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# DESIGN AND IMPLEMENTATION OF LOCAL AREA NETWORK

# FOR

# SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY.

BY

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# CERTIFICATION

THIS IS TO CERTIFY THAT THIS PROJECT HAS BEEN EXAMINED AND APPROVED HAVING MET THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG) DEGREE IN ELECTRICAL AND COMPUETR ENGINEERING DEPARTMENT, FEDERAL UNIVERSTY OF TECHNOLOGY MINNA, NIGER STATE.

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## DECLARATION

I hereby declare that this project was solely designed and implemented by me under the supervision of Engr. Jonathan Kolo of Electrical and Computer Engineering Department, Federal University of Technology Minna, during 2000 / 2001 Academic session.

IZUKA. C. VINCENT

26/02/2002
DATE

# DEDICATION

This work is dedicated to my beloved parents.

And

To all lovers justice.

# ACKNOWLEDGEMENT

My sincere thanks are to the almighty God for ensuring for the successful implementation of this work and completion of my first-degree programme.

My profound gratitude goes to my lecturer, project supervisor, Mr. Jonathan Kolo (M.Eng) for his undivided attention and encouragement's towards the completion of this work.

I also appreciate the efforts of my colleagues and project partner, Miss Atolagbe Omotayo, and Miss Omolara Shittu.

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# ABSTRACT

This project focuses on the design and implementation of a Local Area Network (LAN), using a client- server model. And the implementation was done with star topology architecture, Star topology was used due to its numerous advantages over types of topologies. The design covers the School of Engineering and Engineering Technology (SEET). While implementation is within Electrical /Computer Engineering Department of Federal University of Technology Minna.

Windows NT Server software was used as the Network Operating system (NOS). The client computers and workstations uses Windows 95, Windows 98, Windows Me, as their Operating System.

The operation of the design was carried out and tested which satisfy favorable Local Area Network and the limitations were also discussed.

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# CHAPTER ONE

## INTRODUCTION AND LITERATURE REVIEW

### 1.1 INTRODUCTION

In this era of computer exploration and the increasing dependency on computer technology, there is need for adequate knowledge of computer application as an information tool. With the current trend of information technology, the engineers, bankers, network designers, computer scientists and the general public needs to know how computer networks enhance its ability to exchange, share, preserve, and protect information. The concept here is aimed at the approach required for design, analysis of computer networks and implementation of client-server local area network model.

The system engineers quest to reduce the sufferings encountered by a stand-alone computer, lead to interconnection of two or more computers with communication devices termed computer network. The concept of the interconnecting computers and sharing resources is called computer networking. The factors militating against stand-alone computers includes, information dissemination, sharing hardware resources, preserving information, exchanging information, protecting information etc. A computer on network has access to other computers on network worldwide.

There are two major types of computer networking namely: Local Area Network (LAN) and Wide Area Network (WAN). This project is categorically a design and implementation of a LAN using a client-server model .A client-server model is any system in which the client computer makes a request over a network to a server computer that then satisfies the request. The server and client cooperate to provide the illusion that remote services are local to the computer.

Server based networks have great advantages such as security, central organization, share expensive hardware equipment, a network support programs such as E-mail, GroupWare and group scheduling that were not effective on a stand -alone computers, and host of other advantages.

In order to achieve a good report, this work has been splitted into various segments. In chapter one, discussion is based on the general introduction and literature review. The scope of project as well as the objectives of computer networks is also discussed in chapter one. In chapter two, I elaborate on computer networks and it's various standards. In this chapter, network topologies, LAN architecture, network operating systems, network hardware requirements, open system interconnection reference model, Ethernet etc has been discussed. Chapter three is based on local area network, design, implementation, and testing while chapter four treats analysis and discussion of results. The chapter five of this report-discussed conclusion and recommendation(s) followed by the references.

## 1.2 LITERATURE REVIEW

Computer networking is the act of linking a group of computers with the aim of making them communicate with each other and also share available resources among themselves. However, computer networking came into existence from system engineers bid to improve communication standard of a computer.

In the mid- 1960`s, the most commonly reported experiment was conducted by Marill and Roberts (1966), which later formed the basis of computer networks. In their work, they connected Tx-2 computer at Lincoln laboratories and Q-32computer at the system Development Corporation such that the user of one computer could access the others.

Subsequent advancement led to the establishment of a WAN by U SA defense department in the late 1960`s. The WAN was named Advance Research Projects Agency network (ARPANET), which is a network of military sites situated in the US and Mexico. Later the network went into connecting universities and research organizations in the US, U.K, Mexico and Norway.

In 1983 ARPANET was divided into two. ARPANET caries out civil tasks and researches while the MILNET caries out military task. With both networks interconnected and later joined with

others like BITNET, CSNET thus forming Internet --- coined from international networks. Recently, however, the Internet has emerged as the largest WAN in the world.

New techniques were also established, such as network topologies namely BUS, STAR, RING, MESH topologies, bridges, repeaters, routers, protocols, packet switching etc. Packets switching is form of communication that works on the principle of splitting data into small units called packets before transmitting and later reassembles them at the destination. Much approach has been tried in exploiting the interconnectivity of computers, but due to problems arising from different manufacturing companies and different communication conventions, the Open Systems Interconnection (OSI) model was developed by the International Organization for Standardization (ISO). Which provide a means of describing the data flow in a network and how it could be generally managed. The aim of this project is design, analysis, and implementation of a LAN using a client - server model and implementation carried out with star topology architecture.

## 1.3 SCOPE OF THE PROJECT

**PROJECT DEFINITION.**

The design and implementation of a Local Area Network (LAN), using a client - server model and implementation done with star topology architecture. The network design covers the school of Engineering and Engineering Technology (SEET) while implementation is within Electrical and computer Engineering Department of Federal University of Technology Minna.

## 1.4 OBJECTIVES OF COMPUTER NETWORKS

There various types of computer networks such as local area network (LAN), Metropolitan Area Network (MAN), Wide Area Networks (WAN), each computer network satisfy a broad range of purposes and meet various requirements. A major goal of the first network; ARPANET is to permit resource sharing. This project however is designed to meet some of the common objectives of linking computers together as mentioned below.

* To establish a communication link between computers located at various places using a star topology.
* To provide sharing of distant resources such as information (databases) or processors. Perhaps resource sharing is the most common objective for providing networks, within the constraints of cost and reliability of transmission links.
* To provide an efficient means of transporting large volumes of data among remote locations.
* To provide compatibility of dissimilar equipment and software. Hence, there is a growing trend towards compatibility through standardization, for all types of communication hardware and software.
* To provide network users with maximum performance at minimum cost.
* To provide centralized management and allocation of network resources such as host processors associated databases, transmission devices, and the files.

# CHAPTER TWO

## COMPUTER NETWORKS AND VARIOUS STANDARDS

### 2.1 INTRODUCTION

In this section much is discussed on what networks are and how networks can enhance the usefulness of computers. This discussion introduces computer as an information tool and then shows how networks enhance the computer ability to exchange, share, preserve, and protect information. I also discussed here, how networks could make it easier to share expensive hardware and software.

Computer networks are broadly divided into two main categories viz., the LAN and the WAN. The wide area network will be discussed briefly while much will be discussed on local area network due to its fundamental features in networking in general . Also looked into are the hardware and software requirements, network standards, network securities and knowing the right networks type suitable for certain conditions.

### 2.2 LANs AND WANs

In the simplest of terms, a Local Area Network (LAN) is a branch of computer running a specialized communications software and joined through an external data path. basic LAN characteristics include :

- Relatively small geographical area , usually no longer than a single building .
- Direct high-speed connection between all workstations and servers.
- Shared hardware resources and data files .
- Centralized management of resources and network security .

## 2.2.0 LAN FEATURES

The features built into most LAN operating systems provide a number of benefits to the organization and the end user. These include,

- Standard personal computer (PC) hardware .
- resource sharing .
- Common applications .
- File sharing .
- Data security .
- Fault tolerance .
- Centralized security.
- Communications .

## 2.2.1 LAN TO WAN

Connection between cities will almost always require some sort of telecommunication links unless one has access to satellites or some other form of bypass. In any case , the wide range of transmission speeds that may be involved in the complete wide area network may have considerable impact on the performance of applications running across the network .

In most cases , WANs involves data transmissions across public carriers . This can take several forms, such as dial-up lines , dedicated lines , packet switching , or other carrier options . Complexity of LAN to WAN linkages is not just the tremendous differential in cost , but also the presence of multiple vendors . By law , local exchange carriers(LECs) can only provide local access while an inter-exchange carrier (IXC) must connect services across local access transport areas (LATAs) .

### 2.2.2 WAN

The wide area network expands the basic LAN model by linking LANs and allowing them to communicate with each other. By traditional definition, a LAN becomes a WAN when it crosses a public right –of – way, requiring a public carrier for data transmission. More current usage of the term (WAN) usually includes any situation where one expands beyond certain premises. A WAN is characterized by:

- Wide geographical area, ranging any sizes up to international level.
- Low to high-speed links.
- Remote links may be operational LANs or groups of workstations only .

With the exception of a WANs wide area of operation, the benefits and features of LANs and WANs are almost the same .

### 2.2.3 LOCAL AREA NETWORKS (LANs).

One common definition of a local area network (LAN) is the interconnection of computers located within a geographically clustered area. This LAN would consist of a collection of small, departmental LANs connected through some sort of backbone facility. Even within a building, distance limitations of LANs may become an issue along with the questions of mixing different types of networks and computers, such as PCs, hosts and terminals. Other terms, besides LAN, which may be defined in various ways, include Metropolitan Area Networks (MAN), Wide Area Networks (WAN), and Campus Area Network (CAN). Common usage of the term has WAN referring to any configuration linking LANs together.

As it becomes necessary to establish connections across town, Metropolitan Area Network (MAN) comes into play. Depending on the distances and facilities available, these connections to more distant sites may involve telecommunication links provided by the local Telephone Company.

## 2.4 NETWORK TOPOLOGY

In this session discussion is based on how computers are organized in networks to share information and hardware resources. The ways in which the media (cables) can be run to link these computers together are also discussed.

The way in which the connections are made is called the topology of the network. Network topology specifically refers to the physical layout of the network , especially the locations of the computers and how the cables is run between them .It is important to select the right topology for how the network will be used, each topology has its own strengths and weaknesses.

The four most common topologies are:

- Bus topology
- Star topology
- Ring ,,
- Mesh ,,

There are three types of topologies commonly used on LANs ; the Bus, Ring , and the Star topologies. Additional topologies have been developed for WAN connectivity, including point-to-point, multi-point, mesh networks. Star-Bus and Star-Ring topologies (hybrid topologies) often find in a WAN, is simply an implementation of multiple topologies to improve network services.

## 2.4.0 BUS TOPOLOGY

The bus topology is often used when a network installation is small, simple, or temporary. On a typical bus network, the cable is just one or more wire, with no active electronics to amplify the signal or pass it along from computer to computer. This makes the bus a passive topology. When one computer sends a signal up (and down) the cable, all the computers on the network receives the information, but only one (the one with the address that matches the one encoded in the message) accepts the information. The rest disregard the message. Only one computer at a time can send a message; therefore the number of computers attached to a bus network can significantly affect the speed of the network .A computer must wait until the bus is free before it can transmit.

Another important issue in bus network is termination . Since the bus is a passive topology, the electrical signal from a transmitting computer is free to travel the entire length of the cable . Without termination, when the signal reaches the end of the wire, it bounces back and travels back up the wire . When a signal echoes back and forth along an unterminated bus, it is termed ringing .To stop the signals from ringing, terminators must be attached at either end of the segment. The terminators absorb the electrical energy and stop the reflections. Thus cables cannot be left unterminated in a bus network.

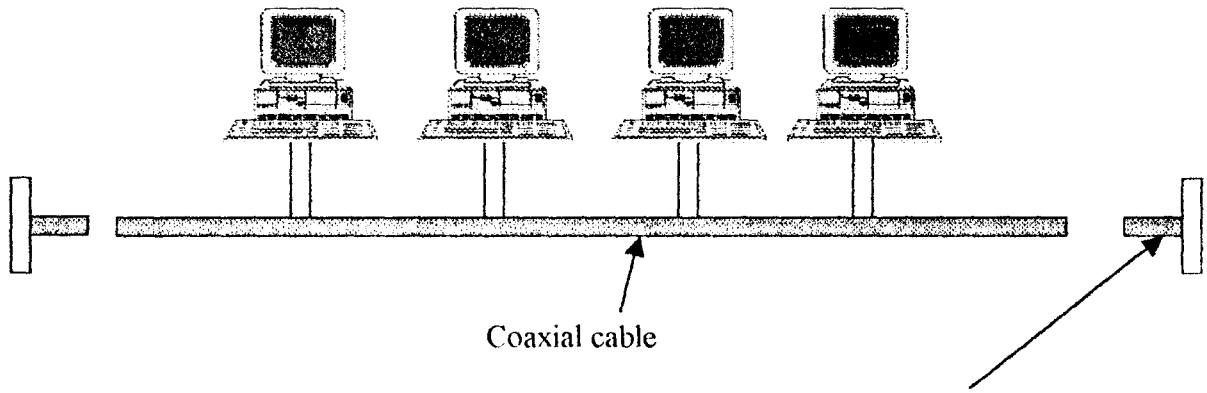


**Figure 2.0 BUS TOPOLOGY.**

**Advantages of the Bus topology.**

- The bus is simple, reliable in very small networks, easy to use, and easy to understand.
- The bus requires the least amount of cable to connect the computers together and is thus less expensive then other cabling arrangements.
- It is easy to extend a bus .Two cables can be joined into one longer cable with a BNC barrel connector, and allowing more computers to join the network.
- A repeater can also be used to extend a bus; a repeater boosts the signal and allows it to travel a longer distance.

**Disadvantages of Bus network.**

- Heavy network can slow a bus considerably.
- Any computer can transmit at any time, and computers on most networks do not coordinate with each other to reserve times to transmit thus computers can spend a lot of its bandwidth with the computers interrupting each other instead of communicating.
- Each barrel connector weakens the electrical signal, and too may prevent the signal from being correctly received all along the bus.
- In Bus topology, limited numbers of computers are connected due to its lack of coordination and interrupting characteristics.
- It is difficult to troubleshoot a bus .Since failure of one or two computers can bring down the entire network.

### 2.4.1 STAR TOPOLOGY

In a star topology, all the cables run from the computers to a central location where they are all connected by a device called Hub. Stars are used in concentrated networks, where the endpoints are directly reachable from a central location, when network expansion is expected and greater reliability is needed.

Each computer on a star network communicates with a central hub that resends the message either to all the computers or only to the destination computer. The Hub may be passive or active. An active hub regenerates the signal and sends it to all the computers connected to it . This type of hub is often called a multi-port repeater. Active hub requires electrical power to run. A passive hub, such as wiring panels or punch-down blocks merely acts as a connection point and does amplify or regenerate the signal, also they do not require electrical power to run.

Star topology provides architectural flexibility and allows use of several types of cable to implement a network. Expansion can be effected in a star network by placing another star hub where a computer might otherwise be this is called stacking the network. Thus this allows several more computers or hubs to be connected.

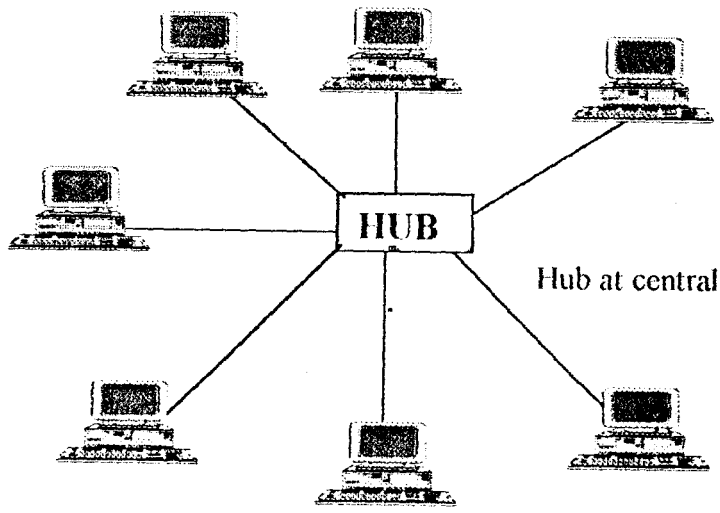


**Figure 2.1 Star topology architecture.**

**Advantages of star topology.**

- It is easy to modify and add new computers to a star network without disturbing the entire network.
- The center of a star network is a good place to diagnose network faults. Intelligent hubs (Hubs with microprocessor that implement features in addition to repeating network signals) also provide for centralized monitoring and management of the network.
- Simple computer failures do not necessarily bring down the whole star network. The hub can detect a network fault and isolate the offending computer or network cable and allow the rest of the network to continue operating.
- Star topology allows use of several cable types with a hub that can accommodate different cable types.
- Virtually all modern data networks are configured in star, this allows for simplified adds, moves and changes.

**Disadvantages of star topology**

- If the central hub fails, the whole network fails to operate.
- Many star networks require a device at the central point to rebroadcast or switch network traffic.
- It costs more to cable a star network.

### 2.4.2 RING TOPOLOGY.

In a ring topology, each computer is connected to the next computer with the last one connected to the first. With ring, each computer retransmits what it receives from the previous computer. The message travels around the ring in one direction.

Some ring networks do token passing. A short message called a token is passed around the ring until a computer wishes to send information to another computer. That computer modifies the token, adds an electronic address and data, and sends it round the ring. Each computer in sequence receives the token and the information , passes them to the next computer until either the electronic address matches the address of a computer or the token returns to its origin. The receiving computer returns a message to the originator indicating that the message has been received. The sending computer then creates another token and places it on the network , allowing another station to capture the token and begin transmitting. The token circulates until a station is ready to send information, and hence captures the token.

All this happens very quickly, a token can cycle a ring of 200 meters in diameter at about 10,000 times a second. Some faster networks even circulate several tokens at once. Other ring networks have two counter rotating rings that helps them recover from network faults.

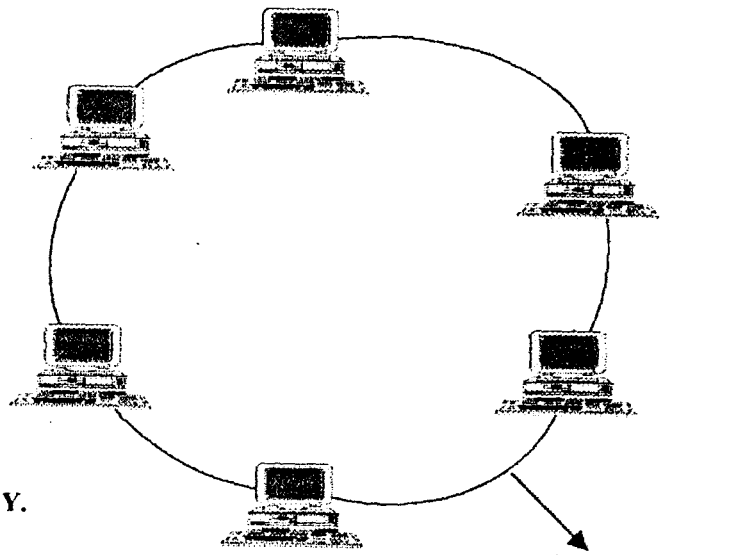


**Figure 2.3 RING TOPOLOGY.**

**Advantages of ring topology**

- Each computer is given equal access to the token, no one computer can monopolies the network.
- The equal sharing of the network allows the network to function in a useful, if slower, manner rather than fail once capacity is exceeded.

**Disadvantages of ring.**

- Failure of one computer on the network affects the whole network.
- Adding or removing of any computer disrupts the network

## 2.4.3 MESH TOPOLOGY

A mesh configuration consists of a network in which each device has a point-to- point connection to every other device on the network. This gives us a dedicated capacity of point-to-point link to each device, and provides significant fault tolerance. However, the complexity and cost make this configuration impractical for networks, imagine that the network could get unmanageable beyond a very small number of devices. Also much of the bandwidth available in mesh configurations is wasted. For these reasons, mesh topology is generally used for interconnecting only the most important sites with multiple links. This is called a hybrid mesh or partial mesh.

**Advantages of mesh topology**

- Troubleshooting is easy.
- Isolation of network failures is easy.
- Fault tolerance is maximized by rerouting traffic around failed links.

**Disadvantages of mesh**

- Difficult to install.
- Reconfiguration, like installation, gets progressively more difficult as the number of devices increases.
- It is expensive because of redundant connections and wasted bandwidth.

## 2.5 LOCAL AREA NETWORKS (LANs) ARCHITECTURE.

There are three roles for computers in a local area network

- **Client** ----These are computers that use network resources but do not provide other resources.
- **Peers** ----. These are computers that use and also provide network resources.
- **Servers** ---- These are computers , which only provide network resources.

The type of operating system the computer uses determines each of these computer roles. Servers run network operating systems such as Windows NT server, Novell NetWare etc. Clients run client operating systems, such as ms-dos, OS/2, windows 9x etc. Peers run peer network operating systems, such as windows 9x, Macintosh operating system. Each of these operating systems is optimized to provide services for the role it plays. Based on these roles the computers on network are divided into three environment types.

**I Peer-to-peer network architecture.** In this, the network is made up of machines of compatible strength, with no server. It uses the network to share resources among independent peers . This is characterised by ease of installation and usage, also where no ambition for expansion is paramount.

Advantages of peer networks.

- ✓ No extra investment in server hardware or software is required.
- ✓ Easy to setup.
- ✓ No network administrator required.
- ✓ Ability of users to control resources sharing.
- ✓ No reliance on other computers for their operation.
- ✓ Lower cost for small network.

**Disadvantages of peer networks**

- ➢ Additional responsibility on individual computers.
- ➢ Lack of central organisation, which can lead to data mismanagement.
- ➢ Weak and intrusive security.
- ➢ No central point of storage, for file archiving.
- ➢ Each computer must posses all hardware requirements.

**II Client-server network architecture**. This network is usually called multi-user network. It emerges as the need to connect more systems together arose. This consists of a computer (called the server) to which all other computers (clients or workstations) are connected. The server provides security and administration of the network. It is usually more powerful than the clients in terms of speed, memory and the hard disk capacity.

**Advantages of server-based networks.**

- Strong central organisation and security
- Allows all users to work from the central file / data storage and provides easy backup of critical data.
- Ability of servers to pool available hardware and software, lowering the overall costs.
- Easy manageability of a large number of users.
- Less tasks of managing the shared resources by the user.
- Less intrusive security
- Makes network faster.
- Ability to share expensive equipment, such as printer, modem etc.

**Disadvantages of server-based networks.**

- Expensive network operating system software required
- Dedicated hardware required
- A dedicated network administrator is usually required.

**III Hybrid Networks.**

Hybrid networks have all three types of computers on it and generally have active domains and workgroups. This means that while most shared resources are located on server, network users still have access to any resources being shared by peers in the workgroup. The network users do not have to log on to the domain controller of server to access workgroup resources being shared by peers.

**Advantages of hybrid computing.**

- The advantages of server-based networking.
- Ability of users and network administrators to control security based on the importance of the shared resource.
- Some of the advantages of peer-based networking.

**Disadvantages of hybrid computing.**

- The disadvantages of server-based networking.

## 2.6 Network hardware requirements.

The local area network hardware's include

- Servers
- Workstations (clients)
- Shared peripherals
- Network adapters
- Media (cables)
- Support hardware: bridges, routers, and gateways.

The hardware components of a LAN include those physical items one can see and touch. These may vary slightly by network operating system in use. Server(s) on most LANs will be standard PCs. It will contain the shared disk storage and shared peripherals may include: printers, modem, CD-ROM drive, or other devices as needed. Most network operating systems peripherals. Shared support PCs and Macintosh systems as workstations. Enough flexibility is built into the network operating system to allow workstations operating system selections to match user requirements.

Each server(s) and workstations ,must have a network adapter on board or a network interface card (NIC) on it. This provides the physical connection between the PCs and the media (cable) plant. The media (cable) is the communication path between the server(s) and workstations. Depending on

the network scale and configuration, it may contain additional connection devices such as bridges, routers and gateways.

## 2.7 Hardware Protocols.

Hardware protocols defines how hardware devices operate and work together. The 10Base T Ethernet protocol is a hardware protocol specifying exactly how two 10Base T Ethernet devices will exchange information and what they will do if it is improperly transmitted or interrupted. It determines such things like voltage levels and which pairs of wires will be used for transmission and reception. There is no program involved, it is all done with circuitry.

## 2.7 Network Operating System

A Network Operating System (NOS) is very similar to a regular client operating system such as windows or OS/2 only that it controls the basic functions of the computer in the network. Unlike regular operating systems, network operating system provides network services such as file and print sharing, and user account management.

As reliance of many computers on the services of a server increases, good network operating systems are implemented with features such as preemptive multi-tasking; which prevents poorly written server component software from crashing the server, and strong security, and also manages the accessibility of the different resources provided by the server. Technically, the only different between a server and a client computer is the software each runs. A complete network requires two types of network software namely:

- The network operating system, which runs on the server and allows the share of server resources such as hard disk, printers and CD-ROM.

- Client networks access software, which runs on the client and provides access to the resources shared by the server.

## 2.9 NETWORK SOFTWARE RESOURCES

➢ **Client software.**

The purpose of client network software is to make the services that are available on network appear to be local to the client computer. Thus with this, application software can be written without regard to where printer, hard disk , and so on, are located.

Client software works by intercepting calls to DOS such as for print and file services. The network client software determines whether the drive, designator, refers to a local drive letter or to a network drive. If the drive letter refers to a local drive, the network client software simply passes the request to the local operating system. If the request refers to a network resources, the client software intervenes, communicates with the server to get the contents of the file or to transfer print data, and returns information to the application program the same way the local operating system would.

This way, application programs do not know anything about networks in order to use network resources. They can simply treat networks as very large hard disk drives and as local printers. The network client software intervenes whenever necessary to communicate with the network. Network client software is referred to differently in various networks. In Novell Netware, the network client software is called a requester, because it requests services from the server whereas in Microsoft and IBM networks, the client software is called a redirector because it redirects services from client to the network. The above explanation is shown in figure 2.4

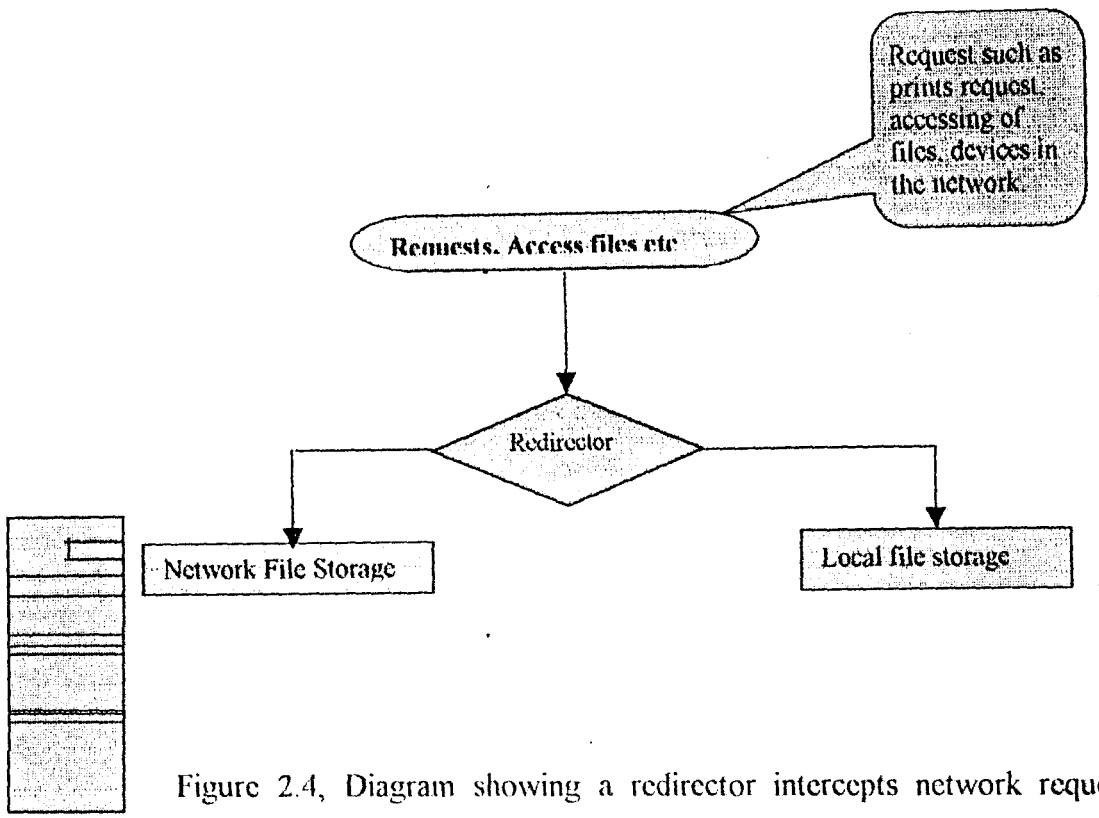


Figure 2.4, Diagram showing a redirector intercepts network requests and forwards them to the server if necessary.

- **Server software.**

Server(s) are the waiters of the network demand, they exist simply to listen for and satisfy the requirements of clients. Server actually store most of the data on a network, they provide a convenient location to perform a number of other services, such as:

- Managing user accounts.
- Security.
- Central licensing.
- Data protection.
- Multi-tasking and multiprocessing.

Each of these functions is more applicable to server operating systems than client operating systems. Most client operating systems do not normally provide these functions.

## 2.10 OPEN SYSTEM INTERCONNECTION (OSI)

In 1977, the International Organization for Standardization (ISO) approved Open System Interconnection (OSI) reference model that was adapted in 1983. The term "Open" denotes the ability of any two computers systems conforming to the reference model and the associated standards to connect, (i.e. systems capable of interconnection by virtue of each system having implemented the common set of protocols).

In order for computers to communicate, there must be accepted rules of communication. For communication to take place on a network composed of a variety of network devices, these rules must be clearly defined. The OSI model is nothing tangible, it is simply a conceptual framework that can be used to better understand the complex interactions taking place among the various devices on a network. It (OSI) simply defines which tasks to be done and which protocols will handle those tasks at each of the seven layers of the model, which is downward compatible. They are as follows:

Level 1 Physical layer.

Level 2 Data link layer.

Level 3 Network layer.

Level 4 Transport ,,

Level 5 Session ,,

Level 6 Presentation ,,

Level 7 Application layer.

Brief explanation of roles each of these layers performs is given as follows:

### 2.10.0 OSI Physical Layer.

This layer defines the mechanical and electrical characteristics of the medium and network interface hardware. Items defined at this layer include;

- Media: This defines cable characteristics, examples ,coaxial cable, fiber optics, and twisted- pair cables.
- Transmission method: Transmission types, signal characteristics such as signal strength are defined this layer.
- Topology: This include, bus, ring, and star.

### 2.10.1 OSI Data Link Layer.

This layer specifies how to ensure error-free delivery of data . It organizes data into frames . It also adds control information in the form of a packet header. The header includes the source, destination address, frame length, and upper layer protocol used for communications. It monitors for acknowledgement of transmitted frames, recent frame. The IEEE 80.2 specification divides this layer into two sub-layers:

- Logical link control. This defines error and flow control. It ensures the integrity of end-to-end transmission.
- Media Access Control (MAC) . Defines access control.

### 2.10.2 OSI Network Layer.

This is responsible for data routing in a multiple segment network. This is referred to as network layer addressing. Its functions are ;

- Translates addresses: Logical addresses, such as machine names, that had passed down from upper layers are transmitted into physical addresses that the data link layer can use.

- Determines best routing: It determines the best route for the data packet to ensure timely delivery.
- Manages network traffic: Problems like packet congestion are managed by this layer

### 2.10.3 OSI Transport Layer.

This layer ensures that data moves, for e.g., from point A to point B in order without errors. This layer provides:

- Repackaging of large data blocks into smaller packets.
- Flow control, packets, sequencing, and sequence checking.
- Resynchronization with time-out and retransmission.
- Error detection and recovery.
- Transport connection multiplexing.

### 2.10.4 OSI Session Layer.

The session layer is designed to deal with session errors. A session is the logical connection between two network devices. This layer provides:

- Dialog management.
- Error correction.
- Logical address names.

### 2.10.5 OSI Presentation Layer.

Presentation layer translates data from the application layer into a transmission format. This implies that even though workstations may use different local data formats they can still all communicate. This layer provides the following functions:

- Data format translation.
- Data encryption / decryption.
- Data compression / expansion.
- **2.10.6 OSI Application Layer.** This layer provides a means for end user applications to access the network. Services provided here includes:
- End user interface.
- Network management.
- Directory services.
- File access.
- File transfer.

## 2.11THERNET

Ethernet is the most popular physical network architecture in use to day. It was first conceived in the 1960's at the university of Hawaii as the ALOHA network, it was a packet radio network that used the Carrier Sense Multiple Access with Collision Detect(CSMA/CD) protocol.

In 1972 Robert Metcalfe and David Boffs at Xerox parc implemented the network architecture with a cabling and signaling scheme, in 1975, they introduced the first Ethernet product. Xerox, Intel, and Digital took the original specification and extended it from 3mbps to 10mbps. This was the basis for the IEEE 802.3 specification. In 1990 the IEEE 802.3 committee released the specification for running Ethernet over twisted pair wiring. Ethernet is a bus or star-bus based technology that uses baseband signaling and CSMA/CD to arbitrate network access . The Ethernet medium is passive, which means that the computers drive the signals over the network.

### 2.11.0 HOW ETHERNET WORKS.

Ethernet arbitrates access to the network with the CSMA/CD media access method. Thus only one workstation can use the network at a time. In Ethernet, the workstation sends signals (packets) across the network. When a collision occurs, the workstations transmitting the packets stop transmitting and wait a random period of time before re-transmitting. Using the rules of this model, the workstations must contend for the opportunity to transmit across the network. For this reason, Ethernet is referred to as a contention based system. Most Ethernet networks currently run at 10mbps and also available for many types of cable. The different types of Ethernet use different signaling characteristics, but they share the Ethernet framing specification, the 10mbps speed, and the use of CSMA/CD to arbitrate access. The four commonly used 10mbps Ethernet cabling systems are:

- 10Base5, or thicknet. It uses thick coaxial cable.
- 10Base2, or thinnet. It uses thin coaxial cable.
- 10BaseT, which uses unshielded twisted pair cable.
- 10Base FL, It uses single or multi-mode optic fiber.

#### 2.11.1 10Base-T Ethernet.

The use of unshielded twisted pair (UTP) cable is now a well-established trend in Ethernet network wiring schemes. UTP costs less and is more flexible than 10Base5 and 10Base2 cabling. The IEEE 802.3 sub-committee created the specification for UTP in 1980. 10BaseT Ethernet has the following specifications:

- Maximum segments 1024
- Maximum segments with nodes 1024
- Maximum segment length 100 meters (330ft)
- Maximum nodes per segment 2
- Maximum nodes per network 1024

Maximum hubs in a chain 4

10BaseT are wired as a star, each device has its own set of wires connected directly to a hub. Although the physical topology of 10BaseT is a star, its logical topology is a bus. Each node uses its own separate segment, hence it is easy to isolate a device that develops problem by just disconnecting its cable from the hub. Some hubs have built-in management capabilities that will report errors or problems, as well as allow disconnection of the device from the hub remotely. These types of hubs are known as intelligent hubs. Shown below is an Ethernet network with a 10BaseT hub.

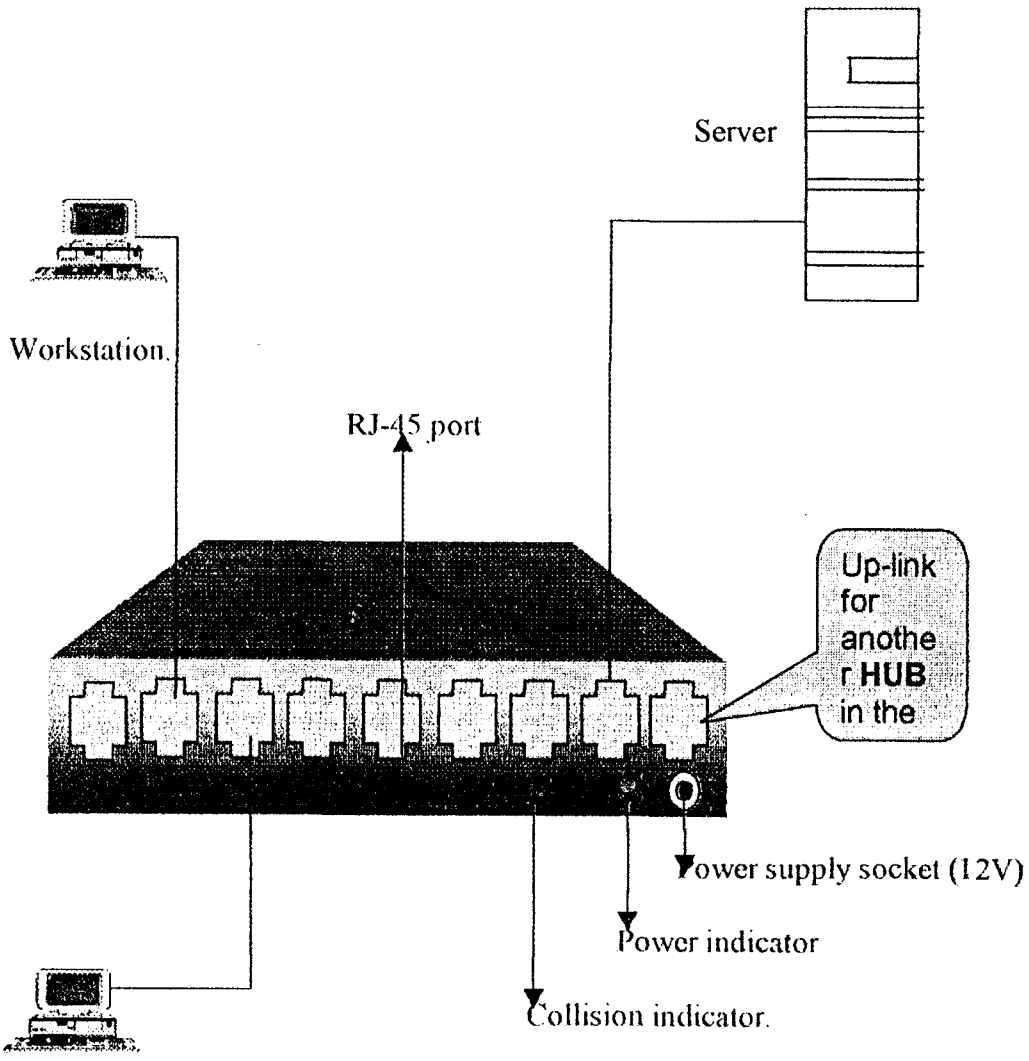


Figure 2.5, Diagram of Ethernet network with a 10Base T active Hub.

The connection to the LAN cards and the hub is made with a RJ-45 connector. UTP cable is classified in categories defined by electrical industries association. Categories 1 and 2 are voice-graded cable. Categories 3, 4, and 5 are data-graded. Category 5 has advantage of more number of twists per foot and better insulation, thus it offers reduced noise level. It is suitable for rates of up 100mbps. Shown below are the pin functions of RJ-45 connector.

1. Not used
2. Ground
3. Transmit +
4. Receive +
5. Receive –
6. Recovery
7. Ground
8. Not used

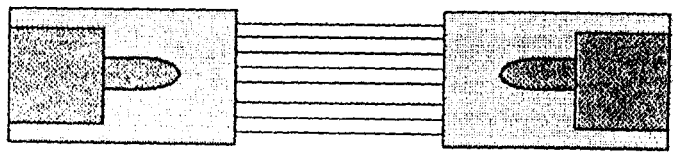

Figure 2.6 RJ-5 Pin connections.

## 2.12 NETWORK STANDARDS

Standards are set of rules, such that it allows a common point of reference for discussing network devices and concepts. Standards are required to govern the physical, electrical and procedural characteristics of a network environment, and also assure that there will be a large market for a particular piece of equipment or software. Many network approaches exists by various vendors, each with their own ideas on how network should work. Without coordinate, there will be failures in the whole network, the only way to resolve this , is by setting a standard.

The American Institute of Electrical and Electronic Engineers (IEEE) computer society in February 1980 formed its local network standards committee termed project 802, [after the year and month the project started ]. Project 802 defines cabling and data transmission corresponding to the physical and data link layers of the OSI model. Some of the standards that relate to LANs are:

- IEEE 802.1 Internetworking
- IEEE 802.2 Logical link control (LLC)
- IEEE 802.3 Carrier Sense Multiple Access with Collision Detection
- IEEE 802.4 Token Bus
- IEEE 802.5 Token Ring
- IEEE 802.6 Metropolitan Area Network (MAN).
- IEEE 802.7 Broadband Technical Advisory Group.
- IEEE 802.8 Fiber Optic Technical Advisory Group.
- IEEE 802.9 Integrated voice and data in LAN
- IEEE 802.10 Standard for interoperable LAN security.
- IEEE 802 .11 Wireless Networks
- IEEE 802.12 Demand priority accesses LAN.

## 2.13.0 NETWORK SECURITY.

Providing security means more than controlling a system to prevent theft. It means controlling the system to prevent exposure, loss, and freewill access to network critical data's and resources. Accidental loss, especially in information systems, is quite common. Users sometimes delete files to create space in their hard disk without really knowing what they have deleted. Computers can crash, sometimes losing data in the process. A file can be overwritten with a different document of the same name.

The security measures implemented in networks are designed to prevent both accidental and unintentional loss. All network-operating systems require a log on, so that no access to information is given without accountability. Windows NT implements resource-level security whereby, individual information resources are secured by type, and lists of trusted users control access to the resource called Access control lists. These measures are quite effective in preventing loss, and they form an important part of the total networking process.

When a user or group has an access control entry in an access control list for a specific resource that allow access, that user has permission to use the resource. The set of access control lists is called permissions, the permission is ascertained mostly by entering a password. The network administrator defines and implements a security policy that protects critical resources without preventing users from performing their work. The balance between protection and usability changes for every organization, and it is up to the network administrator to strike the appropriate balance for each individual organization.

# CHAPTER THREE

## LOCAL AREA NETWORK, DESIGN, IMPLEMENTATION, & TESTING.

### 3.1 INTRODUCTION

Implementation of a local area network requires careful planning. The common procedure is that the designer should put into consideration, the future growth of the initial network. Networks are always modular, once a network is built on a solid base, an additional network device can easily be added. In order to ensure that the LAN meets standards set by the International Standards Organization (ISO) and the Open System Interconnection (OSI) reference model the following steps were followed.

- Determination of suitable topology.
- Determination of networks cabling.
- Installation of Network Interface Cards (NICs) .
- Locating and configuration of server and clients operating systems.
- Implementation of security in the network.

### 3.2 LIST OF ITEMS USED.

The hardware components employed in the implementation of this project are listed below.

- 10BaseT Ethernet hub
- RJ- 45 wall sockets
- Category 5 UTP cable
- Network adapter cards
- Cable clips

Tools used are; crimping tool, set of screw driver, Digital multi-meter Pliers, Cutter, tape rule, Hammer, Chisel, Light tester, screw driver.

## 3.1 NETWORK TOPOLOGY IMPLEMENTED.

The choice of star network topology was made after careful studying of the prevailing factors such as:

i. Future expansion of the network.
ii. Locations of the computers to be networked.
iii. Number of the computers involved
iv. Distance between each computers etc.

The diagram is as shown in Appendix 2, also shown in the figure is the active 8 port hub used.

## 3.4 CHOICE OF CABLE

The first step taken in the determination of choice of cables include; careful assessment and measurement of the site, required speed of the network, required installation properties etc .A drawing labeled Appendix was produced, showing locations of various offices to be linked.

## 3.5 INSTALLATION OF UTP CABLES.

On examining the site plan (the offices and locations), a cabling layout drawing (Appendix 2) was produced. It shows connection of cables from the workstations and wall sockets to the hub. Unshielded twisted pair [UTP] cable cat.5 was chosen since it supports star network topology.

The UTP cat.5 contains four twisted pairs of copper wire capable of data transmission of up to 100mbps. It is connected at both ends with RJ-45 connectors using crimping tool for plugging into the hub and network adapter card respectively.

**Table 3.1 Colour code for UTP cable category 5**

| WIRE ID | COLOUR CODE | ABREVIATION |
|---|---|---|
| 1 | White--Blue | W—BL |
| 2 | Blue | BL |
| 3 | White--Orange | W---O |
| 4 | Orange | O |
| 5 | White--Green | W--G |
| 6 | Green | G |
| 7 | White---Brown | W--BR |
| 8 | Brown | BR |

The cables were installed from the hub to RJ-45 and NICs respectively via different methods of cabling. These methods are the overhead cabling, surface cabling and trunk cabling. Table 3.1, shows various cabling types, cable length, and RJ45 wall socket types.

During the installation, consideration was given to cabling path such that effect of nearby sources of electromagnetic interference, radio frequency sources is minimized. The maximum length UTP cable can transmit data effectively is 100 meters (328ft).

## 3.6 NETWORK OPERATING SYSTEMS USED IN THE IMPLEMENTATION.

In the making a choice of network operating systems, considerations were based on the operating systems with network features. Windows NT was designed with network environments in mind, hence was used in the implementation of this project. Windows NT server share a number of common features, these include

- Hardware platform support. The designer of network has the choice of selecting the hardware platform that best suite the operational requirements. Windows NT supports X86- based systems.
- Preemptive multi-tasking.
- Security.
- Application support.
- Network support.
- Internet / Intranet support.
- Microsoft exchange.

## 3.7 INSTALLATION AND CONFIGURATION OF NETWORK ADAPTER CARDs.

The Network Interface Cards (NICs) were installed by shutting down the computer and putting off the power supply, and then removing the CPU casing. The NICs were secured in the slot by tightening the screw onto metal mount of the system's chassis. The casings were closed, and the RJ-45 connector connected with the UTP cable were plugged into the adapter and the other end of the UTP cable connected to the 10BaseT hub.

After the above process, the computers were booted and the operating systems detected the NICs and the best driver for each one were loaded using the manufacturers installation diskette. After loading the driver, the network neigbourhood, and each system were supplied with information viz.:

- The computer name and description.
- The protocol for the network in this case we used NetBEUI.
- The access control.
- Internet Protocol (IP) address and sub-net mask.
- User name and password.

## 3.8 RESOURCE SHARING AND SECURITY TECTNIQUES.

### 3.8.0 RESOURCE SHARING.

To enable sharing of resources such as, the hard disk, CD-ROM drives, printers, files etc, We selected START- Program- Administrative tool and then clicked on the resources to be shared.

### 3.8.1 NETWORK SECURITY.

Security is an important part of any network, and user definitions are the first line of defense. Network security is generally identified as one of two general security models, viz., share level and user level. The following security measures were implemented from the administrative tool.

- User manager for domains.
- User name and password.
- User right policy.

## 3.9 TESTS CARRIED OUT.

The continuity test was employed to ensure that cables were all in perfect working condition. This test was carried out using a digital multimeter.

### 3.9.0 CONNECTIVITY AND COMMUNICATION TEST OF THE LAN.

To ensure that there is a communication link, between all the computers in the network via the cables and hub, a DOS command "ping" followed by the IP address was applied to each of the systems for connectivity test. The syntax for this command is as follows: **C:\> PING < IP address >.** **IP** addresses provide logical node Ids. They are unique addresses assigned by an administrator according to certain guidelines. They are expressed in four-part dotted-decimal notation. In this project, IP address used is 132.45.67.X. Where X starts from 1 up to N- maximum number of computers in the network. For this work, X = 5.

### 3.9.1 COMMUNICATION TEST

In order to observe the networking objectives and performance, communications such as sharing of hard disk, CD-ROM, e-mail services, etc were carried out respectively.

# CHAPTER FOUR.

## ANAYSIS AND DISCUSSION OF RESULTS.

### 4.1 DISCUSSION OF RESULTS.

The results of the tests carried out in the implementation of the project are discussed as follows.

### 4.2 RESULT FOR CONTINUITY TESTS FOR THE UTP CAT.5 CABLES.

The table shown below shows the result of the pin-to-pin tests of the UTP cables. Beep indicates that there is continuity in the single conductor being tested in each case.

**TABLE 4.0 CONNECTIVITY TESTS OF UTP CABLES.**

| Pin to Pin Tested | Four pairs of conductor in the UTP cat.5 cable | | | | | | | | Meter indication | Certified For data Transmission. |
|---|---|---|---|---|---|---|---|---|---|---|
| | W-B | B | W-O | O | W-G | G | W-BR | BR | | |
| W-B | ,, | | | | | | | | Beeped | Beeped |
| B | | ,, | | | | | | | Beeped | Beeped |
| W-O | | | ,, | | | | | | Beeped | Beeped |
| O | | | | ,, | | | | | ,, | ,, |
| W-G | | | | | ,, | | | | ,, | ,, |
| G | | | | | | ,, | | | ,, | ,, |
| W-BR | | | | | | | ,, | | ,, | ,, |
| BR | | | | | | | | ,, | ,, | ,, |

### 4.3 CONNECTIVITY TEST RESULT AMONG THE COMPUTERS NETWORKED.

At the command prompt, after typing in the ping command followed by IP address gives the following response.

Reply from IP address: Bytes = 32

Time = 150ms

TTL = 244

In each computer being pinged.

### 4.3.0 RESULT OF COMMUNICATION TEST.

After the implementation of the network requirements, the communication test carried out showed that the objective of this project were achieved within the limits of resources available in the network. Hence the following results were obtained:

- ✓ We were able to share hard disk within the network.
- ✓ Sharing of CD-ROM drive.
- ✓ Sharing of application software.
- ✓ E-mail services within the network.
- ✓ Sharing of printer.
- ✓ Sharing of files and large volumes data transfer process etc.

## 4.4 ANAYSIS OF RESULTS OBTAINED.

Results shown in table 4.0, indicates that the cables are continuous, and hence fit for data transmission or receiving processes. The connectivity test results of the computers in the network shows that the systems are actually linked via the UTP cables and the active hub used. The destination port and response given back by the receiving computer received the

Internet control message protocol (ICMP) echo packets sent by any of the system to another. The TTL in the response means time-to-leave.

The results obtained from the communication test confirm the success of the implementation in general. Though the speed of communication were not much, the capabilities were exploited within the hardware factors like the RAM size, environmental factors and other limiting factors.

# CHAPTER FIVE.

## CONCLUSION AND RECOMMENDATION.

### 5.1 CONCLUSION.

Computers are communication tools, and networks are how the computers exchange information. Networked computers can share data and peripherals, allowing people in an organization; individuals to communicate better and more effectively use their hardware and software resources.

In peer-to-peer networks, every computer is both a client and a server. Server based networks dedicates a computer to more effectively perform server functions.

Topology is the shape of the network·

- In a BUS, the computers are connected in a line.
- In a STAR, the computers are linked together at a central point with a Hub.
- In a RING, the computers form a circular shape.
- STAR-BUS or STAR-RING results when network topologies are combined.

Media are what the network links are made of. Copper is the most common networking medium, while fiber optics is used for high performance and where other may not work well. Infrared and radio are used when cables are inappropriate for a certain network locations.

## 5.2 HARDWARE AND PROTOCOLS.

In most computers today, cables are what ties computers together into networks, one of the commonly used type is the UTP cable. Network adapter cards in the computer places the information on the network. A network adapter card must match both the number of bits in the computer and the network to which it will be attached. A protocol stack is a group of protocols arranged on top of each other as part of a communication process, which must be followed.

## 5.3 DESIGNS AND COST OF IMPLEMENTATION.

The problems of designing this project were compounded by capital (cost) involved, though we were able to make it a successful one within the limits we can reach, especially with respect to finance. Finally from the performance observed, the aim and objectives of this project were successfully achieved.

## 5.4 RECOMMENDATION.

In the course of carrying out the task of doing this project, I discovered some deficiencies. I wish to suggest a way to amend such deficiencies as follows.
The financial task in carrying out projects that enhances technological advancement is very much. The university authorities and Nigeria Universities Commission (NUC) should through ministry of education and Federal Government alleviate this problem by financing projects of technical interest.

## 5.4.0 AREA OF FURTHER STUDIES.

Further studies on this project should be focused on how expansion components such as repeaters, bridges, routers, brouters, and gateways enables Local Area Network (LAN) growth. As it is designed, one can add workstations in remote parts of a building or in separate LANs to the local physical media to create a larger integrated local network.

Thus, expansions on this work should be linking of several LANs in various schools in Federal University Of Technology Minna, to yield what is termed Campus Area Network (CAN). To implement this, the following transmission media can be used:

- The Public Switched Telephone Network (PSTN).
- High- speed fiber-optic cable.
- Microwave transmission links.
- Wireless radiated media (radio frequencies).
- The Internet.
- Satellite links.

## 5.5 SUMMARY.

This project revealed the practicality of theoretical Local Area Network model, purpose of the implementing this work. The aim, scope and limitation, assumptions in the project were also outlined.

After the implementation of the network, results showed that the objectives of this project were achieved within the limits of resources available in the site layout.

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**WEB LINKS:**


www.howstuffswork.com/networking.

www.pcworld.com/networking.htm.

www.itaudit.org/security.htm

http:// mspress.microsoft.com/support/network.

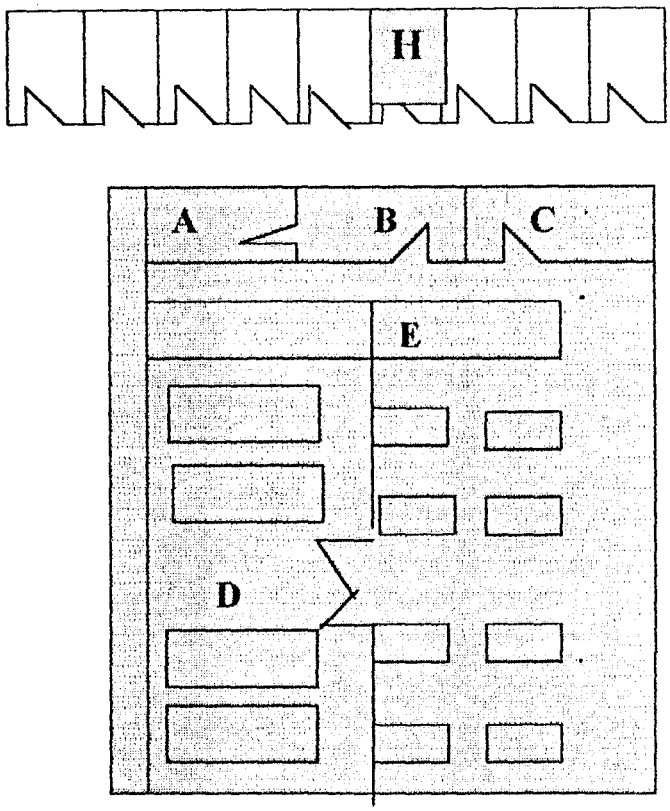
http:// www.microsoft.com/training

Home Network(http:// work.home.net/white papers/backbone.htm)

Qwest (http://www.qwest.com/about/inside/network)

# APPENDIX 1

## SITE LAYOUT




| LEGEND | |
|---|---|
| SYMBOL | DESCRIPTION |
| A | SERVER LOCATION |
| B | SECRETARY'S OFFICE |
| C | TECHNICIANS OFFICE |
| D | COMPUTER LABORATORY |
| E | ELECTRICAL LABORATORY |
| H | OFFICE:- THE H.O.D ELECT. AND COMP. ENGINEERING. |

**ROJECT TITLE:**
ESIGN AND IMPLEMENTATION OF LOCAL AREA NETWORK (LAN)
OR SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

| **AME OF STUDENT** | **REG. NO :** |
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EPARTMENT: ELECTRICAL AND COMPUTER ENGINEERING TECHNOLOGY.

UPERVISOR: MR. JONATHAN KOLO

OURSE CODE : EEE 515 / EEE 525.

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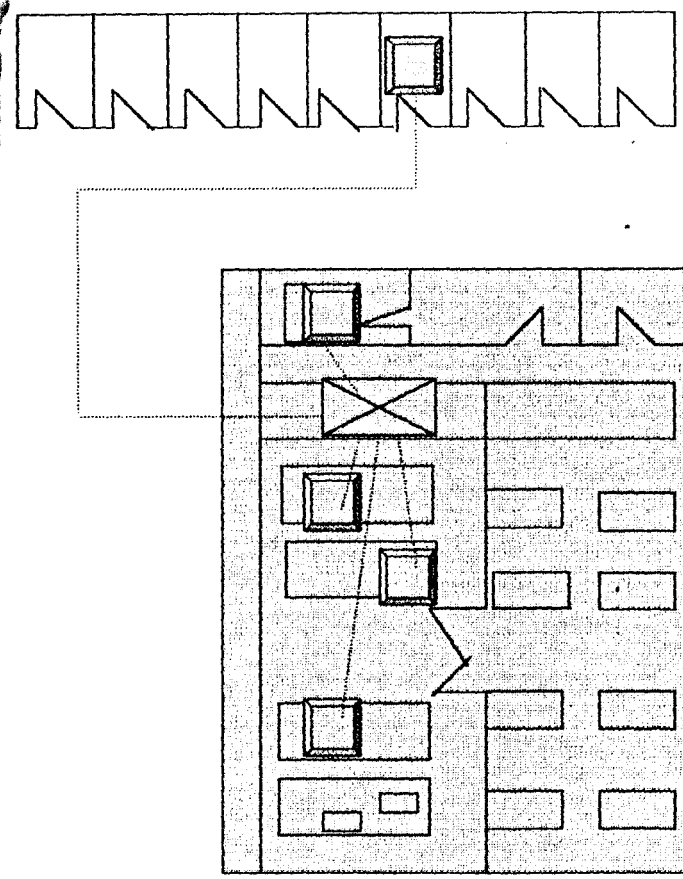
# APPENDIX 2

## CABLING LAYOUT.



| LENGEND | |
|---|---|
| SYMBOL | DESCRIPTION |
| | CABLES |
| | 9 PORT HUB |
| | SERVER |
| | WORKSTATIONS |
| | EXPECTED COMPUTERS |
| | EXISTING COMPUTERS |

**PROJECT TITLE:**
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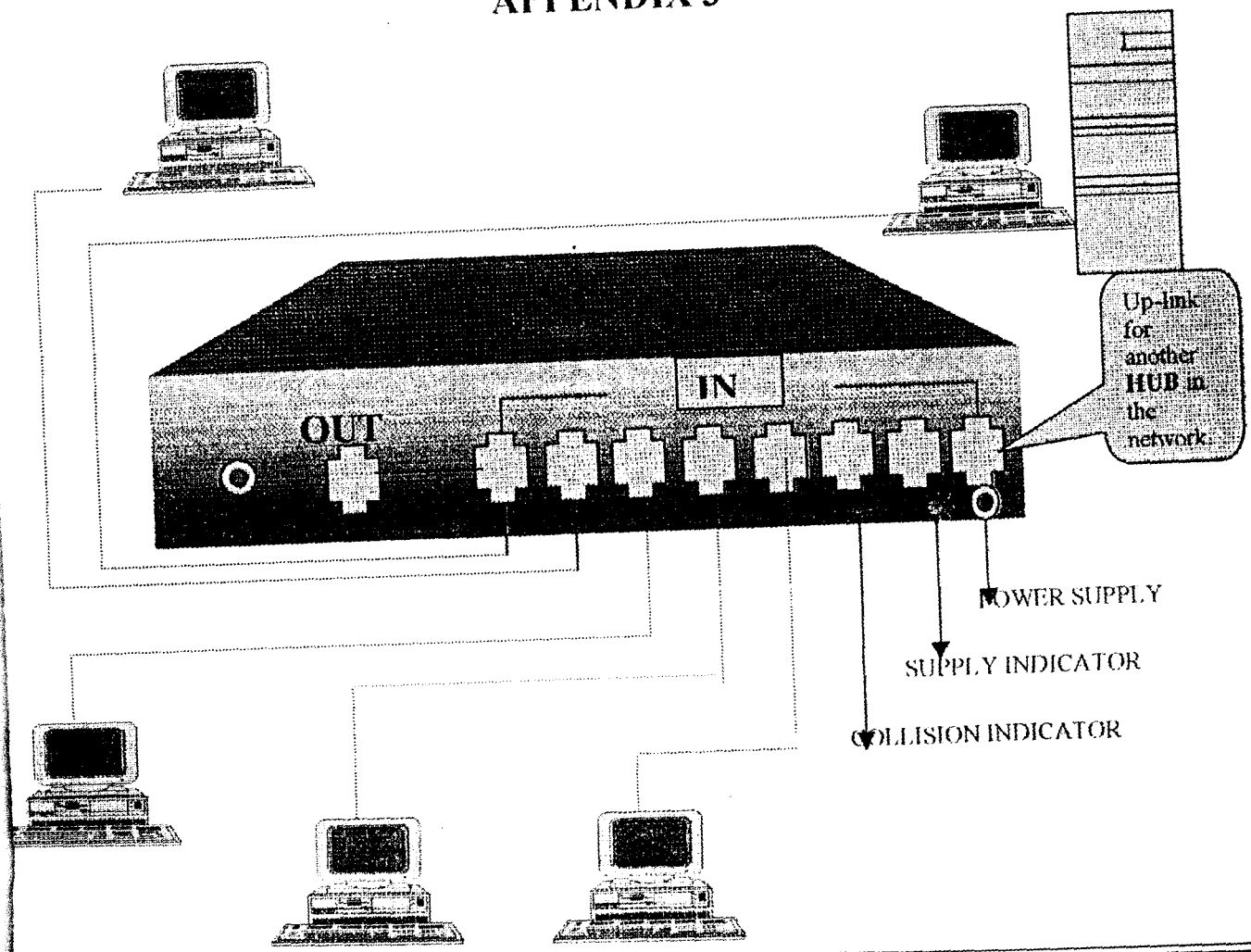
SUPERVISOR: MR. JONATHAN KOLO

COURSE CODE : EEE 515 / EEE 525.

DATE 7TH JANUARY 2002. | DRAWING NO: **2**

# APPENDIX 3

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COURSE CODE : EEE 515 / EEE 525.

DATE 7TH JANUARY 2002.

DRAWING NO: 3