Evaluation and Investigation of Throughput and Delay on Ethernet and FDDI Technologies using OPNET.

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ABSTRACT

The performance evaluation of any technology is based on certain parameters such as throughput and delay among others, experienced from one user to the others. The behavior of this technology can be affected by the number of users or nodes and certain generation parameters. This design work is aim to evaluate and investigate the behavior of throughput and delay on two different technologies: Ethernet and FDDI. Using two scenarios with 20 nodes each and design with OPNET-MODELER simulator, the two technologies operate at a speed of 100Mbps. The two scenarios created were analyzed using the result generated from the graph. It was concluded that throughput in Ethernet is greater than that of FDDI and delay experienced by the Ethernet network is more than that of FDDI when the same number of nodes were used.

(Keywords**:** OPNET-Modeler, Ethernet, FDDI, throughput, delay, CSMA/CD, carrier sense multiple access with collision detection)

INTRODUCTION

Introduction to Ethernet (802.3)

Ethernet is a local area technology that is flexible, relatively cheap, reasonably fast, and very popular technology used for most applications [1]. It was originally developed by Digital Equipment Corporation (DEC), Xerox, and Intel and was standardized by IEEE as the 802.3.

Ethernet was designed as a 'broadcast' system, that is, a station can send messages to any other stations at any time. Only the station to which the message is sent will respond. The common Ethernet technologies include 10 Base-5(thick wire), 10 Base-2(thin wire), 10 Base-T (Ethernet over UTP), 10 Base-FL (Ethernet over fiber Optics), and 100 base-T [2] among others.

All versions of Ethernet use a Media Access Control (MAC) protocol called CSMA/CD to controls which devices can transmit data to the network, and when they can do so [2].

FDDI

FDDI known as Fiber Distributed Data Interface is a 100 Mbps LAN technology that runs over fiber optic or copper cable. Being the oldest 100 Mbps network type available, it is mostly used as a backbone technology for connecting many Ethernet or Token Ring networks together. It can also be used for a specific application that requires high speed. Three topologies used by FDDI are Ring, Star and Tree. They can be combined to form a larger and robust network (for example, 400 or more nodes) with many advantages over each different network while avoiding their drawbacks [2]. There are four cable types that can be used with FDDI namely: Multimode Fiber Optic Cable (cover distance of up to 2000m), Singlemode Fiber Optic Cable (cover distance of up to 10,000m), Category 5 UTP (maximum distance of 100m) and IBM Type 1 STP (maximum distance of 100m) [1].

RELATED WORK

This section describes the past work on various aspect of Ethernet and FDDI technology. Chan et al. [2] investigated several different technologies such as ATM, FDDI and Gigabit Ethernet on LAN backbones using OPNET.

Using several scenarios, the authors concluded that Gigabit Ethernet outperforms other two backbones because of its high bandwidth and easy adaptability with LANs.

In Amarvir Singh's [3] work, two networks- Ethernet and Fiber Distributed Data Interface (FDDI) were created using OPNET. The test carried out on the result measured a combination of network throughput, delay and collision count. The performance results, according to the author, provided interesting insights into the behavior of these networks under various load conditions.

SCENARIOS DESCRIPTION

To be able to evaluate the performance of the two technologies in consideration, OPNET (Optimized Network Engineering Tools) network simulator [3] was used to build the simulation networks and environment was set up to compare their performances.

The Ethernet is a full duplex multi-access network and uses a Media Access Control (MAC) protocols called CSMA/CD to control which and when devices can transmit and receive data over the network. Every device that needs to send data to a network first listens to the wire to know if someone else is sending (carrier sense), and if there is, wait for a random amount of time for that device to finish sending otherwise it sends its own data. This is done to prevent collision and is efficient under periods of light load [1]. As the network load increases, collision also increases and a point will be reached where devices spend more time retransmitting and waiting unnecessarily for a longer time than they actually do in transmitting.

FDDI uses two rings (for fault tolerance) to connect all nodes or users in the network. Each ring transmits data in opposite direction to each other. Mostly, the primary ring carries the data while the secondary ring is idle. When there is a break in the ring, the primary ring is looped to the secondary ring by the nodes or users nearest the break thus bypassing the fault and results in an unbroken ring [1]. In addition, the two rings can be used for data transmission at the same time to boosts the network speed by double.

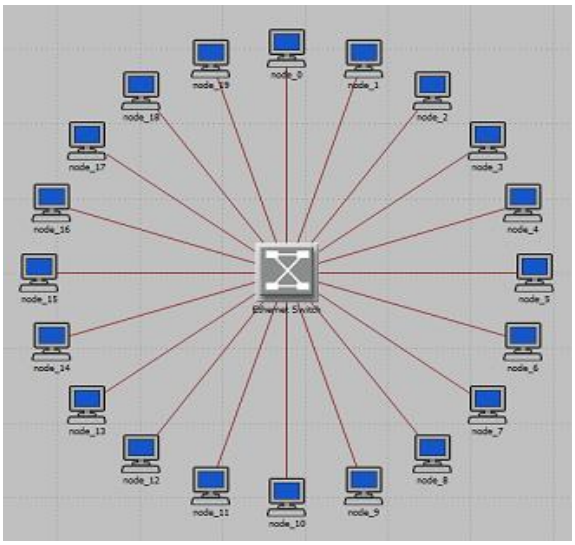

Figure 1: Ethernet Network Model for 20 Ethernet Nodes (Scenario 1).

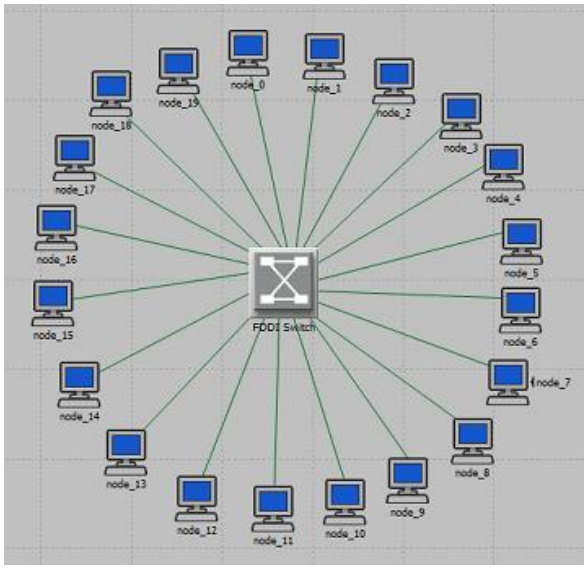

Figure 2: FDDI Network Model for 20 FDDI Nodes (Scenario 2).

DESIGN PARAMETERS

In scenario 1, Ethernet model was created using 20 nodes connected to a central switch (Ethernet32_switch) using 100 Base T link. 100Base T link was used to ensure the design of 100Mbps Ethernet which gives a faster speed of 100mbps and the switch used support up to 32 interfaces, 100mbps data rate and it is a duplex link.

The Ethernet32_switch used perform intelligent function like filtering and prevent collision when information is been passed among the nodes. Table 1 below shows the parameters used to generate traffic and packet for Ethernet model.

Table 1: Ethernet Traffic Generation Parameters.

Start time (seconds)	Constant (1.0)
ON State Time	Exponential (100.0)
OFF State Time	Exponential (0.0)
Interarrival Time	Exponential (0.02)

In scenario 2, FDDI model was created using 20 nodes connected to an fddi64_layer_switch at the center using FDDI link. FDDI link was used to connect each user to a 64-ports switch to form an FDDI ring at 100mbps. A 64-port switch was used because 32-port switch was not available for this work and using two 16-ports switch will create an additional cost overhead.

Table 2 below shows the parameters used to generate traffic and packet for FDDI model.

Table 2: FDDI Traffic Generation Parameters.

Start time (seconds)	Constant (1.0)
ON State Time	Exponential (100.0)
OFF State Time	Exponential (0.0)
Interarrival Time	Exponential (0.02)
Packet Size	Exponential (1024)

Performance Parameters

Throughput: This is the average number of successful message delivered over a communication link or channel. It is measure in bits per second (bps) or data packets per slot. The system throughput is the sum of the data rate delivered to the network terminals.

Delay: This is the time taken for messages to be passed between nodes or users in a network. It is refers to as the time it takes a packet of data to go from one node to the other. It is expressed in seconds and sometimes called latency.

INVESTIGATION AND ANALYSIS

Analysis for the Throughput

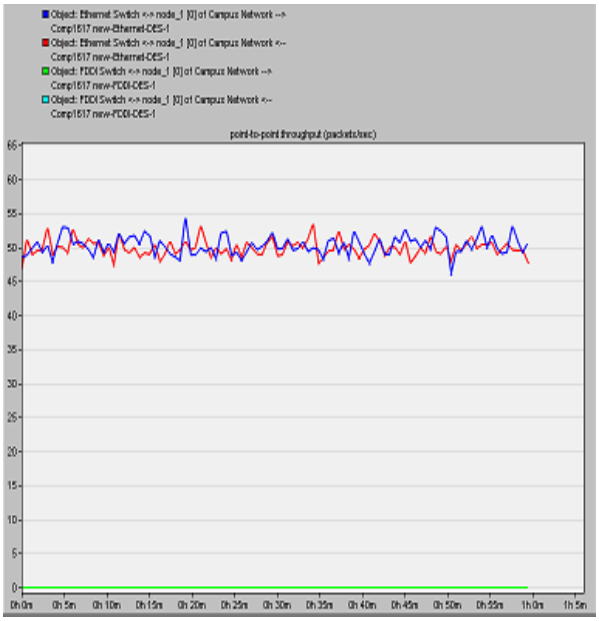

Figure 3: Throughput for Ethernet and FDDI

In Figure 3 above, the throughput in bit/sec of FDDI is shown in green color and that of Ethernet in red and blue for 20 users. It could be observed that the throughput of FDDI is less than 1 bits/sec at node_1 and node_2 while the throughput of Ethernet is at 50 bits/sec at each node_1 and node_2. This means that in FDDI, as more traffic is generated, the rate of collision increases and thus lowering the throughput. Throughput is high in Ethernet because CSMA/CD is used to filter and prevent collision.

Result Analysis for the Delay

In the Figure 4, the delay for FDDI in seconds is shown in red color and Ethernet in blue color. It is observed that delay in FDDI is lower (about 0.00026secs) as compared to Ethernet (about 0.00030secs). This shows that FDDI operates at higher speed than Ethernet. This result also shows that FDDI are good for demanding applications which need to transfer large amounts of data in a short amount of time. However, the delivery of the data may not be guarantee as collision is bound to occur.

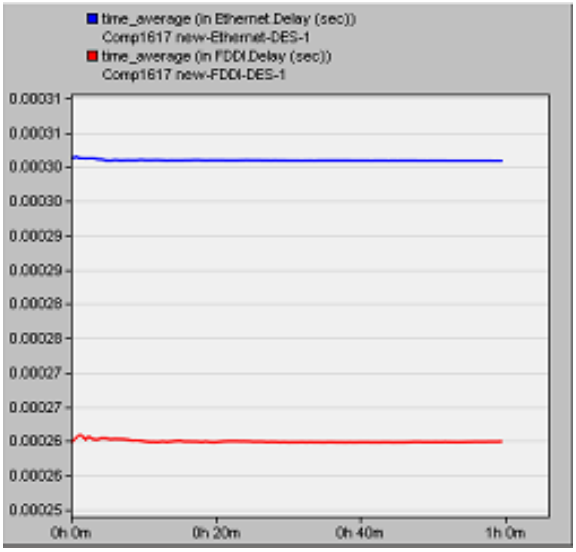

Figure 4: Delay for Ethernet and FDDI.

CONCLUSION

The network model designed here clearly helps to evaluate and investigate behavior of an Ethernet and FDDI technologies. Different parameters and arguments were used and various observations made in terms of throughput and delay. This work clearly indicates that an Ethernet technology is better when throughput is being considered because of its ability to filter error and prevent collisions. Thus, justify the higher throughput as shown in the result.

However, FDDI is the best and suitable for larger network when putting delay into consideration. FDDI technology is faster, does not filter and does not delay much because it uses fiber-optic cables which are a faster technology.

RECOMMENDATIONS

Since each of the two technologies under consideration behaves differently using the two parameters above, it would be recommended that both technologies should be combined in a network to create a high speed backbone interconnecting a large number of small Ethernet networks. The resulting network will combine the advantage of the speed and reliability of FDDI with the high performance and cost benefit of Ethernet. More work can be done based on the above result to evaluate and investigate behavior of throughput and delay on Ethernet and FDDI by varying the number of nodes. Other parameters than throughput and delay can be used for better evaluation. In addition, other simulators or software apart from OPNET may also be used to investigate behavior of Ethernet and FDDI further.

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SUGGESTED CITATION

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