Unit 2
Data Communication & Network

1. Communication: The Process of sending and receiving information from sender to receiver using any medium and certain protocols is called communication. The communication system is a system which describes the information exchange between two points. The major elements of communication are the **Transmitter** of information, **Channel or medium** of communication and the **Receiver** of information.

2. Basic Elements of Communication System:

Information: informations are source that is to be transmitted. It can be in the form of audio, video etc

Signal: Signal are information that are passes through any communication system. The information is converted into an electrical form for transmission.

Transducer

A device or an arrangement that converts one form of energy to the other. An electrical transducer converts physical variables such as audio, video, into corresponding electrical signal variations. Example: Microphone – converts audio signals into electrical signals.

Amplifier/Repeater

The electronic circuit or device that increases the amplitude or the strength of the transmitted signal is called an amplifier. When the signal strength becomes less than the required value, amplification can be done anywhere in between transmitter and receiver. A DC power source will provide for the amplification.

Modulator

As the original message signal cannot be transmitted over a large distance because of their low frequency and amplitude, they are superimposed with high frequency and amplitude wave called carrier wave. This phenomenon of superimposing of message signal with a carrier wave is called modulation. And the resultant wave is a modulated wave which is to be transmitted.

Antenna

An Antenna is a structure or a device that will radiate and receive electromagnetic waves. So, they are used in both transmitters and receivers. An antenna is basically a metallic object, often a collection of wires. The electromagnetic waves are diverged according to the position of the antenna.

Communication Channel

A channel refers to a physical medium such as wire, cables, space through which the signal is passed from the transmitter to the receiver. There are many channel impairments that affect channel performance to a pronounced level. Noise, Attenuation and distortion to mention the major impairments.

Noise

Noise is channel imperfection or impairment while signal is transmitting to its destination. There are two types of noise internal noise and external noise. Internal noise occurs in sender's computer while signals passes through different electrical components and External noise are interference also called EMI or Cross talk, interference generated by natural sources which can be minimized by appropriate design of channel and shielding of cables.

Attenuation

Attenuation is decrease of signals in longer distance which can be regenerated by using amplifiers and repeater .

3. Data Communication

The term “Data Communication” comprises two words: Data and Communication. Data can be any text, image, audio, video, and multimedia files. Communication is an act of sending or receiving data. Thus, data communication refers to the exchange of data between two or more networked or connected devices.

Components of Data Communication

Sender: A sender is a computer or any such device which is capable of sending data over a network. It can be a computer, mobile phone, smartwatch, walkie-talkie, video recording device, etc.

Receiver: A receiver is a computer or any such device which is capable of receiving data from the network. It can be any computer, printer, laptop, mobile phone, television, etc. In computer communication, the sender and receiver are known as nodes in a network.

Message: It is the data or information that needs to be exchanged between the sender and the receiver. Messages can be in the form of text, number, image, audio, video, multimedia, etc.

Communication media: It is the path through which the message travels between source and destination. It is also called medium or link which is either wired or wireless. For example, a television cable, telephone cable, ethernet cable, satellite link, microwaves, etc.

Protocols: It is a set of rules that need to be followed by the communicating parties in order to have successful and reliable data communication.

4. Types of Data Communication

Simplex Communication

It is a one way or unidirectional communication between two devices in which one device is sender and other one is receiver. The device can either send information or receive information. Information from newspaper, TV and Radio is an example of this communication.

Half-duplex Communication

It is two way or bidirectional communication between two devices in which both the devices can send and receive data or control signals in both directions, but once at the same time. Walkie-talkie is an example of this communication.

Full-duplex Communication

It is two way or bidirectional communication in which both devices can send and receive data simultaneously. This type of communication channel is employed to allow simultaneous communication, for example, in our mobile phones and landline telephones.

5. Computer Networking: A group of two or more computers and other devices connected to each other through wired or wireless media like cables, fiber cables WiFi, satellite etc to exchange data and information and share hardware, software and other resources is called computer network.

a. Advantages of computer networking

- Resources Sharing: We can share hardware resources like Hard disk, Printer etc.
- Centralized Management: The computer in the network can be connected to a server which can control and provide security to the computers.
- Speed: Information can be shared within a second.
- Backup & recover: Data can be easily backed up and recovered.
- Access: File can be easily accessed from any computer in the network.

b. Disadvantages of computer networking

- Installation cost is higher.
- Virus may spread through network.
- Skilled manpower in needed to operate and maintain it.
- Cybercrimes are originated from computer Network.
- Failure of network may hamper day to day operation

6 . Signal: A signal is a wave that carry information over a transmission medium. Signals can be electric, light, electromagnetic, or radio signals. The electric signals have limited bandwidth and cannot be used in long distance. They need to be amplified or regenerated.

a. Analog Signal: Analog signals are continuous wave signals that change with time period. It is used to measure physical value such as light, sound, pressure, or temperature. A signal carried by microphone, phone are analog signals.

b. Digital Signal: A digital signal are discrete signals wave. These signals are non-continuous, they change in individual steps. Digital signals consist of binary digits 0 & 1. Data transmission between computers is in the form of digital signals.

7. Types of Network

a. LAN (Local Area Network)

LAN is a connection of computers done in a single room, single buildings or group of buildings in a limited distance. It connects workstation, PCs, or node to share devices, send message, emails etc. (Wireless LAN is also called WLAN or Wi-Fi).

Advantages and Disadvantages

b. WAN (Wide Area Network)

A WAN is a computer network that spans in a large geographical area. Typically a WAN consists of two or more LAN and they are connected through public network (ISP), such as telephones lines or radio wave systems, they also can be connected through satellites. Internet is the best example of WAN.

c. MAN (Metropolitan Area Network)

Man is a computer networking that covers a city or beyond 100km. The best examples of MAN are the cable television networks. It is used in organization having different branches within a city.

On the basis of architecture

d. Client Server Architecture

The Network Architecture in which one computer is dedicated server and others are client computer is referred as Client Server Architecture. In this architecture, client request to the server and server respond to the client. Server is a centralized computer which controls client computers and client have to depend on the server. It provides services to the client computers

Advantages

- High Security can be provided through server.
- It is appropriate for large organization.
- Easy to backup and recovery data.
- Centralized network is possible.

Disadvantages

- It is difficult to setup and manage.
- Cost is expensive.
- If server fails, it will effect network
- Skilled manpower required.

e. Peer to Peer to Architecture

The Network Architecture in which all the computers are either client or server is referred as Peer to Peer Architecture. In this architecture, all the computer has equal responsibility. It can share data, hardware and software with each other. It is suitable for a small area such as small offices, small room, building, etc. It uses many operating systems such as Windows 2000, Windows 7, Windows 10 etc

Advantages

- It is simple and easier to setup.
- Overall cost is cheaper.
- If any computer fails, it will not affect others.
- User can easily manage system, so no skilled manpower required.

Disadvantages

- Data security is poor.
- Backup and recovery is difficult.
- Suitable only for small organization.
- It cannot control other computers

8. **Topologies/ LAN Topologies**

The way of connecting computers in LAN is called Topology. It is also called physical and logical layout of interconnection of the computers in the Network. It is a pattern or cabling structure of network components.

<u>There are mainly three types of Network Topology</u>

a. Ring Topology
b. Bus Topology
c. Star Topology

a. Ring Topology: The topology in which all the computers are connected to each other in a closed loop by a single cable with each other. Data travel around the network, in one direction in a sequential manner. The data passes through all the computers connected in the network.

<u>Advantages of Ring Topology</u>

Easy to setup.
Reliable for small Network.
It is cheap to install.
Each computer has equal priority.

Disadvantages of Ring Topology

It is difficult for troubleshooting.

adding or deleting the computers disturbs the network activity.

Failure of one computer will affect whole network.

b. Bus Topology: The topology in which all computers, nodes and network devices are connected to single main cable called bus topology. Terminators are attached at the cable's start and end points. it is also called linear Bus Topology. The cable used in this topology is the backbone of the network. Data passes in the network through the main Cable.

Advantages of Bus Topology

Easy to setup and cheap in cost.

It is used in small networks.

It is easy to expand networks.

Disadvantage of Bus Topology

Failure in main cable will make the whole network fail.

Heavy network traffic or increase in nodes will decrease the performance of network.

Terminators are necessary at both ends of the cable

c. Star Topology: The topology in which all the computers or nodes are connects to the central device called hub/switch through a cable. It is the most common topology. Switch acts as a repeater for data flow. Star topology are mostly used with twisted pair cable.

Advantages of Star Topology

One of the latest topology.

Used in big organization.

It is easy to expand networks.

Easy to troubleshoot.

Failure on any node doesn't effect network

Disadvantage of Star Topology

Failure of hub/switch will make the whole network fail.

Expensive that other topologies.

d. Mesh Topology: The topology where each computer is connected to every computer in point to point connection. It is advanced from of Ring topology.

Advantages

Direct connection between computers.

Data transmission in higher & traffic is reduced.

Disadvantage

Higher in cost.

Requires more cables.

Complex in nature.

f. Hybrid Topology: The combination of two or more topologies is called hybrid topology. It combines Bus topology to a star topology.

9. Transmission Media / Communication Media

Transmission media refers to the wires, cables and other means through which data travels from its source to destination. It is an electronic roadways through which data transfer from one place to another place.

Two Types of Communication Media

a. Guided Communication Media/ Wired Communication Media/ Bounded Communication Media
b. Unguided Communication Media/ Wireless Communication Media/Unbounded Communication Media

a. Guided Communication Media

The media that uses cable or wire to transfer data between computer computers or network is called guided media. The different types of cable or wire are as follows.

i. Twisted Pair Cable
ii. Co-axial Cable
iii. Fiber Optic Cable

i. Twisted pair Cable

It is a wired communication channel that transfer data signals from one location to another location. It contains pair of copper wire twisted to each other and insulated with a plastic. It is used in LAN to connect computers. It uses RJ45 Jack as a connector. CAT 5 & CAT 6 are latest cables. Which can transfer 200 Mbps of data

Types of **Twisted pair Cable**

*** UTP (Unshielded Twisted Pair)**

Unshielded twisted pair cable or wire is most popular wire. The cable without a shield is called unshielded twisted pair. It is cheap in cost and not good against EMI (Electromagnetic Interference).

*** STP (Shielded Twisted Pair)**

Shielded twisted pair is a wire that contain special shield to protect against EMI (Electromagnetic Interference). They are expensive that UTP.

Advantages

Common and easily available in market.
Cheaper than other cables.
Data transfer rate is higher in short distance.
It is thin and light weighted.

Disadvantages

It cannot be used for long distance.
Data transmission becomes slow in long distance.

ii. Coaxial cable

It is a wired communication channel that transfer data signals from one location to another location. It uses thick copper wire in center and thin web like a wire in outer layer, separated by insulator and covered by a plastic. BNC and T connectors are used to connect this wires. These wires are specially used in TV cable network.

Types

Thinnet (10mbps 200 Meter)
Thick net (10mbps 500 Meter)

Advantages

Data transmission is faster than twisted pair cable in medium range distance.
Easier to install and modify.

Disadvantages
Expensive than twisted pair cable.
Not appropriate for long distance.
They are not used for computer network.

ii. Fiber Optics Cables
It is a wired communication channel that transfer data signals from one location to another location. It is made of plastic or glass fiber to transmit data. It uses light to carry data signal from one end of the cable to other end. It is of high quality and transmits data signals at very high speed. The speed is higher than twisted pair cable and co-axial cable.
Advantages
Data transmission is faster than twisted pair cable and coaxial.
Best cable for long distance communication.
It can transfer multiple data in a same time.
Disadvantages
Expensive than twisted pair cable and coaxial cable.
Not appropriate for short distance (difficult to bend).

b. Unguided Communication Media
The media which transfer data and information between two devices without using wire or cable is Unguided Communication Media. Data travel through in the air in this media. It uses radio signal for receiving and transmitting electronic data.

i. Radio wave
ii. Microwave
iii. Satellite
iv. Infrared
v. Bluetooth
vi. Wifi

i. Radio wave
Radio wave is wireless communication media that uses electronic magnetic wave for transmission of signals. Radio waves are widely used in modern technologies such as television, mobile phones and radio communications, broadcasting, radar, satellites, wireless computer networks etc.

ii. Microwave
Microwaves is wireless communication media used for transmission of signals in line of sight positions. It means that antenna should be kept in line of sight position. It cannot pass obstacles like hill or tall buildings. Repeaters are used to amplify the signals in long distance.

iii. Satellite

Satellite is wireless communication media. It is placed in outer space as satellite station which receives signals from the earth station with the help of an antenna as well as send signals to earth station.

iv. Infrared

It is a wireless communication media that uses electromagnetic wave to send signals in short distance. There are used in TV remote, mobiles etc to share information or signals.

v. Bluetooth

It is wireless communication media that can transfer information within 10 meters. It is specially found in Mobiles, Tablets and Laptop. It connects to devices and transfer signals or information.

vi. Wi-Fi

Wi-Fi which stands for Wireless Fidelity. Wi-Fi is a technology that uses radio waves to provide network connectivity. It is used to access the internet on portable devices like smartphones, tablets, or laptops. It also provides access to a local network of connected devices.

10. Network Connecting Devices

The hardware devices that are used to connect computers to the network are called Network Connecting Devices. The different devices are NIC, Hub, Switch, Bridge, Router, Repeater, Gateway etc.

a. NIC (Network Interface Card) / Network Adaptor / network Card/Ethernet Card

It printed circuit board which contains port where network cable is plugged. It is attached into motherboard expansion slot which controls the flow of data between computers in the network. NIC helps to connect your computer to network. Now days in newer version of computer NIC is found in built in the motherboard.

b. Hub.

Hub is network connecting device which contain multiple ports to connect many of computers in a network, but Hub works slower because it distributes information to all computers connected to its port. To connect HUB in a network, one part of cable is attached into hub and another part of cable is attached into NIC.

c. Switch

Switch is network connecting device which contain multiple ports to connect many of computers in a network, Switch works faster because it distribute information to the related computer connected to its port. To connect Switch in a network, one part of cable is attached into Switch and another part of cable is attached into NIC. switches are used because it broadcast the packets only to the destination computers.

d. Bridges

Bridge is a network connecting device that is used to connect two networks having similar protocols in LAN. It checks incoming signals and decides whether to forward or discard it.

e. Routers

Router is a network connecting device which is used to connect two different networks in WAN (internet) having similar protocol. It looks the address in the packet and determines where the packet should go and then determines the best route for the packets to arrive to its destination hence the name is 'router'.

f. Repeater

It is a network connecting devices that accept weak signals and regenerate or amplify the signals over a long distance. So, it boosts the data signals that are received from network.

g. Gateways

Gateway is the networking device that is used to connect two different networks having different protocol. A packet from different network has different address (header). So the gateway reads header and add second header that is understood by the second network.

h. MODEM

Modem Stands for Modulator and Demodulator. It is a device that convert Analog signals from cable to Digital signals so that computer can understand. This process is called Modulation. And again convert digital signal to analog signal so that cable or wire can understand. This process is called Demodulation.

11. Protocol

A set of rules governs communication between computers in a network is called a protocol. it is rules followed while sending and receiving information Protocol defines how computers identify one another in a network. Some common protocols are as follows:

TCP/IP (Transmission Control Protocol/Internet Protocol):- is commonly used in Internet, dividing data into packets arranging and checking them as well addressing them.

UDP (User Datagram Protocol):- is commonly used in Internet. But it doesn't check error.

HTTP (Hypertext Transfer Protocol):- is used to transfer HTML do

HTTPS (Hypertext Transfer Protocol secure):- is used to transfer HTML documents or webpages securely in insecure network.

SMTP (Simple Mail Transfer Protocol):- is used in sending e-mail.

POP (Post Office Protocol):- is used to receive e-mail from a mail server. POP3 is the latest POP used by Gmail, yahoo etc.

FTP (File Transfer Protocol):- is used to transmitting files between computers.

IPX/SPX (Internetwork Packet Exchange / Sequential Packet Exchange):- is a networking protocol that interconnects networks that use Novell's NetWare clients and servers.

Apple Talk:- AppleTalk is a set of LAN communication protocol that is developed for apple computers.

Net BEUI: It stands for NetBIOS Extended User Interface is a protocol used in Windows NT Server.

Telnet:- The protocol that is used to exchange data between two computers in a real time.

VIOP (Voice Over Internet Protocol):- The protocol that is used to transfer voice via internet.

IMAP(Internet Mail Access Protocol):- is used to receive e-mail from a mail server just as POP do. But, it is more powerful than POP.

12. Transmission Impairment in Data Communication

In communication system data or signals passes through communication medium and there are some imperfection in transmission medium which cause signal impairment or impurity. In other word we can say that signals that are transmitted at beginning of the medium are not the same as the signals that are received at the end.

a. Noise

Noise is channel imperfection or impairment while signal is transmitting to its destination. There are two types of noise internal noise and external noise. Internal noise occurs in sender's computer while signals passes through different electrical components and External noise are interference also called EMI or Cross talk, interference generated by natural sources which can be minimized by appropriate design of channel and shielding of cables.

b. Jitter

The information is transmitted from your computer in the form of data packets across the internet. They are sent at regular interval and take a little amount of time. Jitter is am impairment that occurs when there is a time delay in sending these data packets over an internet. It can occurs by network congestion and routes changes.

c. Singing / Echo

Echo and singing occurs as a result of transmitted signals being coupled into a return path. In other word when the returning signals repeatedly coupled back into the forward path singing or echo is produced.

d. Crosstalk

Crosstalk is a disturbance caused by coupling of signals between two parallel lines in a wire. The signals passes through one wire is coupled by another wire in a same parallel lines. Crosstalk can be reduced by shielding a wire.

e. Attenuation

Attenuation is decrease of signals in longer distance. A data or signals passes over a long distance it losses its strength which can be regenerated by using amplifiers and repeater.

f. Distortion

If signals changes its form or shape, it is referred as distortion. Distortion occurs because of long distance, environment and other physical phenomena.

g. Bandwidth

It is also called bits per second. The volume of data that is transmitted in a fixed period of time through a any communication media is referred as bandwidth.

13. Some Basic Terms used in Computer Network

a. IP Address

Internet Protocol address is a unique identifying number given to each computer connected to the network. A IP address look like 216.27.61.137, 63.255.173.183 etc

IPV4 (Internet Protocol Version 4)

IPv4 address are 32 bit long that can hold 4 billions of IP address. There are 4 group of numbers, 8 bit per group with 256 combinations. Eg: 202.12.29.142

IPv6 addresses 128bits long that can hold trillions of IP address to fulfill the needs of all internet users. It contain 8 group of hexadecimal numbers, 16 bit per group with 65536 combinations. Eg: fe38:dce3:124c:c1ac:ba14:67cd:dc12:121c

Network Class

- Class A

0-127 as their first octet with Subnet Mask 255.0.0.0. The address 10.16.52.63 is class A IP Address. In this class First octet number is assign for Network and other three octet is assign for host computer.

- Class B

128-191 as their first octet with Subnet Mask 255.255.0.0. The address 125.16.52.63 is class B IP Address. In this class First and second octet number is assign for Network and other two octet is assign for host computer.

- Class C

192-223 as their first octet with Subnet Mask 255.255.255.0. The address 192.168.52.63 is class C IP Address. In this class First, second and third octet number is assign for Network and fourth octet is assign for host computer.

b. MAC Address

Media Access Control address is a unique number related with a network adaptor also called NIC. It is used to identify each computer in a network. Eg: 00:A0:C9:14:C8:29 where 00A0C9 indicate manufacturer and 14C829 indicates a particular host or computer.

14. The Internet

Internet is a network of networks. The worlds largest Computer Network that connects thousands of Network and millions of computer around the world. It is a global network by which all computers around the world can share information. It uses TCP/IP (Transmission Control Protocol/ Internet Protocol). In order to connect to the Internet, we must have access to an Internet Service Provider (ISP), which acts as the mediator between user and the Internet. The first computer network, was called ARPANET (Advance Research Project Agency Network) by ARPA in 1969 AD.

Advantages of the internet

- The internet is faster than any other communication system.
- The internet is the source of knowledge so all kinds of information can be displayed.

- The internet is the most popular form of entertainment. We can watch movies, songs, videos, games, etc. that are available in the internet for free.
- The internet is massively used in social networking media such as face book, twitter, etc.
- The internet tools can be for E commerce services like online hotel reservations, online ticket booking, online shopping, etc.

Disadvantages of the internet

- The information or any important files can be easily taken by the hackers.
- The unnecessary emails, advertisements, spam mails may slow down the system and create lots of problems while working with computer.
- The malware or virus threats affects the system to a greater extent.
- More chances of social isolation problems.

d. Intranet

Intranet is a private network that is accessed by a private users of any organization.

e. Extranet

Extranet is a private network that is accessed by a private users of any organization using public network.

15.Network Tools

- **Packet Tracer:**

Packet Tracer is a cross-platform visual simulation tool designed by Cisco Systems that allows users to create network topologies and imitate modern computer networks. The software allows users to simulate the configuration of Cisco routers and switches using a simulated command line interface. Packet Tracer makes use of a drag and drop user interface, allowing users to add and remove simulated network devices as they see fit.

Remote Login

Remote Login is a authorized process in which user can login into remote site i.e. computer and use services that are available on the remote computer. TELNET is a protocol that is used to connect your computer to remote computer. Some software that are used are as follows :Team Viewer

Any Desk

Windows Remote Desktop Connection etc