COMPUTER COMMUNICATION

COMMUNICATIONS AND NETWORKS

What is data communication?

This refers to one computer transferring data, instructions and information to another computer or some other computers. The basic model for data communication consists of:

(a) **A sending device** that initiates an instruction to transmit data, instruction or information e.g computer A which sends signals to another computer B.

(b) **A communications device** that converts data, instructions or information from the sending device into signals that can be carried by a communications channel e.g Modem which converts digital signals into analog signals.

(c) **A communications channel** or a path over which signals are sent e.g a standard telephone line along which the analog signals are sent.

(d) **A communications device** that receives the signals from the communications channel and converts them into a form understood by the receiving device e.g Modem B, which converts the analog signals back into digital signals.

(e) **A receiving device** i.e computer B that accepts the signals from computer A.

(f) **Communications software** which consists of programs that manage transmission of data, instruction and information between computers.

Uses of data communications
- Voice mail
- Fax
- E-mail
- BBS
- Instant messaging
- Chart rooms
- Newsgroups
- Internet telephony
- Video conferencing

- Groupware
- Telecommunicating
- Global positioning system

COMMUNICATION DEVICES

These are devices that enable two or more computers to exchange items such as data, instructions and information with each other. The primary function of a communication device (e.g a modem) is to convert or format signals so that they become suitable for the communications channel or a receiving device.

Common types of communications devices are;

1. Dial-up modems
2. ISDN and DSL modems
3. Cable Modems
4. Network Interface cards
5. Multiplexer

1. **DIAL-UP MODEMS**. A modem is a communications device that converts between analog and digital signals. The word modem is derived from a combination of words Modulation and Demodulation
Modulation is to convert digital signals into analog signals
Demodulation is to convert analog signals into digital signals.
A modem connected to a sending computer converts the computers digital signals into analog signals (i.e modulation) which can travel over a communications channel e.g a telephone line.

Another modem at the receiving end converts the analog signals back into digital signals (i.e demodulation) that can be understood by the receiving computer.

A modem can be external or internal.

External Modem is a standalone device that attaches to a serial port on a computer with a cable to a telephone outlet with a standard telephone cord.

Internal Modem is an expansion card that can be inserted into an expansion slot on a computers motherboard; and the modem then attaches to a telephone outlet with a standard telephone cord.

Most personal computers modems transmit data between 28.8kbps and 56kbps

Most modems today are also **fax modems** because they send computer prepared documents as faxes and also receive faxes.

2. ISDN and DSL Modems

ISDN (Integrated Services Digital Network) is a set of standards for digital transmission of data over a standard telephone line. With ISDN, the same telephone line that could normally carry only one signal can now carry three or more signals at once using a technique called **Multiplexing.**

ISDN requires that both ends of the connection have an ISDN modem. ISDN lines also require a special ISDN telephone for voice communications.

Advantages of ISDN lines
- Provides faster transfer rates that dial-up Modems.
- Faster web page downloads and clearer video conferencing.
- Produce very clear voice conversations.

DSL (Digital Subscribe Lines) provides high speed connections to the internet ove r a regular copper telephone line. The user must have a special network card or DSL modem to connect to digital subscriber line. It is much easier to install and can provide much faster data transfer rates than ISDN.

ADSL (Asymmetric Digital Subscriber line) is a type of DSL that supports faster transfer rates when receiving data (i.e **downstream rate**) than when sending data (i.e **upstream**). ASDL is ideal for internet access because most users download more information from the internet than they upload.

3. CABLE MODEMS.

A cable modem sends and receives data over the cable television (CATV) network. Cable modems can transmit data at speeds (500kbps to 2mbps) much faster than dial-up modems or ISDN. It can also be integrated with a set-to-box to provide faster viewing of multi-media websites.

4. NETWORK INTERFACE CARDS

A network interface card (NIC) or LAN adapter is an expansion card that enable a computer or device to connect to a network. The Ethernet card is the most common type of network card. The transfer rate on Ethernet network can be 10mbps, 100mbps or 1,000mbps.

Fig: Network interface card.

DEVICES USED TO INTERCONNECT NETWORKS

5. MULIPLEXER. A Multiplexer is a communication device that combines two or more input signals from various devices into a single stream of data and then transmits over a single transmission medium.

N.B

Transmission Media consists of materials or techniques capable of carrying one or more signals. Transmission media can be physical or wireless.

(a) **Physical transmission** media use wire, cable and other physical materials to send communication signals.

(b) **Wireless transmission** media send communication signals through air or space using radio, microwave and infrared signals.

A multiplexer increases the efficiency of communications and reduces the need for and the cost of using separate transmission media. Both the sending end and receiving ends need a multiplexer for data transmission to occur. At the sending end, a multiplexer combines separate data transmission into a single data stream and then compress the data and sends it over a communications channel. At the receiving end , the multiplexer separates the single stream of data into its original parts.

6. **AHUB.** A hub is also called a concentrator or multi-station access unit. It is a device that provides a central point for cables in a network. It allows devices to be connected to a server.

7. **A REPATER**. This is a device that accepts a signal from a transmission medium, amplifies it and retransmits it over a medium. As signals travel over a long distance, it undergoes a reduction in strength, an occurrence called **Attenuation**.
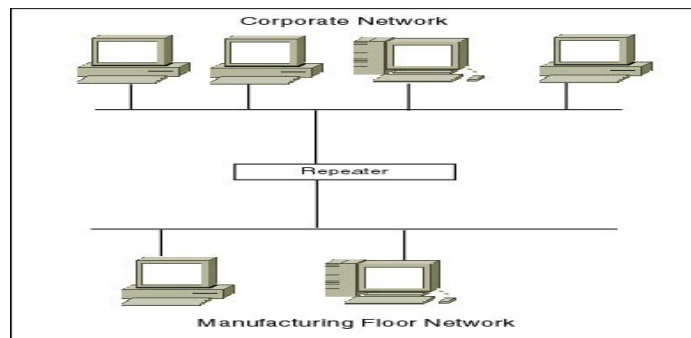
Repeaters are used in both copper wire cables carrying electrical signals and in fibre optics carrying light. Repeaters are also used extensively in broadcasting, where they are known as translators or booster.

8. BRIDGE. A bridge is a device that connects two LANS using the same protocol, such as the Ethernet. Bridges are uses to connect similar networks over a wide area communication links.

Fig: A bridge

Advantages of bridges

- They are self configuring.
- Primitive bridges are often inexpensive.
- LANs interconnected are separate and physical constraints such as number of stations, repeaters and segment length don't apply.

Disadvantages of bridges

- Bridges are more expensive than repeaters.
- Bridging of different MAC protocols introduces errors.
- Do not limit the scope of broadcasts.
- Because bridges do more than repeaters by viewing MAC address, the extra processing makes them slower than repeaters.

9. **GATEWAY.** A gateway is a combination of hardware and software that connects networks that use different protocols.

10**. ROUTER**. A router is an intelligent communication device that sends 9routes) communication traffic to the appropriate network using the fastest available path.

11. SWITCH. A switch is used to store address of every device down each cable connected to it. By delivering each message only to the connected device it was intended for, a network switch conserves network bandwidth and offers generally better performance than a hub. It is more intelligent.

COMMUNICATIONS PROTOCOL

A communications protocol is a set of rules and procedures for exchanging information among computers on a network. Protocols define how communications channel is established, how information is transmitted and how errors are detected and corrected.

Different kinds of computers can communicate with each other using the same protocol. Two widely used protocols for LANs are **Ethernet** and **Token ring**. The TCP/IP is a set of protocols widely used on the Internet.

Ethernet is a LAN protocol that allows personal computers to contend for access to the network. Ethernet was the first industry standard LAN protocol developed by Xerox in 1976.

Advantages of Ethernet
- It is relatively in expensive and easy to maintain and install. Some times it is more efficient and economical to use a bridge to connect two separate LANs instead of creating one large LAN that combines the two separate LANs.

COMMUNICATIONS CHANNELS

A Communications channel is the communications path between two devices. It is composed of one or more transmission media

The width of the communications channel is called **The Bandwidth**. The higher the bandwidth, the more data and information the channel can transmit.

For analog signals, bandwidth is expressed in hertz (Hz) or cycles per second. Foe digital signals, bandwidth is expressed in bits per second (bps)

FACTORS AFFECTING TRANSMISSION RATE OF A NETWORK

(a) **Transfer rate**. Is the speed of transmitting data and information. Transfer rates are usually expressed in bits per second (bps), kilobytes per second (kbps) or megabytes per second (mbps). The transfer rate of a transmission medium depends on the mediums bandwidth and its speed. The following contributes to the transfer rate of a network.

(i) **Network topology**. Since data travels in both direction in a bus network, if data collides, then it as to be sent again, and slow the network down. On the other hand, start networks have fewer collisions and usually run faster

(ii) **Capacity of hardware**. Hubs, switches and network interface cards have their own maximum speeds.

(iii) **The server**. Amount of Ram and the speed of the hard disk.

(iv) **Location of software and files**. Storing software on the workstation hard disks reduce network traffic and speed up performance.

Transfer rates of various connection lines to the Internet

Types of lines	Transfer rates
Dial up	Up to 56kbps
ISDN	Up to 128kbps
ADSL	128kbps to 9mbps
Cable TV	
T1	1.544mbps
T3	44mbps
ATM	155mbps to 622mbps

(a) **A dial up Line**. This is a temporary connection that uses one or more analog telephone lines for communication. Using a dial-up line to transmit data is similar to using the telephone to make a call.

Advantages of dial-up lines
- It cost no more than making a regular telephone call.
- Computers at any two locations can establish a connection using modems and the telephone network.

Disadvantages
- The user cannot control the quality of the connection because switching the telephone company's switching office randomly selects the line for connection.

(b) **ISDN (Integrated services Digital Network)** is a set of standards for digital transmission of data over standard copper telephone lines. It requires both ends of the connection to have an ISDN Modem.

(c) **DSL (Digital subscriber lines)** provides high speed connections to the internet over a regular copper telephone line

(d) **ADSL (Asymmetric Digital Subscriber line)** is a type of DSL that supports faster transfer rates when receiving data (i.e down stream rate) than when sending data (i.e upstream rate)

(e) **Cable TV** network also provides high speed internet connections fro users equipped with cable modem.

(f) **A T-carrierline** is a digital line that carries multiple signals over a single communication line using the multiplexing technique. T1 line can carry 24 separate signals at a transfer rate of 64kbps each for a transmission rate of 24mbps. A t3 can carry 672 individual signals at a transmission rate of 43mbps. **The internet backbone also use T-3 lines**

Advantages

- T-carrier lines provide very fast transfer rates.

Disadvantages

- T-carrier lines are so expensive that only medium to large companies can afford the investment.

(g) **ATM (Asynchronous Transfer mode)**. This is a dedicated connection switching technology that organizes digital data into 53 bytes cell units and transmits them over a physical medium using digital signal technology.

TRANSFER RATE

This is the speed of transmitting data and information usually expressed in bits per second (bps) and kilobytes per second (kbps) or megabits per second (mbps)

Transfer rates of various communications media.

Type of transmission media		Transfer rate
Twisted Pair cable	10 Base-T (Ethernet)	10mbps
	100 Base-T (Fast Ethernet)	100mbps
	1000 Base-T (Gigabit Ethernet)	1000mbps
	Token ring	4-16mbps
Coaxial Cable	10 Base 2 (Thin wire Ethernet)	10mbps
	10 Base 5 (Thick wire Ethernet)	10mbps
Fibre optic	10 Base F (Ethernet)	10mbps
	10 Base Fx (Fast Ethernet)	100mbps

cable	FDDI(Fibre Distributed Data Interface)	100mbps
Broadcast radio		Up to 2mbps
Micro wave		45 mbps
Communication satellites		50mbps
Cellular radio		9,600bps to 14.4kbps
Infrared		1-4mbps

1. TWISTED PAIR CABLE. This consists of one or more twisted wires bundled together. Each twisted pair wire consists of two separate insulated copper wires of diameter o.4 – 0.8mm that are twisted together (to reduce noise). They are of two types.

Fig: A twisted pair cable

  (i)Shielded twisted pair (STP) has a metal wrapper around each twisted pair wire to further reduce noise. STP cables are used in environment susceptible to noise, such as local area network.

(ii) Unshielded twisted pair (UTP) cable doesn't have this metal wrapper for shielding noise. UTP cables are commonly used in telephone networks and data communication between computers because it is inexpensive and easy to install.

Advantages of twisted pair cable
- Data cannot be easily distorted due to reduced noise interface.
- Twisted pair wire is inexpensive.
- Easy to install.
- Used in transmission of data and voice

Disadvantages
- Susceptible to noise.
- Slows data transmission between devices.
- Limited to short distances.

2. COAXIAL CABLE. A coaxial is a high quality communication line that consists of a single copper wire conductor surrounded by atleast three layers;

- A non conducting insulating material
- A woven or braided metal outer conductor
- Plastic outer coating

Fig: Coaxial cables

It is insulated more heavily than twisted-pair. It is not susceptible to electrical interferences and transmits data faster over longer distances. Cable TV wiring often uses coaxial cable because it can be cabled over long distances than twisted-pair cable.

Advantages of coaxial cables

- Can be cabled over long distances.
- Less susceptible to electric interference.
- Can transmit much more data at a time

Disadvantages

- More expensive than a twisted pair cable.
- Not easy to install
- Need boosters to transmit data.
- They are bulky

3. FIBRE OPTIC CABLE. This consists of dozens of hundreds of smooth thin strands of glass or plastic that use light to transmit signals. Each strand called an optical fibre is as thin as human hair. An insulating glass cladding and a protective coating surround each optic fibre. Each optic fibre can carry several hundred thousand-voice communications simultaneously. Fibre optic cables are used by many local and long distance telephone companies, cable Tv and in high traffic networks or as the main cable in the network.

Figure: Fibre optic cable

Advantages of fibre optic cable
- Carry significantly more signals than wireless cables.
- Less susceptible to noise
- Better security for signals during transmission
- Smaller size and much thinner and lighter than wire cables.

Disadvantages
- Cost more than wire cables
- Difficult to install and modify.
- More fragile than other wire based communication channels.

4. COMMUNICATION SATELITES. These receive microwave signals from earth based communications facilities, amplify the signals and retransmit the signals back to the communications facilities. The earth based stations use large dish shaped antennas to transmit and receive data from satellites. The transmission to the satellites is called **uplink** and the transmission from the satellite is called a **down link**.

Communication satellites are usually placed about 22,300 miles above the earth's equator and moves at the same rate as the earth.

Applications of communication satellite

- Television.
- Radio broadcast.
- Video conferencing.
- Paging and global positioning systems.

Advantages of Communications satellites

- Lots of data can be sent simultaneously
- Allow high quality broadband communication across continents.
- Covers a large geographical area for data transmission.
-

Disadvantages of communication satellite

- The fee to launch a satellite is extremely expensive.
- The infrastructure needed to access satellite communications is also expensive.

5. MICROWAVES. These are radio waves that provide a high-speed transmission of both voice communications and data signals. Microwaves transmission involves sending signals from one earth based microwave station called **a terrestrial** microwave to another. It is fast (up to 4,500 times faster than a dial-up modem) but it limited to line of sight transmission, which means that the micro wave must transmit a straight line with no obstructions such as buildings between microwave antennas. To avoid obstructions, microwaves stations are often located on tops of buildings, towers or mountains to avoid possible obstructions.

Advantages of microwaves

- Provides high-speed communication transmission.
- No need to install cable.
- Lower installation and maintenance costs.
-

Disadvantages of microwaves

- Limited to line-of-sight transmission
- May be affected by temporary atmospheric disturbances

N.B

(a) **BASEBAND TRANSMISSION**. This transmits only one signal at a time.

(b) **BROADBAND TRANSMISSION**. This can transmit multiple signals simultaneously. They transmit signals at a much faster speed. Two widespread applications of broadband transmission are;

- Digital subscriber lines
- Cable television networks.

(c) **SIMPLEX TRANSMISSION**. In simplex transmission, data flow in one direction from the sending device to the receiving device. It is used only when the sending device does not require a response from the receiving device. Examples include:

- Security systems
- Fire alarms
- Temperature sensors that contain a sensor
- Printing systems, pagers.

(d) **HALF DUPLEX TRANSMISSION**. In half duplex transmission, data can flow in either direction, from the sending device to the receiving device and back but only in one direction at a time. Examples include:

- Fax machines
- Radio calls
- Credit card verification systems.
- Automatic teller machines

(e) **FULL DUPLEX TRANSMISSION.** In full duplex transmission, data can flow in both directions at the same time. A regular telephone line supports full duplex transmission so that both parties can talk at the same time. It is used for most interactive computer applications and for computer-to-computer data transmission i.e a regular telephone line.

A NET WORK

A network is a collection computers and devices connected together via communication devices and media. Communication devices enable two or more computers to exchange items such as data, instructions and information with each other.

The primary function of a communication device (e.g a modem) is to convert signals so that they become suitable for the communications channel or a receiving device.

A network can relatively small or extensively large.

A LOCAL AREA NETWORK (LAN)

This is a network that connects computers in a limited geographical area such as a school computer laboratory, an office or a group of closely positioned buildings.

Each computer or a device on the network is called a node. The nodes are connected to the LAN via cables.

A wireless LAN is a local area network that uses no physical wires but wireless media such as radio waves.

A network operating system is the system software that organizes and coordinates the activities of a LAN.

KINDS OF A LAN
Two kinds of LAN are peer to peer and client/server network.

(a) PEER-TO-PEER NETWORK
- Each computer on a peer-to-peer network can share hardware, data or information located on any other computer on the network.
- Each computers stores files on its own storage devices.
- Each computer on the network contains both the network operating system and application software.
- A peer-to-peer network is a simple, inexpensive network that generally connects less than 10 computers together.
- Ideal for home and small business.
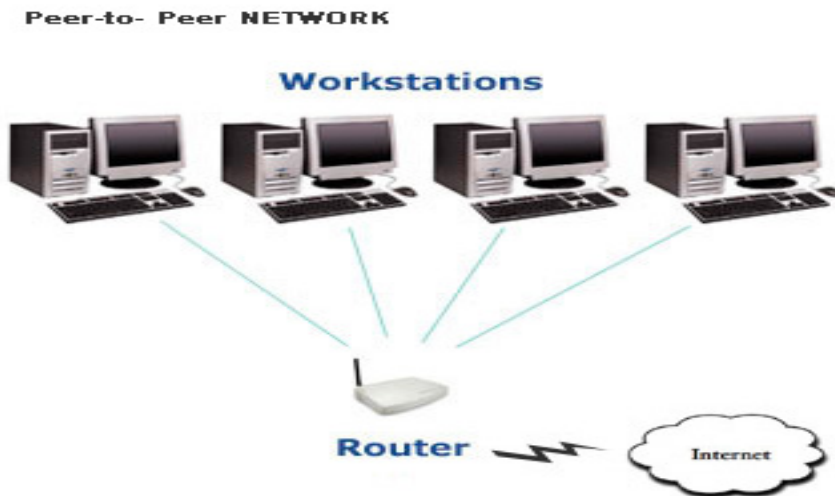
Fig: Illustration of a peer-to-peer network

Advantages of peer-to-peer network

- Less expensive to implement.
- Does not require additional specialized network administration software.
- Does not require a dedicated network administrator.
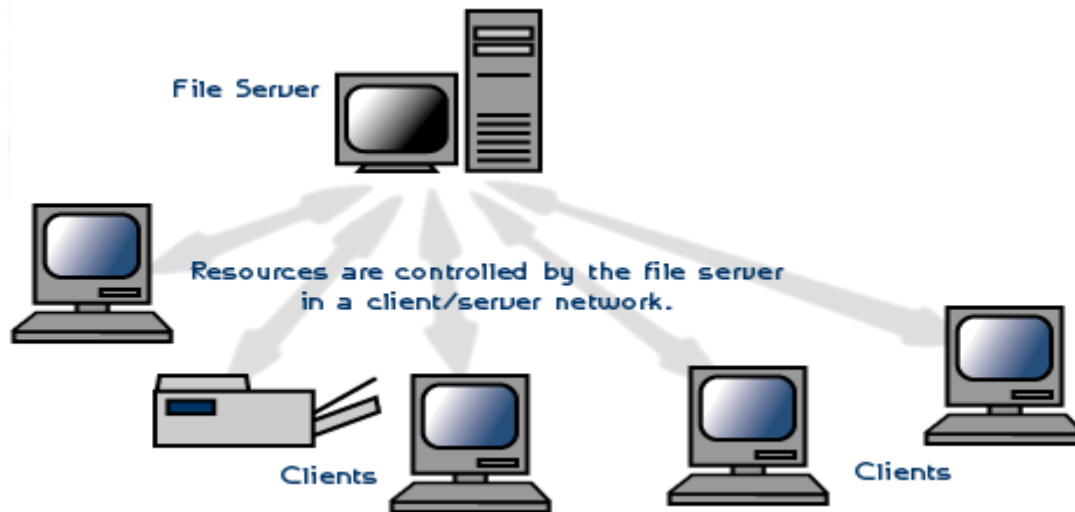
Disadvantages

- Does not scale well to large networks and administration becomes unmanageable.
- Each user must be trained to perform administrative tasks.
- Less secure.
- All machines sharing resources negatively impact the performance.

(b) CLIENT/SERVER NETWORK

A client/server network has one or more computers acting as a server while the other computers (i.e clients) on the network can request services from the server.

A client/server network typically provides an efficient means to connect 10 or more computers together.

Most client/server networks have a network administrator who is in charge of the network.

Fig: Illustration of Client server network

Advantages of client/server network

- Provides for better security.
- Easier to administer when the network is large because administration is centralized.
- All data can be backed up on one central location.

Disadvantages

- Requires expensive specialized network administrative and operational software.
- Requires expensive, more powerful hardware fro the server machine.
- Requires a professional administrator.
- Has a single point of failure, User data is un available if the server is down.

A WIDE AREA NETWORK (WAN)

This is a network that covers a large geographical area such as one that connects the district offices of an enterprise across the country or across several countries in the world.

WANS are designed to:

- Operate over a large geographical area
- Allow access over a serial interfaces operating at a slow speed.
- Provide full time and part-time connectivity.
- Connect devices separated over wide, even global areas.
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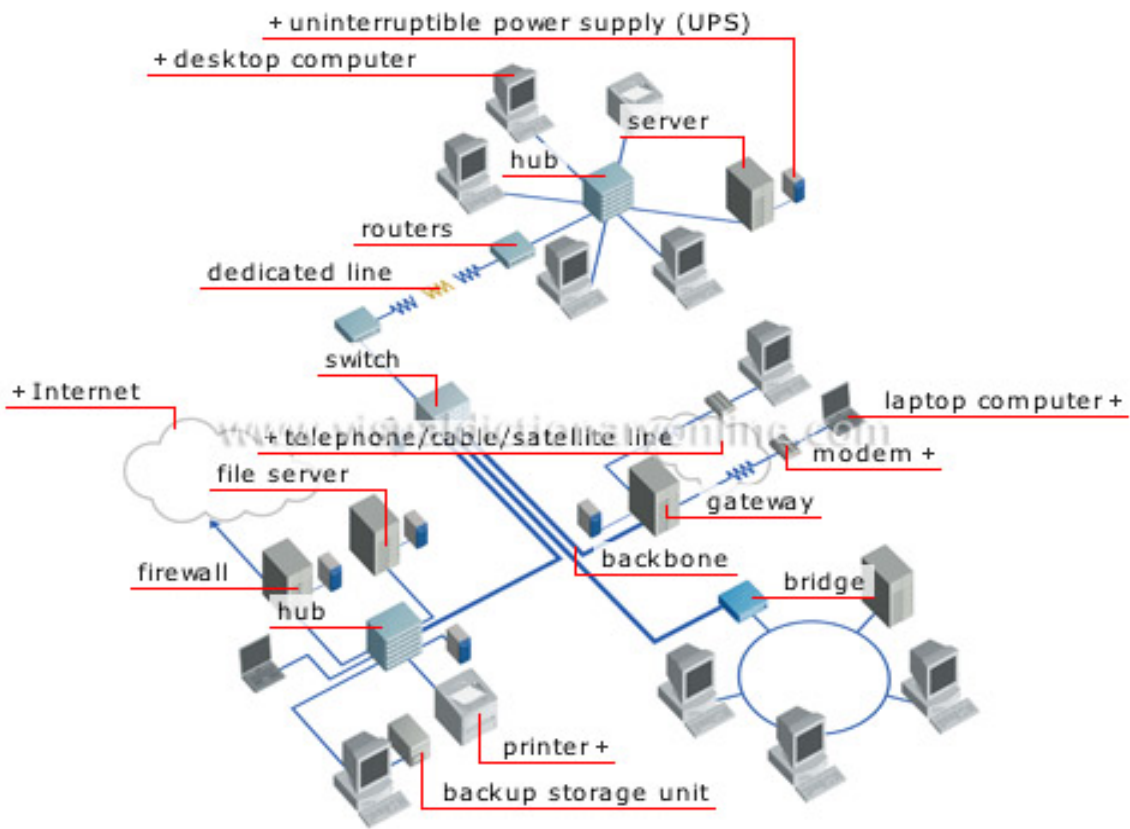
Computers are often connected to a WAN via public networks such as the telephone system or by dedicated lines or satellites. A WAN can be made up of two or more LANs connected together. The **INTERNET** is the worlds' largest WAN.

ADVANATAGES OF USING A NETWORK

(a) Facilitates communication because people can communicate efficiently and easily via e-mail, instant messaging, chat rooms, telephony and video conferencing.
(b) Reduce costs by sharing hardware (e.g a printer) and software (e.g using a network version or site license of a program).
(c) Sharing data and information stored on other computers on the network.
(d) Allow tight control over who has access to what data.

DISADAVANTAGES OF USING A NETWORK

(a) The hardware, software and expertise required to set up a network can be expensive.
(b) Networks are vulnerable security problems.

(c) If the server fails to work, the complete network may also fail to work.

COMPONENTS OF A LAN

Local area networks are made up of several standard components.

(a) **Connecting or cabling system**. LANs do not use a telephone network, instead they use some other cabling or connection system either wired or wireless. Wired connection may be twisted pair wiring, coaxial or fibre optic cable. Wired connection may be infrared or radio wave transmission. Wireless network are especially useful if computers are portable and moved often. However, they are subject to interference.

(b) **Microcomputers with interface cards**. Two or more computers are required along with network interface cards. A network card which is inserted into expansion slot in a micro-computer enable the computer to send and receive messages on the LAN. Now days, newer computers come with network cards already embedded in the motherboard.

(c) **Network operating systems**. The network operating system software manages the activity of the network. Depending on the type of a network, the operating system may be stored on a file server or on each microcomputer on the network. Examples of network operating systems include:
   - Novell's Netware
   - Windows NT etc.

(d) **Other shared devices**. Printers fax machine, scanners, storage devices and peripherals may be added to the network as necessary and shared by all users.

(e) **Bridges and gateways**. A LAN many stand-alone but it may also connect to other networks either similar or different in technology. Hardware and software devices are used as interfaces to make these connections.

**A Bridge** is an interface that enables similar networks to communicate.

A gateway is an interface that enables dissimilar networks to communicate such as a LAN with a WAN.

NETWORK TOPOLOGY

A network topology is the configuration or physical arrangement of the devices in a communications network. The commonly used network topologies are;

- Bus
- Ring
- Star

(a) **BUS TOPOLOGY**. This is a network that consists of a single central cable that connects all computers and devices together.   The physical cable that connects the computers and other devices is known as the **bus** or the backbone. Data, instructions and information in a bus can be transmitted in both directions.
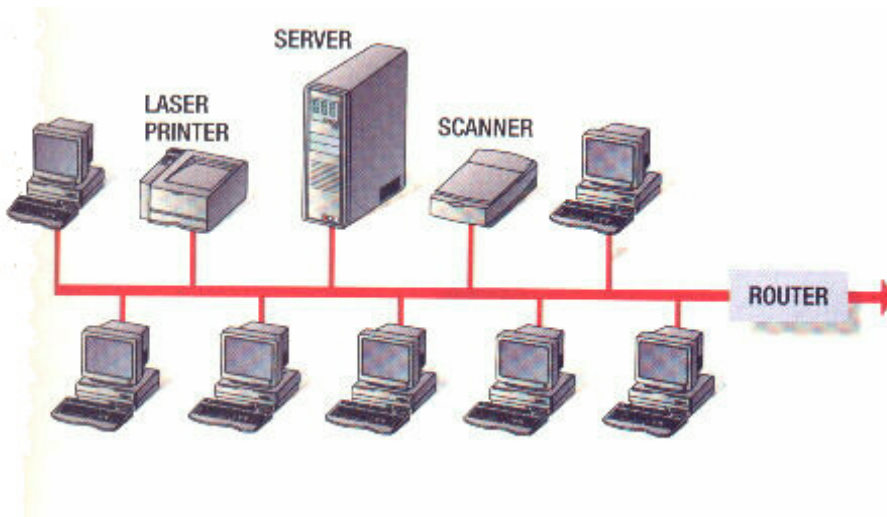
**Fig: Illustration of a bus topology**

Advantages of a bus network
- Inexpensive and easy to install.
- Computers and devices can be attached and detached any point on the bus without disturbing the rest of the network.
- Failure one device usually does not affect the rest of the bus network.
- Requires less cable length.

Disadvantages

- If the bus fails to work itself, the complete network remains inoperative.
- If many computers are attached, the amount of data flowing along the cable increases, data collision occur and the network slows down

(b) **RING TOPOLOGY**. This consists of a cable forming a closed ring or loop, with all the computers and devices in a network.
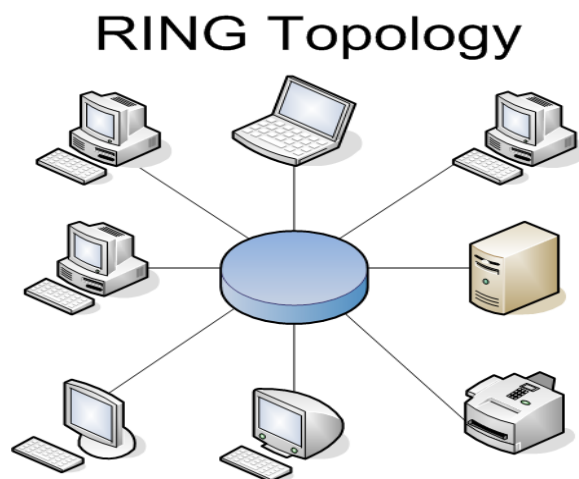
Data transmitted on a ring network travels from device to device around the entire ring in one direction only. If a device on a ring network fails, all devices before the failed device are unaffected but those after the failed device cannot function.

Advantages of ring topology

- Can span a larger distance than a bus.
- No collision occur (one direction only) so that the speed of data is high.

Disadvantages of ring topology

- If the cable fails, the whole network goes down.
- More difficult to install and troubleshoot the ring.
- Because all stations are wired together, to add a station, you must shut down the network temporarily.

(c) **STAR TOPOLOGY**. Star networks are one of the most common computer networks. In this all computers and devices connect to a central computer thus forming a star. The central computer that provides a connection point for devices in the network is called the **HUB** or **Switch**.
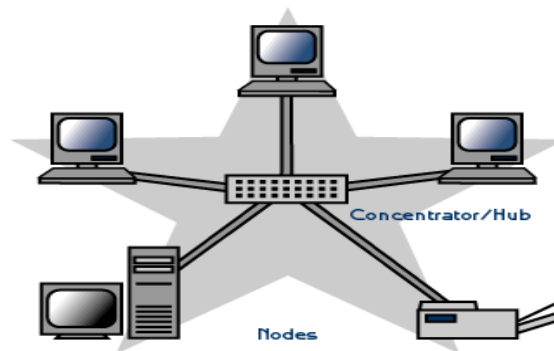
Advantages of a Star network

- Easy to install and maintain.
- Computers and devices can be added to or removed from the network with little or no disruption to the network.
- It is reliable because each device connects directly to the hub. If one device fails, only that device is affected
- Good performance. Data packets are sent quickly as they do not have to travel through any unnecessary nodes.

Disadvantages of a star network

- If a hub fails, the entire network is inoperable.
- Lots of cable required so the installation cost is expensive.
- If the central computer fails, the entire network fails.

Networks can use a combination of these topologies. Hybrid networks are a combination of star, ring and bus networks. They include:

- Extended star topology
- Hierarchical Topology
- Mesh topology

For example a small college campus might use a bus network to connect buildings and star and ring network with in certain buildings.

N.B

FDDI (Fibre Distributed data Interface) is a newer and higher speed network capable of transmitting 100megabits per second. A FDDI network uses fibre optic cable with an adaptation or ring topology. The FDDI network is being used for such high speed-tech purpose as electronic imaging, high-resolution graphics and digital video.

Considerations When Choosing a Topology:

- **Money**. A linear bus network may be the least expensive way to install a network; you do not have to purchase concentrators.
- **Length of cable needed**. The linear bus network uses shorter lengths of cable.
- **Future growth**. With a star topology, expanding a network is easily done by adding another concentrator.
- **Cable type**. The most common cable in schools is unshielded twisted pair, which is most often used with star topologies.

FACTORS AFFECTING DATA TRANSMISSION

(a) Transmission rate; **higher frequency, wider bandwidth, more data.**
Higher frequency, wider bandwidth, more data. The amount of data that can be transmitted on a channel depends on the wave frequency-cycle of waves per second. Frequency is expressed in hertz. As mentioned earlier, bandwidth is the difference between highest and lowest frequencies. Data may be sent not just on one frequency but on several frequencies within a particular bandwidth. The more frequencies it has , the more data that can be send through that channel.

(b) Line configuration: **Point to point and multipoint.**
There are two ways of connecting communication lines;
Point to point directly connects the sending and receiving devices such as a terminal with a central computer. This arrangement is appropriate for private line whose sole purpose is to keep data secure while transmitting it from one device to another.

A multipoint line is a single line that interconnects several communication devices to one computer. Often a multipoint line, only one communication device, such as a terminal, can transmit at any given time.

(c) **Serial and parallel transmission**. Data is transmitted in two ways; serially and in parallel.

In serial data transmission, bits are transmitted sequentially, one after another. Serial transmission in the way most data flows over a twisted-pair telephone line. It is found in communication lines, Modems and mice.

In parallel data transmission, bits are transmitted through separate lines simultaneously. The arrangement resembles cars moving in separate lanes at the same speed on a multilane freeway. Parallel lines move faster than serial lines do e.g to transmit data from a computer's CPU to a printer.

(d) **Direction of transmission flows; Simplex, half duplex and full duplex**

In simplex, data can travel in only one direction e.g traditional TV antenna. There is no return signal.

In half duplex, data travels in both directions but only in one direction at a time. It is seen with police and marine radios in which both parties must take turns talking. It is also a common transmission method with computers.

In full duplex, data is transmitted back and forth at the same time. An example is two people on a telephone talking and listening simultaneously. Full duplex is used frequently between computers in communication system.

(e) Transmission mode; asynchronous versus synchronous

(f) Packet switching: getting more data on the network.

A packet is fixed-length block of data for transmission. The packet also contains instructions about destination of the packet. Packet switching is a technique for dividing electronic messages into packets for transmission over a network to their destination through the most expedient route. The benefit of packet switching is that it can handle high volume of traffic in a network. It also allows more users to share a network.

(g) Protocols; the rules of data communication

A protocol or a communication protocol is a set of conventions governing the exchange of data between hardware and or software components in a communications network. The protocol in your communications software will specify how receiving devices will acknowledge sending devices a matter called **handshaking.** Protocols will also specify the type of electrical connections used, the timing of message exchange, error-detection technique and so on.

COMMUNICATIONS PROTOCOL

A Communications protocol is a set of rules and procedures for exchanging information among computers on a network.

Protocols define how the communication channel is established, how information is transmitted and how errors are detected and corrected. The width of the communications channel is called **Bandwidth**. The higher the bandwidth, the more data and information the channel can transmit.

Different kinds of computers can communicate with each other using the same protocol.

N.B: Without protocols, communication wouldn't have been possible

PROTOCOLS USED IN COMMUNICATION

(a) **TCP (Transmission control Protocol).** TCP manages the transmission of data by breaking it into packets. It then provides routing information for sending the packets along the fastest available path to the recipient's computer and then reassembles the data at the receiving end.

(b) **Ethernet**. Ethernet is a LAN that allows computers to contend for access to the network. It uses a coaxial cable that carries radio frequency signals between computers at a rate of 10megabytes per second.

(c) **Token ring**. Token ring is a computer LAN arbitration scheme in which conflicts inn transmission of messages are avoided by granting of tokens, which give permission to send data to other computers.

(d) **IP (Internet Protocol).** Internet protocol is a method by which data is transmitted from one computer to another over the internet. It employs the use of a four part numerical address which every computer has to send information e.g. 326.478.570.888

(e) **HTTP (Hyper Text Transfer Protocol).** HTTP is used for information exchange on the World Wide Web (WWW). It defines how messages are requested, formatted and transmitted over the Internet and what actions an HTTP server (browser) should take response on various messages.

(f) **FTP (File transfer protocol).** File transfer protocol is a communication protocol that sends data and files and folders over the Internet.

(g) **TELNET**. Telnet provides a fairly general bi-directional 8 bit oriented communication facility. Its primary goal is to allow a standard method of interfacing terminal devices to each other.

(h) **IPX (Inter-network Packet Exchange).** IPX is a networking protocol that interconnects networks that use Novell's network clients and servers.

(i) **SPX (Sequenced Packet Exchange).** SPX is the protocol for handling packet sequencing in Novell Netware network. It prepares the sequence of packets that the message is divided into and manages the reassembling or received packets.

(j) ATM (Asynchronous Transfer Mode). ATM is a dedicated connection switching technology that organizes digital data into 53 bytes cell units and transmits them over a physical medium using digital signal technology.

NETWORK OPERATING SYSTEMS

A Network operating system is the system software that organizes and coordinates the activities on a local area network.

Tasks performed by a Network Operating system

- Administration of system users.

- System maintenance tasks such as back up.

- File management tasks.

- Prioritizing print jobs on the network.

- Monitoring security on network resources.

Operating systems that supports the Network

Operating system	Requires separate OS	Network type
IBM OS/2 Wrap	-	Client/server
Linux	-	Client/server
Microsoft Windows NT, 98,ME	-	Peer-to-peer / Client/server
Novell Netware	Dos	Client/server
Sparta Com LAN Tastic	Any Pc OS	Peer-to-peer
Sun Solaris	-	Client/server
Unix	-	Client/server

COMMUNICATIONS SOFTWARE

This consists of programs that help to establish a connection to another computer or network, and manage the transmission of data, instruction and information between computers and other devices. Communication software usually includes one or more of the following features.

(a) **Dialing feature** that allows a user to store, review, select and dial telephone numbers to connect to another computer.

(b) **File transfer feature** that allows a user to store, review, select and dial telephone numbers to connect to another computer.

(c) **Terminal emulation feature** that allows a personal computer to act as a specific type of terminal so that the user can connect to and access data and resources on a mini computer or mainframe.

(d) **Internet access feature** that allows a user to use the computer to connect to the internet to send e-mail, participate in chat rooms, visit World Wide Web sites and so on.

Software related to communications include:

- E-mail
- Web browser
- Chat room software
- News recorder
- Instant messenger
- Groupware
- Video conferencing software

(a) **E-mail** or electronic mail is the transmission of messages via a computer network such as a local area network or the Internet. The message can be simple text or can include an attachment such as a word processing document, a graphical image, an audio clip or a video clip. **E-mail software** creates, sends, receives, forwards, stores, prints and deletes e-mail addresses.

(b) **Web browser** allows users to access and view web pages on the Internet. Most web browsers allow the use of other internet services such as e-mail and chat rooms. Two popular web browsers are Microsoft Internet explorer and Netscape navigator.

(c) **A chat room** is a location on an internet server that permits users to chat with each other by typing lines of text on the computer. Some chat rooms support video and video chats.

(d) **A newsgroup** also called a discussion is an on line area where users conduct written discussions about a particular subject. To participate in a discussion, a user sends a message to the newsgroups and other users in the newsgroup read and reply the message. **A news reader program** is required to participate in a newsgroup, and most web browsers include a newsreader.

(e) **Instant messaging** is a real time communication service that notifies a user when one or more people are on line and then allows the user to exchange messages of files with them.

(f) **Groupware** is a software application that helps groups of people work together and share information over a network.

(g) **A Videoconference** is a meeting between two or more geographically separated people who use a network or the Internet to transmit audio and video data. A videoconference conducted over the Internet using web browsers and web servers to deliver the service is called a **Web Conference**.

THE TELEPHONE NETWORK

The public switched telephone network (PSTN) is the worldwide telephone system that handles voice-oriented telephone calls. The telephone network is originally built to handle voice communications. However, it is also an integral part of the computer communication today.

Data, instructions and information can be sent over the telephone network using dial-up lines or dedicated lines.

A dial-up line is a temporary connection that uses one or more analog telephone lines for communications. Using a dial-up line to transmit data is similar to using a telephone to make a call.

Advantages of a dial-up line

- It costs no more than making a regular telephone call.
- Computers at any two locations can establish a connection using modems and the telephone network.

Disadvantages

- The user cannot control the quality of the connection because the telephone company's switching office randomly selects the line for connection.

A dedicated line is a permanent connection between two communication devices.

Advantages

- The quality and consistency of the connection is better than a dial-up line because dedicated lines provide a constant connection.

A leased line is dedicated line leased from a telephone or communications service company.

Popular types of dedicated lines are;

- ISDN lines
- Digital Subscriber Lines
- Cable TV lines
- T-carrier lines
- ATM

Advantages of a telephone

- Immediate contact is available.

- Tone of voice helps communications

Disadvantages of a telephone

- It may take a long time to get someone on the phone.

- A call is successful only when the person to contact is present.

- Time zone problems between different countries.

USES OF DATA COMMUNICATION

Uses of data communication include;

1. VOICE MAIL. Voice mail functions like answering machine and allows a caller to leave a voice message, which is stored in a voice mailbox for the called party. A called party can listen to the message, add comments to the message and reply or forward a message to another voice mailbox in the mail system.

2. FAX. A facsimile (fax) machine is a device that transmits and receives documents over telephone lines. Documents sent or received with a fax machine are known as **Faxes**. Fax capability can also be added to the computer using a fax modem.

3. E-MAIL. E-mail or electronic mail is the transmission of messages via a computer network such as a local area network or the Internet. E-mail software creates, sends, receives, forwards, stores, prints and deletes e-mail

Popular E-mail software
- Microsoft outlook express
- Endora

An e-mail address. This is a combination of a user name and a domain name that identifies one specific user who sends or receives e-mail.

A user name or User ID. Is a unique combination of characters that identifies one specific user e.g for the e-mail address katumbarich@yahoo.com katumbarich is a user name, and yahoo.com is the domain name.

Most e-mail programs allow users to create an address book which contains a list of names and e-mail addresses. Most ISP's provide their users with mail box which stores their e-mails on a special server called a mail server.

When an e-mail arrives at the recipient's mail server, the e-mail transfer to a POP or POP3 server until the recipient retrieves it with his or her e-mail software.

A domain name: (e.g www.nkpublishinghouse.com) is the text version of an IP address e.g (**216.200.47.93**). The components of a domain name are also separated by periods.

Every domain name contains a top level domain (TLD) abbreviation that identifies the type of organization that is associated with the domain.

TLD Abbreviations	Type of Domain
Com	Commercial organizations, business and companies
Org	Non-profit organization
Net	Network providers
Edu	Educational institutions
Gov	Government agencies
Mil	Military organisations

The **Internet Corporation for assigned names and Numbers** (ICANN) is responsible for assigning and controlling TLDs

For international websites outside the United States, the domain name also includes the country code.

Country code	Country name
Hk	Hong Kong
Cn	China
Tw	Taiwan
Uk	United Kingdom
Au	Australia
Jp	Japan
Ug	Uganda
Ke	Kenya

The **Domain name system (DNS)** is the system on the internet that stores the domain names and their corresponding IP addresses.

The DNS server translates the domain name into its associated IP address, so that data can route to the correct computer.

TERMS IN RELATION TO E-MAIL

(a) **Subject**:   The name of the e-mail message.
(b) **To**:   carries the address of the recipient.
(c) **cc**:   Enables copies of the E-mail message to be sent to the third party while acknowledging other recipients.
(d) **Bcc:**   Enables copies of the e-mail message to be sent to the third party without acknowledging any other recipients (if present)

ADVANTAGES OF E-MAIL OVER ORDINARY MAIL

E-mail has many advantages over both ordinary mail and the telephone for example;
(a)   A message can be sent anywhere in the world at the price of a call without having to leave your desk.

(b) Speed of delivery. The message will arrive in few minutes and can be picked up the next time recipient looks at their e-mail.

(c) Ability to send multiple recipients. The message can be sent simultaneously to a group of people.

(d) It is easy to send a reply to an e-mail as soon as it is received using a 'reply' button.

(e) Large files such as spread sheets and graphics can be sent as attachments.

(f) An e-mail address is universal and ordinary mail, one has to change addresses wherever he or she is located.

(g) Assurance of whether the mail has been sent.

(h) No use of stamps.

(i) Convenient when retrieving and delivering.

3. BBS. A bulletin board system (BBS) is a computer that maintains a centralized collection of electronic messages. The use of a BBS is declining because the Internet can be used to access many of the same services.

4. GroupWare. This is a software application that helps groups of people work together and share information over a network. Groupware enables members of the workgroup to communicate, manage projects, schedule meetings and make group discussions.

5. Telecommunicating. Telecommunicating is a work arrangement so that employees may work away from the standard workplace of a company, but communicate with the office using some kinds of communication technology.

Advantages of telecommunicating

- Reduces the time and expenses fro traveling to and from work.
- Allow a flexible work schedule for employees.
- Provide a convenient, comfortable work environment for disables employees or those recovering from injuries or illness.
- Reduces air pollution caused by vehicles driven to and from work.
- Employees reduce costs due to less office space and furniture is required.

Disadvantages

- Reduces human face-to-face interaction among working staff.
- Data security may be jeopardized.
- Work has to stop if any component of the communications system fails to work.
- Leisure time at home may be replaced by work.

6. Global Positioning system. A Global positioning system (GPS) consists of one or more earth-based receivers that accept and analyse signals sent by satellites in order to determine the receiver's geographical location.

Uses of GPS

- To locate a person or an object.
- Ascertain the best route between two points.
- Monitor the movement of a person or object.
- Create a map.

Many cars and ships also use GPS to provide directions to a destination and weather information.

INTERNET

The internet is a worldwide collection of networks linked together. The internet is a largest wide area network in the world.

The internet has its roots in networking project called the **ARPANE**T that became functional in 1969 started by the **Pentagon's Advanced Research Agency** (ARPA)

The goal of the project was to build a network that;

1. Allowed scientists at different locations to share information and work together on military and scientific projects and
2. Could function even if part of the network were disabled or destroyed by a disaster such as a nuclear attack.

The ARPANET became functional in September 1969, linking Scientific and academic researcher in the United States.

In 1986, the National Science Foundation (NSF) connected its huge network of five supercomputer centers called NSFnet to the ARPANET and this configuration of complex networks and hosts became known as the Internet.

The NSFnet served as the major backbone on the internet until 1995 and then returned its status to a research network.

Today a variety of corporations provide networks to handle the internet traffic. These networks along with telephone companies, cable and satellite companies and the governments, all contribute towards the internal structure of internet.

The internet remains a public cooperative and independent network. However, the **World Wide Web Consortium (W3C)** is a group that overseas research and sets standards and guidelines for many areas on the internet.

People have different reasons for connecting to the internet and most of them connect to the internet through an Internet Service Provider.

FUNCTIONS OF THE INTERNET

(a) **Communicate and collaborate.** The exchange of electronic messages with business associates and friends (sending and receiving electronic mail messages), transmit documents and data and participate in electronic conference e.g via yahoo messenger.

(b) **Access information**. With the internet, you can browse a lot of information through website search e.g www.google.ug. A variety of information regarding academics, sports and entertainments is available on the internet.

(c) **Downloading programs**. With the use of internet, you can download various programs and files to your personal disk from other computers elsewhere in the world.

(d) **Participate in discussion**. You can conduct voice transmission and join discussions with people and friends from all over the world.

(e) **Supply information**. This involves the transfer of computer files, programs, animations, graphics, sound, video to other computers via the internet.

(f) **Find entertainments**. A variety of interactive video games, short video clips, sound and music clips are all available on the internet.

(g) Reading news and listening to broadcasts e.g from BBC, Monitor ,Bukedde among others.

(h) General information about a subject.

(i) Do research and take online courses

CONNECTING TO THE INTERNET

There are **three** requirements

- An access device e.g a personal computer with a modem.
- A physical connection e.g a telephone line.
- An internet service provider (ISP) The ISP offers options in three categories;
    - Use of a telephone line
    - Use of a server
    - Use of a protocol

AN INTERNET SERVICE PROVIDER

An internet service provider (ISP) is a company that supplies connections to the internet usually for a monthly fee. Users may connect to their ISP through a LAN or through dial-up-access. A dial-up access is a slow speed technology.

FACTORS CONSIDERED WHEN CHOOSING AN INTERNET SERVICE PROVIDER

(a) **Services offered**. When choosing an ISP, one should ensure that the ISP supports the services you want to access on the internet. Some ISPs do not supports all services available on the internet.

(b) **Costs for internet access**. It is important to ask the ISP for the detailed fee structure. Some ISPs charge depending on the services accessed, amount of time spend on the internet, standard fee per a given period say a month e.t.c…   Most ISPs offer a flat rate fee for a certain number of hours.

(c) **Type of communication offered**. This refers to the modes by which your computer connects to the ISP for the internet access. Some ISPs offer some of the methods and not others. Find out whether the mode of connection you are interested in is supported by the ISP.

(d) **Technical support**. It is good to know how much (if any) support you can expect from the ISP. Find out whether it is free or charged, whether it is available on phone and for how long. Some local ISPs send a service technician to your house when you have a problem installing software, dialing into their systems etc.

(e) **Security.** Security is very important to protect your activities on your system. I you do not want someone to access your e-mail box, ask for the ISP how they manage security and whether they support any kind of encryption, firewalls, virus guards etc.

(f) **Software**. If you are using an online service provider, you may need special software to access their systems. Although this software is free, you need to learn them. Some systems don't work well with common application packages. Check with the ISP and find out whether your applications work.

EXAMPLES OF ISPs
- Infocom

- Utl
- MTN
- Airtel

The internet use an IP address system to send data to a computer at a specific destination.

An IP (Internet Protocol) address is a number that uniquely identifies each computer or device connected to the internet. Each IP address consists of four groups of umbers, each separated by a period (e.**g 216.200.47.93**)

The number in each group is between 255. In general, the first portion of each IP address identifies the network and the last portion identifies the specific computer.

A DOMAIN NAME

This is the text version of an IP address, which makes all the numeric IP address easier to remember and use.   A domain name name e.g www.nkpublishing house.com) is a text version of an IP address (e.**g 216.200.47.93)**

N.B The world wide web is one of the most popular services on the internet.

INTRANET
Intranet is a small version of the internet used with in an organization. Intranet uses TCP/IP protocols, supports multimedia web pages and is accessible via a web browser. Intranet generally makes company information accessible to employees and facilitates working in groups.

An intranet that extends to authorize users outside the company is called an **Extranet.**

To prevent an authorized access to data and information, an internet or extranet is often protected by a Firewall.

A Firewall is a general term that refers to both hardware and software used to restrict access to data and information on a network.

A HOME NETWORK

A home network connects all computers and devices together at home or in a home office.

Common types of networks are;

- Ethernet network

- Home PLC

- Phone line network

- Home RF network

(a) Ethernet. This is a LAN protocol that allows personal computers to contend for access to the network.

(b) A home PLC (Power line cable) This is the network that uses the same lines that bring electricity and power into the house. The advantage is that, it requires no additional wiring because data simply transmits through existing power lines in the house.

(c) A phone line network. This a network that uses existing telephone lines in a house. The phone line network does not interfere with voice and data transmissions on the telephone lines (i.e the ser can talk on the telephone and use the same line to connect to the internet.

(d) **A home RF (Radio frequency) network**. This uses radio waves, rather than cables to transmit data.

Advantages of a home network
- All computers in the house can be connected to the internet at the same time.
- Each computer can access files and programs on the computers in the house.
- All computers can share peripherals such as scanner or a printer.

UNDESIRBALE BEHAVIOURS INVOLVING THE INTERNET

- Spam (Containing un solicited messages)

- Pirating (Illegal access to other users messages)

- Watching immoral websites.

- Illicit material.

- Abusive and threatening messages.

- Hacking and cracking.

- Impersonation.

THE WORLD WIDE WEB

The World Wide Web (WWW) also called the web consists of a worldwide collection of electronic documents. Each of these documents on the web is called a **Web Page.** TheWWW emerged in the early 1990's but has grown rapidly to become the most widely used service on the Internet.

 A web page can contain text, graphics, animations, audio (i.e multi-media elements), as well as built-in connections called hyper links to other documents.

 A HYPERLINK also called a link is a built-in connection to another related web page or part of a web page. A link can be a word, a phrase or an image. The shape of the pointer usually changes to a small hand with a pointing index finger when it is pointed on a link.

A HOME PAGE. Is a starting page or a table of contents for a website and normally has a name called index.htm or index html.

 A WEBSITE. This is a collection of related web pages.

A WEB BROWSER. This is a software program used to access and view web pages. Examples of web browsers include;

- ➢ Internet explore
- ➢ Netscape navigator
- ➢ MOzilla fire fox
- ➢ Konquerer

Today's browsers also support push technology in which web based content is downloaded automatically to the computer at regular intervals or whenever the site is updated.

Each web page has a unique address called **Uniform Resource Locator (URL)** which tells the browser where to locate the document.

A WEB SERVER. This is a computer that delivers web pages requested by users. Multiple websites can be stored on the same web server.

A WEB MASTER. This is the individual for developing web pages and maintaining a website.

SURFING THE WEB. This is the activity of jumping from one web page to another.

THE UNIFORM RESOURCE LOCATOR (URL)

This is the unique address of a web page which tells the browser where to locate the document. The URL tells the browser where to locate the web page.

A URL consists of a protocol, a domain name and some times the path to a specific web page or location on the web page.

URL: http://www.nkpublishinghouse.com/internet/data

Protocol: http

Domain name: www.nkpublishinghouse.com

Path: internet/data

N.B: http stands for hyper text transfer Protocol, which is a standard that enables pages to transfer on the web.

WEB PUBLISHING. This is the development and maintenance of web pages. The five steps to web publishing are;

- planning a website
- analyzing and designing a website
- creating a website
- deploying a website

A SEARCH ENGINE

A Search engine is a software program that can be used to find websites, web pages and files on the internet. To find a website, a user just enters a word or a phrase called the keywords or search text.

The URLs of several Internet search engines are listed below.

Search engine	URL
Excite	www.excite.com
Google	www.google.com
Hotbot	www.hotbot.com
Lycos	www.lycos.com
Yahoo	www.yahoo.com
Webcrawler	www.webcrawler.com

MULTIMEDIA. This refers to using computers to integrate text, graphics, animation, audio and video into one application. A web page contains text graphic, animations. Audio and video (i.e. multimedia elements) as well as built in connections called hyperlinks to other documents.

A GRAPHIC. This is a digital representation of information such as drawing, a chart or photgraph. Graphics were the first media to enhance the originally text based internet. Common graphical formats on the web are JPEG and GIF.

N.B

1. **GIF stands for Graphics Interchange Format** which uses compression techniques to reduce file size.

2. JPEG stands for Joint Photographic Experts group which is a graphical image using compression technique to reduce the file size. It often used for scanned photographs, artwork and other images that include smooth transition of colours.

ANIMATION. Is the appearance of motion that is created by displaying a series of still images in rapid sequence.

STREAMING. This is the process of transferring data in a continuous and even flow, which allows users to access and use a file before it has been transmitted completely. An electronic music instrument such as a keyboard, synthesizer or drum machine is connected to a computer. The frequency or a pitch and other musical data received is converted to digital data that can be read and stored by the computer. The computer can in turn send signals back to the electronic music instrument.

Some websites use streaming Audio on the web which allows a user to listen to the sound as it downloads to the computer. Two accepted standards for streaming audio on the web are;

- Windows media player
- Real audio

N.B: **MPEG** is a popular video compression standard defined by the moving picture Experts group (MPEG)

ELECTRONIC COMMERCE

Electronic commerce (E-commerce) is a financial business transaction that occurs over an electronic network such as the internet. Online shopping and banking are two popular types of E-commerce that uses either electronic money (e-money) or electronic data interchange (EDI)

Electronic Money. This is a means of paying for goods and services over the internet.

EDI (**Electronic data Interchange**) is a set of standards that control the transfer of business data and information among computers both within and among companies.

E-commerce business can be grouped into three basic models:

(a) Business-to-consumer (B2C) e-commerce consists of the sale of goods to the general public.

(b) Consumer to consumer (C2C) e-commerce occurs when one consumer sells directly to another, such as in an online auction.

(c) Business to Business (B2B) e-commerce consists of businesses providing goods and services to another r business.

ADVANTAGES OF E-COMMERCE

- Transactions can occur instantly and globally, thus save time for participants on both ends.
- Transactions can occur 24 hours per day.
- Businesses have access to millions of people over internet connects.
- Businesses have the ability to gather customer information, analyse it and react if appropriate.
- Information can be exchanged and be available quickly.
- Distribution costs for information is reduced or eliminated.
- Manufacturers can buy and sell directly avoiding the cost of middleman.
- Feedback can be immediate.

- Customers can compare prices easily.