Comparative Analysis of Packet Loss in Extended Wired LAN Environment

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ABSTRACT
Computer network allows the sharing of data and resources in timely and an efficient manner. The devices used in computer network may be wired or wireless. Although wireless network provide more flexibility than wired network, but still to achieve fast data transfer speed most of the offices and colleges labs are still functioning on fixed infrastructure i.e. wired LANs. Wired LAN provides better results in terms of packet-loss and handover latency than wireless LANs. This paper simulates an office LAN using OPNET IT GURU EDUCATIONAL VERSION 14.5. Evaluation has been done onto different devices in different extended topologies, measuring performance metrics like traffic sent, traffic received, delay, packet loss that has occurred at lower levels of packet loss and collision in the Ethernet environment on different extended topologies. In addition, simulation shows the performance of extended LAN with respect to the utilization of hub and switch on mentioned parameters.

Index Terms
Ethernet, hub, switch, Collision count, Delay, Traffic Received, Traffic Sent, Utilization.

1. INTRODUCTION
A computer network [1] is a special arrangement of computers, printers, scanners etc. along with network devices such as hubs, switches, routers etc. to communicate data packets over internet and Internet. The communicating devices may be wired such as desktop, printer etc. or wireless such as laptop, mobile, PDA etc. Switches acts as a multiport bridge as they uses hardware addresses to process and forward data at the data link layer (layer 2) of OSI model.

The Ethernet hub [2] is one of the oldest devices for wired communication. The Ethernet hub is a device for connecting multiple Ethernet devices together and making them act as a single network segment, and also the Ethernet hubs are responsible to operate on a single network segment using the physical layer (layer 1) in OSI model. Hubs are now largely obsolete, having been replaced by Ethernet switches [3] except in very old installations or specialized applications. Ethernet switches create series of instant networks that contain only the two devices that communicate with each other at that particular moment.

On the basis of the working of hub can be categorized as follows:

A) **Active Hub**: It regenerates signals. Active hubs also called multiport repeater.

B) **Passive Hub**: It is just used to create connection between various devices without regenerating the incoming signal.

C) **Intelligent Hub**: It can perform tasks of both active and passive hubs. It increases the speed and effectiveness of total network hence making performance of whole network fast and efficient.

Ethernet switch and hubs are both used to network file servers, printers and workstations together, as these are the frequently used devices in any area related to computer science. The primary difference between a hub and switch is how the nodes communicate with the network. The basic measuring characteristics of wired medium are:

A) **Bandwidth:** Generally a layer-2 switch that operates on 10/100 Mbps speed. On the other hand, hubs can have maximum data transfer speed 10 Mbps and all nodes shares the bandwidth those are connected to the hub.

B) **Collisions:** A collision domain is a section of a network where data packets can collide with one another when being sent on a shared wired medium. The switch divides the wired medium into collision domains while hub doesn't. Hub always operates in half-duplex mode i.e. it cannot send and receive data at the same time. On the other hand, switch work in full-duplex mode i.e. it can send and receive data at the same time and no collisions occur in a full-duplex switch.

C) **Speed:** The hubs operate on 10 Mbps speed and switches operate on 100Mbps speed. With switch 100/10Mbps available with a network and switch allows devices on the network to reach their full capacity. For example hubs are not designed to handle this speed which operates by fiber optic cable.

D) **Network Failure:** The network failure may occur due to network communicating devices such as hub and switch along with faulty cable.

A similarity can be considered when thinking about the differences between a switched network and a hub network. With a hub, the network is like a single-lane highway, with data traffic often get slow due to some problem or even a crash along the road. A switch-based LAN [4] is like a multilane highway with traffic flowing in both directions. Users are always eager to communicate with higher speeds and greater reliability on the switch as compared to hub. They can add traffic to the network

without slowing to another down and simply bypass any problem.

Rest of the paper organized as follows: section 2 discusses related work and different type of switches. Section 3 deals with simulation scenarios for different topologies. Simulation results are shown in section 4. Conclusion and future work are discussed in section 5.

2. RELATED WORK

Ethernet switch is a device used to build a network connection between the attached communicating. Switches works on point-to-point methodology. Switches understand the packets addressing scheme for all ports, and forwards the data packet only to its destination address, thus limiting the number of collisions (data sent at the same time). The forwarding mechanism is based on Media Access Control (MAC) table. Ethernet switch is one of the important components of the computer technology today. Generally, it is defined as the type of networking switch that is used for the sake of data transmission between different computers over the network as the same speed of the as Ethernet switch. Now days, Ethernet switches may have data transfer speed up to 1Gbps. While hubs broadcasts the incoming data packets to all ports.

The working of Ethernet starts from developing their connection with the required networks with the help of parts present on the switch. When they are properly connected to the network, then Ethernet switch try to study the Media Access Control address (MAC) [5] of the computer system as soon as they receive their first information from the user's computer. Ethernet switch saves or record the number of MAC address in its memory and tries to locate another device on the network instead of the first computer device along with the help of the packet information. Ethernet switch build a connection with the switch after reading the MAC address of the device that receive the packets and record it like the first one and with the help of such storage of Ethernet switch it plays really important role for the Ethernet users. So this governs the working and performance of Ethernet switch along with their duties in Ethernet technology [6].

Broadly Ethernet switch are there that are used commonly to connect the different devices to the Ethernet and also helpful in maintaining the data transmission. Three basic types of switch [4] as discussed as follows:

A) **Cut-Through Switch**: The cut-through switch is used to forward the data packets that they received from different devices and also reduces the time taken by the Ethernet switch for their working operation is called as the cut through switch. They are generally not reliable and are unable to perform the task more accurately. Hence, these also affect the production of the packets over the network in the negative way.

B) **Store and Forward Switch**: The working of store and forward switches are quite different as compared to the other cut through switch. In this case data packets that are sent over the network store temporarily in the memories of these switch and only forward when there is the need of the packets otherwise they store all the data in it. As they can prevent the spread of errors on the network hence are more reliable and safer for the networking.

C) **Fragment Free Switch**: Fragment free is a variation on cut-through switch that partially addresses this problem by assuring that collision fragments are not forwarded. First 64 bytes are read from the source to detect a collision before forwarding. This is reliable only if there is a chance of a collision on the source device.

Ethernet switches significantly reduce the number of collisions on a LAN up to some extent. Switches do not create a single shared bus as hubs do. Instead swatches do the following:

a) Switches can typically send the frame out the one required port, rather than all other ports as these are capable enough to interpret the bits in received frame.

b) When it needs to forward multiple frames out the same port, the switch buffers the frames in memory, sending one at a time, thereby avoiding collisions.

3. SIMULATION

For the sake of simulation, we have setup an Ethernet network using Star topology which is interconnecting the hubs and switches in certain manners. The topologies chosen are forming extended LANs.

The key problem that Ethernet switch is that, it must deal with is the usage finite bandwidth to produce output. When packets destined for a certain output arrive at a switch and their arrival rate exceeds the capacity of that output. In this case, the switch will queue like structure of packets until the contention switch sides.

In simulation, a switched LAN set up with two basic connecting devices: hubs and switches. It is found during study the throughput and collision of packets in a switched network is affected by the configuration of the network and the types of switch devices that are used. Also it affects the amount of packet loss by each switch device using certain scenarios. During simulation, three extended topological scenarios are taken into consideration and discussed as follows:

A) First Scenario: Only hub Environment (5 Hubs)

In this scenario, LAN is created using 50 nodes and 5 Ethernet hubs with 16 ports each as maximum capacity.

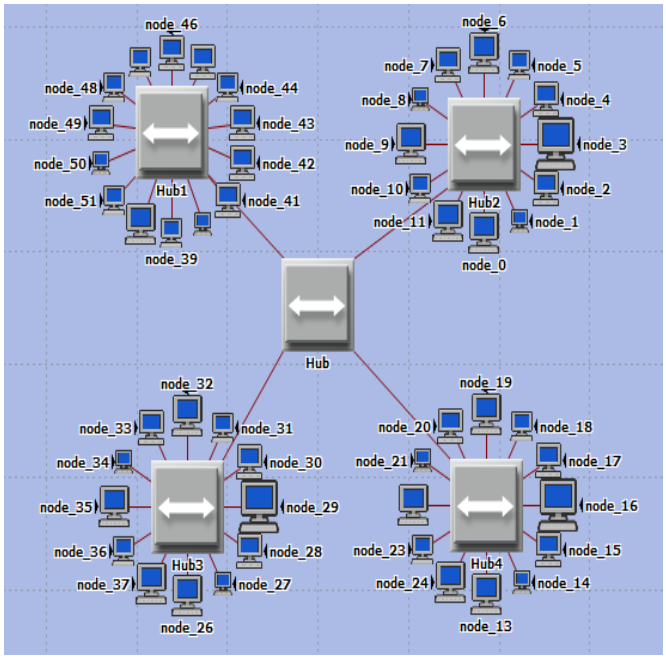

Figure 1: Ethernet hub connected with 50 nodes using Extended Star

B) Second Scenario: Only Switch Environment (5 Switches)

All 50 nodes are made connected through with hub using extended star topology using 10BaseT links that are connecting the node to the hub.

C) In this scenario, LAN is created using 50 nodes connected with 5 Ethernet switches, with maximum capacity of connecting 16 nodes, using extended star topology. The 10BaseT links are used to connect the node to the switch.

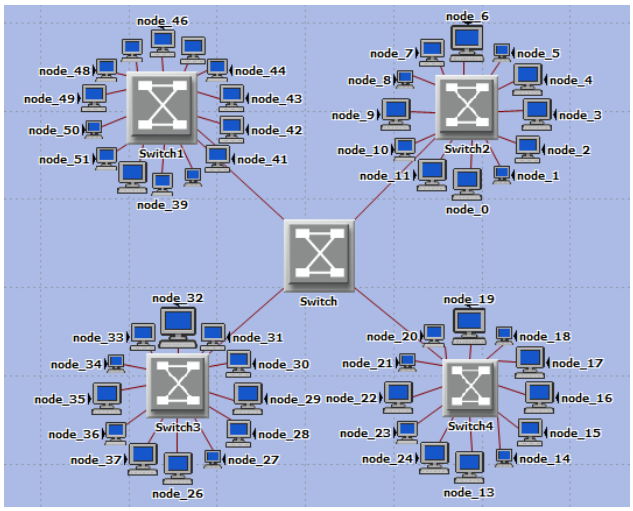

Figure 2: Ethernet switch connected with 50 nodes using Extended Star

D) Third Scenario: Mixed Environment (1 switch and 4 hubs)

In this scenario, a switch is added to the network of Figure 1. First it is divided into four segments, each as separate domain connected with Ethernet hub. Each hub will have connection to either 12 or 16 nodes. The LAN segments with hubs are connected via Ethernet switch, having 16 ports as maximum capacity and 10BaseT link is used for all connections.

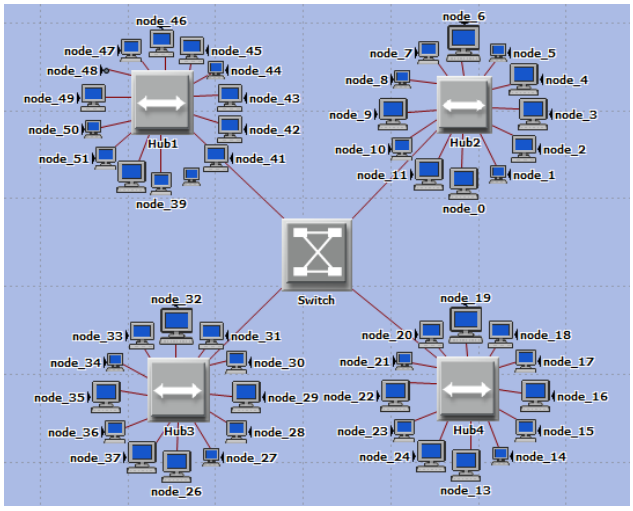

Figure 3: Four hub LANs are connected with Ethernet switch

4. ANALYSIS OF SIMULATION

After implementing and running the simulation for all three scenarios defined above. We found that in each scenario switches are performing better than hub environment. The analysis for different scenarios on different aspects is as following:

A) Traffic sent: The graph shows an identical picture for all three scenarios. The two devices are capable enough to transfer the packets to the destined device. But is seen to be more frequent in case of switches.

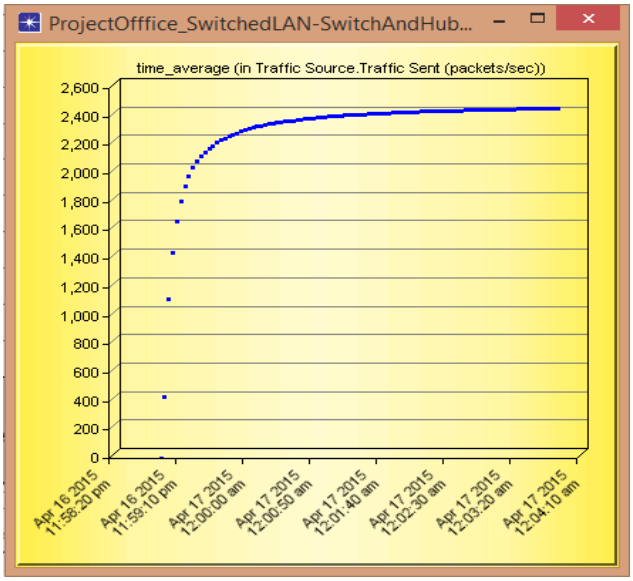

Figure 4: Traffic sent for all three scenarios

B) Traffic received: In case of only hub and only switch, the packets received are identical, but while in case of switch and hub, in Figure 5, got with the better availability when added a switch to the existing network.

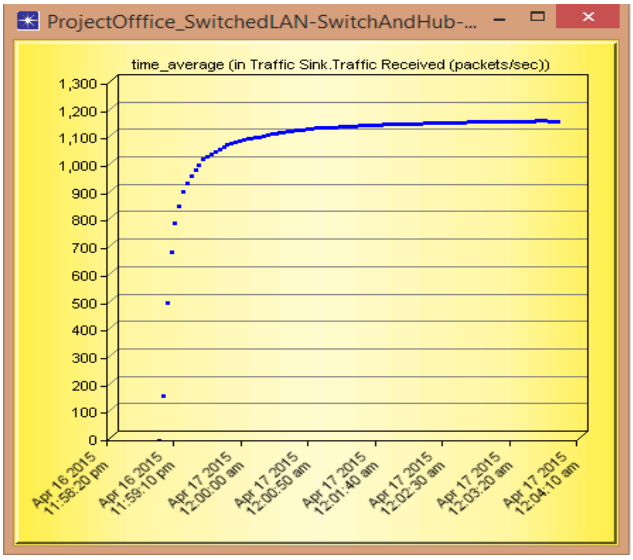

Figure 5: Packets Received for all three scenarios

Switch transmits Packets to the destination node on basis of MAC address; it will increase the throughput of the network and by using switch reduces the sharing of bandwidth which provides better availability of transfer packets for each node.

C) Delay: For only hub scenario, delay is increasing at the beginning when used hubs, which are non-self-configured devices, so the starting delay is expected. For only switch scenario, delay has reduced to some extent as they are

automatically configured devices and hence minimum or no delay is expected. While in case of switch and hub scenario, delay has reduced and also at the beginning there is no delay that means switch are more efficient than hubs.

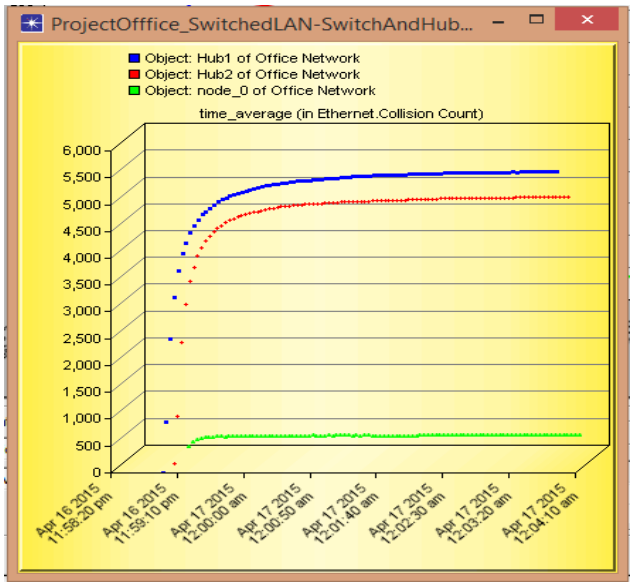

Figure 6: Delay for all three scenarios

D) Collision count: The collisions count refers to the numbers of collisions that occurred in the network

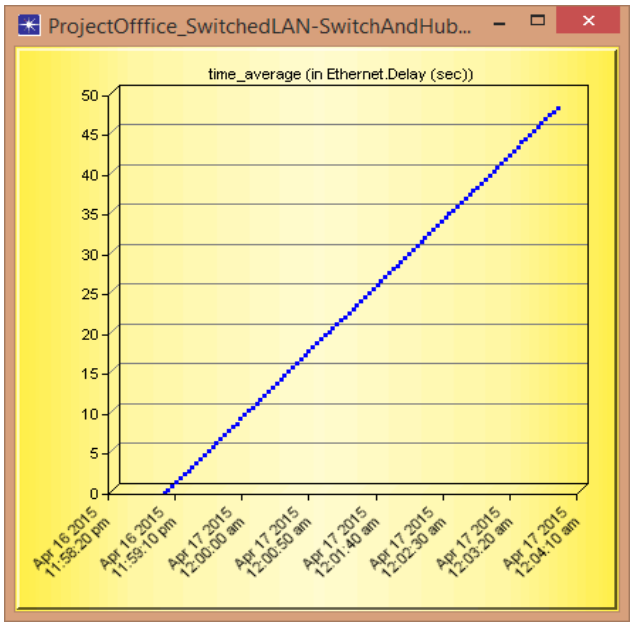

Figure 7: Collision count for all three scenarios.

It is clearly seen that there are only two graphs that visible in the Figure 7, as by using of switch that create no or minimum collisions in a network. In case of only hub and switch and hub scenario, delay factor has considered. In case of only hub scenario, collision count is high, but in scenario of switch and hub, the collision count is very low. Protocols which are used in network that contain switch help in reducing the collision of packets in the network.

E) Load: Load [7] can be taken as traffic in a network that may occur as obstacle to a network. The load factor should be decreased while communicating in a network.

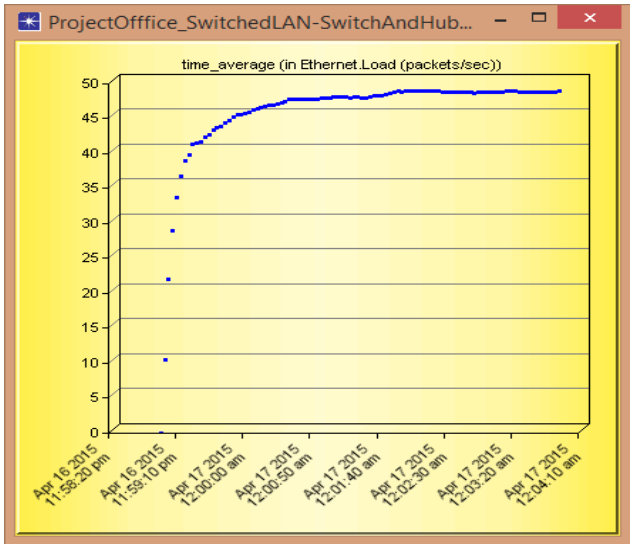

Figure 8: Load for all three scenarios

Hub will send data packets to all other output lines, which means that when one receives a packet on an input line, the hub will forward the packets to all other nodes, while switch will send the received packet to the dedicated line from all other nodes. This functionality of switch helps in increasing the throughput.

F) Low level point-to-point packet loss: Packet loss that has occurred at the starting when dealt with hubs. Hubs introduced the higher packet loss ratio, started at the beginning of transfer.

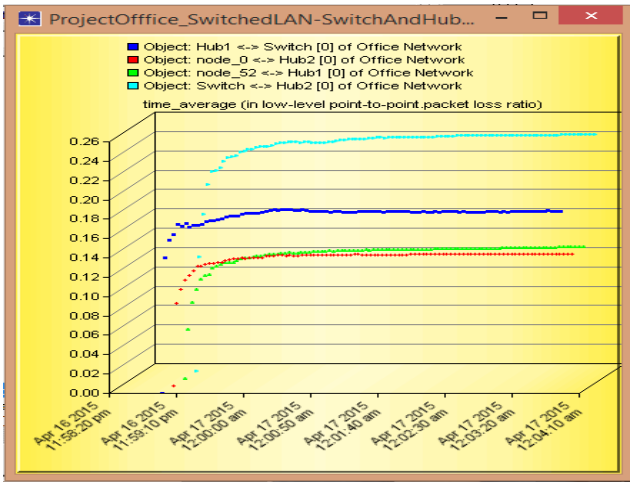

Figure 9: Packet loss ratio for all three scenarios.

5. CONCLUSION

Packet loss in LAN depends on number of collisions taken place, clearly depicted in Figure 9. If the numbers of collision are more, the packet loss will be more. On considering the comparative study it is found that hubs suffered from delay, decreased throughput, packet loss and increased collision count. On the other hand, switch increases the performance of the network in compare to a hub. This proves that adding a switch in a network and it can be clearly justified by analysis done. When it is concerned with the particular field consisting of larger numbered devices, switches behaves in an efficient way, leading to full utilization to a network. On the basis of

above parameters analysed, in future it is seemed to optimize the delay at more sophisticated level.

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