COMPUTER COMMUNICATIONS: A CASE STUDY OF FUMTA LOCAL AREA NETWORK

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This Project is submitted to the department of Mathematics and Computer Science, School of Science and Science Education, Federal University of Technology, Minna, Niger State, Nigeria, in partial fulfilment of the requirements for the Award of Post Graduate Diploma in Computer Science.

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CERTIFICATION

THIS IS TO CERTIFY THAT THE PROJECT TITLED "COMPUTER COMMUNICATIONS: A CASE STUDY OF FUMTA LOCAL AREA NETWORK" IS AN ORIGINAL WORK UNDERTAKEN BY YAKUBU USMAN DUHU, PGD/MCS/008/96.

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....

Dr. K. R. Adeboye Date
(Head of Department)

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External Examiner Date

D E D I C A T I O N

To my cherished wife, SAKINAH YAKUBU DUHU for her support and encouragement throughout the gestation period.

ACKNOWLEDGEMENT

The subject matter of the Project touches on many different fields of Computer Communications and much of it is on the leading edge of an advancing wave of knowledge. It would not have been possible for me, working alone, to have collected all the materials which has gone into the composition of the project.

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I am also grateful to all my course mates and numerous friends who helped me put the manuscript into finished form. My gratitude also goes to **Mallam Shehu G. K. Yusuf,** Sole Administrator NSTA, Minna for his valuable support towards the successful realization of the project. Similar gratitude goes to all my Directors and the Federal Urban Mass Transit Agency, Abuja for their sponsorship I enjoyed for my PGD Studies.

And finally, I am very much indebted to my mentor, **Dr. Abimbola Odumosu**, who guided and encouraged me throughout the long period of my training. I live to cherish his efforts.

A B S T R A C T

This project work highlights computer communications with particular reference to the local Area Network (LAN). Emphasis was laid on the Novell Network concept with its related software while the program was written on EMAIL.

The Chapter 1 of the project discussed its introduction, the mandates of FUMTA, reasons for the project study and the types computer networks available.

The Chapter 2 explained intensively the characteristics of LAN, its types and topologies.

The Chapter 3 dealt with the LAN medium, its devices and installation overview.

In Chapter 4, an in-depth study was carried out on the design of the LAN based on its system requirements, configuration, installations and management.

The Chapter 5 outlined the implementation of the LAN and related cost implications for its development while the associated conclusion and recommendation were discussed.

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CHAPTER ONE

1.0 INTRODUCTION

Human movement is fundamental in the creation, development and growth of settlements. Although most people live in the rural areas of Nigeria today, the major area of change and focus in settlement studies is the city. The cities of Nigeria are centres of administrative, industrial, commercial, educational, social and recreational activities. They generate and attract very large number of person-trips daily and because of their multi-various functions, these urban centres are complex in the pattern of their interaction and traffic.

With the rise in urban population and increase in urban expansion, the way man lives and moves becomes incompatible. The increased urban population, the expansion of roads and increased urban trip volumes have all placed a great burden on the city's transport system.

Transport is the engine of growth for a nation's economy. Multi-modal transportation system is an indispensable infrastructure, which provides the desired momentum for economic development and reconciliation. In fact, the development process depends on the overall efficiency of the country's transportation system.

FUMTA is the initials for **F**ederal **U**rban **M**ass **T**ransit **A**gency and was established in 1988 by the Federal Government to ease the problems of commuting workers in urban cities. The Programme of the Agency was mainly a Government response to the acute transportation demand and related hardships experienced by Nigerian workers upon the introduction of the structural Adjustment Programme (SAP). The programme was conceived as an instrument to modernise and lay a solid foundation for Urban Mass Transit System Development in the country.

1.1 MANDATE OF FUMTA

The primary mandate of the FUMTA is:

(a) To plan and advise on the orderly and efficient implementation of the Urban Mass Transit Programme.

(b) To develop and issue operational guidelines for co-ordinated Mass Transit System development, the execution of Transit Projects and the delivery of Transit Projects and services.

(c) To offer financial, technical and projects assistance to Government owned Mass Transit Agencies and other organised private transporters and bodies, where and when feasible.

(d) To liaise with National and International Agencies, through appropriate Federal Government Organs, on matters related to Federal Government Urban Mass Transit Agency.

1.2 JUSTIFICATION FOR COMPUTERISING FUMTA

The computerization of FUMTA has many advantages, and thus the choice of the proposed project work.

(I) **VOLUME:-** Computerized facility offers the advantage of handling higher volume of information effectively and efficiently at a relatively lower cost than manual system.

(ii) **PROJECTION:-** To be able to project the estimated transportation data of the country and advice the government on the likely problems that many result in future if such projected data is not properly addressed.

(iii) **TIME:-** To reduce the longer time usually taken the FUMTA to release the result of vehicle delivery and allocations conducted.

(iv) **COST:-** To reduce cost on DataBase Management, instead of the manual method of data collection and collation which are carried out manually.

(v) **ACCURACY:-** Data duplication will be eradicated and accurate calculation is achieved.

1.3 OBJECTIVES OF THE STUDY

The computerization exercise entails an efficient renditions of problem solving, where applicable, to abviate labourous manual methods.

The followings are the objectives of the study:-

(a) **National Data Bank Development**

The data Bank would form a broad based information centre on:

(I) Types of vehicles used for all FUMTA schemes and states operations.

(ii) Manufacturers of each type

(iii) Types of vehicles used for transportation system in the whole country and their manufacturers.

(iv) All Transport related information in Nigeria which would form an avenue for sharing of ideas with other mass transit private operators outside the country.

(b) **Support Services System**

The support services system facilitate the operations/functions of FUMTA and would contain details on:-

(I) The private operators' scheme

(ii) The Mass Transit Special Scheme

(iii) The activities of the state Mass Transit Agencies.

(iv) The Accounts department (Payroll, General ledger and so on)

(v) Spare parts (The Network distribution Pattern)

(vi) Personnel records, and so on.

(c) **UNIFORM ACCOUNTING SYSTEM**

This system ensures the monthly or quarterly analysis of the statement of Accounts of all the state Mass Transit Agencies and assess their Performance in terms of fuel consumption, mileage, vehicular usage, and so on.

(d) **UNIFORM REPORTING SYSTEM**

The system accommodate a Uniform System of reporting on:

(I) State Mass Transit Agencies

(ii) Beneficiaries of FUMTA Schemes

(e) Promotion of Computer Literacy/usage within the Agency.

1.4 THE CONCEPT OF COMPUTER COMMUNICATION NETWORK

Raw facts and figures are processed and interpreted in a systematic manner that can be easily retrieved, transferred, evaluated and stored within an integrated network.

Data Communication is the process of transferring data from one point to another. Thus, the processing of transferring data from one point to another with the aid of a computer is referred to as **Computer Communication**. These processed data called information are transmitted via computer networks which depends on the geographical areas. And its connectivity involves sharing hardware and software resources.

Early forms of computers communicating with each other was through electronic devices called MODEMS which converts analog signals to their digital equivalents, and vice versa. With Moderm, the public telephone network usually serves as the transmission medium.

In managing a computer network, the continuous training of the resourceful personnel and security information is always on top priority.

The optimization of computer communication network is based on the evaluation of the performance of software, hardware and human resources in maximizing profit for the organization.

1.5 TYPES OF COMPUTER COMMUNICATION NETWORK

Based on their geographical size, networks are divided into 2 groups, viz:-

(i) Local Area Network (LAN), and
(ii) Wide Area Network (WAN).

1.5.1 LOCAL AREA NETWORK (LAN)

LANs are series of connected devices, such as personal computers or workstations, which are distributed over a small geographical area. LANs have data rates up to 100 megabits per second. LAN can either be a client - server network or a peer-to-peer network.

A client - server network is one in which the server provide dedicated services to other workstations or devices (i.e. clients).

A peer-to-peer network is one in which the server may alternatively provide or receive non-dedicated services.

1.5.2 WIDE AREA NETWORK (WAN)

WANs are concerned with the interconnection of computer network devices over a wide geographical area that extends over distance of up to 1000 kilometers.

Many existing WANs have data rate of about 100 kilobits per second.

Example of WAN is the public switched telephone Network (PSTN).

CHAPTER TWO

2.0 LAN TECHNOLOGY

2.1. CHARACTERISTICS OF LAN

The characteristics of an ideal LAN can be summarized as follows:

(I) High Speed

(ii) Low Cost

(iii) High reliability

(iv) Installation feasibility

(v) Expandability

(vi) Ease of Access

(vii) Application Adaptability

(viii) Interface Standardization

(ix) Low error-rates

(x) Logical Access

2.1.1 HIGH SPEED

LAN is designed to provide suitable communication paths for all types of information at high speed.

2.1.2 LOW COST

LAN administrators always recommend low-profile system unit that complies with both the user's requirement and system requirement at affordable cost.

2.1.3 HIGH RELIABILITY

When considering LAN connectivity and integrity, both system designers and suppliers provide systems with high degree of fault tolerance.

2.1.4 ERROR RATES

LAN applications requires a high degree of information, which are achieved using low-level error detection and re-transmission techniques.

2.1.5 INSTALLATION FLEXIBILITY

LAN are installed in a variety of conditions. Provisions are always made for expansion of electrical cable and furniture.

2.1.6 EXPANDABILITY

While installing LAN, provisions are made for future expansion of personnel, hardware and software resources.

LAN administrators provide facilities for re-configuration of a running system, upgrading and expansion of new user groups and applications.

2.1.7 EASE OF ACCESS

LANs are installed in view of certain environmental conditions for the office users ease of access should be guaranteed so that they can have physical access easily to the system

2.1.8 LOGICAL ACCESS

The LAN systems must be logically accessible to the users through their applications.

2.1.9 APPLICATION ADAPTABILITY AND INTERFACE STANDARDIZATION

In LAN Projects, standard interfaces are provided for the range of required equipment to be connected to it.

2.3 LAN STANDARDS

There are general-purpose networks capable of satisfying many application requirements and handling different information types and volumes.

The International standard Organisation (ISO) has proposed the open systems interconnection (OSI) reference model as the common basis for describing communication systems in both LAN and WAN.

2.3.1 OPEN SYSTEM INTERCONNECTION REFERENCE MODEL

This model uses a 7-layer approach. It is often called ISO - OSI Model. This reference model was created for two purposes:

(i) To help co-ordinate the development of new communication standards by dividing them by function into seven sub-groups or layers.

(ii) To help put existing communication standards into perspective by defining where they fit in a complete communication system. The OSI model made provision for each layer to use services provided by the layer below it and provides services to the layer above it.

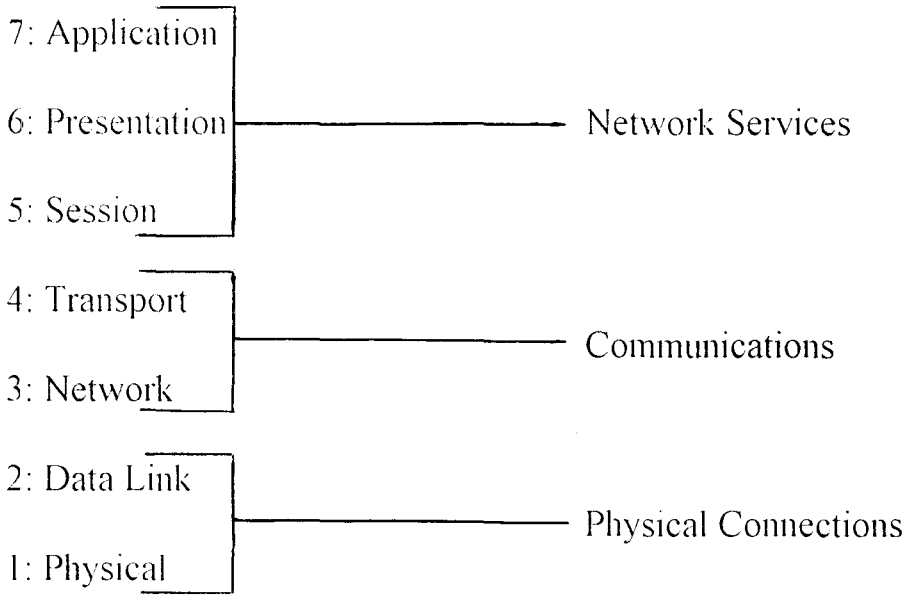


Fig. 2.2.1. ISO - OSI REFERENCE MODEL

2.2.2 FUNCTION OF OSI LAYERS

LAYER 7 - APPLICATION: It manages the programs that users interact with. Also, it defines network services.

Examples are: Terminal emulation, file transfer, Electronic mail, network operating systems, LAN utilities, identification and security passwords.

LAYER 6 - PRESENTATION: It converts data from a format that can be read by application level software on another system.

Example: Host operating system.

LAYER 5 - SESSION: This layer establish a communication session between two Application processes. It has facilities to Police the session and to terminate it in an orderly fashion.

It also ensure integrity of the whole message.

LAYER 4 - TRANSPORT: It provides for an end-to-end data delivery by connecting processes at different locations.

The transport software determines the route which data will take from one point on the network to another by calculating the speed and cost of available connections.

LAYER 3 - NETWORK: This layer is responsible for ensuring that information is transferred correctly across a network. It keeps track of possible connections a network can make and passes this information to the transport layer.

LAYER 2 - DATA LINK: This layer is responsible for maintaining the integrity of information sent between two points. It is also responsible for bit level operations (i.e. groupings), tracking of unit of information and performing error checking.

LAYER 1 - PHYSICAL: This layer is concerned with the electrical and mechanical means of transmitting and receiving information using particular communication medium.

It specifies the details of connecting cables and processing digital signal.

2.3 TYPES OF LANs

We have different types of LANs based on standard, topology, access protocol and data rates as shown below.

(A) Standard LAN	Topology	Access Protocol	Data Rate
(i) Ethemet	Bus (tree)	CSMA/CD	10 MB/s
(ii) Token bus	Bus	Token Passing	1,5 or 10 MB/s
(iii) Token Ring	Ring	Token Passing	1 or 4 MB/s
(iv) Cambridge Ring	Ring	Empty slot	10 MB/s

(B) Non-Standard LAN			
(v) PABX	Star	Not applicable	Vary
(vi) MICRONET	Bus (Ring)	Vary	< 1 MB/s

Table 2.3 A LAN classification matrix

The Standard Ethernet LAN was opted for networking FUMTA because of its highest data rate and easy topology.

The Ethernet was based on the Bus - oriented technique called carrier sense Multiple Access with collision detection (CSMA/CD).

2.4 LAN TOPOLOGIES

Topology refers to the layout of the route data travels along the network.

The form of LAN topologies can either be **physical** or **logical**. A physical topology is a description of the route the network cables takes as they link nodes. The logical topology is a pattern in which the nodes on the LAN handle messages among themselves.

There are four common types of topologies: star, bus loop and Ring Network.

2.4.1. STAR TOPOLOGY

The star topology is also called the HUB topology. In this topology, the network wire runs between the network nodes and a central wiring hub. Each device is connected to a central point.

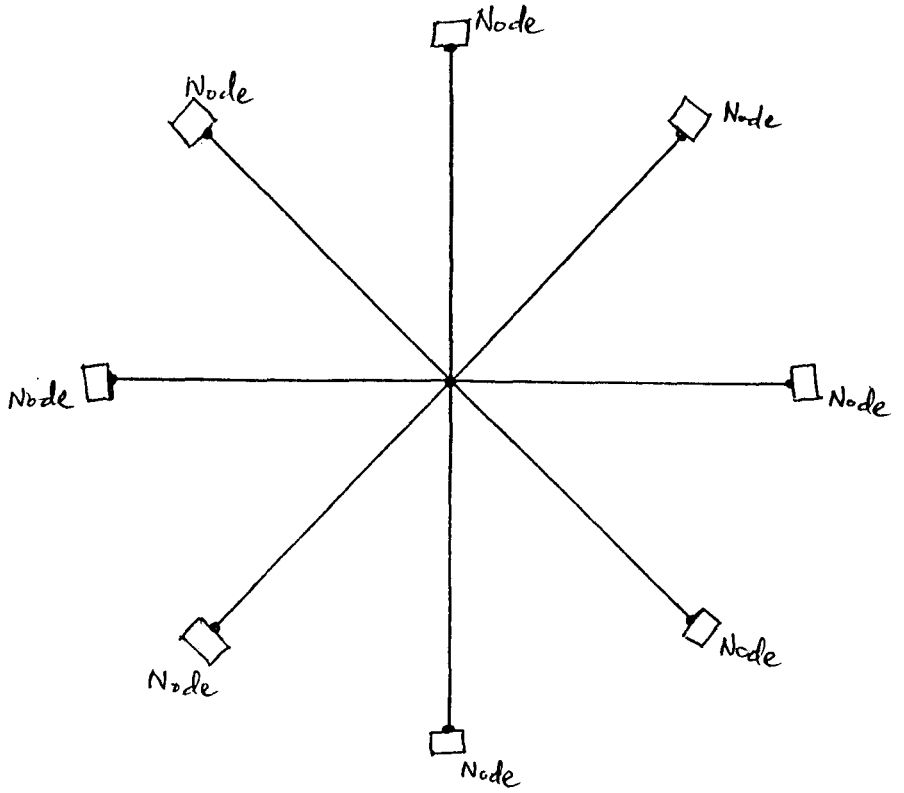


Fig. 2.4.1. Start Topology.

These central points are also called hubs, concentrators or multi-port repeaters. There are three types of hubs such as: (i) Passive (ii) Active and (iii) Intelligent.

The basic advantage of a star topology is that most network trouble shooting and wiring changes takes place at the hub.

The major **disadvantage** of star topology is that you have to run a separate cable to every computer that wants to access the network. If the hub goes down, so does every station connected to it.

2.4.2 RING TOPOLOGY

The Ring topology network has intelligent nodes to spread evenly over the network and hence no central control is necessary. Most Ring networks have one monitoring station (i.e. a network node) that takes care of any error in the data transmission.

Data transmission around ring network is normally one-way. Although, some Ring network system can be configured for data transmission in either directions.

The Ring network topology was shown below:

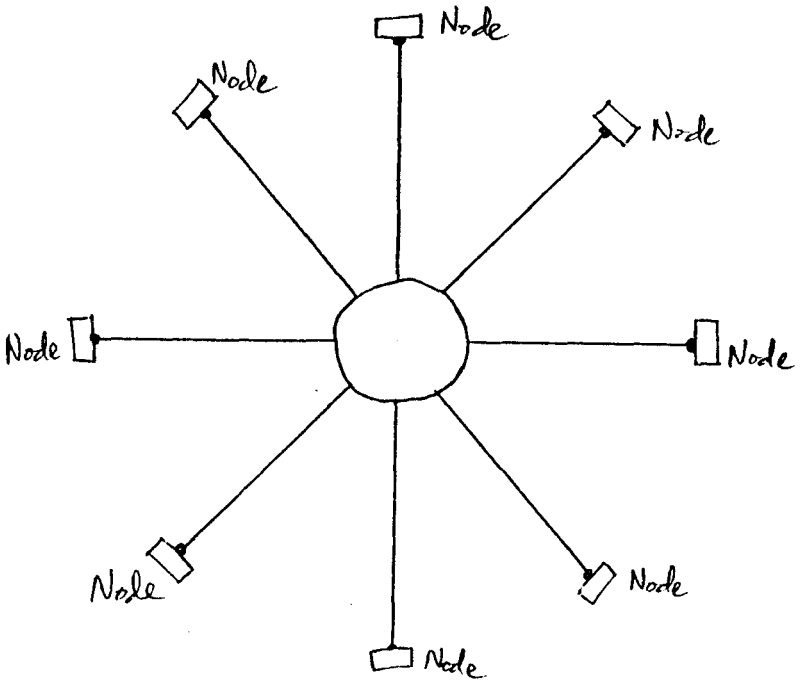


Fig. 2.4.2 Ring Topology

2.4.3 LOOP TOPOLOGY:

The loop network topology is similar to that of the Ring network, except that all messages on the network must Pass through an Intelligent Controlling Node. Message which is transmitted by the device poll each other on the network.

Pollingis the task of constantly asking a device (at regular intervals) whether or not it needs attention, such as sending a message over the network, etc.

The diagram of a loop network topology is shown below:

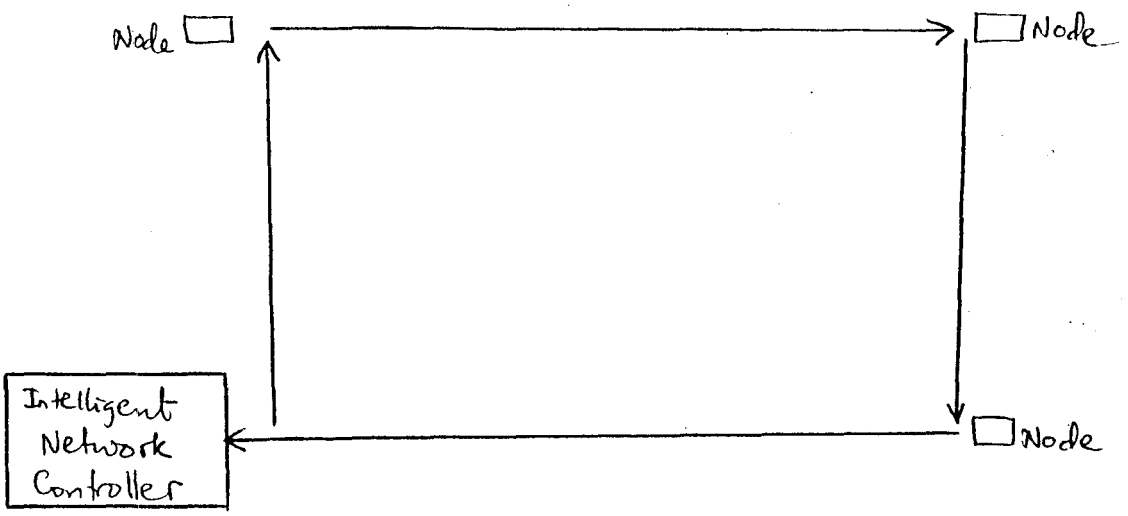


Fig. 2.4.3 Loop topology

The major **disadvantages** of the loop network are:

(i) The System relied on the intelligent controller node. If this node breaks down, the whole system will fail and communication across the network would be impossible.

(ii) The system has a low data transmission speed and hence the data through-put is some-what restricted.

2.4.4 BUS TOPOLOGY

The Bus network topology consists of one bus and terminators at both ends. The nodes in the network send data along the bus, and all devices quickly examine the data to look for the address, just in case it corresponds to them.
A bus network topology is shown below:

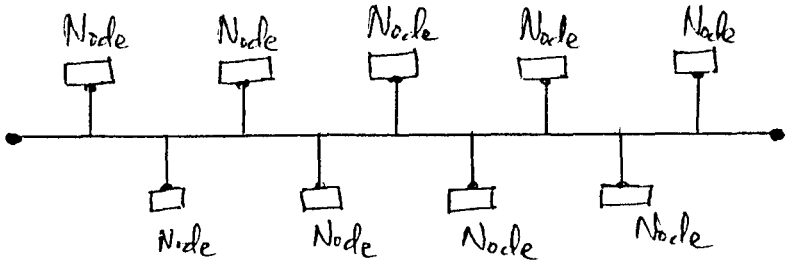


Fig. 2.4.4 Bus topology

The Bus network is "Passive" meaning that the devices on the network listens for data addressed to them

When a device wants to transmit data over the network, it **"listens"** to determine if the network is busy (i.e. if any data is being transmitted). When the network goes quiet for a brief moment, the device will then transmit its information.

The Bus network uses intelligent terminal as its node to recognise an address, receive information and transmit message safely.

This type of network is normally used in probabilistic systems, using a protocol such as CSMA/CD over a LAN.

The Bus topology is **recommended** for FUMTA network due to the following advantages:

(i) It makes provision for easy installation and expansion

(ii) A break in the main bus that isolates one or more devices may not cause a total network breakdown.

The disadvantage of this type of network is the expensive nature of installation and limitation in cabling.

CHAPTER THREE

3.0 LAN MEDIUM

LAN carry information between computers and also between computers and their peripheral devices. The ability to connect computers of different makes or models in order to create communication among the network devices is referred to as **"Connectivity".**

LANs are used to link a series of devices in a limited area. Information are transmitted between the devices on the network via a medium. The **medium** is the physical path between the transmitter and receiver. The medium maybe **bounded** such as coaxial cable, twisted pair and fibre optic or **unbounded** such as microwaves, radiowaves, infrared, etc.

The medium can be wireless especially in areas where cabling is difficult or hazardous.

3.0.1 TWISTED PAIR

A twisted pair consists of a Pair of conductor, an open line of flat ribbon cable containing several lines and a common return wire.

3.0.2 OPTICAL FIBRE

Optical fibres are suited for digital communications. It uses the light-emitting diode (LED) or the Injector larger diode (ILD) and a photodiode to convert light into pulses of electrical energy at the receiving end and under total internal reflection.

The advantages of optical fibre over other transmission systems includes:

(i) Their attenuation with distance is low.

(ii) Their transmission bandwidth is high

(iii) The cables are immune to induced electromagnetic fields or interference.

The cost of the fibre optic cable is very expensive and therefore it remained disadvantageous for this project work.

3.0.3 COAXIAL CABLE

Coaxial cable consists of a hollow outer cylindrical conductor which surrounds a single inner wired conductor. The coaxial cable also results a better performance.

Greater bandwidth is obtained with coaxial cable compared with twisted pair and it enables digital transmission rates up to 140 mbps to be obtained over several distances at high frequencies.

For this LAN project, the coaxial cable was recommended as a medium. There are two types currently in use:

(i) 75 ohm broadband cable, and

(ii) 50 ohm baseband cable

3.1 LAN DEVICES

The LAN devices are used in connecting PCs to a LAN, WAN or Internet. The LAN devices include Modems, repeaters, bridges, routers and gateways, and so on.

3.1.1 REPEATERS

The digital signal on a LAN gets weaker over a long distance. A repeater is a device that boost the signals on a LAN cable so that it can travel further.

3.1.2 BRIDGES

A Bridge is a connection between two Area Networks having similar or dissimilar topologies. We have local Bridges (FULL) and remote Bridges (HALF) that connect LAN and WAN respectively.

3.1.3 ROUTERS

Routers are used in connecting several networks by means of one device. The routers recognise what is going on the network and keeps an Address Table of the whole network structure.

3.14 GATEWAYS

Gateways are used to exchange information and access dissimilar networks as a single logical entity.

3.1.5 MODEMS

Modems interpret the digital signals of the UART (i.e. Universal Asynchronous Receiver/Transmitter) to the analogue telephone system, vice versa.

They are the gateways between the computer and the telephone system. There are two types of Modems:

(i) Synchronous Modem, and

(ii) Asynchronous Modem.

Both Modems functions by converting the digital signals sent by the computer's UART to two or more tones sent across a phone line.

(i) Synchronous Modems

Synchronous modems are expensive modems that uses synchronized clocks to achieve high transmission rates, thereby permitting very efficient use of the phone line.

(ii) Asynchronous Modems
Asynchronous Modems are inexpensive modems that monitor frequency switches in the phone line. They use clocks to determine where one bit ends and another begins.

3.1.6 TERMINATORS

Terminators are devices that are positioned at the end of the main Coaxial Cable segment. They are used to terminate the main cable segment.

3.1.7 CONNECTORS

Connectors are devices that are positioned between cables in order to connect one cable to another via a computer system or devices. Examples are: T-connector, Connector plug, connector jack, etc.

2. LAN PERFORMANCE

The importance of LAN technologies is their comparative performance. For the end user, the importance is in the end-to-end performance of the network at the Application level. For example, how fast does a particular network transfer a file of a certain size or editing a file on a computer located remotely over a network.

Based on the OSI model, two measures are used to determine the performance value for a given network, viz:-

(i) Delay, and

(ii) throughput

Delay refers to the time that a workstation having a frame ready to send, must wait before it is allowed to access the medium. The lower the delay, the better.

The throughtput of a LAN refers to the rate of information it can carry. Also, it is the total rate of data transmitted between nodes.

The following factors contribute to the evaluation of a network's performance:

(a) Capacity

(b) Propagation delay

(c) Frame length

(d) Number of stations

(e) Offered load

(f) Access Protocols

(g) Error rate of the medium.

Summarily, there is no "Best" LAN for all possible circumstances. When it comes to choosing a LAN for a particular application, the following factors are fundamental in determining which LAN to use:

(i) Availability of network access units for customer's host computers.

(ii) The cost of the hardware offered by the various vendors.

3.3 INSTALLATION OVERVIEW

To work on LAN, you should connect your appropriate PCs to enable you share expensive resources, system peripherals, files and data. It also allows communication with other users on the work stations, thereby increasing productivity.

The overview was based on two criterion:

(A) HARDWARE

The hardware includes: (i) Terminals (ii) Workstation (iii) file - servers and (iv) Network Interface cards (NICs) or, Network Adapter cards (NACs).

(B) SOFTWARE

Software are hardware activator called operating system.

3.3.1 NETWORK INTERFACE CARDS (NICS)

A network card enables a computer to be connected to other computers on the network. They are adapter cards that established most of the network's hardware characteristics that includes cable type, topology, access scheme and data transmission rate.

The major network interface cards are:

(i) Ethernet (ii) Arcnet and (iii) IBM Token ring.

(i) ETHERNET ADAPTERS

These are cards that enables the inter-connections of a wide variety of computer equipment including UNIX, Apple, IBM and Clones.

It is mostly used for small installation based on Ethernet topologies. Ethernet provides a fast interface to the file server. However, its performance can degrade as the network traffic increases.

For the sake of this project, the **Ethernet Adapters** was preferred.

(ii) ARCNET ADAPTERS

These are the oldest type of LAN hardware that are reliable and cost less than Ethernet. Arcnet is slower than Ethernet but does not suffer from the same performance degradation as traffic increases.

(iii) TOKEN RING ADAPTERS

These are the most expensive type of LAN adapters. It is widely used when a great deal of traffic from many work stations are required. They use token passing scheme.

3.3.2 WORKSTATION

Workstation, also known as NODES, are the individual computers hooked on to the network file server to share network information and resources.

The individual workstations can also work independently as a stand-alone PC.

3.3.3 FILE SERVER

A file server is a personal computer that contain the network software (e.g. Novell NetWare), a network adapter card and all the applications and files the user wish to share.

There are different ranges of high-performance and cost effective file server that provides application from five users and up to a thousand users.

There are two main types of file server, viz:

(i) Dedicated file server (alias client - server network) - used for file serving only.

(ii) Non-dedicated file server (alias peer-to-peer network) - used for serving in workstations.

3.4. NETWORK OPERATING SYSTEMS

Just as DOS is used to manage application in stand-alone computer, a **network operating system** is used to control the flow of messages between workstations.

They are software used to activate the hardware installed in the file server and workstations in order to establish and maintain communications between them.

A list of some network operating system and their manufacturers is shown in table 3.4. For the sake of this project, much emphasis was laid on the **Novell NetWare.**

S/N	OPERATING SYSTEMS	MANUFACTURERS
1.	NETWARE	NOVELL
2.	SERVER	MICROSOFT
3.	APPLE TALK	APPLE
4.	NETWARE FILE SYSTEM (NFS)	SUN MICROSYSTEM
5.	O/S LAN MANAGER	MICROSOFT
6.	O/S LAN SERVER	IBM
7.	UNIX	BELL LABORATORIES

Table 3.4 Network Operating Systems

(i) NOVELL NETWARE

Novell Operating System - **NETWARE** - is the first operating system to link desktop PCs together with each other. It is the most popular and most capable around the world.

The NetWare is popular for some reasons:

(i) More Applications will work on it than on any other kind of network environment.

(ii) It works with more types of network adapters than any network operating system.

(iii) It has adequate security features

(iv) NetWare LANs are expandable in terms of capability and accessibility.

CHAPTER FOUR

4.0 LAN DESIGN FOR FUMTA

4.1 INTRODUCTION

This Chapter covers very brief fundamentals of LAN design, installation and administration using Novell NetWare Concept. It involves step by step operation in setting up communication within an integrated computer Network for the FUMTA.

This practical approach is based on my proposed installation and administration of LAN in my Office and administration Designing the network involves' a simple layout that covers the topology of the LAN for the FUMTA via their respective departments. Installation and operation of the LAN consists of selecting and integrating compatible components based on expected use and budget.
The LAN will consist of devices connected through some medium for the purpose of communication and sharing resources. The components will be managed and controlled by means of a network operating system.

4.2 DESIGN OF THE LAN

Designing the LAN for the FUMTA offices was based on three factors:

(i) The technology i.e. Ethernet topology

(ii) The nature of the building, and

(iii) Spacious room to accommodate the PCs.

For easy administration of the LAN, a six-user network was proposed that will be cost effective.

4.2.1 THE FUMTA OFFICE

The FUMTA office accommodates the Sole Administrator and the relevant Heads of Department, along with their respective staff. It can be divided into departmental rooms: S1, C2, D3, D4, D5 and D6. The Rooms in relation to the occupants are shown in Table 4.2.1.

	ROOMS	OCCUPANTS
1.	S1	Sole Administrator, (S. A.)
2.	C2	Computer Officer (C. O.)
3.	D3	Director, Finance & Supply (DFS)
4.	D4	Consultant, Personnel Management (CPM)
5.	D5	Director, Planning, Research & Statistics (DPRS)
6.	D6	Director, Operations (DOPS)

Table 4.2.1.

The minimum of six personal Computers was proposed for the Offices with each in every department while the file server remains in the Computer Room. Few Computer terminals may be added for future departmental usage where necessary.

The Sole Administrator should be provided with all the system security codes and Passwords that would enable him control the operations of every department and their accessibility to classified information within the FUMTA.

4.2.2 CHOICE OF TOPOLOGY

For easy configuration and cabling, the Ethernet topology was proposed based on bus layout as shown in Fig. 4.2.2.

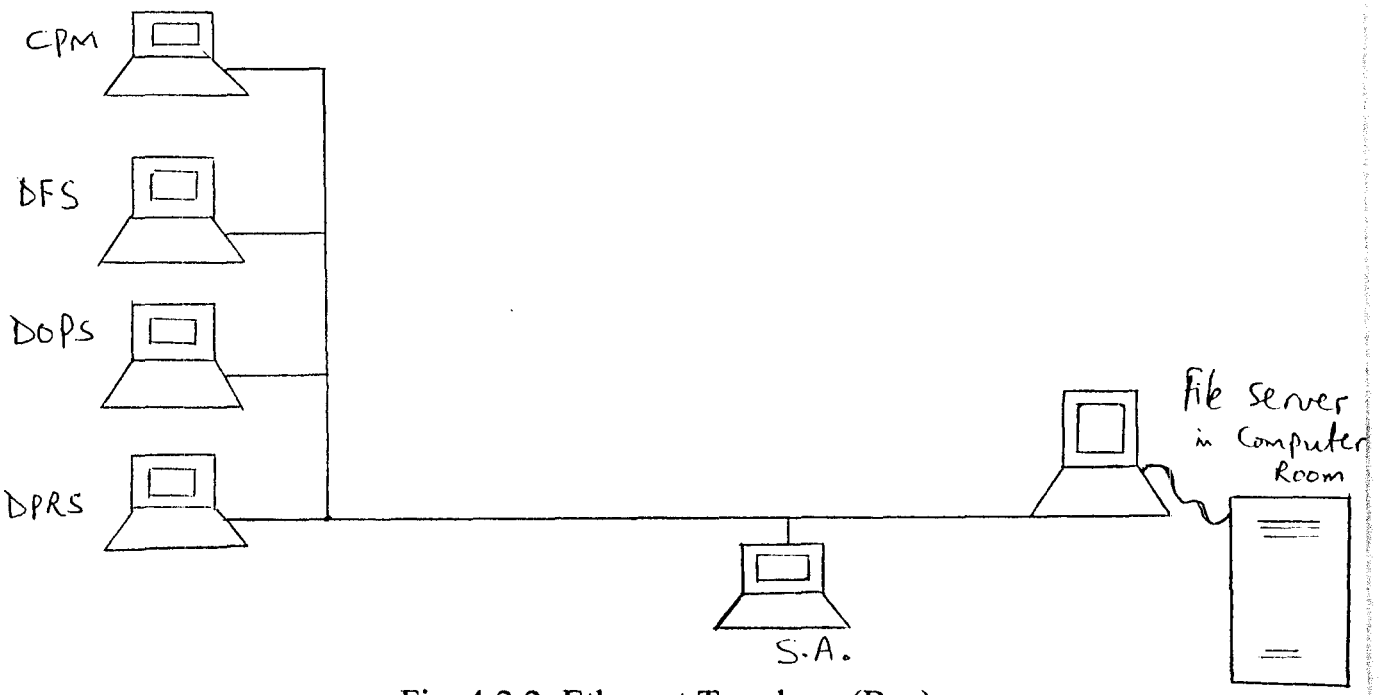


Fig. 4.2.2. Ethernet Topology (Bus).

The main server was kept in the Computer Room and was connected to the respective systems in the departments and the Sole Administrator's Office. The topology is based on the Ethemet network interface cards (NICs) that is used to connect the file server and the work stations together.

4.2.3 INSTALLATION GUIDELINES

To instal and set up a Computer Network we must comply with the manufacturer's installation guidelines. Therefore, we need to:

(i) Verify that the FUMTA has the required hardware such as the network card, cables, connectors and other items needed during installation.

(ii) Instal the server hardware and software..

(iii) Configure the network card so that it will work with the Computer.

(iv) Connect cables to the network card and then connect them to the other computers on the network.

(v) Instal the work stations

(vi) Set up the users

(vii) Instal the network printers

(viii) Set up applications.

All the above steps are accomplished using the Novell NetWare **386 3.11** to activate the hardware installed in the file server and the workstation in order to establish and maintain communications.

4.2.4 HARDWARE & SOFTWARE REQUIREMENT

TECHNICAL SPECIFICATIONS

The Server PC (Computer Room).
486 with 64 KB RAM Expandable to 2292 KB RAM
1 Ethernet Card
1.44 Megabyte 3.5" Floppy Drive with optional CD-ROM drive, and
3 Megabyte hard drive.

A colour VGA monitor and graphic Adapter and a multi I/O Card containing 1 Serial Port and 1 Parallel Port ISA (AT-BUS) PC with 1 Megabyte of RAM expandable to 64 Megabyte of RAM.

WORKSTATIONS: 5 PCS with at least 64KB of RAM

MINIMUM SPECIFICATION:
File server PC: 386 Sx with 4 Megabyte of RAM and a hard drive.

WORK GROUP FILE-SERVER PACKAGES:
Novell NetWare 386 operating system 3.11 and MS-DOS version 6.0

OTHER EQUIPMENT:

A Tape Backup drive in one of the workstations and a UPS (Uninterrupted Power Supply) for the File server to be plugged into BNC T-Connector, thin-Ethernet cable and Terminators.

MEMORY ADDRESS, I/O PORTS AND INTERRUPTS REQUIREMENT:

Memory Addresses:	DODO
I/O PORTS:	300h, 2 serial port and 1 parallel port
Interrupt:	4
Cable:	100m Connecting Cable

4.2.5 CHOICE OF INSTALLATION SITE

(i) Availability of Large desk top area.

(ii) Availability and easy access to all the documentation and manuals for the hardware and software.

(iii) Availability of extra tape devices in Backing up file servers.

(iv) Choosing a dedicated Power in order to prevent any power surges or drains.

(v) Use of Power Conditioning Equipment e.g. UPS to protect spikes, burnouts and retain the power supply.

(vi) Keeping the environment in a controlled humidity e.g.. Using Air Conditioning Equipment to keep the area cool.

4.2.6 INSTALLATION TOOLS

(i) A good PC diagnostic program.

(ii) Software disks that were included with the network card.

(iii) Manuals or documentation included with the system hardware.

(iv) Computer Configuration disks included with the Computer.

(v) Anti-Virus Software.

(vi) A tape backup unit in one of the workstation.

(vii) Cables, Connectors, terminators and other cabling hardware compatible with the network card.

(viii) A screw driver.

4.2.7 SYSTEM CONFIGURATION

The following terminologies are useful in connection with the system configuration:

(i) JUMPER - This is a pair of copper pins that are connected via a small block of plastic with copper inside.

(ii) DIP SWITCH - A DIP Switch is a row of Switches in a line which normally have two positions, either ON or OFF.

(iii) ACCESS RIGHTS - Permission granted to users to access certain directories, files or resources on the file server.

(iv) MAP - A process by which the user is insulated from a long, complex directory structure by replacing it with a letter designation.

(v) GROUPS - A collection of users who will be using the same application, printers, and so on.

(vi) USER - The individual sitting at his/her computer who needs to access certain directories and printers.

(vii) BINDERY - A group of hidden files on the file server that contain information relating to users, printers, configurations and other related items.

(viii) PRINTER SERVER - A PC (either the file server or dedicated PC) that handles the printing of reports and/or documents that did not originate from the PC.

4.3 HARDWARE INSTALLATION

To install the network card in the computer:

(i) Switch off the system and remove the cover of the PC's chassis and then locate an unused bus expansion slot in the computer either an 8-bit or 16-bit slot or 32-bit slot.

(ii) Comply with the Ethernet and Manufacturer's installation instructions to install it.

(iii) Cover the chassis back and screw tightly.

(iv) Plug everything back and Power ON the server.

The network card to be used must be Ethernet card which is NOVELL'S NE 2000 Card that is set for interrupt 4, I/O Port 300.

4.3.1. INSTALLING THE SERVER SOFTWARE

The system - 1 and system 2 diskettes of the Novell NETWARE 386 3.11 was used.

From the hard drive C prompt, we make a directory called the SERVER from the root directory.

MD\SERVER and press [ENTER]

We make the current directory.

CD\SERVER and press [ENTER]

The following files were copied from the system -1 diskette to the hard drive:

SERVER.EXE
NUT.NLM

From the system - 2 diskette, the following files were copied:

INSTALL.NLM
VREPAIR.NLM
NMAGENT.NLM

To **install** the network interace card:
Copy the NE 2000. LAN driver.

To **install** the hard drive controller cards
copy the ISADISK. DSK Driver

Now, the directory will contain the following:

SERVER.EXE, NUT.NLM, NE 2000.LAN, ISADISK.DSK.

To **create** a server Boot disk:

(i) Copy the files from the server directory on the hard drive (C:\>) to the floppy diskette drive (A:\>)

(ii) Copy the following from DOS directory:
FDISK.EXE and FORMAT. COM

To **start** the file server:

(i) Insert the server boot disk into the A:\> drive and Power ON the server and monitor

(ii) Boot Novell from the hard disk drive C:\> by typing:

FDISK and press [ENTER]

To **create** the file serve to Boot from hard drive:

(i) Format the hard drive C:\> from the DOS by typing:

FORMAT C:/S [ENTER]

(ii) Reset the server and boot from the hard drive C:\> to confirm.

(iii) At the C:\> prompt, Copy the contents of the server boot diskette to the hard disk drive.

(iv) Start up the PC to confirm.

To **load** the file server, type the followings:-

(i) SERVER and press [ENTER]

(ii) Name it e.g. YUDUHU

Note: Space or use of a period (.) is not allowed in naming to avoid converting the name to UPPERCASE Letters.

(iii) Enter the internal network number by choosing number 0 through 9 or letters A through F as hexadecimal numbers.

The hard drive adapter must be initialize in order to activate the hard drives:

(i) At C:\> prompt, type:
LOAD ISADISK and press [ENTER]

(ii) Type:

LOAD INSTALL and press [ENTER]

Choose main menu options: Disk, volume and system option for the installation by inserting the following disks in the following order:

System-1, System-2, System-3,
Upgrade,
Dosutil - 1, Dosutil-2, Dosutil-3, Dosutil-4,
Backup-1, Backup-2,
Print-1, print-2
Help-1, help-2, help-3,
Btrieve.
Then, abort by pressing [F7] key and [ENTER] to create
STARTUP.NCF File and save it.

To load the network driver, type:

LOAD NE 2000 [ENTER]

Specify the number of the Network Interface Card (NIC) and the Interrupt by entering the number 300 once again, enter the number 4.

In order to establish communication with DOS work-station via IPX, type:

BIND IPX TO NE 2000 NEE = 99 [ENTER]

To confirm, type

DOWN and press [ENTER]

Return to DOS, by typing:

EXIT and press [ENTER]

At C:\> prompt, type the following:

Copy CON AUTOEXEC.BAT and Press [ENTER]
@ ECHO OFF [ENTER]

SERVER [ENTER]

To save the file, press:
[F6] or [CTRL + Z] [ENTER]

To verify, type at the colon prompt (:)

VOLUMES and Press [ENTER]
CONFIG and press [ENTER]

Next, view the system console, NETWARE 386 print server and monitor screen by using:

[ALT] + [ESCAPE] Keys
To cycle through the Current Screens and list the screens by using:
[CTRL] + [ESCAPE] Keys, after typing the number of screens to view.

4.4 CABLING THE LAN

After finishing the installation and configuration of the network card, the next step was to connect the cables that links the computer server to the other computers on the network. Conduit cabling was proposed for the office layout.

Since it was a six-user network that will be cost effective, we recommended a thin Ethernet System Cabling known as THINNET.

The table 4.4. shows the following installation guides to connect the network card to a thin Ethernet System via other computers.

	ITEM	DESCRIPTION
1.	Network card with connector jack	The BNC Connector jack on the back of the network is connected to a T-Connector.
2.	BNC T-Connector	The T-Connector connects to the network card connector jack. Thin-Ethernet cables are connected to the jacks on either side of the T-connector (for computers at the ends of the network, a terminator replaces one of the cable connections).
3.	Thin-Ethernet Cable with BNC Connector plugs	Thin-Ethernet cable (coaxial cable) can be used in segments to connect all the 6 computers joined by the connectors.
4.	Terminators	When a computer is the last in the groups of computers, a terminator must be connected to the open end of the computer T-Connector.

Table 4.4. Installation Guide

4.4.1 INSTALLING THE WORKSTATIONS

This is done by configuring and activating the network card in the following orders:

We have to create IPX.COM in combination with NET3, NET4, NET5, or NETX to build the workstation shell.

PROCEDURES:

(i) From the C:\> prompt, type:
CD\
MD\NETWARE
CD\NETWARE
MD WSGEN
CD WSGEN

(ii) Insert the WSGEN Diskette into the floppy drive, then from the DOS prompt:

C:\NETWARE\WSGEN will appear.

(iii) TYPE CD.. press [ENTER]

The current directory is now:
C:\NETWARE

Confirm by typing:
CD and press [ENTER]

(iv) To generate the WSGEN Program,
Type:
WSGEN and press [ENTER]

Then press [ENTER] to display options of Network NE2000, I/O Port and Internet option Number.

(v) Type:
CD WSGEN and press [ENTER]
For record purpose, a different sub-directory was prepared on a blank diskette. To Backup files for each of the configuration for the NE 2000 workstation shells:

(a) In the root directory, make a sub-directory called 30013 and:

(b) Copy IPX.COM by typing:

Copy IPX.COM A:\30013 [ENTER].

Return to the NETWARE directory and repeat the WSGEN process by changing directories to WSGEN and type IPX and press [ENTER] in order to ascertain the job.

We have to bring the hardware and software online by testing the combination of the hardware and software. We have to save the CONFIG.SYS and ANTOEXEC.BAT files to CONFIG.LAN and AUTOEXEC.LAN for use later.

At the C:\> Prompt, we type:

MD\LAN and press [ENTER]

CD\LAN and press [ENTER]

Next, Copy the current drives from the NE 2000 workstation shell diskette:
Copy A:\NETX.COM and press [ENTER]

Copy A:\30013/IPX.COM and press [ENTER]

To test it, type :

IPX and press [ENTER]

Finally, we can test the connection by logging into the network as a user by typing the following:

F: and press [ENTER]

LOGGING GUEST and press [ENTER]

Check the operation of the network by typing the following and pressing [ENTER] key after each step:

USERLIST, WHOAMI, SLIST, CHKVOL and LOGOUT.

4.4.2 SETTING UP THE USERS

In setting up the users for the LAN, we should lay out the application that will be accessed by the users of the network. In this network, we had several groups of people that this network will serve.

We have a planning, Research and statistics (PRS) department where word processing are used to process correspondences, memo and project works.

The FUMTA has an Accounting department that uses a general ledger package and also does some forecasting in a spreadsheet. Also, there exist a department of personnel management, where the use of database management systems are employed. Both department of vehicle operations and the office of the Sole Administrator required the use of word processing packages. On this LAN, we need some sort of electronic mail (E-mail) package so that the various staff within the office can communicate with each other.

The users, each need their own personal directories so that they may store sensitive files in a secure place. Based on the above information, we can use the SYSCON utility to construct the group of users and log in script based on their application and data needs as follows:

GROUP NAME	PURPOSE
Every one	Staff on the LAN
Word Proc	Word Processing
Management	Management Personnel

Since it was pointless to have groups without people in them, let's get some users.

USER NAME	DEPT. THEY BELONG TO
Staff/Director's name	Word processing
Tukur	Management
Idowu	Accounting
Bolade	Word Processing
Danyaya	Management
Ikya	Management/LAN Administrator.

Now, we can establish what programs we can run and where they are installed.

PROGRAM NAME	PURPOSE	DIRECTORY
DB Mail	Electronic Mail	Sys: DBMAIL
WP	Word Processing	Sys:WP
123	Spreadsheet	SYS:123
DATABASE	DataBase Mgt.	Sys:DBASE
ACCTG	Accounting	Sys: ACCTG

Since we want our users to have private directories in which to store their documents and spreadsheet, we also need the followings:

USER NAME	DIRECTORIES
Ikya	Sys:USERS/IKYA/DOCS Sys:USERS/IKYA/WKS
Tukur	Sys: USERS/TUKUR/DOCS Sys: USERS/TUKUR/WKS
Idowu	Sys: USERS/IDOWU/DOCS Sys: USERS/IDOWU/WKS
Bolade	Sys: USERS/BOLADE/DOCS Sys: USERS/BOLADE/WKS
Danyaya	Sys: USERS/DANYAYA/DOCS Sys: USERS/DANYAYA/WKS

Also, the user level rights can be set up by placing the letters corresponding to the right within braces. For example, [RWCEM] would indicate the rights for: Read, Write, Create, Erase and Modify.

USER NAME	DIRECTORIES	RIGHTS
Ikya	Sys: USERS/IKYA/DOCS	[RWCEM]
	Sys: USERS/IKYA/WKS	[RWCEM]
Tukur	Sys: USERS/TUKUR/DOCS	[RWCEM]
	Sys: USERS/TUKUR/WKS	[RWCEM]
Idowu	Sys: USERS/IDOWU/DOCS	[RWCEM]
	Sys: USERS/IDOWU/WKS	[RWCEM]
Bolade	Sys: USERS/BOLADE/DOCS	[RWCEM]
	Sys: USERS/BOLADE/WKS	[RWCEM]
Danyaya	Sys: USERS/DANYAYA/DOCS	[RWCEM]
	Sys: USERS/DANYAYA/WKS	[RWCEM]

Every staff on the network belongs to the group EVERYONE, and on this network there are applications that every one will need to access.

4.4.3 SYSCON UTILITY

SYSCON is DOS-based program used to manage many aspect of how the users interact with NETWARE. It has the accounting, group information, supervisor options and user information features.

To access SYSCON, Log into the server as the user supervisor by typing:

LOGIN SUPERVISOR [ENTER]

At the F :> prompt, type:

SYSCON [ENTER]

to display the SYSCON Screen menu option that is used to create group information and user information.

New groups or users are created by highlighting the options.

4.4.4 INSTALLING NETWORK PRINTERS

Some DOS and server-based NETWARE utilities are used to install and configure the network printers. These utilities are: PCONSOLE.EXE, PSERVER.NLM, CAPTURE.EXE, ENDCAP.EXT AND RPRINTER.EXE.

We can access the Pconsole utility by typing at the DOS prompt:

PCONSOLE [ENTER]

And it will display the following options titled:

(i) Change current file server

(ii) Print Queue information

(iii) Print server information

We can setup the network printers by selecting the options in this sequence:

(a) PRINT QUEUE INFORMATION [ENTER] and name it.

(b) PRINT SERVER INFORMATION [ENTER]

i.e. PSERVER [ENTER]

(c) PRINT SERVER CONFIGURATION [ENTER]

Then the printers can be configured by selecting the I/0 Port, interrupt and Queues Serviced by Printer. After configuration, attach the dot matrix printer to the file server's LPT1 port and if there is a laser printer, it should be attached to a workstation.

(d) Press <ALT> + <ESCAPE> to set to the colon: Prompt,
and press [ENTER]

LOAD PSERVER.

(e) Use CAPTURE.EXE utilities to control the print directories by typing:

CAPTURE/Q = DOT-MATRIX/FF [ENTER]

(f) Type: DIR/W [ENTER]

(g) At DOS prompt, press:

<SHIFT> + <PRINT SCREEN>

(h) Type:
ENDCAP [ENTER] to end the capture direction.

(i) Now, we can print any screen observed.

4.5 NOVELL NETWARE 3.11 ADMINISTRATION

This section introduces and describes the subject of LAN management using Novell Approach to provide a continuous and efficient operation of the LAN Communication sub-system.

4.5.1 TYPES OF NETWARE USERS

Netware supports seven - user types:

(i) SUPERVISOR - Supervisor is the highest level network user that has right to every utility and file on the network.

(ii) SUPERVISOR EQUIVALENT - Supervisor Equivalent is a regular user that has been given the same authority as the supervisor.

(iii) WORKGROUP MANAGER - Workgroup manager may be a user or a group of users that can create, delete and manage user accounts assigned to him or created by him.

(iv) ACCOUNT MANAGER - Account Manager can be a user or a group of users that manages and delete accounts assigned to him.

(v) PCONSOLE OPERATOR - Pconsole Operator is either a Queue Operator or a print-server operator that manages and deletes print queues and servers.

(vi) FCONSOLE OPERATOR - Fconsole operator can use the Pconsole utility to view certain information about the Network.

(vii) END USER - End user can only operate based on permissions or restrictions granted by other users.

4.5.2 NETWARE SECURITY LEVELS (NETWORK SECURITY)

NetWare supports the following four levels of Access control:-

(i) LOGIN / PASSWORD

The login/Password controls the access to the file server. This is done through the assignment of a user name with an optional password.

(ii) RIGHTS

Rights comprises of 3 types, viz:

(a) Trustee Rights

(b) Inherited Rights mask (IRM)

(c) Effective Rights.

Trustee Rights can be assigned to individual users or groups.

Inherited Mask allows all rights to flow through to sub-directories.

Effective rights are the results of filtering trustee rights with Inherited right mask.

Also, we have Directory Rights that governs what a user can do in a given directory.

(iii) ATTRIBUTES

File attributes governs what can be done with files.

(iv) File Server Console.

4.5.3. LOGGING IN TO THE NETWORK

This involves the following Basic Steps:

(i) Booting DOS in the Workstation

(ii) Loading the NetWare shell
(iii) Changing the default drive to a network drive.

(iv) Entering a user name and probably a password.

The above steps are dependent on how the workstation is setup.

4.5.4 DRIVE MAPPING

Drive mapping points to certain network locations so that you can access information found at that location.

There are three types of mapping, viz:-

(i) Network drive Mapping - It represent a directory path.

(ii) Local drive Mapping - It represent a disk drive.

(iii) Search drive Mapping - It looks for files in other directories.

Users can view their drive mappings, after logging in, by typing:

MAP And press [ENTER].

4.5.5 USING THE MENU UTILITIES

Below are NetWare menu utilities and some tasks that allows you to perform:

UTILITIES	TASKS
SYSCON	See information about users, file servers, groups and security work with login scripts.
SESSION	Work with drive mapping, send messages.

FILLER	Work with directories, sub-directories and files
PRINTDEF	See information about printer/plotter setup
PRINTCON	Setup print job configurations for special purpose.
PCONSOLE	Print files and monitor print functions. Also, use to define print server and queues
VOLINFO	See information about volumes.
COLORPAL	Change the default colour palettes.

To access a menu utility, type its name at the DOS prompt and press [ENTER].

For example, to access SYSCON, Proceed as follows:

(i) First, log in to the network

(ii) At the DOS prompt, type:

SYSCON And press [ENTER].

(iii) Use the up - and down - arrow keys to highlight an option or by typing the first letter of the option and press [ENTER].

(iv) Press <ESCAPE> to return you to where you are in SYSCON.

(v) To exit to menu utility, press <ESCAPE> until a confirmation box appears or press <ALT> + <F10>.

(vi) Highlight "YES" and Press [ENTER] to EXIT.

4.5.6. WORKING WITH DIRECTORIES AND DRIVE MAPPINGS

The menu utilities and command line utilities are used to accomplish various tasks as presented below:

TASK	MENU UTILITY	DOS/COMMAND LINE UTILITIES
View a list of Drive Mappings	SESSION	MAP
Mapping a Drive to a Directory	SESSION	MAP
Modifying a Drive mapping	SESSION	CD, CD.., MAP
Changing to a Different Drive	SESSION	Type the new drive letter and colon.
Viewing a list of files in a directory	FILLER	DIR
Moving up a level in the Directory Structure	FILLER	CD..
Creating a Sub-directory	FILLER	MD
Renaming sub-directory	FILLER	RENDIR
Deleting a sub-directory	FILLER	RD

4.5.7 VIEWING AND DISPLAYING OF NETWORK USERS

To display a list of all network users who are currently logged in, we can use the command line utility to display:

(i) Network groups
(ii) Listing network users
(iii) Viewing information about yourself as a user.

(iv) List network groups and their members.

4.5.8 HOW GROUPS ARE ORGANISED

Users can be organised into groups for convenience. This is done according to the information they need or the tasks they perform.

To display a list of all the network users who are currently logged in, you can use the SESSION menu utility or the USERLIST command utility.

We can view a list of users by logging in and typing USERLIST and press [ENTER]. Also, SESSION can be used to display a list of users by the following procedures:

(i) To access SESSION, press [ENTER] .

(ii) Highlight "USERS LIST" in the SESSION and press [ENTER].

(iii) To exit SESSION, press [ENTER] twice. Then highlight "YES" in the "EXIT SESSION" confirmation box and press [ENTER].

In addition, to view the groups in the network and information about their, we use the SYSCON utility.

(i) At the DOS prompt, type:

SYSCON and press [ENTER].

(ii) Highlight "Group Information" and press [ENTER].

(iii) To EXIT, press [ENTER] Twice.

(iv) To confirm, highlight "YES" and press [ENTER]

We can print files from DOS users by enrouting Local LPT1: To the network print queue of choice using the CAPTURE COMMAND. NPRINT command. This can be used to print jobs on the network printer.

The ENDCAP command can be used to set the PC Workstation LPT1: To the local print mode. This will enable a user to carry out printing on his/her local printer.

4.5.9 COPYING, RENAMING AND DELETING FILES

The NCOPY command line utility can be used for copying files.

The format for the NCOPY command is:

NCOPY [PATH 1] FILENAME [TO] [PATH 2] / [OPTION] where,

Path 1 - is the source directory

Path 2 - is the target directory.

We can use either FILLER menu utility or the DOS REN command to rename files. For example, to rename YUDUHU to SAKINAH, we can type:

REN YUDUHU SAKINAH [ENTER].

Similarly, deleting files can be done using the DOS DELETE Command in the same manner.

4.6 ELECTRONIC MAIL FACILITY

Novell netware provides an E-mail facility that enable users on the network to send message to one another. It is easy to use the mail by a menu-driver system.

To access the mail service:

(i) Log in to the network
(ii) Type MAIL at the prompt and press [ENTER].

This mailing facility is called "Message Mailing service (MMS).

4.7 LAN MANAGEMENT

Managing LAN communication sub-systems involves: Configuration Management, fault management, Performance Management (monitoring), Access control management and Accounting Management.

(a) CONFIGURATION MANAGEMENT
Configuration Management involves initialization, reset and close down of the single entities within the LAN and the whole system. This encompasses software distribution and installation.

(b) FAULT MANAGEMENT

Fault management covers fault detection, diagnosis and correction. It also involves managing error reporting, confidence testing, alarms of potential faults, hardware repair, software repair, reporting of repairs and software dump.

(c) PERFORMANCE MANAGEMENT (MONITORING)

LAN system are monitored by statistical evaluation of the whole system through collection of various traffic statistics. Counter set/reset functions are needed here.

(d) ACCESS CONTROL MANAGEMENT

This involves the security management of LAN integrity.

(e) COUNTING MANAGEMENT

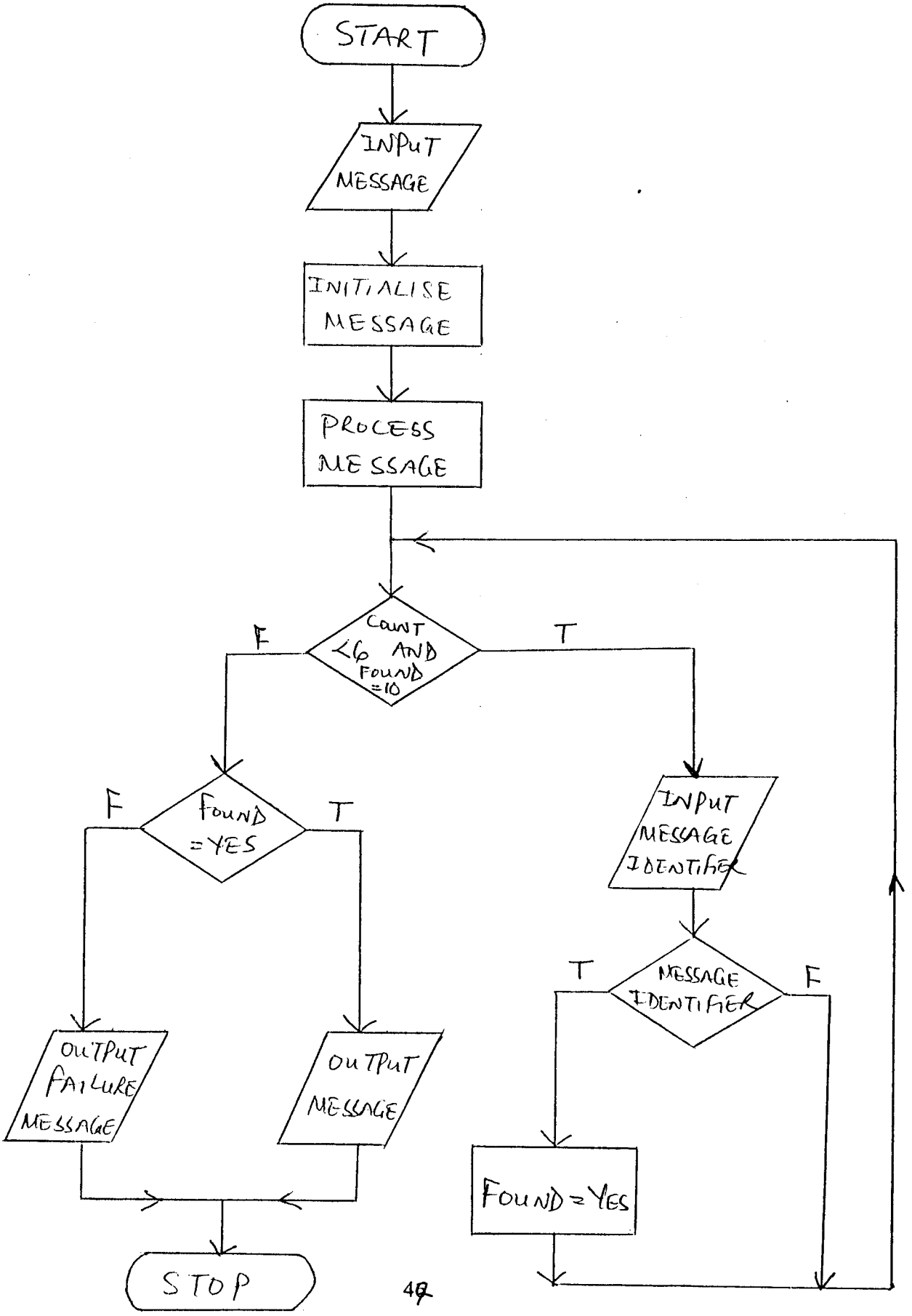
Costing of LAN installation, performance and maintenance helps in the capacity planning of the system.

4.8 ELECTRONIC MESSAGE

The Program is an Electronic version of sending and receiving messages. It is designed and developed for the purpose of communication. It provides a simple scheme of receiving and retrieving messages.

Senders can enter up to five messages to the receipient by assigning special message identifier in numbers O through 9 for easy retrieval. The Program is developed using application generator (object-oriented programming), by developing objects (the windows, menu and menu items) and assigning certain properties or behaviours to the object using **Turbo PASCAL** procedures and units.

4.8.1 FLOWCHART



CHAPTER FIVE

5.1 IMPLEMENTATION

The implementation of the LAN involves the social and technical approach. The social dimensions involves people with their various roles, behaviours, etc while the technical dimension involves jobs, tasks and technology.

Consideration are given to the FUMTA staff to participate in the operation and use of the LAN, in the design and implementation of decision making.

Participants should provide input into the system design process in the aspect of job satisfaction needs. Also, participants do have a say in the decisions affecting systems development but the implementation of the decision is left in the hands of the sole Administrator.

In making decisions, participants do assume full responsibility in the development and implementation processes by providing the moral and financial support.

Although products prices fluctuate with time in the open market, the estimated cost of the following items were given as:

(i)	One unit of IBM 486 PC	=	N200,000.00
(ii)	Five units of IBM 386 PCS @N175,800.00 each	=	N879,000.00
(iii)	Software (Novell Netware)	=	N 25,000.00
(iv)	Cables and related devices	=	N150,000.00
(v)	Labour	=	N 45,000.00
	TOTAL	=	**N1,299,000.00**

The cost may be high but considering the labourious documentation being carried out by FUMTA, the end definitely justified the means.

5.2. CONCLUSION

This project covers very brief fundamentals of LANs and networking technologies using Novell concept. It involves step-by step definition and/or description of key terms and elements involved in a LAN. The study involves the principles and guidelines used in selecting, installing, operating, managing and optimization of a LAN.

The LAN, therefore, provides the cost-effective medium for rapid communications and resource sharing between computers and other devices within the FUMTA.

5.3 RECOMMENDATIONS

I wish to recommend a peer-to-peer scheme that involves non-dedicated server to link the sole administrator's office with those of the respective Directors of Finance, Operations, Personnel and Planning, Research and statistics Departments so that the overall cost of implementing the LAN will be reduced. Also, the system should be designed to provide opportunity for expansion into a more user network as the financial situation improves.

The FUMTA should give their supports to my colleagues that may do their Project on the same topic with emphasis on the installations.

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```
Program E-mail;

        Uses Crt, Objects, views, drivers, menus, dialogues, msgbox, App;

Const
        cmsend          =       200;
        cmReceive       =       201;

Type
        Person Data     =       Record
        Receiver Name   :       Array [1..5] of string;
        Receiver 1dNo   :       Array [1..5] of string;

        SenderName      :       String;
        SenderIdNo      :       Integer;

        Date            :       String;
        Time            :       Array [1..5] of string;
        Message         :       Array [1..5] of string;

End;

        TEmail = Object (TApplication) (*Descendant of the standard object TApplication*)
        Constructor Init;
        Procedure InitMenu Bar; Virtual;
        Procedure InitStatusLine; Virtual;
        Procedure HandleEvent (Var Event: TEvent); Virtual;
        Procedure SendMessage;
        Procedure ReceiveMessage;

End;

Var
        Entrycounter: Integer;
        Email: TEMail;
        Mesfile: File of person-Data;

        Procedure stripBlanks (Var Entry : String);
        Begin
        While (Entry [length (Entry)] = '' ) DO
        Delete (Entry, length (Entry), 1);

End;
```

```
Procedure ErrorBox (TheErrMes:String; X1,Y1,X2,Y2: Integer; BoxTitl:Word);
Var
R:TRect;
ErrCont: Word;
PTheErrMes: ^String;

Begin

Errcont:=O;
Sound(550); Delay (50); Nosound;
New(PTheErrMes);
R.Assign(x1,Y1,X2,Y2);

Errcont:= MessageBoxRect(R,TheErrMes,PTheErrMes,Boxtitl+mfOKbutton);
BoxTitl := mfError;
Errcont:= cmOk;
Dispose(PTheErrMes); (*Cleans Up*)

End;

Constructor TEmail.Init;
    Var
    Dialogue    : Pdialogue;
    R           : TRect:

    Control : Word;
    Cntr: byte;
    alldata: person-data;

Begin

    Cntr:= O;
    Entry Counter:=O;
    Tapplication.Init;
    Repeat
    Inc (cntr);
    With alldata DO
    Begin
    ReceiverIdNo[cntr]      :=O;
    Sender Name             :='';
    SenderIdNo              ;=O;
    Date                    ;='';
    Time [cntr]             ;='';
    Message [cntr]          ;='';
    ReceiverName[cntr]      ;='';
    End;
    Until cntr = 5 ;
```

```
        Assign (Mesfile, 'EMAIL.002');
        Reset (Mesfile);
        If IOresult <> O THEN
        Begin
        Rewrite (Mesfile);
        Write (Mesfile, alldata);
        Reset (Mesfile);
        End;

(*Draws Empty Dialogue box*)

        R.Assign (2,2,75,20);
        Dialogue :=New (PDialogue, Init (R,''));
        With Dialogue^DO
        Begin
        (*Inserts Tittle of Applications*);
        R.Assign (5,2,65,3);
        Insert (New (PstaticText, Init(R,'Electronic Mail Service for
        F.U.T. Minna. Maths dept._')));
        R.Assign (5,3,65,4);
        Insert (New (PstaticText, Init(R,'
        ____________________________________________________________')));

        R.Assign(20,5,56,6);
        Insert (New (PstaticText, Init (R,'Written By: DUHU, YAKUBU.U')));
        R.Assign (20,6,46,7);
        Insert (New (PstaticText, Init(R,'Reg.No.:97/008.')));
        R.Assign (6,8,68,9);
        Insert (New (PstaticText, Init(R,'A Project submitted to the
        department of Maths/computer Science,' )));
        R.Assign (15,9,60,10);
        Insert (New (PstaticText, Init (R,'Federal University of
        Technology Minna,')));
        R.Assign (2,10,72,11);
        Insert (New (Pstatictext, Init (R,' for the Partial fulfilment
        for The Award of PGD (computer Science).')));
        R.Assign (2, 13, 72, 14);
        Insert(New (PstaticText, Init (R,'[.]Supervised By:Mallam
        Audu Isah (Dept. Of Maths/Comp. Science.)')));
        R. Assign (57,16,72,17);
        Insert (New (Pstatictext, Init (R,' March, 1998.')));
(*Inserts OK Buttons*)
        R. Assign (30,15,40,17);
        Insert (New (PButton,Init(R,'~O~K,' cmOK, bfDefault)));
        End;

(*Displays The Dialogue box & Accepts No other Commands Except Those Executed
Within The box*)
```

```
        Control := DeskTop ^.ExecView (Dialogue);
        Dispose (Dialogue, Done);
        End;

        Procedure TEmail.InitMenuBar; (*Draws & Initialises The MenuBar & SubMenus*)

            Var
             R: Trect;

        Begin
        GetExtent (R);
        R.B.Y: =1;
        MenuBar := New(PmenuBar, Init (R,NewMenu(
        Newsubmenu ('~M~ essage; hcno Context, New Menu (
        Newitem ('~S~ end; 'F1,'kbF1, cmsend, hcnocontext,
        Newitem ('~R~ eceive,' 'F2' kbF2, cmReceive, hcnocontext,
        Newline (
        Newitem ('E~x~it' F10,' kbF10, cmQuit, hcnocontext, Nil))))), Nil ))))
        End;

Procedure TEmail.Initstatusline;

        Var
        R: TRect;

Begin
        GetExtent (R);
        (*Returns a Rectangle with Origin (O,O) Matching the current size of the view*)

        R.A.Y. := R.B.Y-1; (*Assigns Dimensions At the Bottom of the View for the      Status
                                                                                      Line*)

        Statusline := New (Pstatusline, Init (R,
        NewstatusDef (O,$FFFF,

            Newstatuskey ('~F10~_[Exit],' kb F10, cmquit,
            Newstatuskey ('~F1~_ [send Message],' kbF1, cmsend,
            Newstatuskey ('~F2~_ [Receive Message],' kb F2, cmreceive,
            Nil))),
            Nil)));

End;

        Procedure TEmail. HandleEvent (Var Event:TEvent);

            Begin
                Tapplication.HandleEvent (Event);
                If EventWhat = evcommand THEN
```

```
        Begin
        CASE Event command OF

                cmsend          :       sendmessages;

                cmReceive       :       receiveMessage;
        Else

                Exit;
        End;
        clearEvent (event);
        End;

End;

Procedure TEmail.SendMessage;

        Label
        start
        Type
Persondata = Record
ReceiverIdNo            : String [4];
Sendername              : String [26];
senderIdNo              : String [4];
Date                    : String [8];
Time                    : String [8];
Message                 : String [255];
ReceiverName            : String [26];

End;

Var

Validrec : boolean;
Scntr:  String;
Counter2, Counter3 : Integer;
Counter, cntr : Integer;
rcode, scode, sidn : Integer;
Code, Recid, senid: Integer;
Dialogue : PDialogue;
R       :       TRect;
Control:        Word;
To Who, from; Pview;

Dt, Tm, Rid, sid : Pview;
Mess    :       Pview;
Perdata, alldata : Person_Data;
Pdata   :       Person Data;
```

```
        Begin
        Counter2 :=O;
        Counter3 :=O;
        (*Initialise Variables*)

Repeat
        inc (counter3);
        with Perdata DO

                Begin
                Receivername[counter3]      :='';
                ReceiverIdNo [counter3]     :=O;
                SenderName                  :='';
                SenderIdNo                  :=O;
                Date                        :='';
                Time [Counter3]             :='';
                End;
                UNTIL Counter3              :=5;
                Pdata. Sender Name          :='';
                Pdata.Sender IdNo           :='';
                Pdata.Date                  :='';

                Repeat
                Inc (counter2);
                with Pdata DO

                Begin
                ReceiverIdNo                :='';
                Time                        :='';
                Message                     :='';
                ReceiverName                :='';
                End;
                Start;
                Validrec                    := false;

                Code : = O; Recid:=O; Senid :=O;
                Rcode:=O; Scode : = O;

                Str (counter2, scntr);

                (*Create a dialogue Box*)
                R.Assign (2, 1, 77, 20);
                Dialogue := New (PDialogue, Init (R,'[[sender's
                form {'+scntr + '}]]'));

                With Dialogue ^ DO
                Begin
                R.Assign (22, 4, 28, 5);
```

```
Rid := New (PInputLine, Init (R,4));
Insert (Rid);
R.Assign (2,4,21,5);
Insert (New (Plabel, Init (R,'receiver I.D. No.:,' Rid)));
R.Assign (22,6,62,7);
From:= New (PInputline, Init(R,26));
Insert (from);
R.Assign (2,6,17,7)
Insert (New(Plabel, Init (R,'from:,'from)));

R.Assign (22,8,28,9);
Sid := New (PInputLine,Init(R,4));
Insert (sid);
R.Assign (2,8,19,9);
Insert (New (Plabel, Init (R,'sender I.D. No. : ,' sid)));

R.Assign (22,10,32,11);
Dt := New (PInputLine, Init (R,8));
Insert (Dt);
R.Assign (2,10,17,11);
Insert (New(Plabel, Init(R,'date :,' Dt)));
R.Assign (22,12,32,13);
Tm := New (PInputline. Init (R,8));
Insert (Tm);
R.Assign (2,12,17,13);
Insert (New (Plabel, Init(R,'Time:,' Tm)));

R.Assign (22, 14, 72, 15);
Mess := New (PInputLine, Init (R,255));
Insert (Mess);
R.Assign (2,14,21,15);
Insert (New (Plabel, Init (R, 'Message:,'Mess)));

(*Create done button*)
R.Assign (4,16,14,18);
Insert (New (PButton, Init (R,'~D~one,'cmOK,bfDefault)));

If Counter 2 <5 THEN
Begin
(*Create more button*)
R.Assign (24,16,34,18);
Insert (New(PButton, Init(R,'~M~one,'cmyes, bfnormal)));
end;

(*Create Cancel Botton*)
R.Assign (44,14,54,18);
Insert (New(PButton, Init(R,'~C~ancel,' cmcancel, bfnormal)));
```

```
        R.Assign (22,2,62,3);
        TO_who := New (PInputLine, Init (R,26));
        Insert (To_who);
        R.Assign (2,2,8,3);
        Insert (New(Plabel,Init(R,'To:,'To_who)));
        Setdata (PData);
        end;
        Control := DeskTop ^.ExecView(Dialogue);
        IF control <> cmcancel THEN
          Begin
          Dialogue ^. Getdata (PData);
          With Pdata DO
          Begin
          stripBlanks(receiverIdNo);
          strip Blanks(senderIdNo);
          Val (receiverIdNo, Recid, rcode);
          Val (senderIdNo, senid, scode);
          End;
          Code := Rcode + Scode;
          IF (code <> O) OR (Recid=O) OR (senid=O) THEN
          Begin
          ErrorBox ('Invalid Data Entry !!!,'20,8,50,16,mfError);
          Dispose (Dialogue, Done);
          Goto start;
End;
Else
          Begin
          IF Counter2 = 1 THEN Sidn := Senid;

          IF (sidn = senid) THEN
          Begin
          With perdata DO
          Begin
          Receivername[counter2]   := Pdata.receiverName:
          ReceiverIdNo [counter2]  := Recid;
          Sendername               := Pdata.sendername;
          senderIdNo               := senid;
          Date                     := Pdata.date:
          Time[counter2]           := Pdata.time;
          Message[counter2]        := Pdata.message;
          end;

          Counter          := O ;
          Repeat
               Inc (counter);
               Seek (Mesfile, counter);
               Read (Mesfile, Alldata);
               IF Perdata.senderIdNo=Alldata.senderIdNo THEN
```

```
        Begin
        Validrec:=true;
        Seek(Mesfile, counter);
        Write(Mesfile, Perdata);
        End
        ELSE IF (eof (mesfile)) AND (Validrec = false) THEN
        Begin
        Seek (mesfile, filesize (mesfile));
        Write (mesfile, Perdata);
        end;
        Until eof (mesfile);

        End
        Else
        Begin
        ErrorBox('You cannnot change Your I.D. No.!!!,'20,8,
        50, 16, mfError);
        dispose (dialogue, done);
        Goto start;
        End;
    End;
End;
Until (control = cmok) OR (Counter2=5) OR (control=cmcancel);
End;

Procedure TEmail.ReceiverMessage;
Label
Start;
Type
Recidata = record
Thenumber : String [4];
End;
Var
        validmess               :       boolean;
        Counter2                :       Integer;
        Dialogue                :       PDialogue;
        R                       :       TRect;
        Rid                     :       Pview;
        Control                 :       Word;
        Recidno                 :       Recidata;
        Idno, code, counter     :       Integer;
        Perdata, alldata        :       Person_Data;
        Stsenid, strecid        :       String;
 Begin
 Recidno.thenumber :='';
 Start;
 Code := idno:=O;counter :=O;
 R.Assign (18, 6, 52, 14);
```

```
 Dialogue := New (Pdialogue, Init (R,'[[Receiver's form]]));
With Dialogue ^ DO
Begin

(*Create OK Button*)
R.Assign (2,5,12,7);
Insert (New PButton, Init (R,'~O~K,' cmok, bf Default)));
(*Create cancel Botton*)
R.Assign (21,5,31,7);
Insert (New (Pbutton, Init (R,'~C~ancel, cmcancel, bfNomal)));

R.Assign (22,2,28,3);
Rid := New (PInputLine, Init(R,4));
Insert (Rid);
R.Assign (2,2,21,3);
Insert (new (Plabel, init (R,'Enter I.D. No.:,'Rid)));
Setdata (Recidno);
End;

Control := DeskTop ^.ExecView (Dialogue);
IF control <> cmcancel THEN
      Begin
      Dialogue ^. Getdata (Recidno);
      stripBlanks (recidno.Thenumber);
      Val (Recidno.Thenumber,IdNo,code);
            IF (code <>O) OR (IdNo = O) THEN
            Begin
            Error box ('Invalid Data Entry !!!,' 20,8,50,16,mfError);
            Dispose (Dialogue, Done);
            Goto Start;
            End
            Else
            Begin
            Validmess := false;
            Repeat
            Inc (counter);
            Seek  (Mesfile, Counter);
            Read (mesfile, alldata);
            Counter2 :=O;
            Repeat
            Inc (Counter2);
            IF IdNo = alldata.receiver IdNo [counter2] THEN
            Begin
            Validmess :=true;
            With alldata DO
            Begin
            Str(receiverIdNo [Counter2], strecid);
            Str(senderIdNo,stsenid);
```

```
                R.Assign (2,2,75,20);
                Dialogue := New (PDialogue, Init (R,'[[Message Pad]]'));
                with dialogue ^ DO
                Begin

                (*Inserts title of Application*);
                R.Assign (2,3,65,4);
                Insert (New (PstaticText,dict (R,'from :-'+senderame)));
                R.Assign (2,4,50,5);
                Insert (New Pstatictext, Init (R,'I.D. No. :-'+stsenid)));
                R.Assign (2,5,50,6);
                Insert (New (Pstatic Text, Init (R,'date :-'+ date)));
                R.Assign (2,6,50,7);
                Insert (New (PstaticText, Init (R,'Time :-'+ time [counter2])));
                R.Assign (2,6,44,9);
                Insert (New (Pstatictext, Init (R,'_Message-')));
                R.Assign (2,10,72,14);
                Insert (New (PstaticText, Init (R,message [counter2])));
(*Insert OK Button*)
R.Assign (30,15,40,17);
Insert (New (PButton, Init (R,'~O~K,'cmOK,bf Default)));
End;

(*Displays The Dialogue Box and Accepts No other commands Except Those
Executed within The Box*)
Control := DeskTop ^.ExecView (Dialogue);
Dispose (Dialogue, Done);

End;
End;
Until (alldata.ReceiverIdNo [counter2] =O) OR (Counter2=5);
IF (eof (mesfile)) AND (Validmess = false) THEN
        Begin
        ErrorBox ('You Have No Messages !!!, 20,8,50,16, mfinformation);
        end;
Until eof (mesfile);

End;
End;

        Begin
        Email.Init;
        Email.Run;
        Email.Done;
        Close(Mesfile);

        End.
```