

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF COMPUTER SCIENCE

**A COMPARATIVE ANALYSIS OF NETWORK PERFORMANCES OF ETHERNET,
TOKEN RING AND FDDI PROTOCOLS IN DISTRIBUTED SYSTEMS**

BY

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DECLARATION

I hereby declare that this thesis is my own work towards the Master of Science Degree and that, to the best of my knowledge, it contains no material previously published by another person or material which has been accepted for the award of any other degree of the University, except where due acknowledgment has been made in the text.

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DEDICATION

I dedicate this thesis to God almighty the giver of Wisdom and knowledge and my son, James Caleb.

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ABSTRACT

Internet connectivity is growing with most enterprises shifting to the use of web-based services to satisfy the demands of clients in their organisations. The choice of suitable LAN protocols in network design is of great concern to individuals and organisations. Failure to make the right choice can lead to poor network performances that lower the speed to access information. How can organizations' LAN performances be improved? How fast is data or information transmitted to and from business organization? This research work was carried out to investigate a comparative analysis of network performances of Ethernet, Token Ring and FDDI protocols in terms of throughput and delay in a distributed system. In the study, three LAN protocols; Ethernet, FDDI and Token Ring were modelled and devices within the network were configured using Cisco Packet Tracer Version 7.1 to evaluate their network performances. Varied packet sizes were sent from one station to another workstation on each of the scenarios created. The simulation exercise was conducted after which the time it takes for a machine to receive a packet and sending machine to receive an acknowledgement is recorded and evaluated. The difference between the times a packet was sent from machine to another and the time to take acknowledgement of receipt of the packet was computed as delay. Several scenarios were evaluated through simulations using Cisco Packet Tracer Version 7.1 to show network performances of the three networks. The simulation was done 10 times each for the different scenarios using FTP and SMTP application of a constant packet sizes with varied time and vice versa. The time was recorded as well as averages computed. The general conclusion is that based on the performance metrics; delay and throughput used in the

study, FDDI recorded the least values of throughput and delay in most of the scenarios according to the tables and figures.

FDDI therefore have better network performance than Token Ring and Ethernet.

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LIST OF ABBREVIATIONS

ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
ARP	ADDRESS RESOLUTION PROTOCOL
CRC	CYCLIC REDUNDANCY CHECK
CSMA/CD	CARRIER SENSE MULTIPLE ACCESS WITH COLLISION DETECTION

DHCP	DYNAMIC HOST CONTROL PROTOCOL
EIGRP	ENHANCED INTERIOR GATEWAY ROUTING PROTOCOL
FCS	FRAME CHECK SEQUENCE
FDDI	FIBER DISTRIBUTED DATA INTERFACE
FTP	FILE TRANSFER PROTOCOL
ICMP	INTERNET CONTROL MESSAGE PROTOCOL
IEEE	INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS
IGRP	INTERIOR GATEWAY ROUTING PROTOCOL
IP	INTERNET PROTOCOL
ISO	INTERNATIONAL ORGANISATION FOR STANDARDIZATION
LAN	LOCAL AREA NETWORK
NTCIP	NATIONAL TRANSPORTATION COMMUNICATIONS FOR INTELLIGENT TRANSPORTATION SYSTEM PROTOCOL
PC	PERSONAL COMPUTER
PDU	PORTAL DATA UNIT
RIP	ROUTING INFORMATION PROTOCOL
SMTP	SIMPLE MAIL TRANSFER PROTOCOL
TCP/IP	TRANSMISSION CONTROL PROTOCOL / INTERNET PROTOCOL
WAN	WIDE AREA NETWORK

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Distributed system is a system whose components are located on different networked computers to communicate and coordinate actions by passing messages to one other to achieve a common goal. The use of LAN protocol in network design affects communication in distributive systems. The need for organizations and individuals to communicate, send messages, share data, and access computing resources has contributed to the development and spread of Local Area Network (LAN). Technological innovations are fundamentally changing the way people live, work, play, share information and communicate with each other (Shelth et al., 2011). This is seen to be improving organisations' competitive edge as it gives them and their customers, quick access to information. With the evolution of Internet, the networking technology is not just confined to resource sharing but has boomed in the arena of cellular and mobile communication as well.

LAN is a network that connects users in a moderately sized geographic area. Typically, a LAN connects users located in the same office, on the same floor, or in the same building. The common LAN technologies are Token Ring, Fiber Distributed Data Interface (FDDI) and Ethernet.

This research seeks to investigate and compare network performances of Ethernet, Token Ring and FDDI protocols in distributed systems using Cisco Packet Tracer Version 7.1. The analysis of result would help compare performances of the three LAN protocols and determine the most suitable one for network design.

1.2 Statement of the Problem

Local Area Networks (LANs) play an important role in everyday functioning of schools, businesses, and government institutions. LANs save people time, lower equipment costs and allow sensitive information to remain in a secure location. Therefore, the choice of appropriate LAN protocol in network design is of great concern. Organisations and Institutions that are unable to make the right choice of LAN protocol in their network design lead to poor network performances and lower the speed of access to information.

How can organisations' LAN performances be improved? How fast is data or information transmitted to and from business organisations? These are some bothering questions the researcher intends to find answers to.

The researcher therefore seeks to compare and evaluate network performances of the three LAN protocols: Ethernet, Token Ring and FDDI in distributed systems for appropriate choices to be made.

1.3 Objectives

The goal of the research is to compare and analyse network performances of the three LAN protocols; Ethernet, Token Ring and FDDI protocols in terms of throughput and delay in distributed systems.

The specific objectives are to:

- i. study and compare the network performances of Ethernet, token ring and FDDI in distributed systems
- ii. investigate what happen to the network performances of the three LAN technologies when the number of the work stations are increased
- iii. analyse the effect of LAN protocols and delay on network performances

1.4 Research Questions

The following research questions will guide the researcher

- i. How is the use of Ethernet, token ring or FDDI LAN protocols affect network performance in network design?
- ii. What happen to network performances when the number of workstation is increased?
- iii. What is the effect of LAN protocols and delay on network performance?

1.5 Research Hypothesis

H1. Network performances are affected using Ethernet, token ring or FDDI LAN technologies in the network design.

H0. Network performances are not affected using Ethernet, token ring or FDDI LAN technologies in the network design.

H1. Network performances are affected when number of work stations is increased

H0. Network performances are not affected when number of work stations is increased

H1. LAN protocols and delay affect network performances

H0. LAN protocols and delay do not affect network performances

1.6 Significance of the study

The study will help network designers and LAN users to understand and choose the right LAN protocol in network design to boost their network performances.

It will also be used as learning or reference material in further studies of related topic.

1.7 Scope of the study

This project will focus on the three common LAN technologies: Ethernet, Token Ring and FDDI and compare their performances in network design using performance metrics delay and throughput. Also, Cisco Packet Tracer Version 7.1 simulator will be used to analyse and compare the performances of these common LAN technologies.

1.8 Organization of the Thesis

The study is organized into five chapters.

Chapter One explains the background to the study, objectives, research questions and hypothesis, significance and the scope of the study.

Chapter Two will review previous studies and theories on networking with emphasis on Ethernet, Token Ring and FDDI and their network performances.

Chapter Three delves into the research methodology used. It further details about the simulation tool: Cisco Packet Tracer Version 7.1 used. Also, the three networks will be modelled, scenarios created and simulation exercises will be conducted and results to be picked for analysis in chapter four.

Chapter Four discusses and analyses all the results obtained from the simulation exercises conducted in a graphical format.

Chapter Five includes summary of findings, conclusion, recommendation(s) and suggestions for further research work.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviewed theoretical literature regarding the use of Ethernet, token ring and FDDI LAN protocols and how they affect network performance in network design. Moreover, the empirical literature is also reviewed regarding the effect of Ethernet load and delay on network performance.

2.2 Theoretical Literature

There are several research efforts on-going in the academia and the industry to analyse and compare the network performances of common LAN protocols.

2.2.1 The Network Performances of Ethernet, Token ring and FDDI in Distributed Systems

Ethernet is the most common LAN technology today. It is designed for point-to-point communications and uses multiple access calculations; Carrier Sense Multiple Access with Collision Detection (CSMA/CD) to manage data collisions that occur while trying to transmit data simultaneously (De Leuw, 2006).

2.2.2 Token Ring and Fiber Distributed Data Interface Networks

Fiber Distributed Data Interface and Token Ring Networks are designed to handle redundant data transmission paths if one of them cannot be used. FDDI can be implemented as the highest speed version of Token Ring and is designed for fiber optic cables. The main principle of marking is that one modem accesses the communication loop at a time. A modem sends its packets around the loop. When the message is completely transmitted in the loop, the modem disconnects data from the loop and transfers control to the next modem token in

the string.

2.2.3 Token Ring Overview

Token loops were originally created to avoid conditions that could lead to data conflicts. In principle, a special code is passed from one node to another so that the node that has obtained the token moves the data. Delete the node from the token in the data path; insert its address and the node address to send the data, and then the data you want to send. The packet is resent in the loop and each node is scanned to determine if it is a receiving node or a transmitting node. If the receiving node copies the packet to the node to its connection, it adds the data it has already received and prepares the data for confirmation to the next node. When the packet is returned to the sending node, the node removes the packet from the loop and passes the token to the next node in the row.

The main difference between the cycles of one token (IEEE 802.5), and FDDI is the sending of FDDI packets, rather than waiting for the code to be sent to the next node immediately after the packet does not make its entry path code free around the loop. This can make the FDDI polling time much faster, as long as the remote node has a ready answer once it has been requested. The transmission system has some associated delays because each node must read enough data to determine if the sender sends downstream of the next node of the data (Halsall, 2006).

In their study (Goff, 2009), assuming that the tag loops in the mode of failover mode, it needs to know if it is physically connected to its neighbor, and the transmitter should carefully check that the interface test will be added to the receiver Remove the package from the ring. If the node is not connected to its neighbor, it retransmits the code received in the same direction it came in, and the package moves the chain in the opposite direction. The cable may be damaged before the data packet needs to reach the receiver node again through the master node. This may be because the node will not receive the icon within the specified time. If this happens, a symbolic query algorithm will be created where a special window is passed in the loop. If this

window is returned to the source node, this node now has a token. This allows a useful marker cycle, even if more than one cable break occurs in the loop, because each cell can send data between connected nodes (Halsall et al., 2006).

2.2.4 Timing Efficiency of the Token Ring

The number of bits describes the minimum known delay for each node in the symbol period. The length of the sign bit is given by the access time in the FDDI input at each node, so 24 bits are from 0 to 6 additional bits. The elasticity of the buffer, which is the extra number of bits needed to maintain regular cycle delays. This buffer allows FDDI nodes to use asynchronous clocks.

2.2.5 Geographical Limitations of FDDI

The FDDI standard has limitations. The maximum distance between any two nodes in the network is 2 kilometers. There are only 500 nodes in one cycle. The distance between two kidneys is 200 kilometers, but if it needs 100 kilometers to work under overload conditions. This drawback is due to the fact that each node in the cycle expects to see at least one actual symbol within 2.5 milliseconds, assuming a periodic problem.

2.2.6 Linear Bus Topology with Master in the Middle

In principle, the line bus can be considered as a redundant circuit in the event of a cable cut. If two remote nodes in the line bus are to be connected together to form a loop, there are two problems that must be eliminated. First, the initiator should be able to separate the request initiated by him from the response generated by the remote node because if the linear carriers are linked as links, they will be located in their own receiving ports. Second, because the master sends data to both rings, the remote node must have some means of identification and knowledge to respond to the query without causing data collisions. This problem is similar to using a LAN bridge to create a loop. LAN bridges use extended tree algorithms to solve this problem (Peterson et al., 2006).

2.2.7 Ring Topology and Cable Break

In principle, the spanning tree algorithm assigns a bridge as a root, and all other bridges create a path for the primary bridge, which will be the only path that will be used for data transmission. This algorithm works in a peer-to-peer network, so the network's host bridge can be any bridge in the network. In addition, if a cable failure or bridge failure occurs, the algorithm should send a configuration message to enable reconfiguration (Stallings, 2007).

2.3 Network with Multiple Loops

2.3.1 Spanning Tree Equivalent Network

The spanning tree algorithm is made simple in the polled ITS application. This is due to the fact that the root node must at all times be used as the master node. Alternatively, the problems as indicated above regarding the ring can be resolved by just incrementing it with one special signal, one tone transmitted from one of the master ports. Once the tone is acknowledged by the neighbouring remote node which is downstream which then is transmitted to the next remote node in the ring (Siller et al, 2012).

2.3.2 The Tone Method

A request received from each field unit master modem, connected to that particular field unit sends a fiber optic modem, and at the same time sends back from the master modem to the next optical modem at the current fiber optic modem. The field device then sends a response back to the master modem, which occurs through each fiber optic modem in the row.

When a control signal is added, the line bus is configured as the final loop. Each field modem contains a data port connected to the master modem. The method used to add the minimum load is called the current packet, which provides signal routing information for each on-site modem. FDDI techniques and tones seem to be the most effective for ITS applications. The system is used for fiber optic ITS applications by using a linear linear topology.

The request from the line bus master is sent downstream, away from the master modem on a fiber, and the annotation is sent by the other fiber itself. In each remote node, a request is sent from the master modem to the remote domain controller, and the synchronous alternate node drag repeats after the last point of the line name requested to be sent. Rules are executed by the site control unit if they are processed without involving the nodes they are connected to. To illustrate this in a different way, all remote nodes have access to all requests from the master modem.

If it is expected that the node will work with the request, different fibers will be used to send the response back to the master modem. Direct network, which is closer to the main component, returns these comments to the next node without having to reformat them into a field controller associated with the node as long as the message reaches the node in the head. This means that remote nodes on the network are only represented by dynamic queries from home without receiving comments from other nodes on the network. Due to the use of other fiber's response data, the remote site used can respond at the same time as the primary node performs the request, making it a complete two-channel node.

If this happens, the master uses two send ports to move the request and set a response at the receive port and can place it anywhere on the line bus, not necessarily at both ends.

2.4 Empirical Literature

2.4.1 The Effect of Ethernet Load and Delay on Network Performances

2.4.2 Data Reliability (Redundancy)

According to Minoli (2003), various means are available to be used in enhancing the options that data sent from one node arrive without being broken at another node in a network. A typical example of such techniques is sending data over different channels from the source of transmission to its destination where the receiver is located.

Data can also be transmitted in one direction, even if this path is not available, it will be sent in different ways. By adding some error/error information to the data packets being sent, the reliability of the data can also be improved.

Fiber optic connections are often organized to obtain a bit error rate, which makes it very important to detect or correct errors in the network where the fiber is located. Attempting to detect errors in the fiber network is necessary, especially if there is a break of the fiber during packet transmission. In fact, the data in the ITS network under investigation contains a so-called cyclic redundancy code (CRC), which is evaluated by the master node and the remote partition, regardless of the transmission method used for the communication.

Therefore, having the communications network which also incorporates error detection/ error correction is unnecessary; since the devices connected to the network already perform this function. (Siller et.al. 2012)

2.4.3 The Network Cost

According to Stallings (2007), the cost one has to incur in having computer network depends on many factors and majority of these are similar to using either FDDI or the tone method.

The variation in terms of cost between the two techniques will largely be based on the cost to incur for using fiber modems. Invariably, a network connection in which fiber modem is used with high latency will eventually shoot up cost.

2.4.4 Parameters Most Critical to the ITS Application

2.4.4.1 The Ring Poll Time

Used for FDDI technology, the central standard for formulation technical tone, called response time (Peterson et al., 2006). It is said that the polling time - time spent on the master node is associated with each remote node. This is very important in communication, from one center to another in many applications in intelligent transportation systems.

In planning to use National Transportation Communications for Intelligent Protocol (NTCIP) from one central location to another, this is an ongoing field study that will need to consider the communication network for the collaborative availability of these key variables:

- Transmission rate, method and delay
- Response delay in the field device
- Time between devices or between polling cycles (if needed)
- Length of message(s) to be sent
- Frequency of each type of message
- Number of devices sharing the same line or channel
- Frequency of communication

2.4.4.2 Geographical Restrictions Related to the Ring

In applications that check network traffic, the number of modems and the distance between modems in a particular cycle are different. If the number of modems exceeds one cycle, the effect will be better. Similarly, the longer the distance in a cycle, the farther the better.

2.4.4.3 Tone Transmission in the Tone Method

If there is a break in the cable, the node downstream from the break will not receive a tone; neither will it transmit a tone to its downstream neighbour. The master node also knows that if it does not receive a tone, the ring has a cable break or one of the remote nodes in the ring has failed. If the master node receives a tone, it knows that the cycle has not been interrupted. Another thing is that the master node also knows that if a tone is received, this reception depends on the secondary input, the request generated by the master node, and determinant which queries can be left unattended.

When all remote nodes can receive a request from their main input, this means that the loop has no effect and the master node will not need to participate in sending requests other than the secondary output. (Minoli et al., 2003).

Tones can be used to show which input ports are waiting for requests from the master node. The remote nodes are also capable of using the tone to make decisions as to which direction they must return their feedback to the master. On the other hand, if it happens that the master is not able to receive a tone which is to be directed at its secondary port, it could detect that there is an interruption in the channel which is the cable; hence, it needs to direct its queries through the two ports available. It is also able to know that data which is received from either of the ports must be responses coming out of remote nodes. The technique used in the tonal method is "self-healing." This means that when the cable repair is complete, the loop returns to its original configuration. If an interruption occurs, the downstream nodes will not be able to reach the tone, but those nodes at the top of the source will continue to send tones. From a physical point of view, the network looks like a loop, but the logical use of the tone method ensures that the grid is still connected in the form of a line bus, which has been substantially rebuilt in the event of a cable failure (JHK & Associates, 2006).

2.5 Token Ring Architecture

In the token ring architecture it is possible for one node to deny service to another node or to compromise integrity by either withholding a message or by modifying a message before retransmitting to the next node. This is unlike typical broadcast networks employing a bus architecture where each node must capture a message as it goes by.

There is no need to help investigate the traffic flow in a unique ring structure. In other words, secret channels may be overlooked and contracts won't be checked. There are many internal security features that include loop structures that do not exist in other LAN architectures.

One obvious feature is the well-known path between each pair of transmitting/receiving stations. In this loop, each packet (message) must go through each station and always terminate at the sending station. This allows the sending station to monitor the message after passing through all stations and also checks the integrity of the message and its availability. The current FDDI standard includes FCS sequences and uses cyclical periodic tests.

Even if the nodes are not checked, each node in the loop structure monitors each traffic and uses its own address to match the source address of the frame transmission. Therefore, the source station can delete the message after completing the entire cycle, and can also identify another station that claims the role of the source station.

2.5.1 Token Ring Security Issues

There are three possible situations that can damage the service and prohibit the availability of data. When a station stores a symbol outside its allocation, the station will completely remove the tag from the cycle, or when multiple instances cross the loop at the same time.

The station is selected as an activity tag screen to manage the constantly occupying token conditions, lost (or stolen) tokens or multiple tokens. This activity screen determines the missing token using a timeout that exceeds the time required for the longest frame to move through the entire cycle. Once the activity monitor detects it, the busy token is free to reset. Other stations on the loop act as passive monitoring devices. When the activity monitor fails, use the conflict resolution algorithm to select any negative monitoring station.

2.5.2 Dual Ring Adaptability

One of the design features of certain loop architectures, such as FDDI, is the use of circular circles with circular rotation to help alleviate the problem of multiple points of failure in the network. When nodes or links do not bypass the return path, they are wrapped together incorrectly to provide continuous communication. The ability to adapt to faults or defects helps

to ensure the reliability of the system and the availability of data during transportation (De Leuw et al., 2006).

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CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The main goal of this project is to evaluate the effectiveness of the network performances of three (3) commonly used network topology; Ethernet, Token Ring and FDDI in terms of data throughput and delay in distributed systems. The three networks would be modelled using Cisco Packet Tracer Version 7.1. The type of research methodology used is applied research.

Detail explanations of the scenarios are discussed in the following sections.

3.2 Cisco Packet Tracer as a Simulation Tool

Cisco Packet Tracer is a powerful network simulation program that allows students to experiment with network behaviour and ask “what if” questions. Packet Tracer provides simulation, visualization, and authoring, assessment, and collaboration capabilities and facilitates the teaching and learning of complex networking technology concepts.

Packet Tracer - Cisco Systems, which allows user-created network topologies and interactive simulation tools that simulate the development of modern computer networks. This program allows you to simulate the configuration of Cisco routers and switches using an analog command line interface. The user interface drag and drop that Packet Tracer uses allows users to add and remove simulated network devices as you view them.

In addition to modelling aspects of the computer network, Packet Tracer can also be used to work together. Team tracer supports multi-user systems, allowing multiple users to connect together through multiple topologies in computer networks

Networking and Computer Simulation Studies of Networks - It is a method of resuming by using mathematical formulas or by capturing and observing from network simulators, where the program shows the network's behavior or behavior by calculating interactions between

different network entities (Host/Package and DA Meter). This is why Cisco Packet Tracer was selected as a modelling tool.

3.3 Ethernet Network Scenario

Ethernet is the most widely installed local area network technology. Ethernet is a link layer protocol in the TCP /IP stack. Ethernet initially assumed a shared medium multiple device on each segment of the network. In this scenario an Ethernet based network topology was created following the steps below

1. Create a logical network diagram with Three PCs, a Server and a Switch to form an Ethernet. The bottom left-hand corner of the Packet Tracer screen displays icons that represent device categories or groups, such as Routers, Switches, or End Devices. Moving the cursor over the device categories will show the name of the category in the box. To select a device, first select the device category. Once the device category is selected, the options within that category appear in the box next to the category listings. Select the device option that is required.
2. Select End Devices from the options in the bottom left-hand corner. Drag and drop three generic PCs onto your work area.
3. Select Switch from the options in the bottom left-hand corner. Add a Switch to the network by dragging and dropping a generic switch onto the design/work area.
4. Select Server from the options in the bottom left-hand corner. Add a Server to the prototype network by dragging and dropping a generic Server onto the design/work area.
5. Select Connections from the bottom left-hand corner. Choose a Copper Straightthrough cable type. Click the first host, laptop1, and assign the cable to the FastEthernet connector. Click the Switch, and select a connection port, fastethernet0/1, to connect to laptop1.

6. Repeat Step 5) for the second laptop2, to connect the laptop, to fastethernet0/1 on the Switch.
7. Repeat the same Step for the third laptop3, to connect the laptop, to fastethernet0/2 on the Switch.
8. Repeat Step 5) for the Server, to connect the server, to fastethernet0/3 on the Switch.

The figure below shows how the Ethernet network should look after the design of the network in packet tracer. The green signal shows the connections are correct and ready to transmit signals.

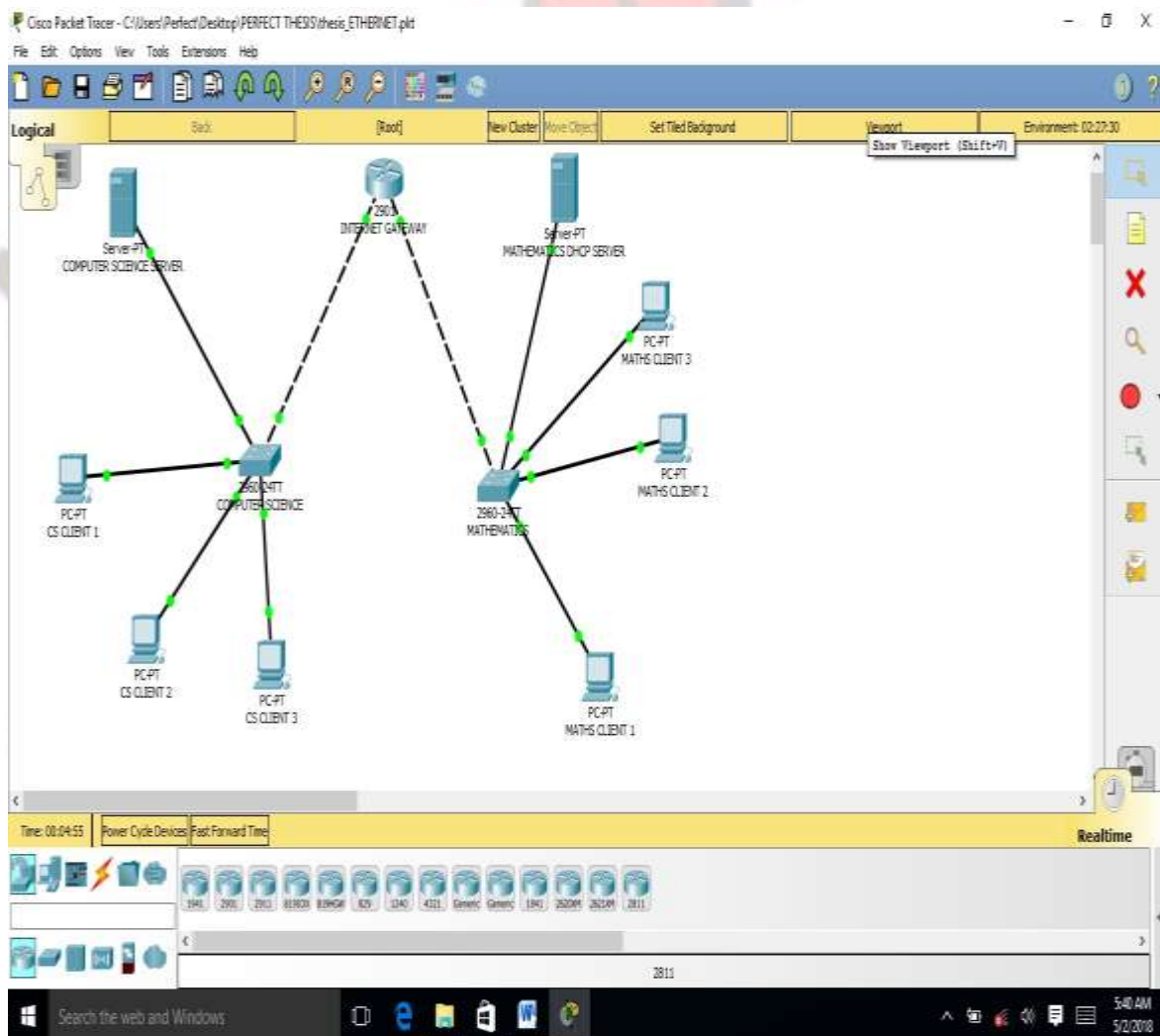


Figure. 3.1 Ethernet Network

For the nodes to communicate in the Ethernet environment, each of the devices on the network were configured to a specific IP Address. The following steps shows how to configure IP Address on the server and the nodes.

1. The Server was made a DHCP server so that the nodes can be assigned dynamic IP Addresses. Click on the Server. A Server window will appear.
2. Select configuration tab and on your left, click on Fast-Ethernet tab. Select static and add the IP address of 192.168.20.1 and subnet mask of 255.255.255.0. Close the Maths PC-A configuration window by selecting the x in the upper right-hand corner.
3. Select Services tab and the DHCP to configure the DHCP services as shown below in the figure below

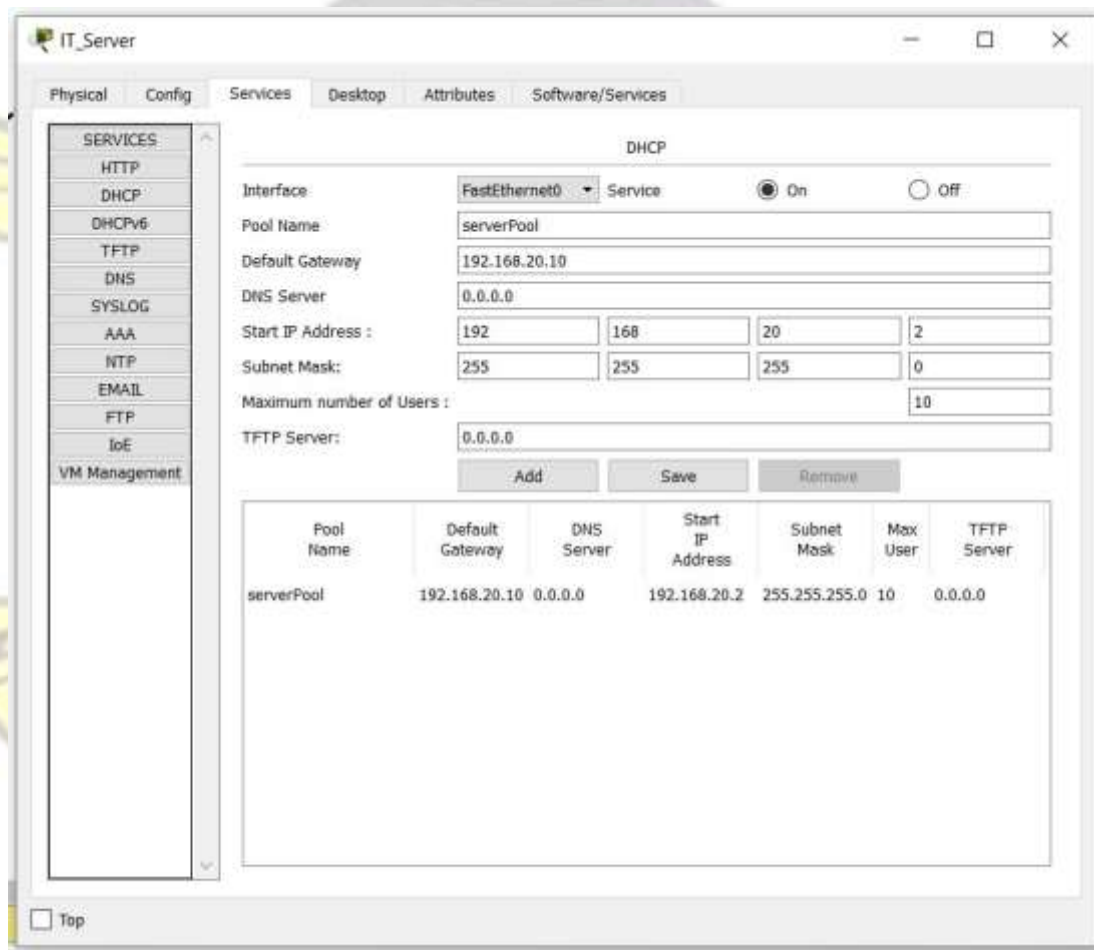


Figure 3.2 DHCP Services Configuration

4. To dynamically assign an IP Address to the nodes, click Laptop1. Select the Config tab. Select the DHCP radio Button on the left and add the IP address of 192.168.20.3/24 and subnet mask of 255.255.255.0. Close the Maths laptop1 configuration window.

5. Repeat for Maths Laptop2 and Maths Laptop3 to assign the IP Address

The above steps were repeated to create another Ethernet Based LAN network.

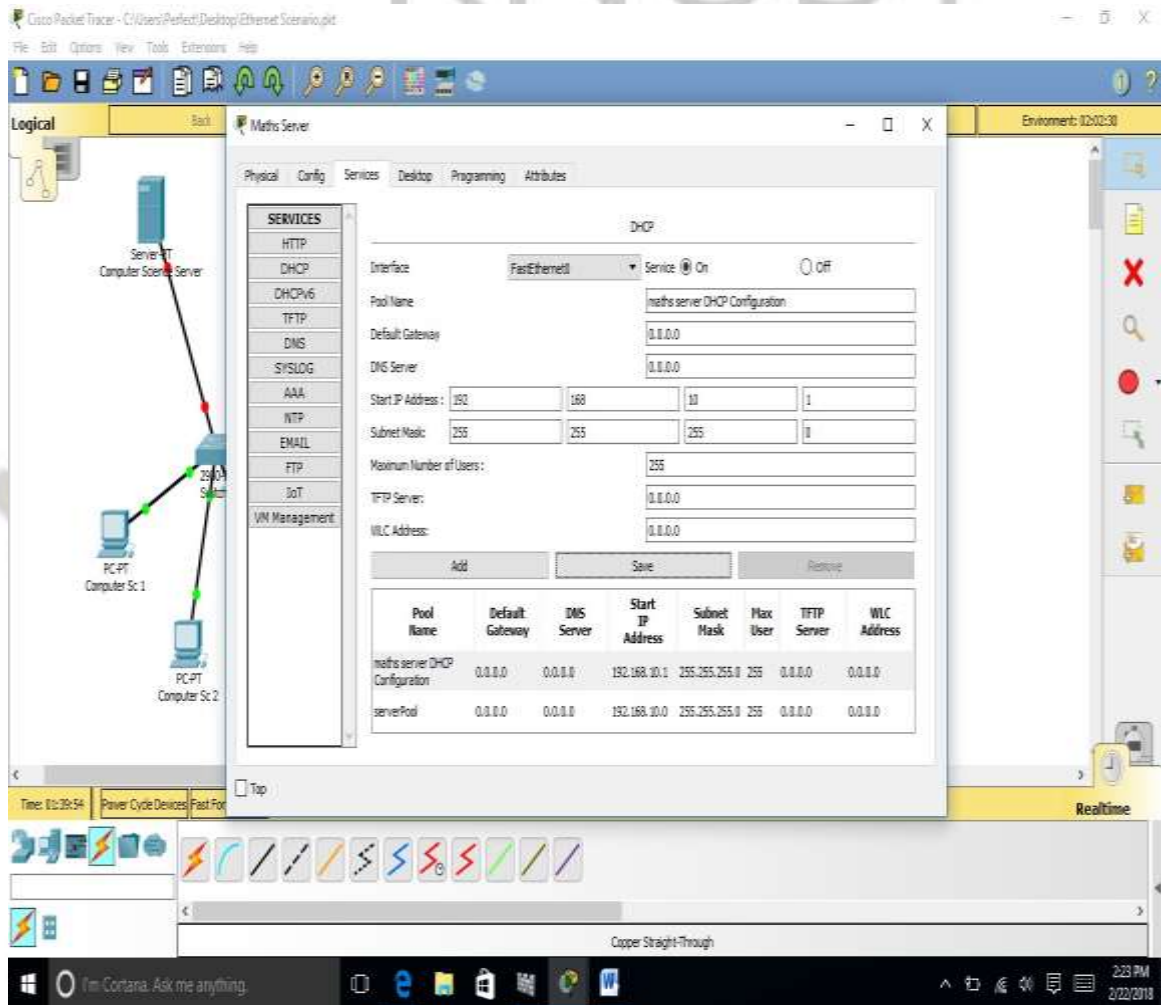


Figure 3.3 Maths DHCP Server Configuration

To create a WAN of Ethernet LAN, a router was added to connect the two Ethernet LANs. To join the two LANs, the following steps were followed

1. Select Router among options at the bottom left-hand corner. Click, hold, drag and drop a generic router onto the work area.

2. Select Connections from the bottom left-hand corner. Choose a Copper Cross-Over cable type
3. Select Switch on one of the Ethernet LAN, and assign the cable to the FastEthernet connector. Click the Switch, and select a connection port, fastethernet0/5, to connect to the Router Fastethernet 0/0.
4. Repeat the same process to connect the Router Fastethernet to the other network

3.3.1 Router Configuration

This section describes how to set the basic configuration of the router. Basic configuration of the router includes configuration of the IP address, default routing, static and dynamic routing, host name, banner, secret password, user accounts, and other options. To configure the router, one or more of the following tasks were performed

- 1) Configure Global Parameters
- 2) Configure Fast Ethernet LAN Interfaces
- 3) Configure WAN Interfaces
- 4) Configuring a Loopback Interface
- 5) Configuring Command-Line Access to the Router

A detail explanation of the configuration is presented with each task to show how the network configuration was achieved in this project.

3.3.2 Configuring Global Parameters

The following steps were performed to configure selected global parameters of the router: Step 1: The terminal was configured to enter global configuration mode, when using the console port. The commands to achieve this were listed below

Router> enable

Router# configure terminal

Router(config)#

Step 2: In this step, the routers name was specified

Router(config)# hostname Router

Router(config)#

Step 3: An encrypted password was specified to prevent unauthorized access to the router.

Router(config)# enable secret KnustMphil

Router(config)#

Step 4: Disables the router from translating unfamiliar words (typos) into IP addresses.

Router(config)# no ip domain-lookup Router(config)#

3.3.3 Configure Fast Ethernet LAN Interfaces

The Fast Ethernet LAN interfaces on the router were automatically configured as part of the default VLAN and as such, they were not configured with individual addresses.

3.3.4 Configure the Fast Ethernet WAN Interface

These steps were performed to configure the Fast Ethernet interfaces, beginning in global configuration mode.

Step 1: Enters the configuration mode for a Fast Ethernet WAN interface on the router.

Router(config)# interface fastethernet 0

Router(config-int)#

Step 2: Sets the IP address and subnet mask for the specified Fast Ethernet interface.

```
Router(config-int)# ip address 192.1.12.2 255.255.255.0
```

```
Router(config-int)#
```

Step 3: Enables the Ethernet interface, changing its state from administratively down to administratively up.

```
Router(config-int)# no shutdown
```

```
Router(config-int)#
```

Step 4: Exits interface configuration mode and returns to global configuration mode.

```
Router(config-int)# exit
```

```
Router(config)#
```

The above steps were repeated for the other Fast Ethernet WAN interface

3.3.5 Configuring a Loopback Interface

The loopback interface acts as a placeholder for the static IP address and provides default routing information. The following steps were performed to configure a loopback interface:

Step 1: Enter interface configuration mode

```
Router(config)# interface Loopback 0
```

```
Router(config-int)#
```

Step 2: Sets the IP address and subnet mask for the loopback interface

```
Router(config-int)# ip address 10.108.1.1 255.255.255.0
```

```
Router(config-int)#
```

Step 4: Exits configuration mode for the loopback interface and returns to global configuration mode.

```
Router(config-int)# exit
```

```
Router(config)#
```

3.3.6 Configuring Command-Line Access to the Router

The following steps were performed to configure parameters to control access to the router, beginning in global configuration mode:

Step 1: Enters line configuration mode, and specifies the type of line. A console was specified for terminal for access.

```
Router(config)# line console 0
```

```
Router(config)#
```

Step 2: Specifies a unique password for the console terminal line.

```
Router(config)# password KnustMphil2015
```

```
Router(config)#
```

Step 3: Enables password checking at terminal session login

```
Router(config)# login
```

```
Router(config)#
```

Step 4: Sets the interval that the EXEC command interpreter waits until user input is detected. The default is 10 minutes. Optionally, add seconds to the interval value. In this project a timeout of 7 minutes and 45 seconds was specified.

```
Router(config)# exec-timeout 7 45
```

Router(config)#

Step 5: Specifies a virtual terminal for remote console access.

Router(config)# line vty 0 4

Router(config)#

Step 6: Specifies a unique password for the virtual terminal line.

Router(config)# password aldf2ad1

Router(config)#

Step 7: Enables password checking at the virtual terminal session login

Router(config)# login

Router(config)#

Step 8: Exits line configuration mode, and returns to privileged EXEC mode.

Router(config)# end

Router#

3.3.7 Configuring the Route

Static routes provide fixed routing paths through the network. They were manually configured on the router. If the network topology changes, the static route must be updated with a new route, static routes are private routes, unless they are redistributed by a routing protocol. While in dynamic routing, the network protocol adjusts the path automatically, based on network traffic or topology. Changes in dynamic routes are shared with other routers in the network.

Dynamic routing protocol such as the Enhanced Interior Gateway Routing Protocol (EIGRP) was used, to learn routes dynamically.

3.3.7.1 Configuring Enhanced IGRP

The following steps were performed to configure Enhanced IGRP (EIGRP), beginning in global configuration mode:

Step 1: Enters router configuration mode, and enables EIGRP on the router. The autonomous system number identifies the route to other EIGRP routers and was used to tag the EIGRP information.

```
Router(config)# router eigrp 109
```

```
Router(config)#
```

Step 2: Specifies a list of networks on which EIGRP is to be applied, using the IP address of the network of directly connected networks.

```
Router(config)# network 192.145.1.0
```

```
Router(config)# network 10.10.12.115
```

```
Router(config)#
```

Step 3: Exits router configuration mode, and enters privileged EXEC mode.

```
Router(config-router)# end
```

```
Router#
```

3.4 Token Ring Network Scenario

A ring network is a network topology in which each node connects to exactly two other nodes, forming a single continuous pathway for signal through each node. A ring data travels from node to node, with each node along the way handling every packet.

Ring can be unidirectional, with all traffic travelling either clockwise or anticlockwise around the ring or bidirectional. Due to point to point line configuration of devices with a device on either side, each device is connected to its immediate neighbour. The diagram below shows a Token Ring Network.

To assign an IP Address to the Token Ring Network and its router configuration, the above steps that used to configure the Ethernet network were followed.

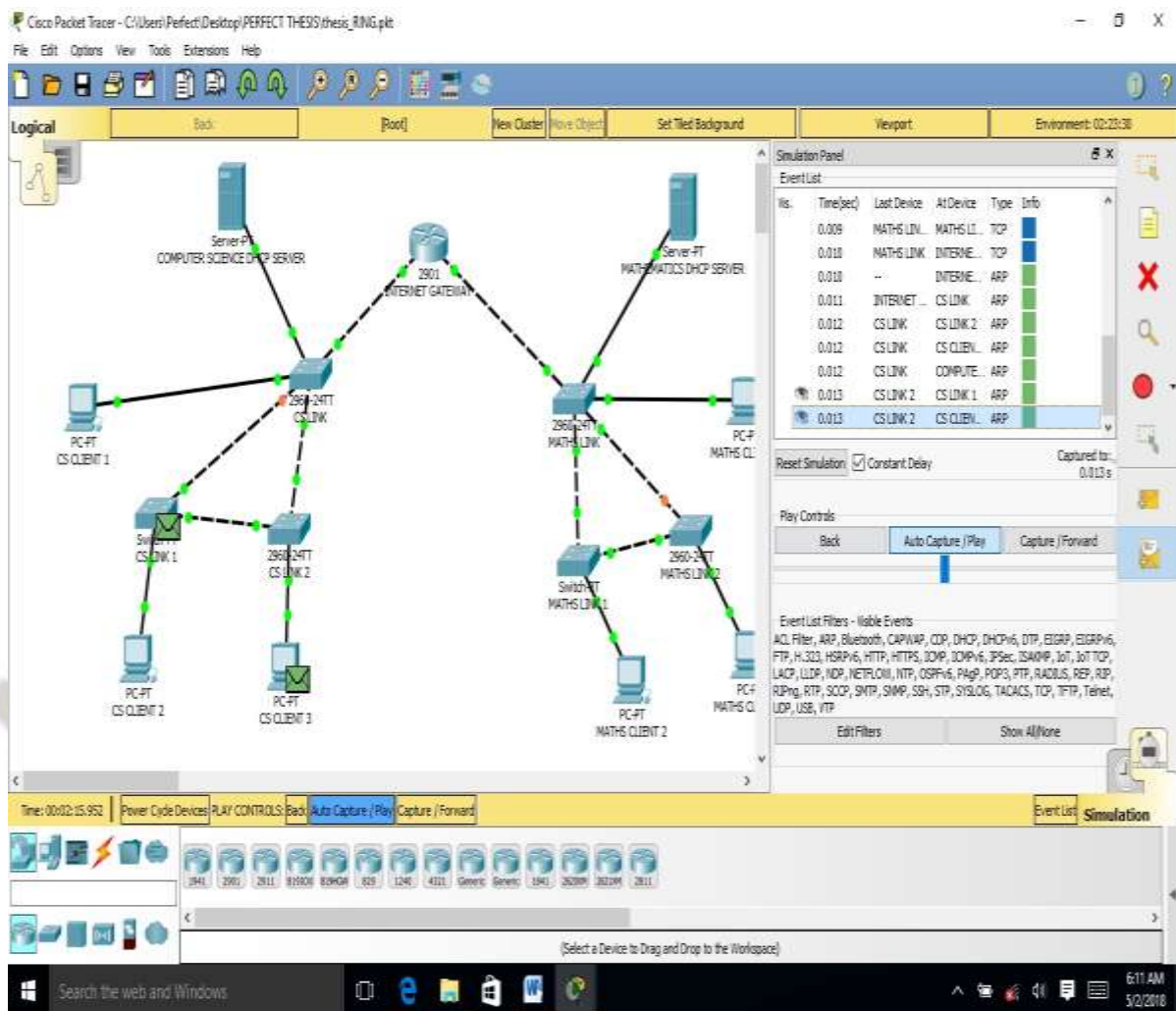


Figure 3.4 Token Ring Network

3.5 Fiber Distributed Data Interface (FDDI)

Fiber Distributed Data Interface is a set of ANSI and ISO standards for data transmission on a fiber optic line /cable in a local area network (LAN) that can extend in range up to 200km.

An FDDI local area network can support thousands of users. The diagram below shows the FDDI network.

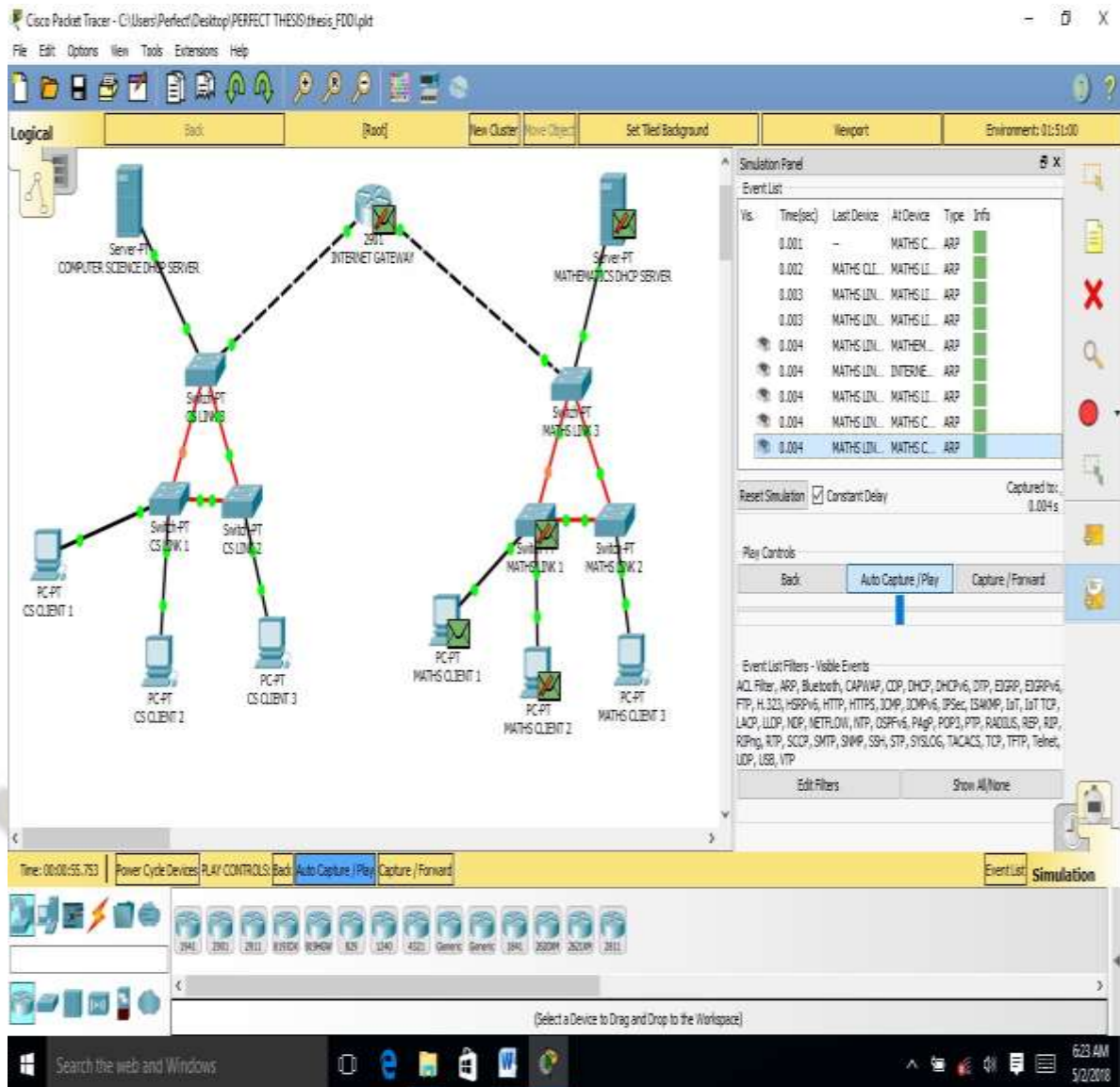


Figure 3.5 Fiber Distributed Data Interface Network

To assign an IP Address and configure the router interface in the FDDI network scenario, the same steps as in the Ethernet network scenario were followed.

3.6 Testing for Connectivity

The next step is to check for data connectivity in the three scenarios presented above. For the networks to successfully route packet from one node to another, there should be data connectivity. The step below show how to use the ping command to test for connectivity

1. Click on one of the node (Laptop).
2. Choose the Desktop tab.
3. Choose Command Prompt.
4. Type: ping 192.168.10.11 and press enter.

A successful ping indicates the network was configured correctly and the prototype validates the hardware and software configurations. A successful ping result should resemble the figure below.

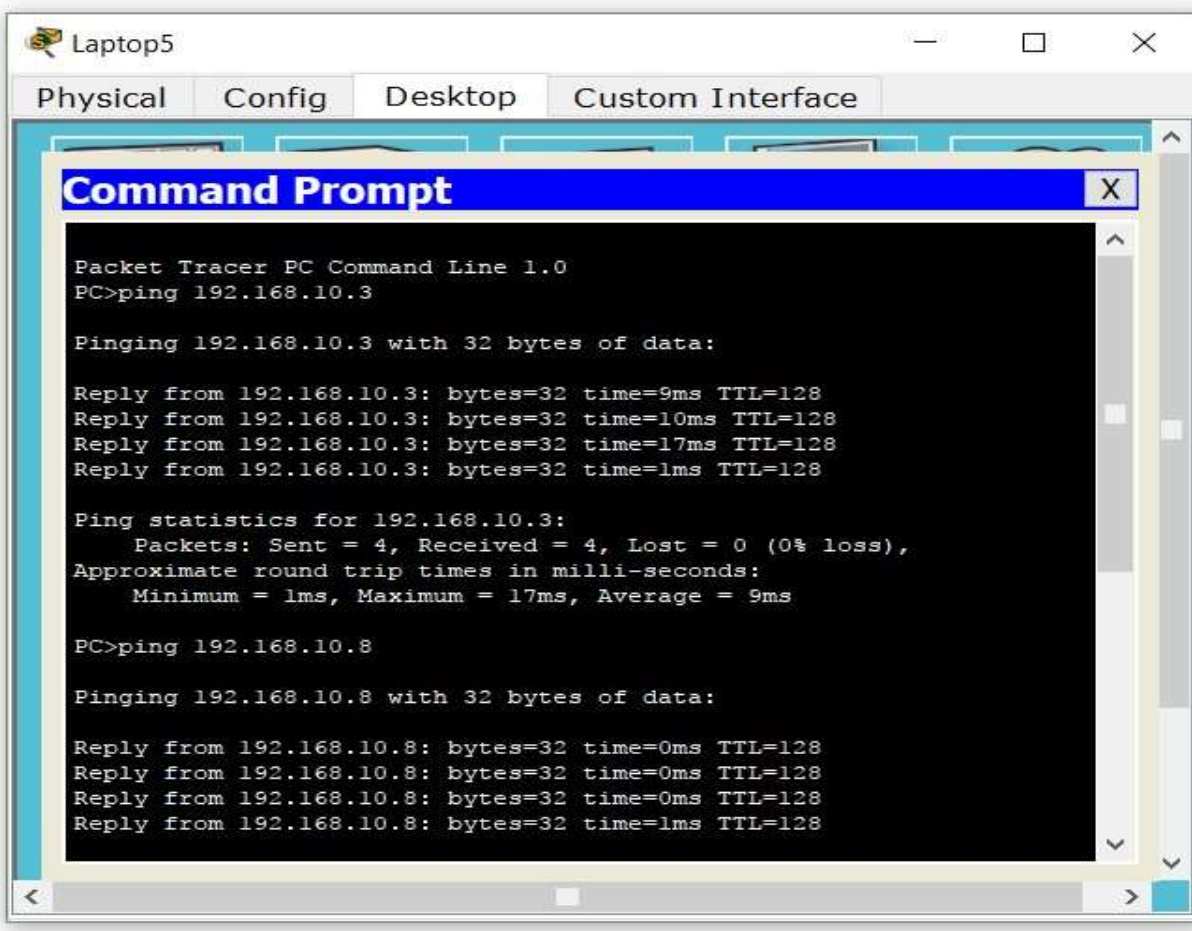


Figure 3.6 Ping result

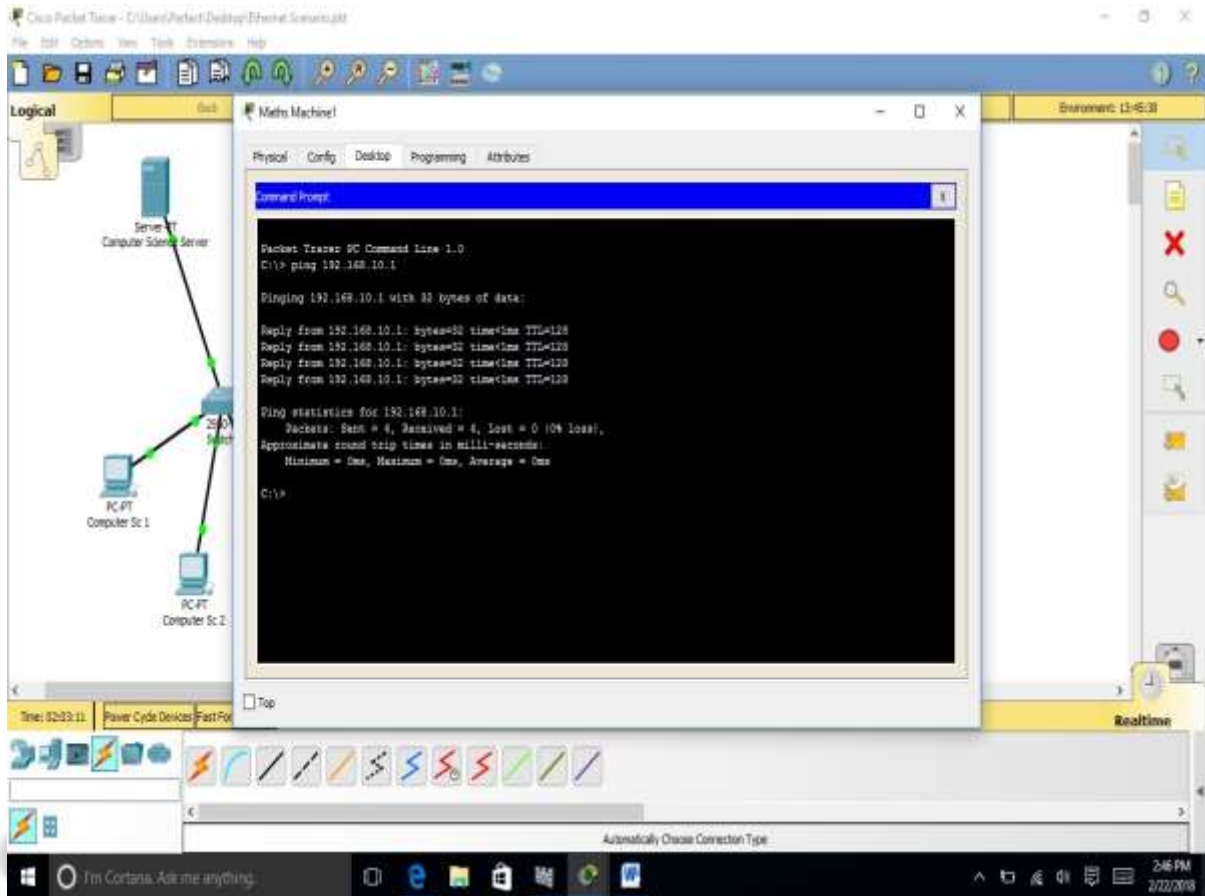


Figure 3.7 Mathematics LAN Connectivity Test

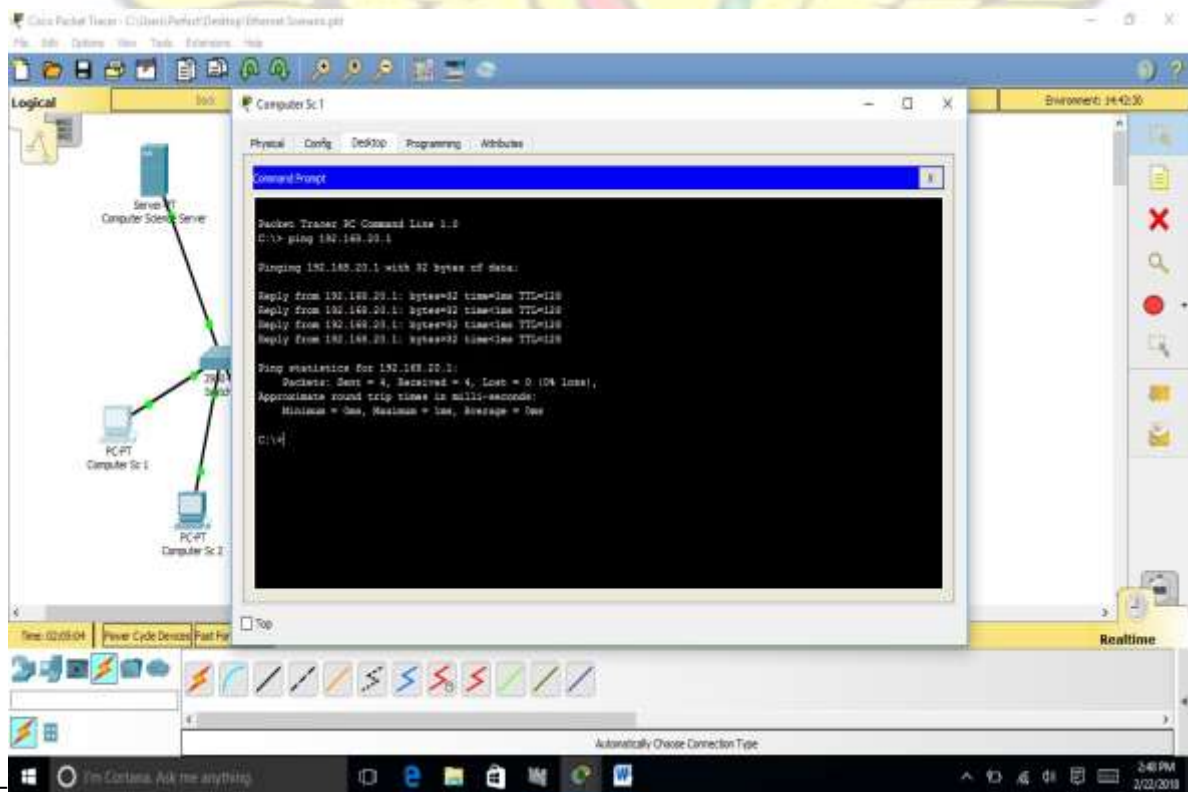


Figure 3.8 Computer Science LAN connectivity test

3.7 Protocol Configuration

To evaluate the effectiveness of the three networks, the following protocols were selected/ configured for evaluation. SMTP, ARP, FTP, ICMP. To configure the protocols, the following steps were followed below

- 1) Select the tab partly concealed behind the Real Time tab at the bottom right-hand corner to change to simulation mode.
- 2) Click on Edit Filters button. This will create a pop-up window. From the pop-up window, click the Show All/None box to deselect every filter. Select ARP, RIP, DHCP, EIGRP and ICMP filters.

Once the protocols have been configured, a packet needs to be sent from one workstation to another on the Ethernet Network Scenario and do the same with the other scenarios.

3.8 Run the Simulation

To evaluate the performance of the Ethernet, Token Ring and FDDI a packet was sent from one station to another workstation on each of the scenarios created and run the simulation 10 times, after which the time it takes for the sending machine to receive an acknowledgement is recorded and evaluated. The steps below show how to send a packet and run the simulation

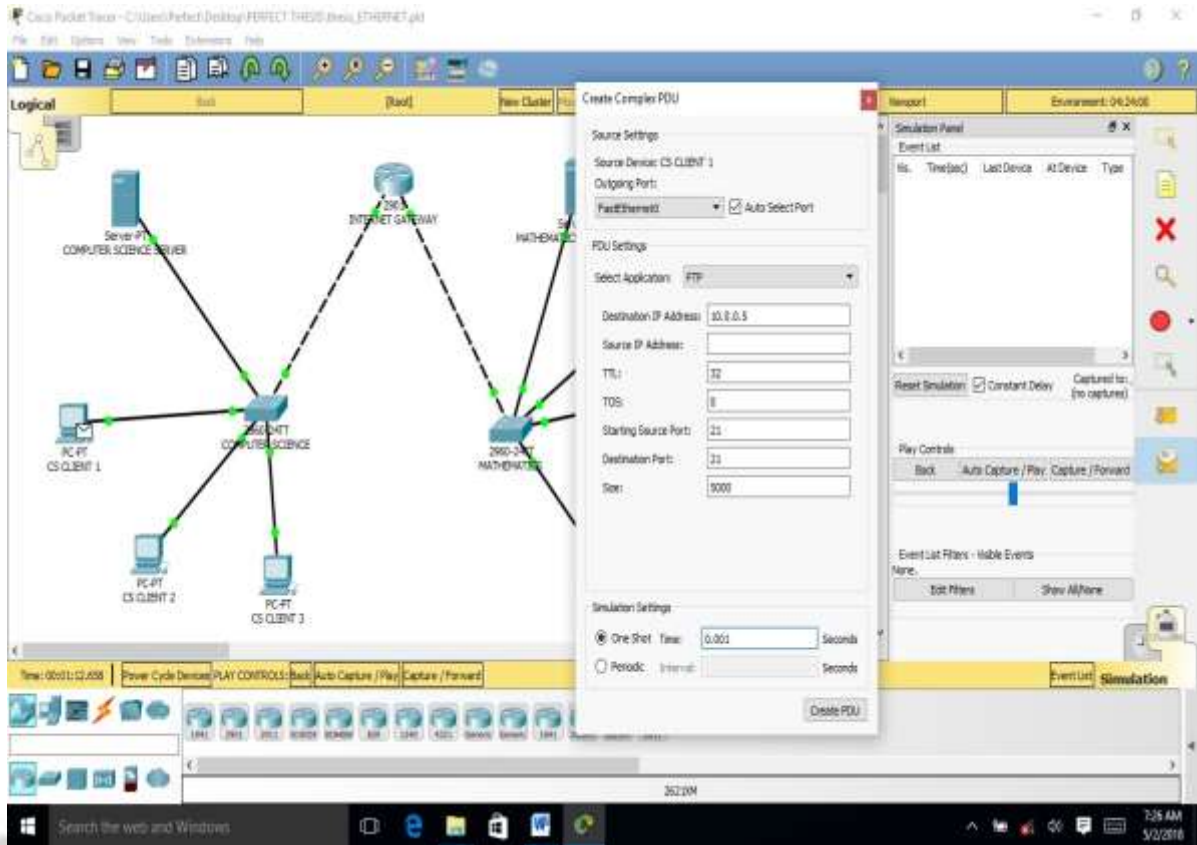


Figure 3.9 Creating Complex PDU

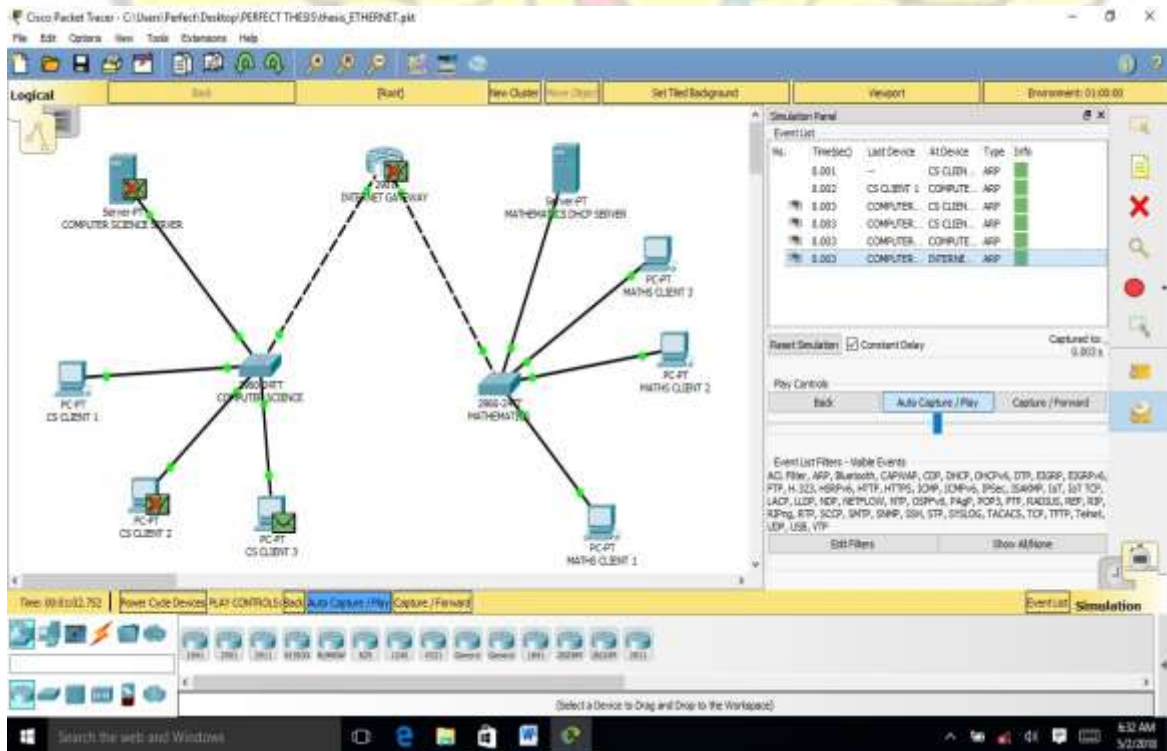


Figure 3.10 Ethernet Network Simulation

The steps above is repeated for the other scenarios and the results picked and analysed.

3.9 Results of the Simulation Exercise

Table 3.1 Results for FTP application of packet size of 1000 MB @ 0.001sec

Scenario /Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.004	0.005	0.011	0.009	0.010	0.011	0.003	0.004	0.303	0.005	0.0365
FDDI	0.003	0.005	0.012	0.013	0.013	0.018	0.007	0.013	0.014	0.004	0.0102
TOKEN RING	0.004	0.008	0.009	0.013	0.013	0.008	0.008	0.011	0.013	0.004	0.0091



Table 3.2 Results for FTP application time to acknowledge receipt of 1000 MB @ 0.001sec

Scenario / Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.00	0.00	0.01	0.30	0.30	0.30	0.00	0.00	0.30	0.30	0.1556
	6	7	4	2	5	2	5	7	7	1	
FDDI	0.00	0.00	0.30	0.30	0.30	0.30	0.01	0.02	0.02	0.30	0.1585
	5	8	3	4	1	2	3	2	6	1	
TOKEN RING	0.00	0.01	0.01	0.30	0.29	0.01	0.01	0.03	0.03	0.01	0.0745
	7	2	4	2	9	4	4	2	3	8	

Table 3.3 Results for delay of 1000MB @ 0.001sec

Scenario / Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.00	0.00	0.00	0.29	0.29	0.29	0.00	0.00	0.30	0.29	0.1491
	2	2	3	3	5	1	2	3	4	6	
FDDI	0.00	0.00	0.29	0.29	0.28	0.29	0.00	0.00	0.01	0.29	0.1419
	2	3	1	1	8	2	6	9	2	7	
TOKEN RING	0.00	0.00	0.00	0.28	0.28	0.00	0.00	0.02	0.02	0.01	0.0654
	3	4	5	9	6	6	6	1	0	4	

Table 3.4 Results for SMTP application of packet size of 5000 MB @ 0.001sec

Scenario / Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.0103
	3	4	9	2	3	8	1	8	1	4	
FDDI	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.0095
	5	1	9	9	3	7	4	4	1	2	
TOKEN RING	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.0080
	3	7	8	0	5	5	4	2	3	3	

Table 3.5 Results for SMTP application for receipt of 5000 MB @ 0.001sec

Scenario / Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.00	0.00	0.30	0.30	0.30	0.32	0.30	0.30	0.01	0.00	0.1885
	5	5	7	4	8	0	4	5	8	9	
FDDI	0.00	0.30	0.02	0.02	0.30	0.01	0.00	0.01	0.02	0.30	0.1051
	8	4	6	8	6	8	9	8	6	8	
TOKEN RING	0.00	0.01	0.02	0.30	0.30	0.00	0.00	0.02	0.01	0.00	0.0737
	9	8	8	4	8	9	7	8	8	8	

Table 3.6 Results for delay of 5000 MB @ 0.001sec

Scenario/ Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.00 2	0.00 1	0.29 8	0.29 2	0.29 5	0.30 2	0.29 3	0.28 7	0.00 7	0.00 5	0.1782
FDDI	0.00 3	0.29 3	0.01 7	0.01 9	0.29 3	0.01 1	0.00 5	0.00 4	0.01 5	0.29 6	0.0956
TOKEN RING	0.00 6	0.01 1	0.02 00	0.29 4	0.29 3	0.00 4	0.00 3	0.01 6	0.00 5	0.00 5	0.0657

Table 3.7 Results for FTP application of packet size of 15000 MB @ 0.001sec

Scenario / Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.00 2	0.00 4	0.01 1	0.00 9	0.00 8	0.01 3	0.01 3	0.00 3	0.01 2	0.00 8	0.0083
FDDI	0.00 5	0.00 7	0.01 2	0.01 0	0.00 9	0.01 3	0.01 1	0.01 4	0.01 1	0.01 3	0.0105

TOKEN	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.0095
RING	1	9	1	1	7	3	4	1	5	3	

Table 3.8 Results for FTP application time to acknowledge receipt of 15000 MB @ 0.001sec

Scenario / Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.20	0.00	0.02	0.01	0.02	0.01	0.02	0.01	0.20	0.30	0.0836
	5	6	6	8	4	9	0	2	4	2	
FDDI	0.01	0.01	0.02	0.30	0.30	0.30	0.20	0.01	0.20	0.02	0.1414
	0	8	4	2	4	1	6	8	4	7	
TOKEN	0.02	0.01	0.02	0.01	0.20	0.20	0.02	0.01	0.00	0.00	0.0542
RING	4	8	0	8	0	2	5	8	8	9	

Table 3.9 Results for delay of 15000 MB @ 0.001sec

Scenario / Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.20	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.19	0.29	0.0753
	3	2	5	9	6	6	7	9	2	4	
FDDI	0.01	0.01	0.01	0.29	0.29	0.28	0.19	0.00	0.19	0.01	0.1317
	3	1	2	2	5	8	5	4	3	4	
TOKEN	0.01	0.00	0.00	0.00	0.19	0.18	0.01	0.00	0.00	0.00	0.0447
RING	3	9	9	7	3	9	1	7	3	6	

Table 3.10 Results for SMTP application of packet size of 5000 MB @ 0.005sec

Scenario / Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.00 8	0.00 9	0.01 3	0.01 4	0.00 7	0.00 8	0.01 5	0.01 3	0.01 4	0.00 7	0.0108
FDDI	0.00 8	0.00 9	0.00 8	0.02 3	0.02 1	0.02 0	0.00 7	0.00 8	0.02 2	0.02 1	0.0147
TOKEN RING	0.00 9	0.00 9	0.01 4	0.01 1	0.01 4	0.01 7	0.01 0	0.00 5	0.01 5	0.01 8	0.0122

Table 3.11 Results for SMTP application time to acknowledge receipt of 5000MB @ 0.005sec

Scenario/Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.01 0	0.01 1	0.01 8	0.02 0	0.00 9	0.01 0	0.30 7	0.30 7	0.30 6	0.01 1	0.1009
FDDI	0.01 0	0.01 2	0.01 1	0.30 6	0.30 6	0.30 5	0.01 5	0.01 2	0.20 7	0.20 4	0.1388

TOKEN	0.01	0.01	0.02	0.02	0.02	0.30	0.01	0.01	0.20	0.20	0.0823
RING	3	2	0	0	1	6	5	0	2	4	

Table 3.12 Results for Delay of 5000 MB @ 0.005sec

Scenario / Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.00 2	0.00 2	0.00 5	0.00 6	0.00 2	0.00 2	0.29 2	0.29 4	0.29 2	0.00 4	0.0901
FDDI	0.00 2	0.00 3	0.00 3	0.28 3	0.28 5	0.28 5	0.00 8	0.00 4	0.18 5	0.18 3	0.1241
TOKEN RING	0.00 4	0.00 3	0.00 6	0.00 9	0.00 7	0.28 9	0.00 5	0.00 5	0.18 7	0.18 6	0.0701

Table 3.13 Results for FTP application of packet size of 5000 MB @ 0.0005ses

Scenario / Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.00 2	0.00 2	0.00 3	0.01 0	0.01 2	0.01 2	0.01 5	0.01 9	0.00 8	0.01 0	0.0103
FDDI	0.00 2	0.00 4	0.00 3	0.01 8	0.01 6	0.01 5	0.01 6	0.01 2	0.02 0	0.02 2	0.0128

TOKEN	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.0132
RING	4	5	7	0	5	6	4	3	4	4	

Table 3.14 Results for FTP application time to acknowledge receipt of 5000MB @ 0.0005sec

Scenario / Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.00	0.00	0.00	0.30	0.01	0.01	0.02	0.01	0.02	0.02	0.0428
	4	4	5	2	8	7	0	2	2	4	
FDDI	0.00	0.00	0.00	0.30	0.30	0.02	0.02	0.01	0.02	0.02	0.0730
	5	7	6	0	4	0	2	5	6	5	
TOKEN RING	0.00	0.00	0.20	0.20	0.30	0.02	0.02	0.01	0.30	0.30	0.1380
	8	7	1	4	0	4	0	5	1	0	

Table 3.15 Results for delay of 5000 MB @ 0.0005sec

Scenario / Packet Size	1	2	3	4	5	6	7	8	9	10	Average

Ethernet	0.00 2	0.00 2	0.00 2	0.29 2	0.00 6	0.00 5	0.00 5	0.00 3	0.00 4	0.00 4	0.0325
FDDI	0.00 3	0.00 3	0.00 3	0.28 2	0.28 8	0.00 5	0.00 6	0.00 3	0.00 6	0.00 3	0.0602
TOKEN RING	0.00 4	0.00 2	0.19 4	0.19 4	0.28 5	0.00 8	0.00 6	0.00 2	0.27 7	0.27 6	0.1248

Table 3.16 Results for SMTP application of packet size of 5000 MB @ of 0.100sec

Scenario/ Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.1 02	0.10 3	0.11 0	0.10 7	0.10 8	0.10 5	0.10 0	0.10 5	0.10 9	0.10 8	0.1057
FDDI	0.1 02	0.10 5	0.10 4	0.11 4	0.10 2	0.10 4	0.10 8	0.10 0	0.10 5	0.10 8	0.1052
TOKEN RING	0.1 03	0.10 4	0.10 4	0.10 6	0.11 0	0.10 9	0.11 4	0.10 2	0.11 2	0.10 5	0.1069

Table 3.17 Results for SMTP application time to acknowledge receipt of 5000 MB @ 0.100s

Scenario / Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.10 4	0.10 5	0.40 1	0.40 4	0.40 1	0.40 2	0.10 8	0.11 0	0.40 4	0.40 1	0.2840
FDDI	0.10 5	0.10 8	0.10 7	0.10 3	0.10 4	0.10 7	0.11 0	0.10 8	0.20 0	0.20 5	0.1257
TOKEN RING	0.10 6	0.10 8	0.10 9	0.10 9	0.40 4	0.40 0	0.40 4	0.10 5	0.20 0	0.01 9	0.1964

Table 3.18 Result for delay of 5000 @ 0.100sec

Scenario / Packet Size	1	2	3	4	5	6	7	8	9	10	Average
Ethernet	0.00 2	0.00 2	0.29 1	0.29 7	0.29 3	0.29 7	0.00 8	0.00 5	0.29 5	0.29 3	0.1783
FDDI	0.00 3	0.00 3	0.00 3	0.01 1	0.00 2	0.00 3	0.00 2	0.00 8	0.09 5	0.09 7	0.0205
TOKEN RING	0.00 3	0.00 4	0.00 5	0.00 3	0.29 4	0.29 1	0.29 0	0.00 3	0.08 8	- 6	0.0895

3.10 Summary

In this chapter, the methodology was presented to compare the Ethernet, FDDI and the Ring Network. The three scenarios were modeled using Cisco Packet Tracer and the simulation was run for ten different times for each of the networks. The packet sizes were varied and keeping the time constant. Also the time was varied and the packet sizes were kept constant.

In the next chapter, results of the simulations shall be discussed and analyzed.



CHAPTER FOUR

RESULTS AND ANALYSIS

4.1 Introduction

In this chapter, the results of the simulation exercises undertaken in chapter three were analysed. The chapter discussed the simulation results after running the scenarios and the averages of the simulations were calculated. The scenarios presented are:

- i. Ethernet scenarios with constant time and varied packet size ii.

Ethernet scenarios with varied time and constant packet size iii.

FDDI scenarios with varied time and constant packet size iv.

FDDI scenarios with constant time and varied packet size

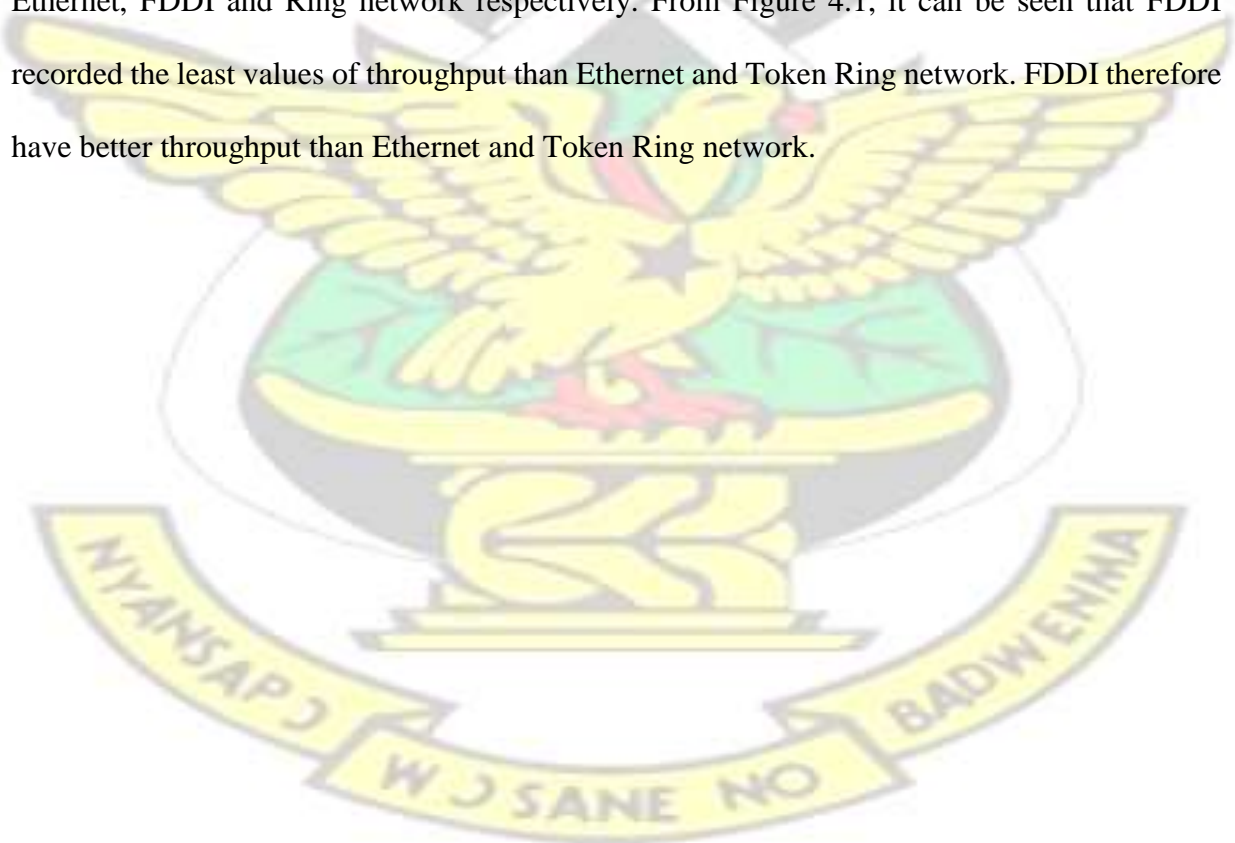
- v. Token Ring scenarios with constant time and varied packet size
- vi.

Token Ring Scenarios with constant time and varied packet size

4.2 Graphical Analysis of the Simulation Result

4.2.1 Data Throughput for FTP application with 1000MB @ 0.001sec

Figure 4.1 shows the data throughput when one of the machine in the computer science department send packet to a client in the mathematics department. From Figure 4.1 when the simulation was run for the first time, the data throughput for the Ethernet was 0.004bps, 0.003bps for FDDI and 0.004bps for Ring network. When the values were taken for the eighth scenarios, it recorded 0.004bps for Ethernet network, 0.003bps for FDDI and 0.011bps for the Ring network. Again, the tenth scenario recorded 0.005bps, 0.004bps and 0.004bps for Ethernet, FDDI and Ring network respectively. From Figure 4.1, it can be seen that FDDI recorded the least values of throughput than Ethernet and Token Ring network. FDDI therefore have better throughput than Ethernet and Token Ring network.



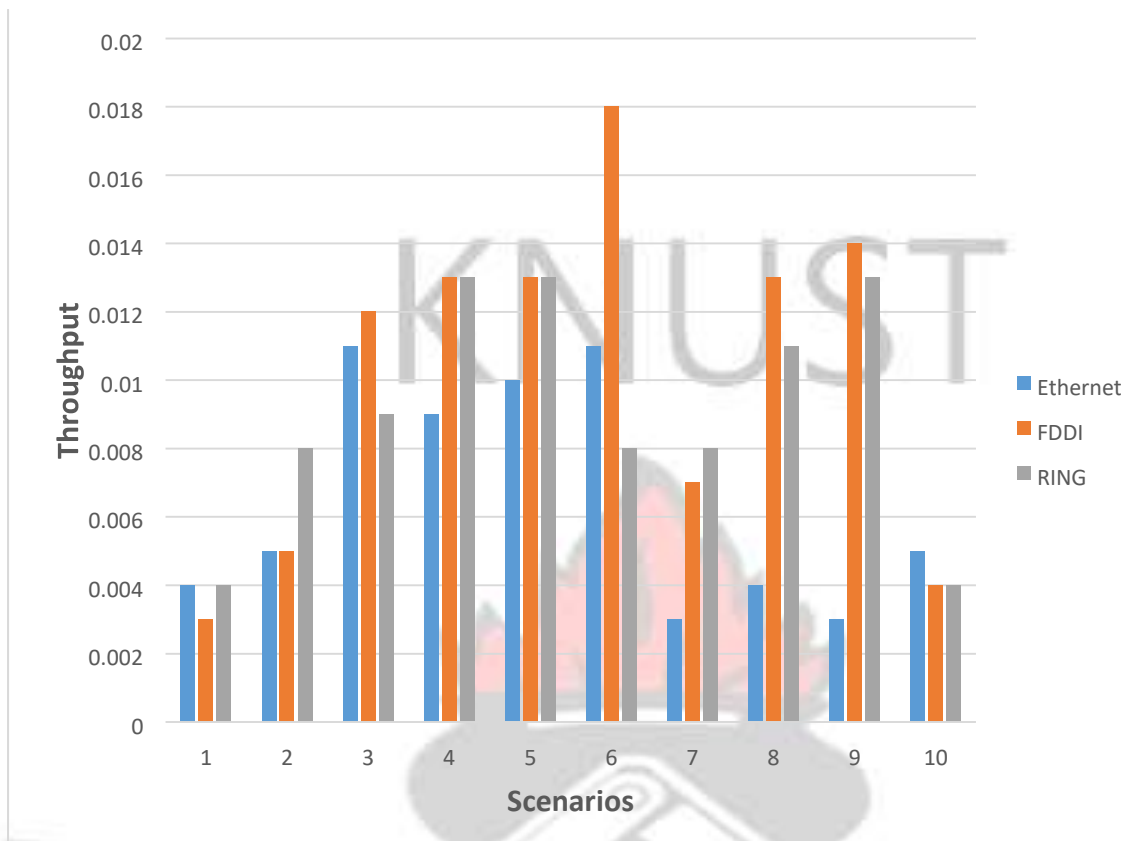


Figure 4.1 Throughput for FTP application with 1000MB @ 0.001sec

4.2.2: Throughput for FTP application with 1000MB @0.001sec (Acknowledgement)

Figure 4.2 shows data throughput when the machine in the mathematics department sends acknowledgement of receipt of packet to the sending machine in the computer science department. From Figure 4.2, when the simulation was run for the second time, throughput for Ethernet was 0.007bps, FDDI and Token Ring recorded 0.008bps and 0.012bps respectively. The seventh scenario recorded 0.005bps for Ethernet 0.013bps for FDDI and 0.014bps for Token Ring. Again the values for the ninth scenario are 0.307bps for Ethernet, 0.026bps for FDDI and 0.033bps for Token Ring network. From the Figure FDDI has lowest throughput than Ethernet and Token Ring Network. FDDI therefore performs better than Ethernet and Token Ring Network

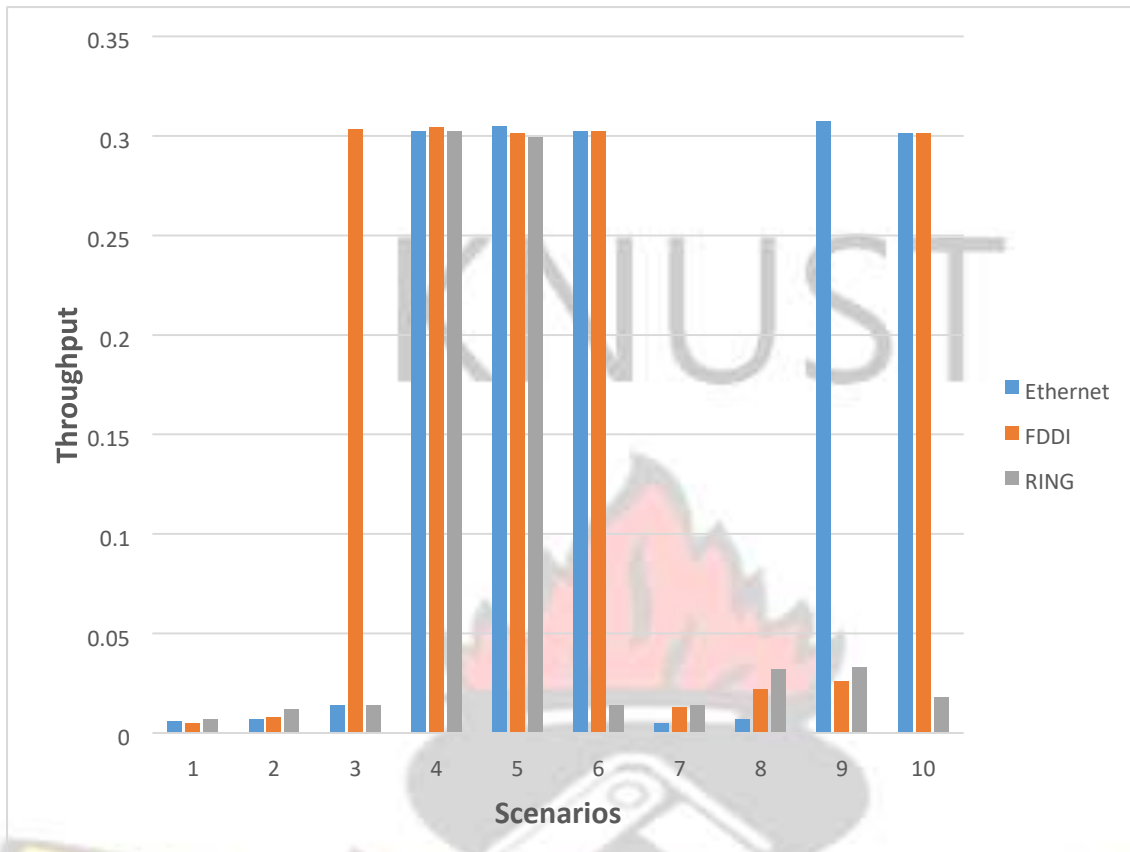


Figure 4.2 Throughput for FTP application with 1000MB @ 0.001sec (Acknowledgement)

4.2.3 Delay for 1000 MB @ 0.001 sec

Network delay is an important design and performance characteristic of a computer network or telecommunications network. The delay of a network specifies how long it takes for a bit of data to travel across the network from one node or endpoint to another. In this research, delay was computed by looking at the time it takes one client to send a packet and receive an acknowledgement for that packet.

From Figure 4.3, it can be seen that the delay in the network when the simulation was run for the first time is 0.002 sec respectively for Ethernet and FDDI network, while it is 0.003 sec for the ring network. From figure 4.3, the delay is low in the Ethernet network, followed by FDDI and token Ring when the simulation was run for the fifth time. The eighth scenario recorded 0.003secs for Ethernet, 0.009sec for FDDI and 0.021sec for token ring network.

Ethernet therefore has lower delay than FDDI and Token Ring network.

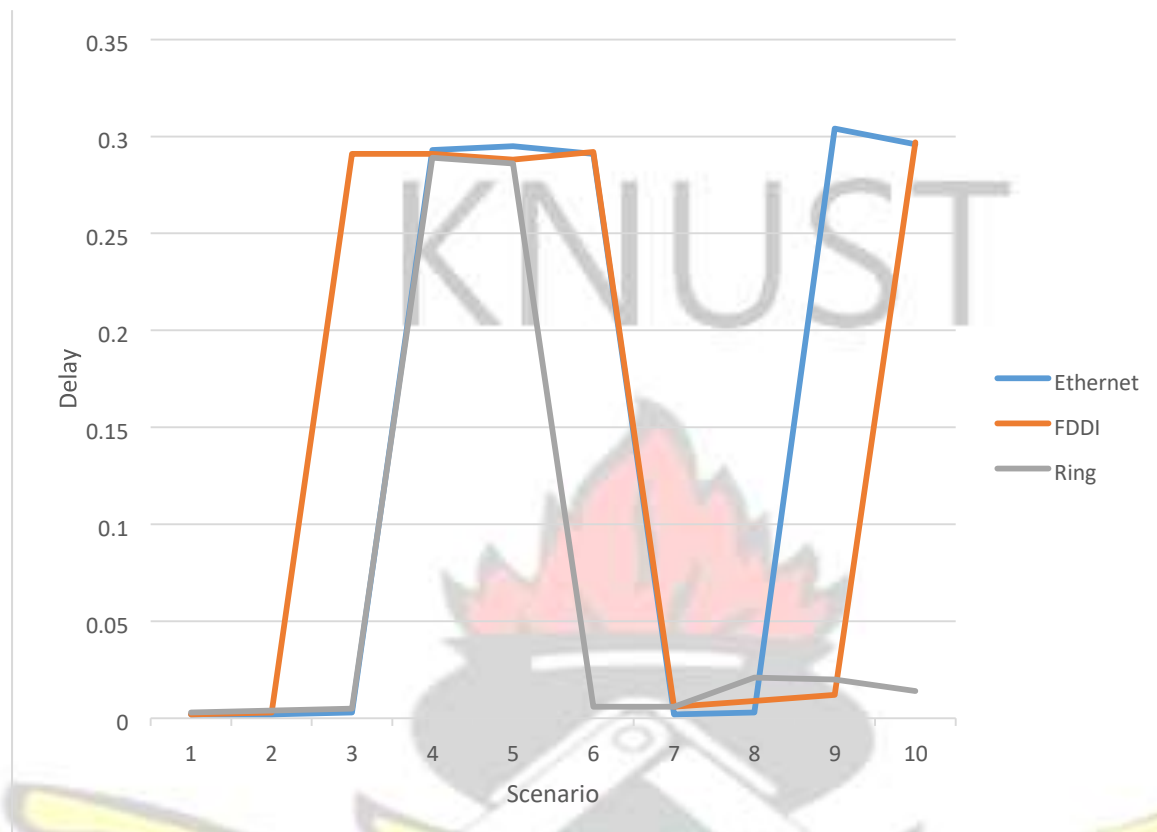


Figure 4.3 Delay for 1000MB @ 0.001sec

4.2.4 Data Throughput for SMTP application with 5000MB @ 0.001sec

Figure 4.4 shows the data throughput when a machine in the mathematics department send packet to a client in the same Mathematics department. From the figure, when the simulation was run for the first time, the data throughput was 0.003bps for both Ethernet and Ring network, while FDDI recorded 0.005bps. When the value was taken for the sixth scenarios, it recorded 0.018bps for Ethernet network, 0.007bps for FDDI and 0.015bps for the Ring network. Again, the tenth scenario recorded 0.004bps for Ethernet, 0.012bps for FDDI and 0.003bps for ring network. 0.011bps, 0.004bps and 0.004 were recorded for Ethernet, FDDI and Token ring network respectively for the seventh scenario. FDDI has lowest value of throughput and therefore performs better than Token Ring and Ethernet network.

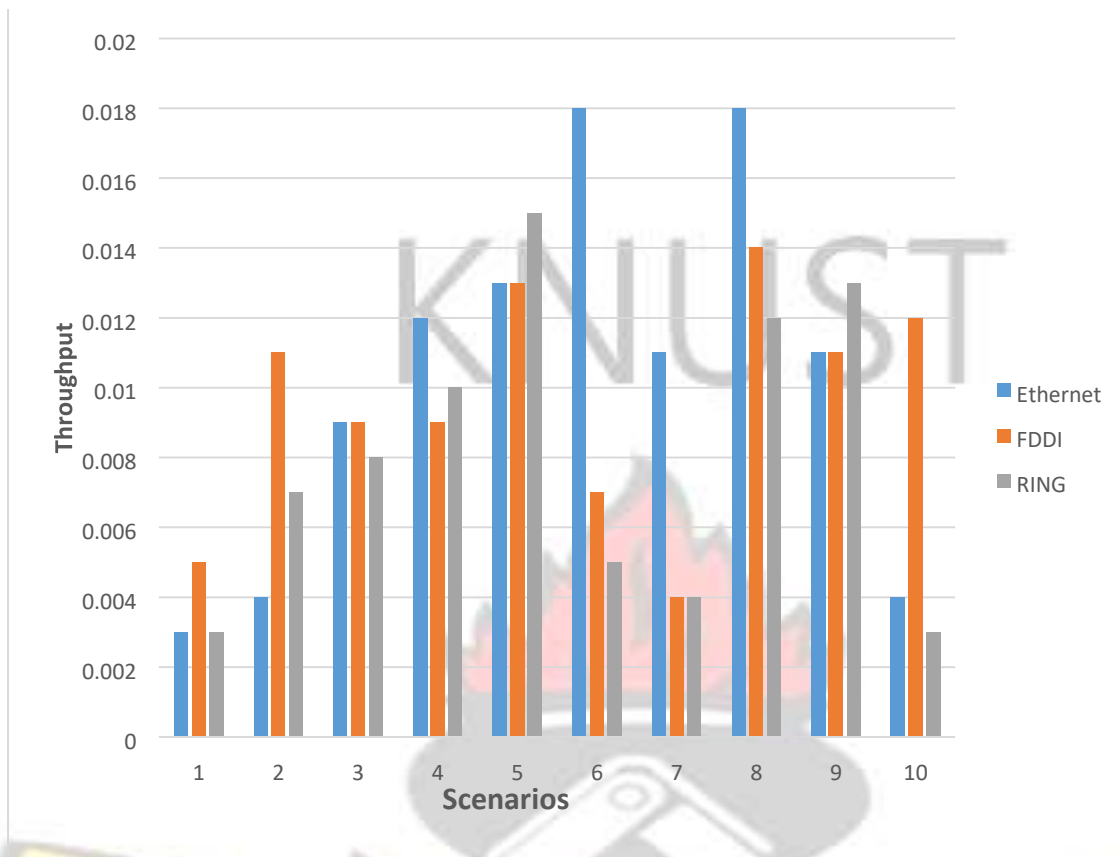


Figure 4.4 Throughput for SMTP application with 5000 MB @ 0.001 sec

4.2.5 Throughput for SMTP application with 5000MB @ 0.001sec (Acknowledgement)

Figure 4.5 shows data throughput when the machine in the mathematics department sends an acknowledgement of receipt of packet to the sending machine in the same department. From the Figure, when the simulation was run for the first time data throughput for Ethernet was 0.005bps, 0.008bps for FDDI and 0.009bps for Token Ring network. The fourth scenario recorded 0.304bps for Ethernet, 0.028bps for FDDI and 0.304bps for Token Ring network as well. Data Throughput for the eighth scenario was 0.305bps for Ethernet, 0.018bps for FDDI and 0.028bps for Token Ring. FDDI recorded the least data throughput and therefore performs better in terms of network than Ethernet and Token Ring.

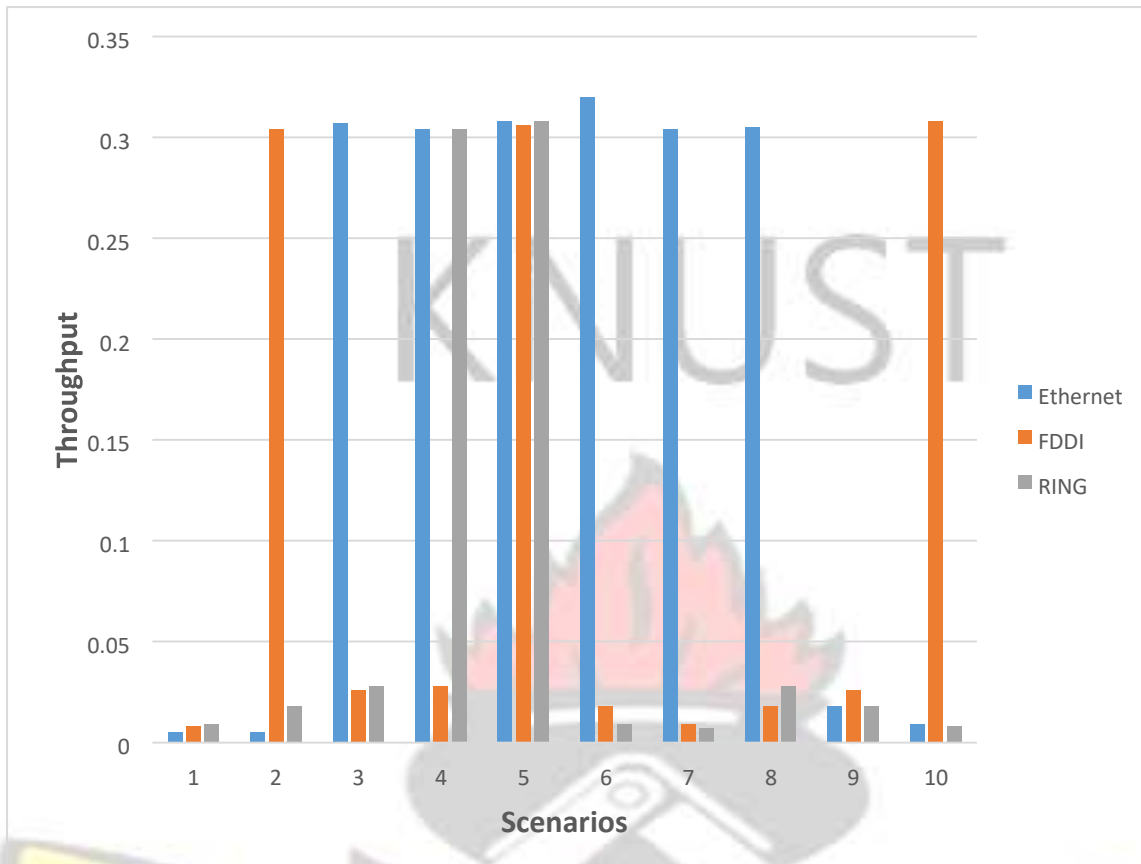


Figure 4.5 Throughput for SMTP application with 5000MB @ 0.001sec (Acknowledgement)

4.2.6 Delay for 5000MB @ 0.001sec

The Delay in the network when the simulation was run for the first time recorded 0.002 sec for Ethernet, 0.003sec for FDDI network, and 0.006 sec for the ring network. From figure 4.6, it can be seen that the fifth scenario recorded delay of 0.295 for Ethernet and 0.295 for FDDI and ring network. Averages for the ten scenarios are 0.1782secs for Ethernet, 0.0956sec for FDDI and 0.0657sec for ring network. Ring therefore has lower delay than FDDI and Ethernet network.

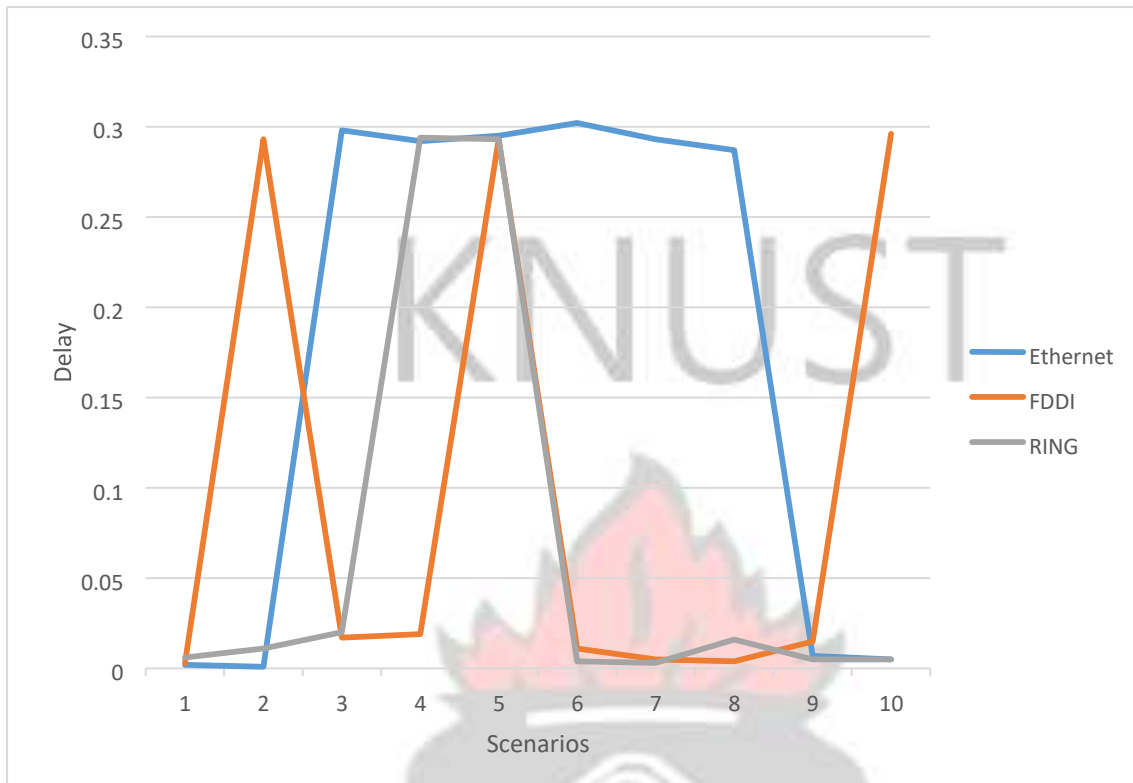


Figure 4.6 Delay for 5000MB @ 0.001sec

4.2.7 Data Throughput for FTP application with 15000MB @ 0.001sec

Figure 4.7 shows the data throughput when a machine in the mathematics department send packet to a client in the computer science department. When the simulation was run for the second time, the data throughput was 0.004bps for Ethernet, 0.007bps for FDDI network, and Ring network recorded 0.009bps. When the value was taken for the seventh scenarios, it recorded 0.013bps for Ethernet network, 0.011bps for FDDI and 0.014bps for the Ring network. Again, the tenth scenario recorded 0.008bps for Ethernet, 0.013bps for FDDI and 0.003bps for ring network. Also, the three networks have 0.0083 bps, 0.0105 bps and 0.0095 bps as averages for Ethernet, FDDI and Ring networks respectively. Ethernet therefore have better throughput than Ring and Ring also have better throughput than the FDDI network.

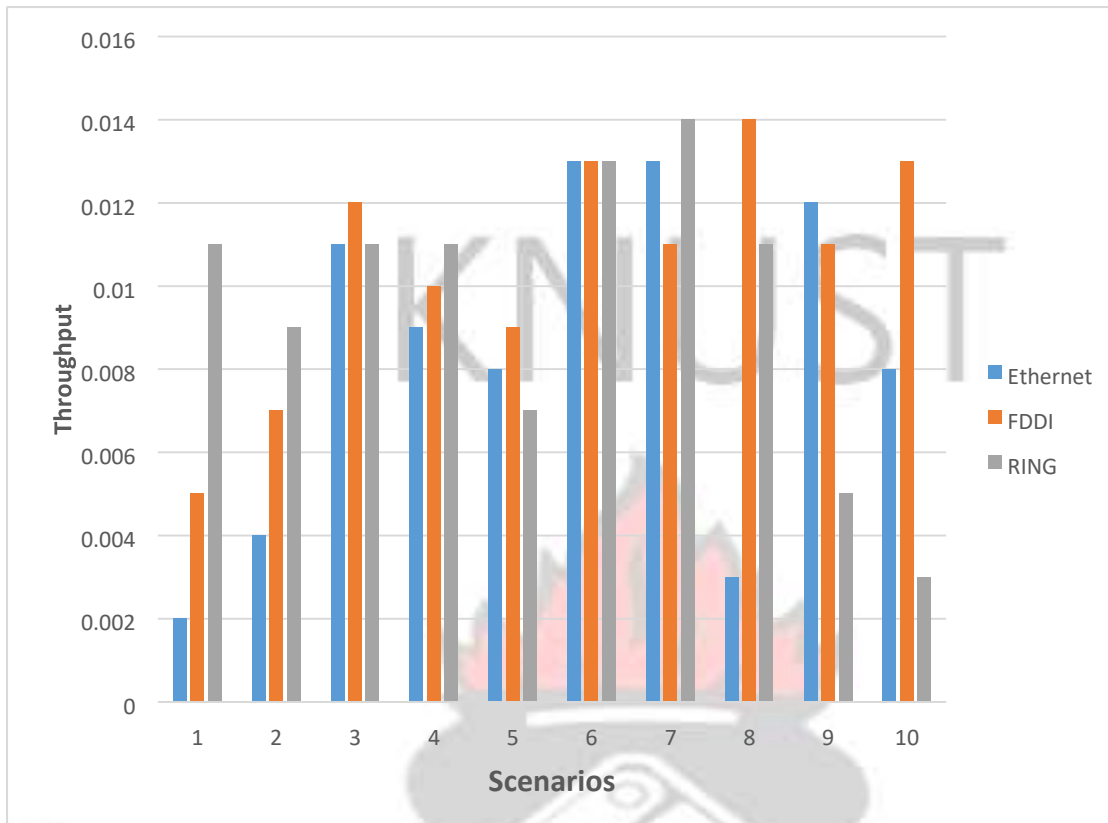


Figure 4.7 Throughput for FTP application of 15000 MB @ 0.001s

4.2.8 Throughput for FTP application with 15000MB @ 0.001sec (Acknowledgement)

Figure 4.8 shows data throughput when the machine in the computer science department sends an acknowledgement of receipt of packet to the sending machine in the mathematics department. From Figure 4.8, the values for the first scenario were 0.0205bps, 0.010bps and 0.024bps for Ethernet, FDDI and Token Ring network respectively. The third scenario recorded 0.026bps for Ethernet, 0.024bps for FDDI and 0.020bps for Token Ring network. Again, the tenth scenario recorded 0.302bps for Ethernet, 0.027bps for FDDI and 0.009bps for Token Ring. It can be seen from the Figure that Token Ring recorded lowest values therefore has better network performance than Ethernet and FDDI.

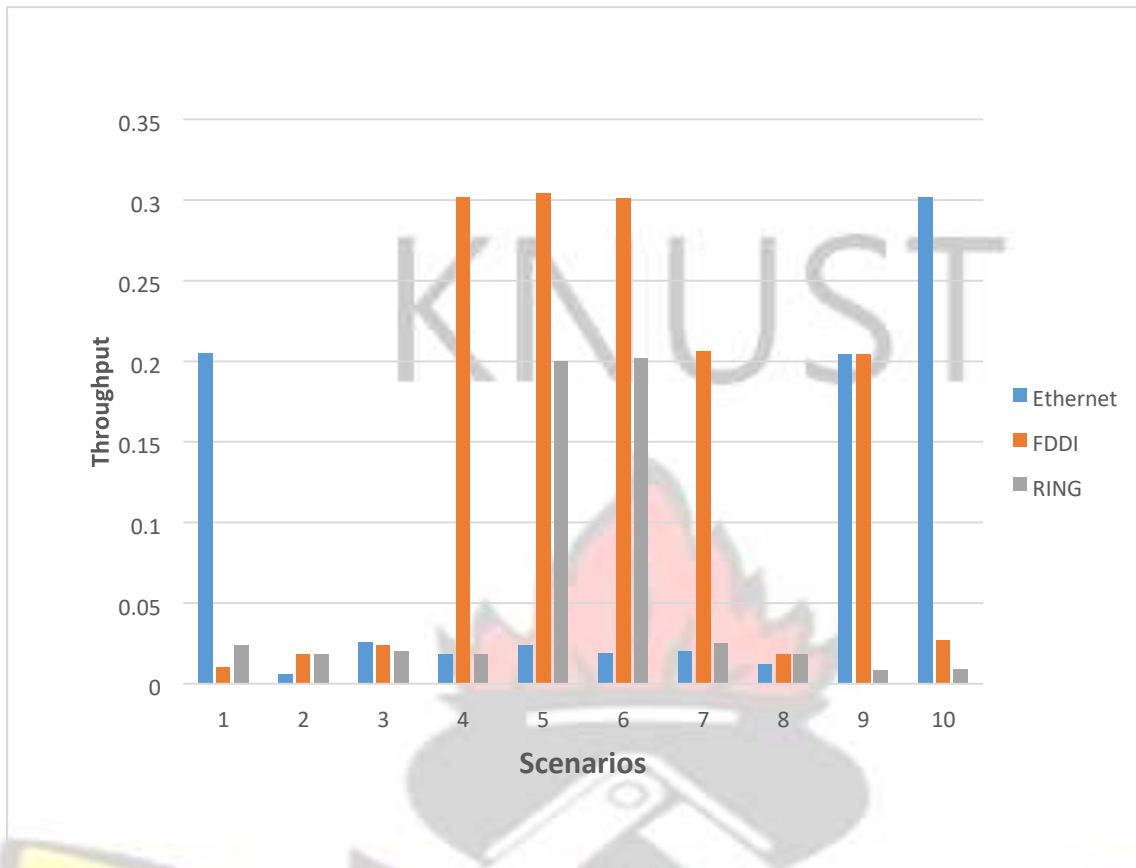


Figure 4.8 Throughput for FTP application with 15000 MB @ 0.001 sec (Acknowledgement)

4.2.9 Delay for 15000MB @ 0.001sec

From figure 4.9, it can be seen that the delay in the network when the simulation was run for the first time is 0.203sec respectively for Ethernet, 0.013sec for FDDI and the Ring network.

The seventh scenario recorded 0.007 sec, 0.195sec, and 0.011 sec for Ethernet, FDDI and Ring network respectively. Averages for the ten scenarios are 0.0753secs for Ethernet, 0.1317sec for FDDI and 0.0447sec for ring network. Ring therefore has lower delay than FDDI and Ethernet network.

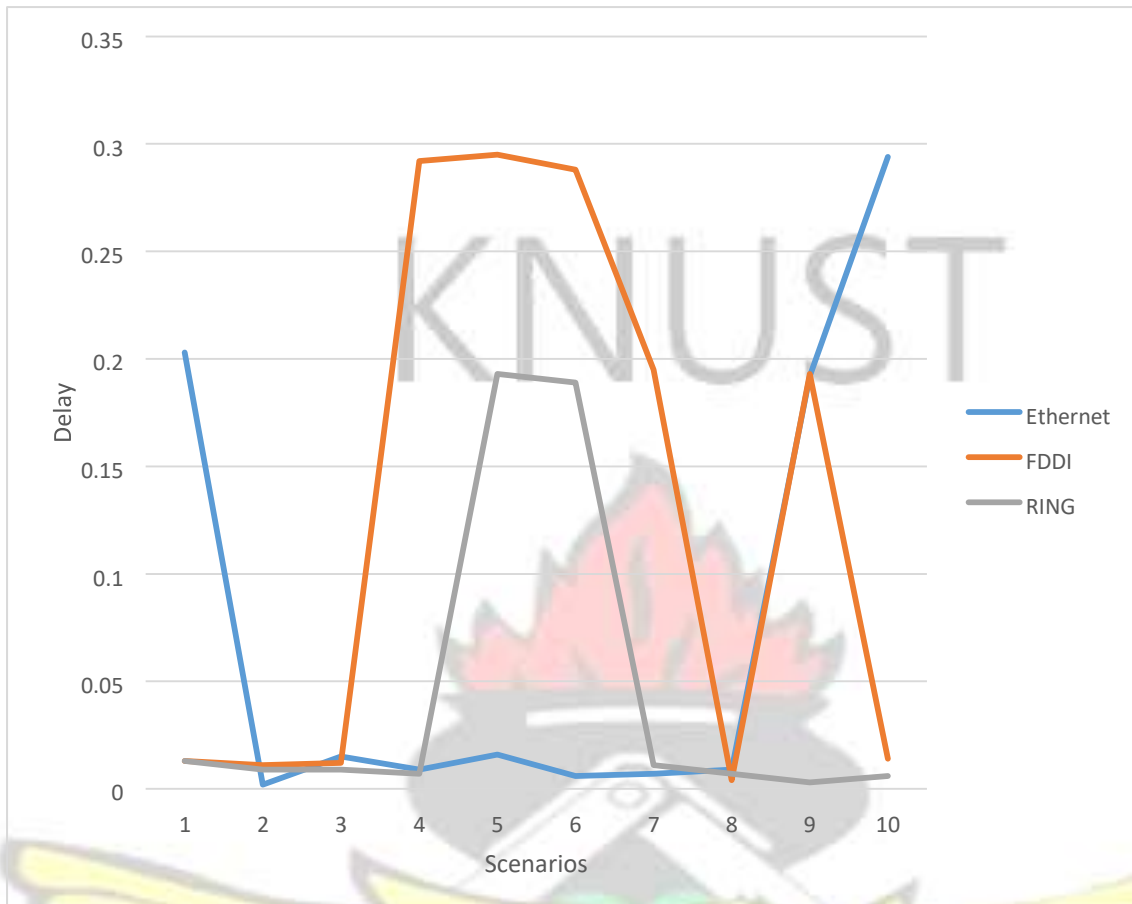


Figure 4.9 Delay for 15000 MB @ 0.001 sec

4.2.10 Data Throughput for SMTP application with 5000MB @ 0.005sec

Figure 4.10 shows the data throughput when a machine in the mathematics department send packet to a client in the computer science department. When the simulation was run for the first time, the data throughput was 0.008bps for Ethernet, 0.009bps for Ring network, and FDDI recorded 0.008bps. When the value was taken for the fifth scenarios, it recorded 0.007bps for Ethernet network, 0.021bps for FDDI and 0.014bps for the Ring network. Again, the averages recorded 0.0108bps for Ethernet, 0.0147bps for FDDI and 0.0122bps for ring network. Ethernet therefore has better throughput than FDDI and Ring.

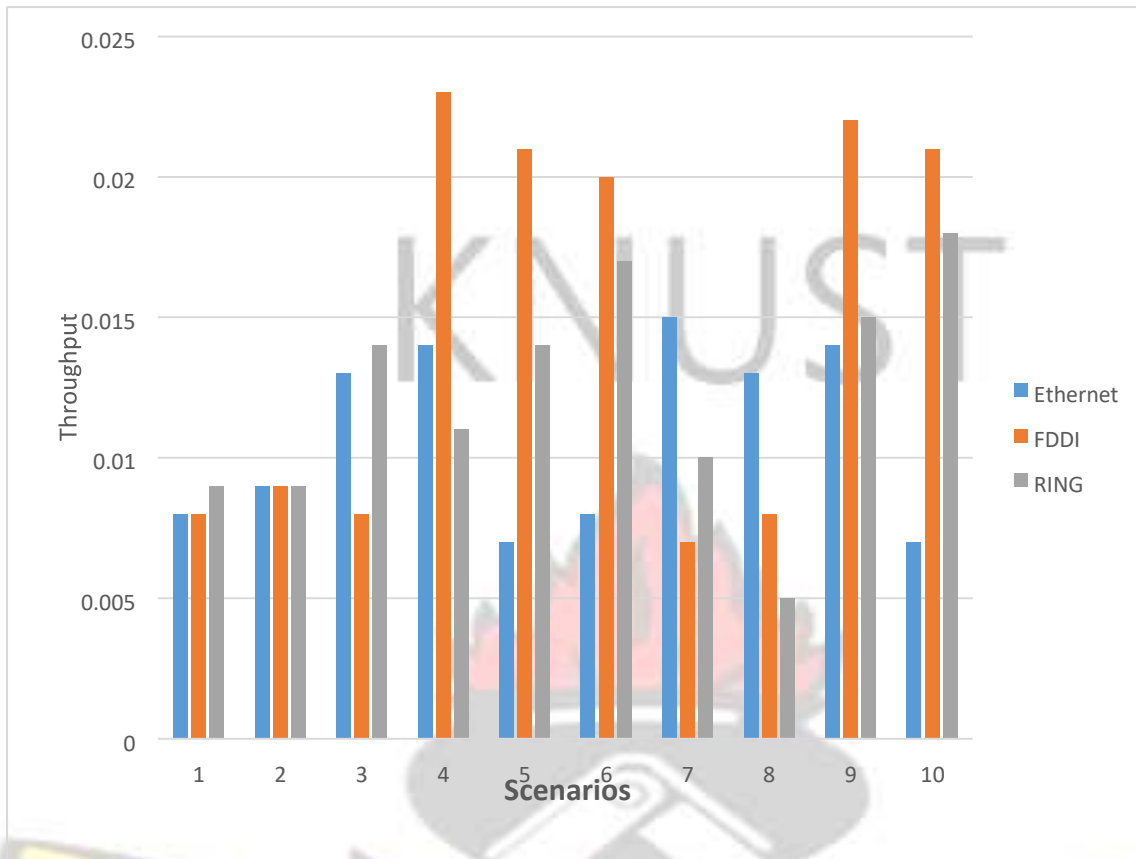


Figure 4.10 Throughput for SMTP application with 5000 MB @ 0.005sec

4.2.11 Throughput for SMTP application with 5000MB @ 0.005sec (Acknowledgement)

Figure 4.11 shows data throughput when the machine in the computer science department sends an acknowledgement of receipt of packet to the sending machine in the mathematics department. From Figure 4.11 when the simulation was run for the first time, both Ethernet and FDDI recorded data throughput of 0.010bps and Token Ring recorded 0.013bps. For the sixth scenario Ethernet had 0.010bps, 0.305bps for FDDI and 0.306bps for Token Ring. The ninth scenario shows 0.306bps for Ethernet, 0.207bps for FDDI and 0.202bps for Token Ring network. FDDI therefore performs better than Token Ring and Ethernet because FDDI has the lowest data throughput than Ethernet Token Ring.

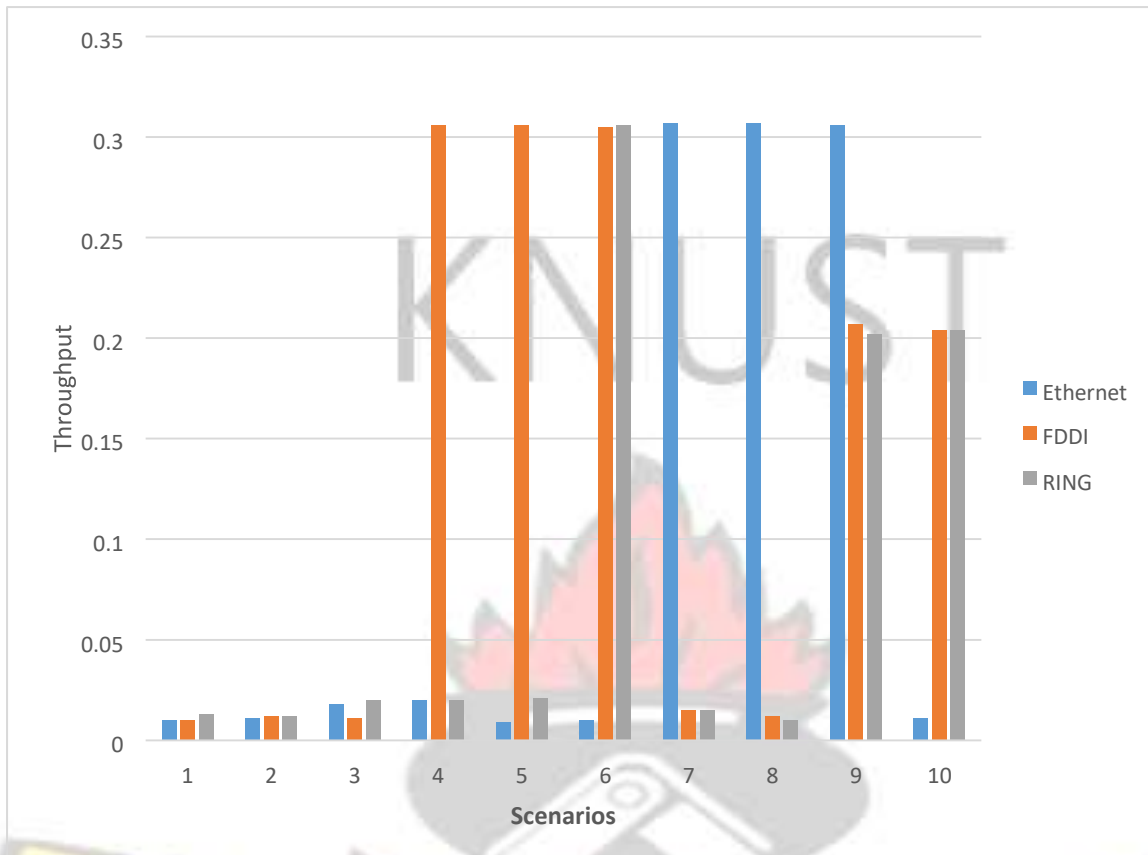


Figure 4.11 Throughput for SMTP application with 5000MB @ 0.005sec (Acknowledgement)

4.2.12 Delay for 5000MB @ 0.005sec

Figure 4.12, shows that the delay in the network when the simulation was run for the first time is 0.002 sec respectively for Ethernet and FDDI network, while it is 0.004 sec for the Ring network. From the figure, it can also be seen that the delay in the Ethernet network is 0.294 sec followed by 0.004sec for FDDI and 0.005 sec for Ring when the simulation was run for the seventh time. Averages for the ten scenarios recorded 0.0901secs for Ethernet, 0.1241sec for FDDI and 0.0701sec for ring network. Ring therefore has lower delay than FDDI and Ethernet network.

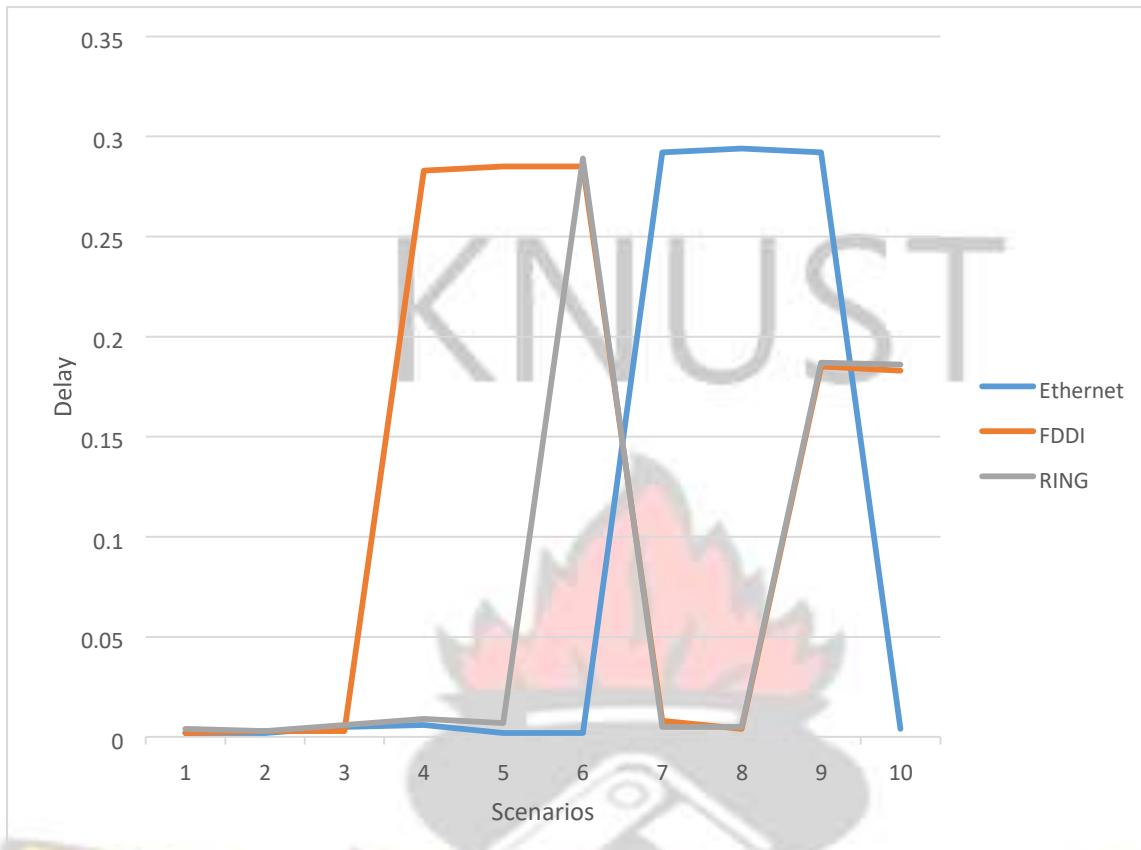


Figure 4.12 Delay for 5000 MB @ 0.005sec sec

4.2.13 Data Throughput for FTP application with 5000MB @ 0.0005sec

Figure 4.13 shows the data throughput when a machine in the computer science department send packet to a client in the same computer science department. The data throughput for the first scenario was 0.002bps for Ethernet, 0.004bps for Ring network, and FDDI recorded 0.002bps. When the value was taken for the fourth scenarios, it recorded 0.010bps for Ethernet network, 0.017bps for FDDI and 0.010bps for the Ring network. Again, the averages recorded 0.0103bps for Ethernet, 0.0128bps for FDDI and 0.0132bps for ring network. Ethernet therefore have better throughput than ring and FDDI.

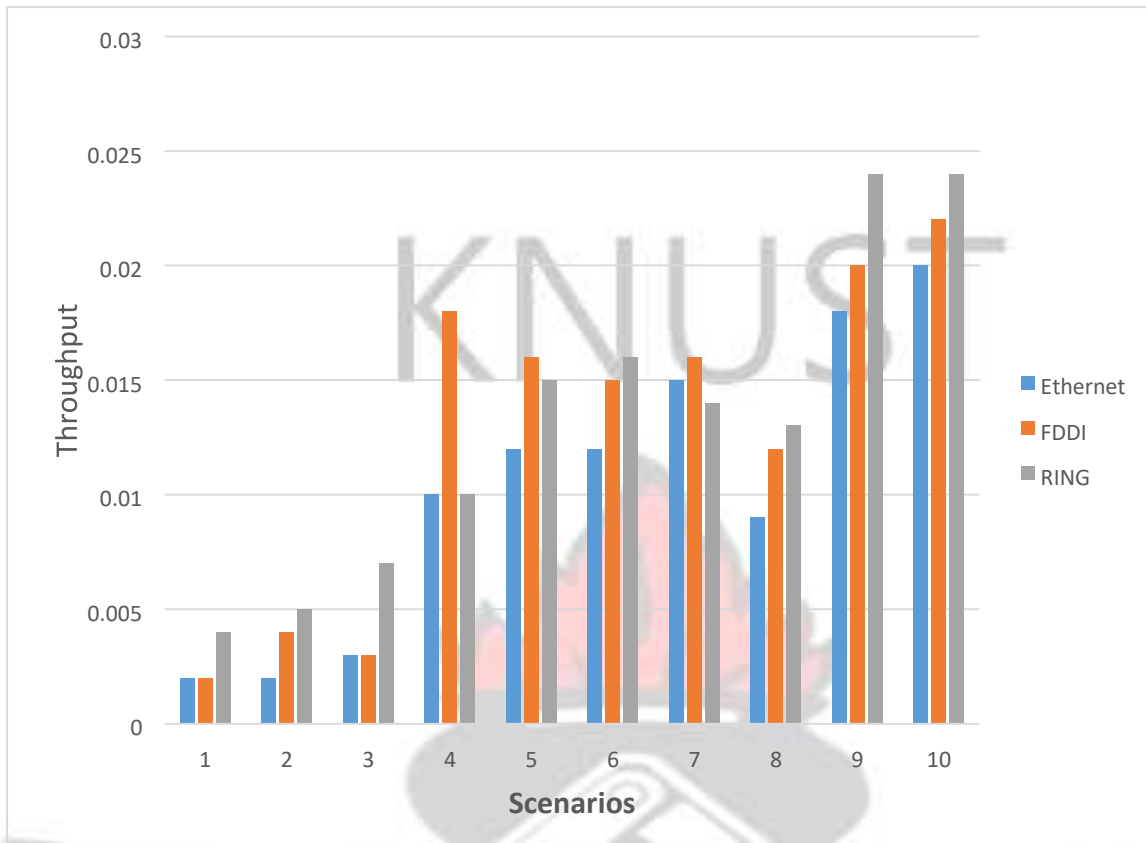


Figure 4.13 Throughput for FTP application with 5000 MB @ 0.0005sec

4.2.14 Throughput for FTP application with 5000MB @ 0.0005sec (Acknowledgement)

Figure 4.14 shows data throughput when the machine in the computer science department sends an acknowledgement of receipt of packet to the sending machine in the same department. From the Figure, data throughput for the third scenario was 0.005bps for Ethernet, 0.006bps for FDDI and 0.201bps for Token Ring network. The seventh scenario recorded 0.020bps for Ethernet, 0.022bps for FDDI and 0.020bps for Token Ring network. Again the tenth scenario values were 0.024bps for Ethernet, 0.025bps for FDDI and 0.300bps for Token Ring. Ethernet had the lowest data throughput than FDDI and Token Ring. Ethernet network therefore performs better than FDDI and Token Ring.

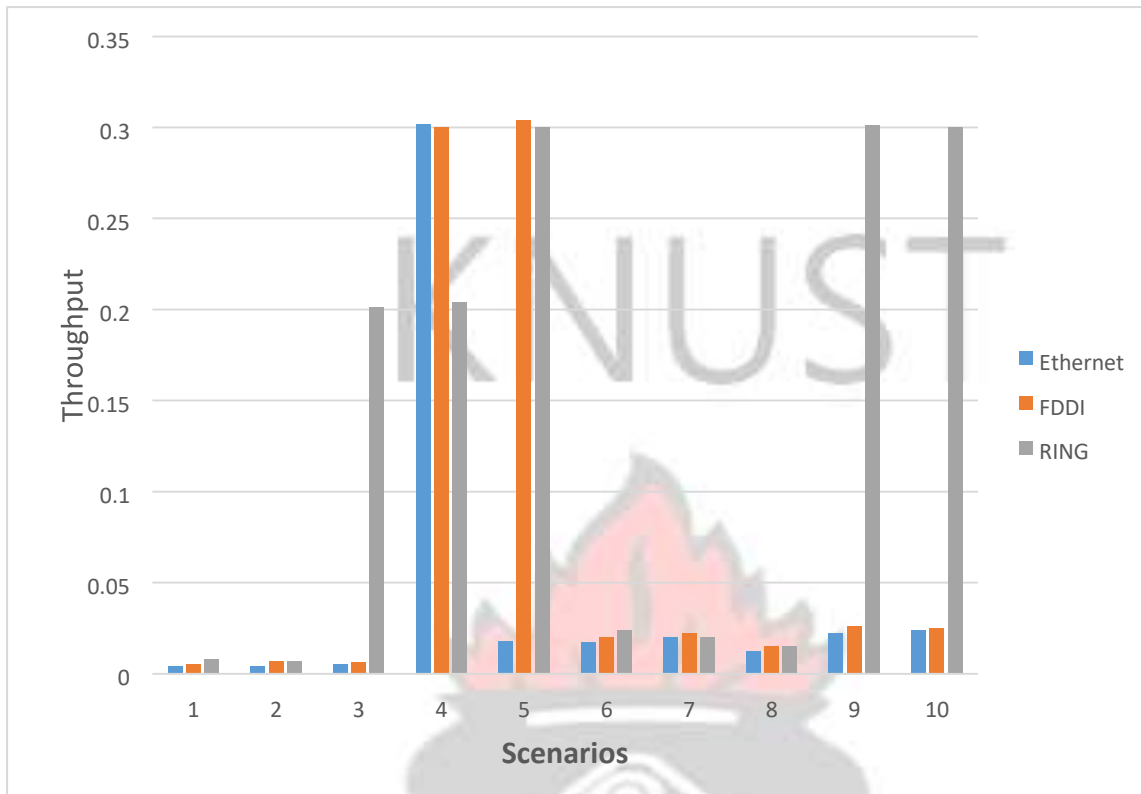


Figure 4.14 Throughput for FTP application with 5000MB @ 0.0005s (Acknowledgement)

4.2.15 Delay for 5000MB @ 0.0005sec

From figure 4.15, it can be seen that the delay in the network when the simulation was run for the first time is 0.002 sec respectively for Ethernet, 0.003 for FDDI network, and 0.004 sec for the Ring network. Averages for the ten scenarios are 0.0325secs for Ethernet, 0.0602 sec for FDDI and 0.1248 sec for Ring network. Ethernet therefore has lower delay than FDDI and Ring network.

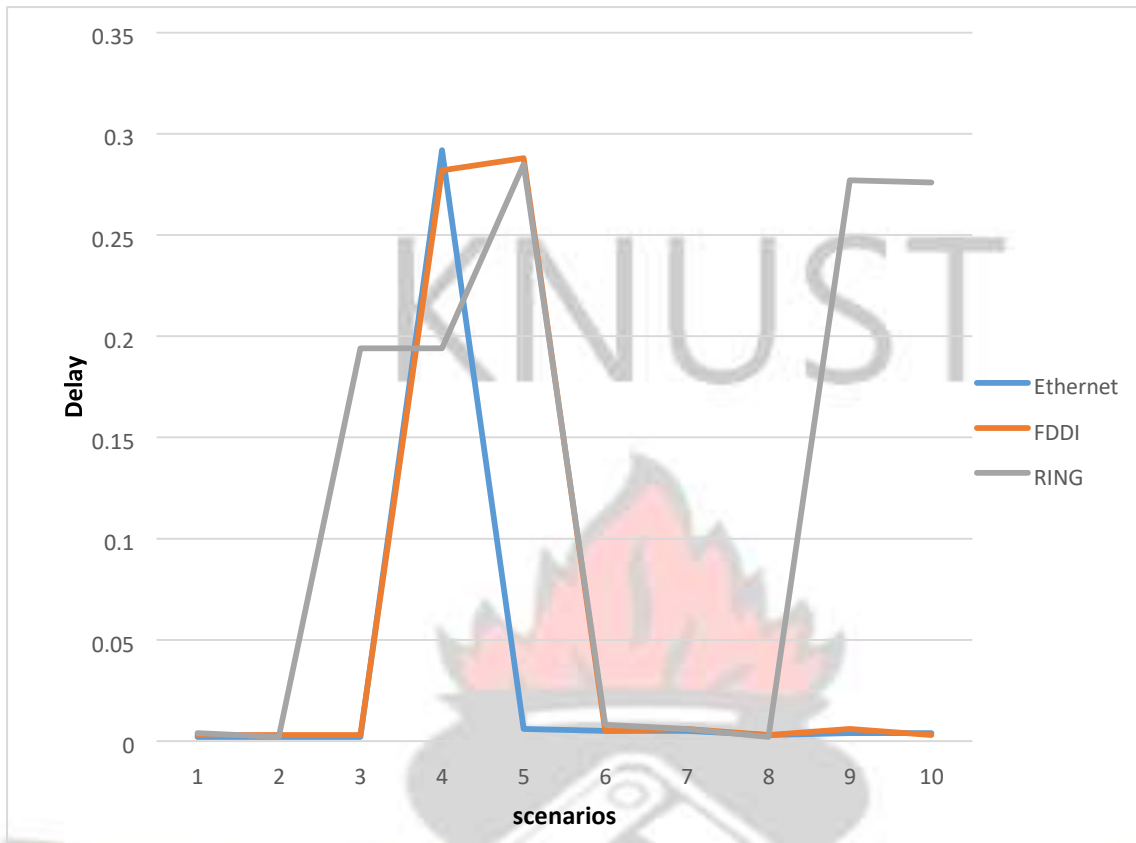


Figure 4.15 Delay for 5000MB @ 0.0005sec

4.2.16 Data Throughput for SMTP application with 5000MB @ 0.100sec

Figure 4.16 shows the data throughput when a machine in the computer science department send packet to a client in the mathematics department. When the simulation was run for the first time, the data throughput was 0.102bps for Ethernet and FDDI network, and Ring network recorded 0.103bps. When the value was taken for the fourth scenarios, it recorded 0.107bps for Ethernet network, 0.114bps for FDDI and 0.106bps for the Ring network. Again, the ninth scenario recorded 0.109bps for Ethernet, 0.105bps for FDDI and 0.112bps for ring network. 0.1057bps, 0.1052bps and 0.1069bps were the averages for Ethernet, FDDI and Ring network respectively. FDDI therefore have better throughput than ring and Ethernet.

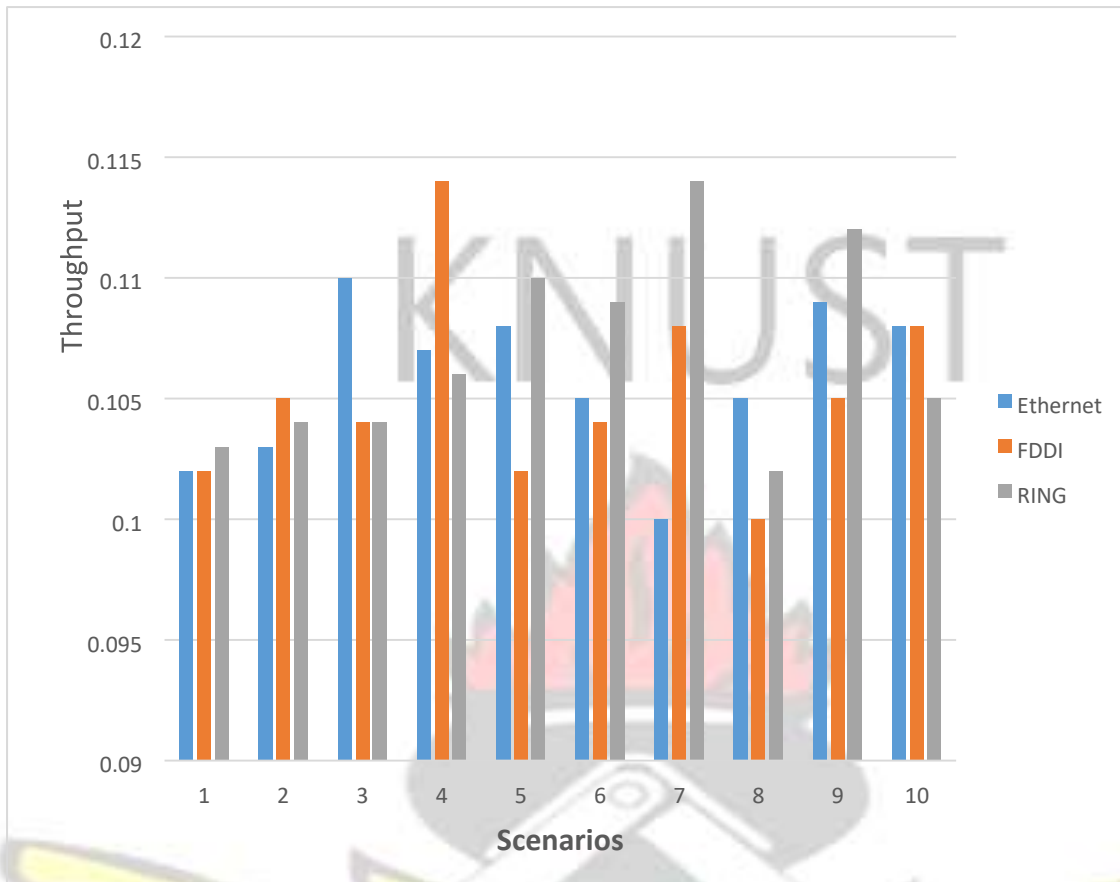


Figure 4.16 Throughput for SMTP application with 5000 MB @ 0.100sec

4.2.17 Throughput for SMTP application with 5000MB @ 0.100sec (Acknowledgement)

Figure 4.17 shows data throughput when a machine in the mathematics department sends an acknowledgement of receipt of packet to the sending machine in the computer science department. From Figure 4.17, the third scenario recorded 0.401bps for Ethernet, 0.107bps for FDDI and 0.109bps for Token Ring network. Values for the sixth scenario were 0.402bps for Ethernet, 0.107bps for FDDI and 0.400bps for Token Ring. When the simulation was run for the ninth times it recorded 0.404bps for Ethernet, 0.200bps for both FDDI and Token Ring network. Figure 4.17 show that FDDI recorded the least values of data throughput. FDDI therefore performs better in terms of network than Ethernet and Token Ring.

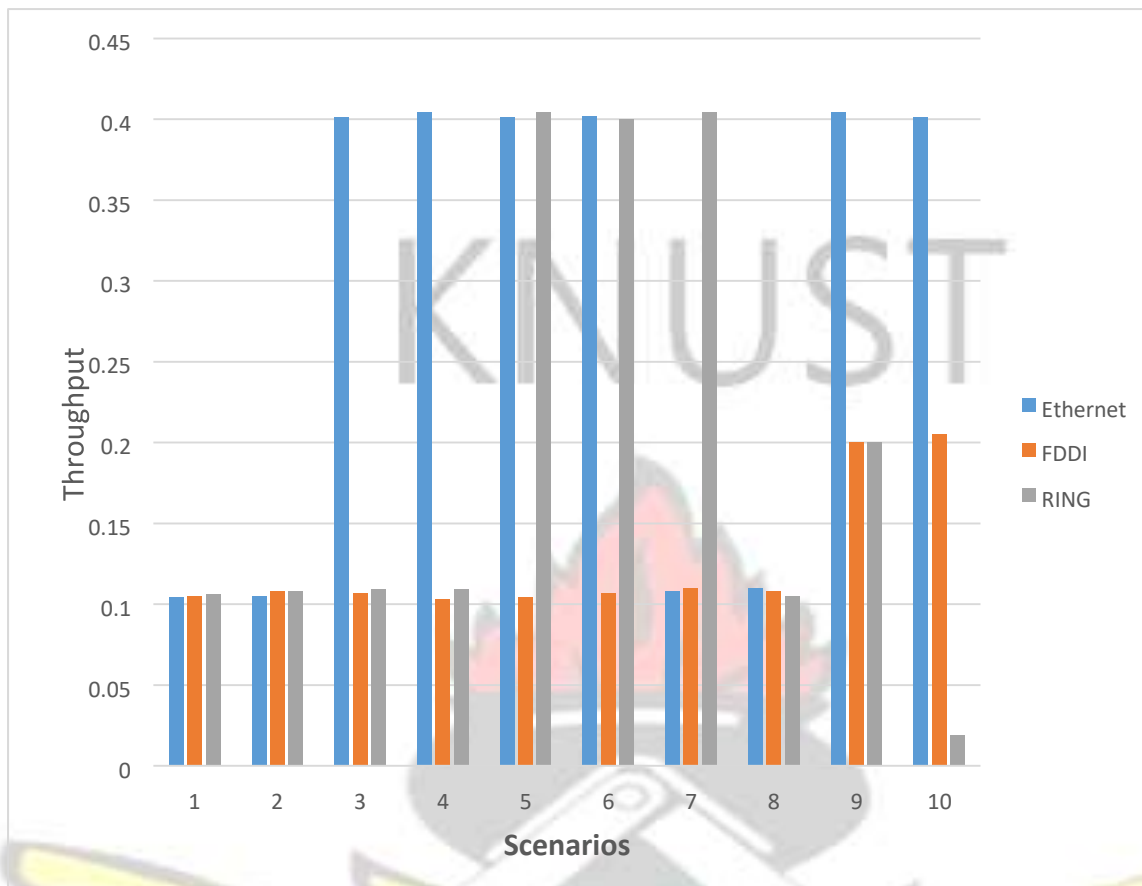


Figure 4.17 Throughput for SMTP an with 5000MB @ 0.100s (Acknowledgement)

4.2.18 Delay for 5000MB @ 0.100sec

Figure 4.18 show that the delay in the network when the simulation was run for the first time is 0.002 sec for Ethernet, 0.003sec for FDDI network, and 0.003 sec for the ring network.

Averages for the ten scenarios are 0.1783 sec for Ethernet, 0.0205 sec for FDDI and 0.0895sec for ring network. FDDI therefore has lower delay than Ring and Ethernet network.

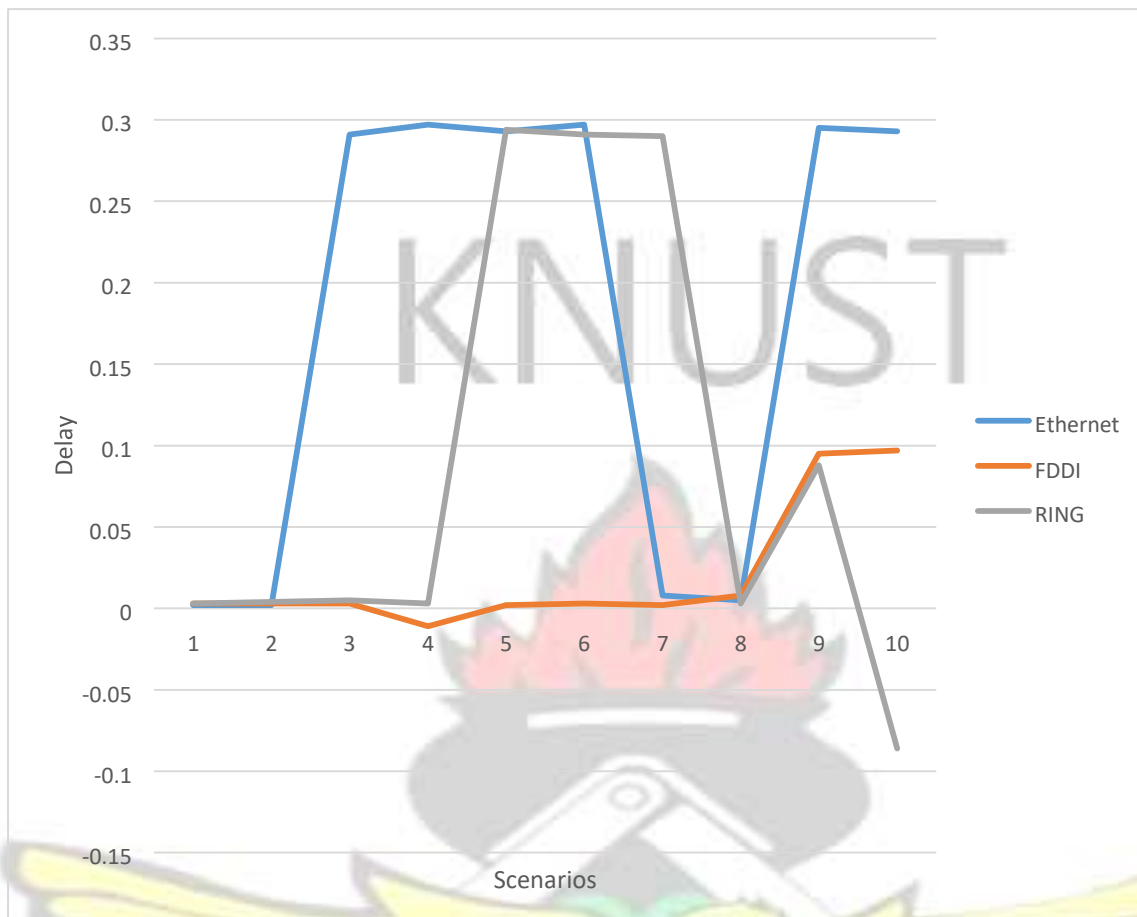


Figure 4.18 Delay for 5000 MB @ of 0.100s

CHAPTER FIVE

FINDINGS, CONCLUSION, RECOMMENDATIONS, AND FUTURE WORK

5.1 Findings

The simulation exercise was conducted to find out the network performances of the three different networks presented in terms of the data throughput and delay of the network topology studied. The simulation results picked in the tables and the figures show that the data throughput and delay for Token ring network is higher than the Ethernet and FDDI network in some of the scenarios. Also, FDDI records lowest data throughput and delay in most of the scenarios. Ethernet also had some least values of delay and throughput in few of the scenarios.

The general conclusion is that FDDI recorded the lowest values with regards to data throughput and delay in most of the scenarios than Ethernet and Token Ring Network. FDDI therefore has better network performance than Ethernet and Token Ring network.

5.2 Conclusion

The internet is global and content of the internet is now highly multimedia. The rate of data uploads and downloads become a concern for most users of the internet. Individuals and business organizations are therefore looking for ways to boost the speed of their network for fast data transfer.

The study has revealed that the performance metrics used; that is throughput and delay indicated that the simulation scenario exercises conducted for data throughput, FDDI had lowest data throughput than Ethernet and Token Ring network in most of them. Also, FDDI recorded lowest delay in some of the scenarios as well.

The general conclusion is that FDDI recorded the lowest values with regards to data throughput and delay in most of the scenarios than Ethernet and Token Ring Network. FDDI therefore has better network performance than Ethernet and Token Ring network.

5.3 Recommendations

Based on the result of the study, it can be recommended that business organisations and individuals who intend to deploy a network infrastructure should consider deploying FDDI network because of its use of fiber optic cables for fast data transfer. Fiber optic cables should not be used as backbone alone instead should be allowed to run through the entire network because of its high speed.

The only disadvantage is the cost of deployment of the FDDI infrastructure. Also, between the Ring and Ethernet network, it can be advised that the Ethernet network should be considered over the Ring network.

5.4 Future Work

The researcher proposes that, the future research could be conducted in the area where the three LAN protocols would be combined in a heterogeneous network to determine their performances as a joint Network instead of the separate network that was studied.

Also, a different simulation software could be employed that will allow three LAN networks to be simulated at the same time and result picked and effectively analysed.

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