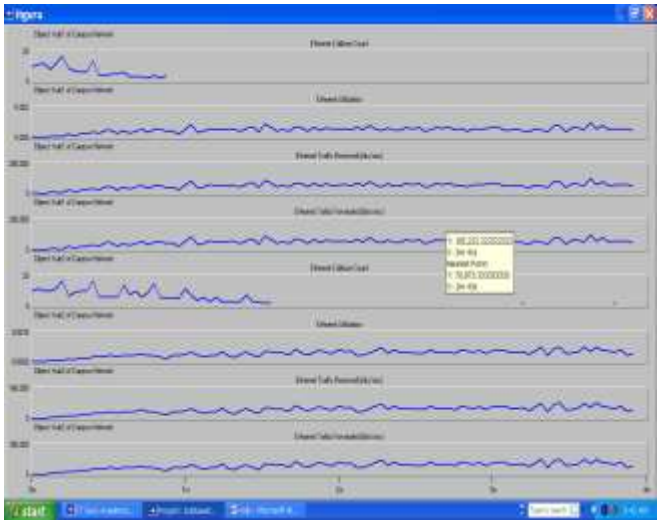

Figure 11. 100BaseT Standard with hub1 and hub2, time period is 4 min

These graphs show collision counts, utilization, traffic received (bps) and traffic forwarded (bps) for hub1 and hub2. All results are for 100BaseT Ethernet wiring standard for 4 minutes.

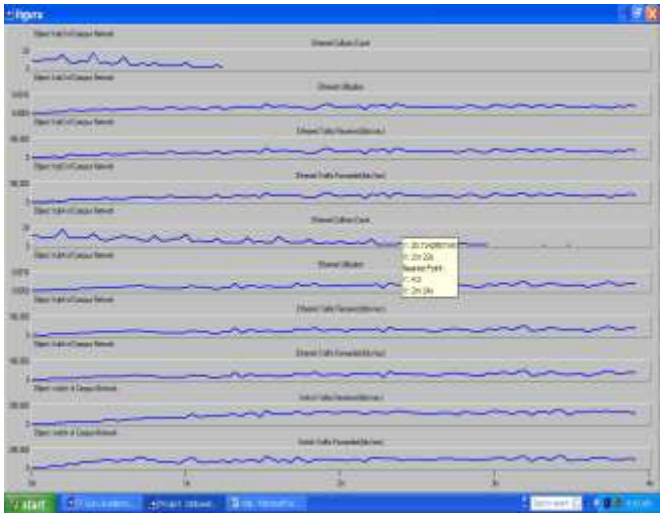

Figure 12. 100BaseT Standard with hub3, hub4 and switch, time period is 4 min

These graphs show collision counts, utilization, traffic received (bps) and traffic forwarded (bps) for hub3, hub4 and switch. Below two curves show results at switch, traffic received (bps) and traffic forwared (bps). All results are for 100BaseT Ethernet wiring standard for 4 minutes.

Note- In these tables we are not showing all simulated values at different time stamps. We calculate average values form all values and then we put them in these tables.

IV. CONCLUSION

We have calculated the performance of a campus LAN under different Ethernet wiring standards with varying time and different number of hubs some of the observations from the experiments are:

a) The numbers of collision counts at all hubs are always more under 10BaseT for all time duration, because of the nature of this standard.

b) Every time the hubs are more utilized in case of 10BaseT, because of more retransmission attempts due to high number of collisions in 10BaseT.

c) When we increase the time not the components (i.e. hubs) the performance of switch is good under 100BaseT because it filter more traffic with increasing time as compare to 10BaseT.

d) When we increase number of components under 100BaseT and also increase the time period, then 100BaseT works well because initially when time is less (2 min) the performance with four hubs is worst (filtered traffic at switch is -213 bps), but when we start increasing the time (4 min) the performance of 100BaseT standard is become good (filtered traffic at switch is 13272.50 bps). The same case with 10BaseT standard but it's not improvement rate is less than 100BaseT.

So final conclusion is that if number of components (i.e. hubs) are fixed and network is used for long time then always use 100BaseT standard in the implementation of LAN because it will give you good performance as compare to 10BaseT(compare Table III and V).

If more numbers of components are required and the network is used for long time, then in those situations always use 100BaseT standard, because it will give you good performance, as we find out in these simulations (compare Table VII and IX). In the same situation if network is used for short time then always preferred 10BaseT standard, it will give you better performance as compare to 100BaseT standard (refer Table VII).

V. FUTURE WORK

This paper can be further extended to calculate the performance of network under other different standards i.e. 1000BaseT with more assumption like frame size because here we consider a constant frame size. If we change the Ethernet standard and the frame size the results are different in those scenarios.

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