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Unit – 04: Introduction to Networks and LAN components

- Understand the Overview of Networking,
- State the Need for Networking,
- Overview of Network Topologies.
- Classification of Networks –LAN, MAN,WAN,
- Explain LAN Devices, Repeaters, Hubs, Switches, Network Interface Cards (NICs), Routers, Modem,
- List the Hardware and Software Components,
- Various Network Communication Standards,
- OSI Reference Model,
- TCP/IP Reference Model,
- Know about LAN Cables and Connectors, wireless network adapter,
- Know about :
  - Coaxial Cables,
  - Twisted-Pair Cables,
  - Optical Fiber Cables, and Connectors.

Questions to be discussed:

1. What is network? Explain different types of computer networks.
2. What are the three necessary criteria for an effective and efficient network?
3. Discuss in brief different types of network topology in computer networks.
4. Explain about different networking devices in details.
5. Explain different layers of OSI model in details.
6. Explain in details about TCP/IP reference model.
7. Differentiate between OSI and TCP/IP model.
8. Write short notes on:
   a) Modem
   b) Router
   c) Coaxial cable
   d) Optical fiber

What is Network?

- Two or more computers are connected together to sharing data or information is called network.
- In network computers are connected either by wired (cables) or wireless (Wi-Fi).
- These networked devices use a system of rules, called communications protocols, to transmit information over physical or wireless technologies.
- A server is a main computer that manages resources connected to a network.
- Any user on the network can access the resources stored on the server.
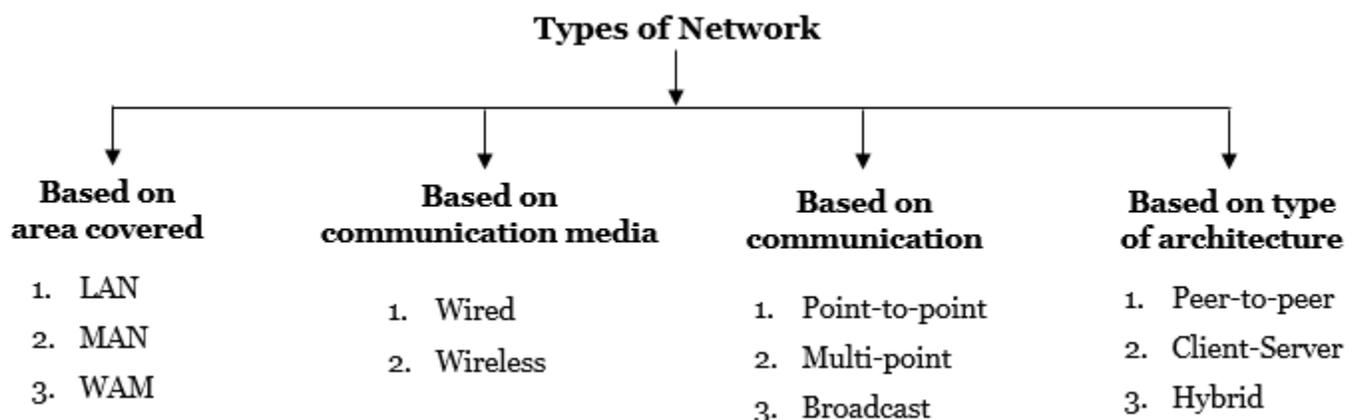

What is networking?

- The process of making connections and building relationships among computers are called networking.
- The main purpose of networking is transmitting or sharing data and resources.
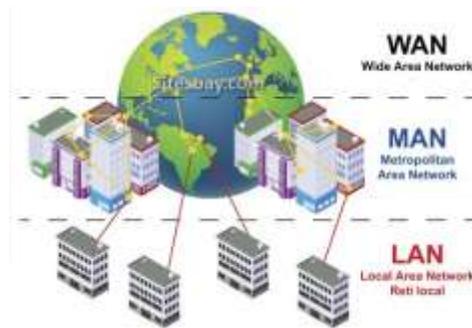
Need of Networking:

- The need for networking is mainly to break the barriers of distance, time and cost.
- For sharing resources, exchange files or allow electronic communications.
- Networking can even help you find unadvertised jobs/internships.
- We can easily access the files stored on various computers on a network.
- Networking also allows many people to work simultaneously on the data stored in a database.
- Computer networks allow people to communicate through emails and instant messaging facilities.

Types of network:

Types of Network

Based on area covered	Based on communication media	Based on communication	Based on type of architecture
1. LAN	1. Wired	1. Point-to-point	1. Peer-to-peer
2. MAN	2. Wireless	2. Multi-point	2. Client-Server
3. WAM		3. Broadcast	3. Hybrid

Based on area covered, there are three types of network:

1. LAN
2. MAN
3. WAN

Local Area Network (LAN):

- LAN stands for Local Area Network.
- It is a computer networks that spans only a small geographical area such as office, home or building.
- In LAN one computer is designed as the file server which stores all the software that controls the network.
- A LAN is the simplest form of network that covers an area of around 10 kilometers.
- For example, a college network or an office network.

Metropolitan Area Network (MAN):

- MAN stands for Metropolitan Area Networks.
- It is a type of network that spread over a "metropolitan" area such as a city.
- A MAN may be operated by one organization or be shared resources used by several organization in the same city.
- MAN connect multiple LANs to one another at high speeds.
- MAN refers to a network that covers an entire city.
- For example: consider the cable television network.
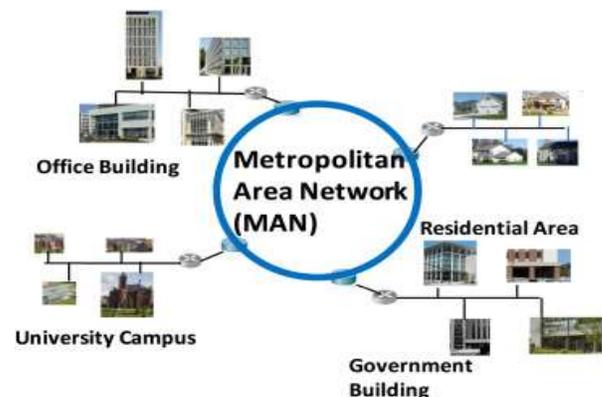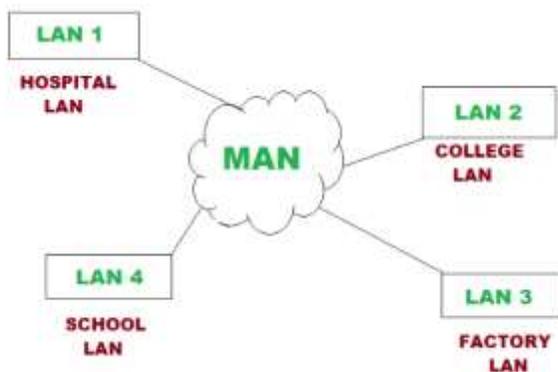
Wide Area Network (WAN):

- WAN stands for Wide Area Network.
- It is a type of network over a large geographical area such as states, countries or even the whole world.
- The large WAN is existence in the Internet.
- These kinds of networks use telephone lines, satellite links and other long range communications technology to connect.
- A WAN connects multiple LANs to one another over great geographic distances.
- WAN interconnects connecting devices such as switches, routers, or modems.

Wide area network (WAN)

What are the three necessary criteria for an effective and efficient network?

- The three necessary criteria for an effective and efficient network are:
  1. Performance
  2. Reliability
  3. Security.

Performance:

- It can be measured in many ways, including transmit time and response time.
- Transit time is the amount of time required for a message to travel from one device to another.
- Response time is the elapsed time between an inquiry and a response.
- The characteristics that measure the performance of a network are Bandwidth, Throughput, Latency(delay) etc.

Reliability:

- Capacity of the network to offer the same services even during a failure.
- The accuracy is measured by frequency of failure, the time it takes a link to recover from failure.

Security:

- Network security issues include protecting data from unauthorized access, damage or loss data.

What is network topology?

- The arrangement or structure of nodes and links is called network topology.
- They can be configured in different ways to get different outcomes.
- There are five types of network topologies:
  1. Bus
  2. Ring
  3. Star
  4. Tree
 5. Mesh
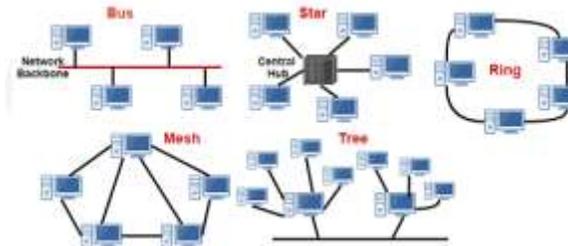
Bus Topology:

- In Bus topology each computer is connected to the single bus cable.
- Linear Bus topology is defined as having exactly two terminals.
- A signal from the source travels in both directions to all machines connected on the bus cable.
- If the machine address does not match the intended address for the data, the machine ignores the data.
- In local area networks bus topology is used.

Advantages

- Installation is simple.
- Compared to other topologies, the bus utilizes less cabling.

Disadvantages

- Difficulty in reconfiguring and isolating faults.
- A bus cable malfunction or break interrupts all communication.
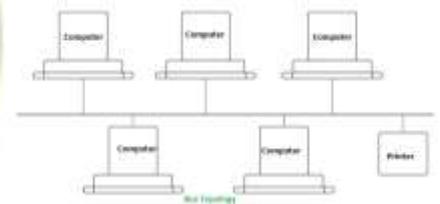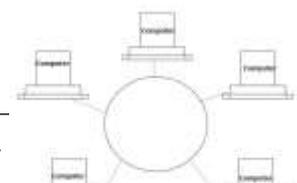
Ring Topology:

- In ring topology each computer is connected to another and the last one is connected to the first.
- A network topology that is set up in a circular fashion in which data travels around the ring.
- Exactly two neighbors for each device.
- Each device receive the incoming signal and transmit the data to the next device in the ring.
- Here, each device on the network acts as a repeater.

Advantages

- Data transmission is relatively straightforward because packets only move in one direction.
- There is no requirement for a central controller to manage communication between nodes.
- Easy installation & Reconfiguration
- Simplified Faulty connections

Disadvantages

➢ In a Unidirectional Ring, a data packet must traverse through all nodes.

➢ All computers must be turned on in order for them to connect with one another.

Star Topology:

▪ In Star topology every node is connected to central controller called hub or switch.

▪ The hub acts as a signal repeater.

▪ The star topology is considered the easiest topology to design and implement.

▪ There is no direct connection between the devices.

▪ Used in high-speed LANs
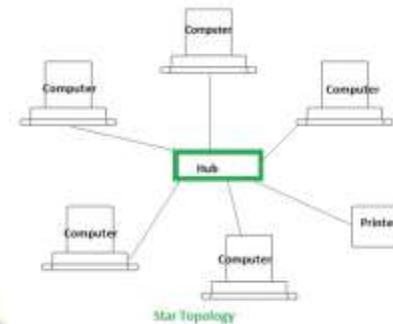
Advantages

➢ It's simple to set up and configure.

➢ Identifying and isolating faults is simple.

➢ Easy to install & configure

Disadvantages

➢ Nodes attached to the hub, switch, or concentrator is failed if they fail.

➢ Because of the expense of the hubs, it is more expensive than linear bus topologies.

➢ More cable required compared to bus or ring

➢ Too much dependency on Hub

Tree Topology:

▪ It is a combination of a star and bus topology.

▪ It is also known as hierarchical topology.
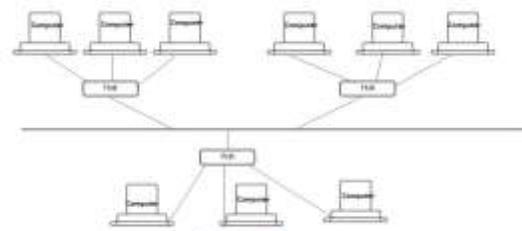
Advantages

➢ Network expansion is both possible and simple.

➢ We partition the entire network into pieces (star networks) that are easier to manage and maintain.

➢ Other segments are unaffected if one segment is damaged.

Disadvantages

➢ All device are connected to bus cable, and if it fails, the entire network is handicapped.

➢ Maintenance becomes more challenging when more nodes and segments are added.

Mesh Topology:

- It is a network topology in which all the nodes are individually connected to the other nodes.
- Every device in a mesh topology has dedicated point-to-point connectivity to every other device.
- To connect n devices, a fully connected mesh network contains n *(n-1)/2 physical channels.

Advantages

- Data can be sent from multiple devices at the same time.
- Even if one of the connections fails, a backup is always available.
- Point to Point links make fault transmission & fault isolation easy.
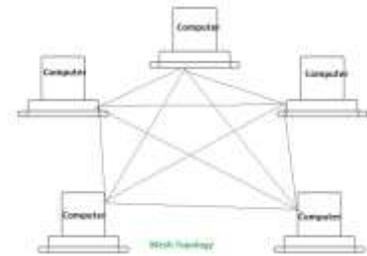
Disadvantages

- The amount of cabling is increased so it is very expansive.
- It is difficult to install and reconfigure.

Example: connection of telephone regional office in which each regional office needs to be connected to every other regional office.
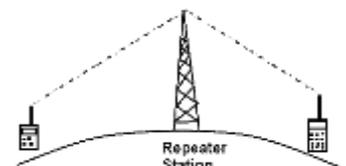
Network devices:

- A network device allows computers to connect through a network and transmit data.
    1. Repeater
    2. Hub
    3. Switch
    4. Bridge
    5. Router
    6. Gateway
    7. Modem
    8. NIC

Repeater:

- A repeater is a network device that increases a signal's strength, so it can travel greater distances without a loss in quality.
- It receives a signal, cleans it of unwanted noise, regenerates it & retransmits it at a higher power level.
- It allowing the signal to travel greater distances without degradation.
- A repeater is also known as range extender.

Hubs

- A hub is a small device that allows wired devices to connect to a network.
- It is also known as multiport repeater.
- A network hub is a relatively simple broadcast device.
- Hubs have no knowledge of the devices connected.
- That means that all packets of data that arrive at the hub are transmitted to all connected computers.
- This affects network performance, as many unnecessary signals are transmitted across its connections.

Switch:

- Switches are similar to hubs, with one important difference - a switch records which computers are connected to which ports.
- When a message is received, the switch forwards each packet of data to its intended recipient only.
- This improves network performance by cutting down on unnecessary transmissions.

Bridge:

- A bridge is a network device used to connect multiple LANs together.
- The mechanism of network aggregation is known as bridging.
- The bridge is a hardware device that operates at data link layer.
- It is also known as a layer of two switches.

Router:

- A router is a network layer hardware device that transmits data from one LAN to another if both networks support the same set of protocols.
- It is used to connect two or more similar networks.
- It is a networking devices that that operates in network layer of OSI model.
- It uses routing tables to find the optimal way to forward data packets between networks.

Gateway:

- A gateway joins together two networks that use different protocols, for example joining a LAN to a WAN.
- It is used to connect two or more dis-similar network.
- It converts information or data from one protocol or format to another.
- Gateway is also known as protocol converter.
- It is a hardware device that acts as a gate among various available networks.
- The gateway operates at the network layer (Layer 3) of the OSI Model.

Modem:

- Modem stands for modulator and demodulator.
- A modem is a box that connects your home network to your internet service provider, or ISP.
- It is a hardware device that allows a computer to send and receive information over telephone lines.
- When sending a signal, the device converts ("modulates") digital data into analog audio signal, and transmits it over a telephone line.
- Similarly, when an analog signal is received, then it converts back ("demodulates") to a digital signal.
- Modems operate on just the data link layer.
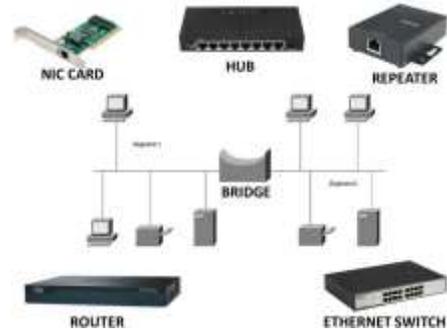
NIC (Network Interface Card):

- NIC stands for Network Interface Card.
- It is a hardware component without which a computer cannot be connected over a network.
- It is also called network interface controller, network adapter or LAN adapter.
- NIC allows both wired and wireless communications.
- NIC is both a physical layer and a data link layer device.

ISO/OSI Model in Communication Networks

- OSI stands for Open System Interconnection.
- It is a standard reference model for communication between two end users in a network.
- In 1983, ISO publish a document called "The basic reference model for OSI" which visualize network protocols as a seven-layered.
- It defines seven layers in a complete communication system.

Figure 12.38 Categories of OSI Model
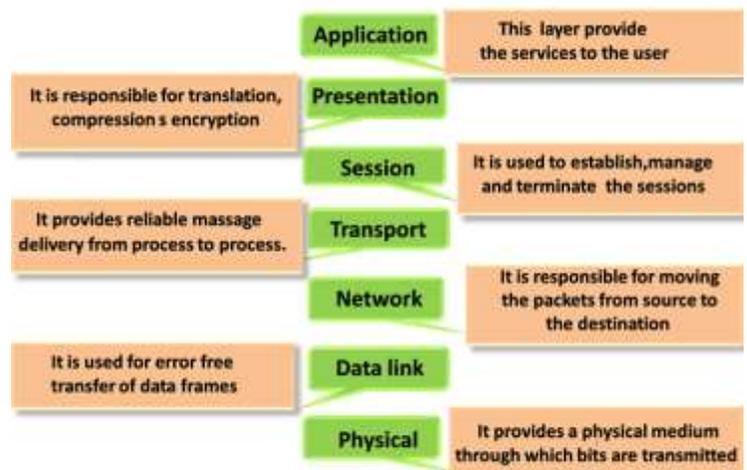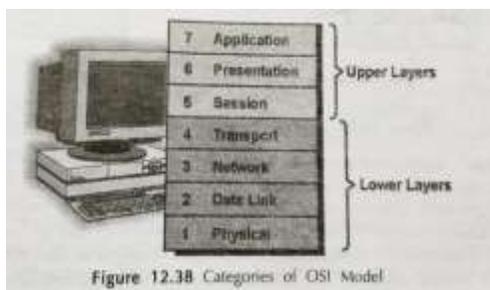
Functions of different layers:

Application Layer:

- It is the topmost layer.
- Transferring of files disturbing the results to the user is also done in this layer.
- Mail services, directory services, network resource etc. are services provided by application layer.

The Presentation Layer:

- Presentation layer takes care that the data is sent in such a way that the receiver will understand.
- If the language can be different of the two communicating systems then it plays a role of translator.
- It performs Data compression, Data encryption, Data conversion etc.

The Session Layer:

- Session layer manages synchronize.
- Transfer of data from source to destination session layer streams of data are resynchronized properly.

Transport Layer:

- It decides if data transmission should be on parallel path or single path.
- Functions such as multiplexing, segmenting or splitting on the data are done by this layer
- It receives messages, convert it into smaller units and passes it on to the Network layer.

The Network Layer:

- It acts as a network controller & manages the traffic.
- It decides by which route data should take.
- It select the shortest path to transmit the packet, from the number of routes available.
- The Network layer contains information in the form of **packets.**

Data Link Layer:

- The main function of this layer is to make sure data transfer is error free from one node to another.
- The data link layer contains information in the form of **frames.**
- Data Link Layer is divided into two sublayers:
    1. Logical Link Control (LLC)
   2. Media Access Control (MAC)

The Physical Layer:

- The lowest layer of the OSI reference model is the physical layer.
- It is responsible for the actual physical connection between the devices.
- The physical layer contains information in the form of **bits.**
- It is responsible for transmitting individual bits from one node to the next.
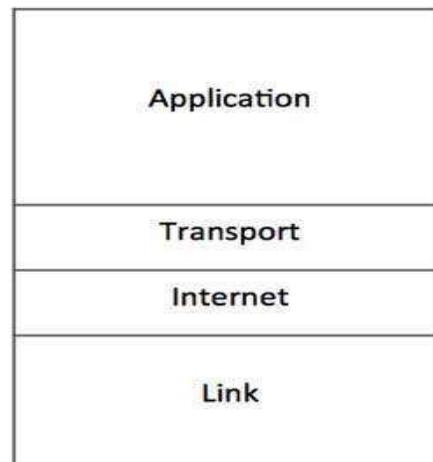
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What is TCP/IP model?

- The TCP stands for Transmission Control Protocol, whereas IP stands for Internet Protocol.
- The TCP/IP model is a concise version of the OSI model.
- This model consists of 4 layers.
- It was developed by ARPANET (Advanced Research Project Agency Network).
- It consists of standard protocols that lead to the development of an internet.
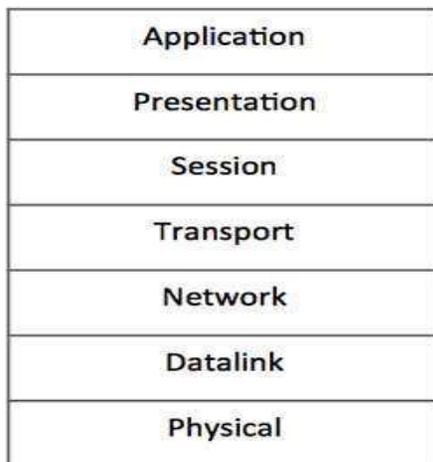
OSI Reference Model   TCP/IP Reference Model

Differentiate between OSI and TCP/IP model:

| OSI	TCP/IP
OSI stands for open system interconnection.	TCP/IP stands for transmission control protocol/ Internet protocol
OSI model has been developed by ISO.	It was developed by ARPANET.
OSI model has 7 layers.	TCP/IP has 4 layers.
The smallest size of the OSI header is 5 bytes.	The smallest size of the TCP/IP header is 20 bytes.
Follows horizontal approach	Follows vertical approach.
Session & presentation layers are a part of the OSI model.	There is no session & presentation layer in the TCP model.
Network layer of OSI model provide both connection oriented and connectionless service.	The Network layer in TCP/IP model provides connectionless service.

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What is Media?

- Media is used to transmit data or information from one location to another.
- It describes the various ways through which device communicate on the network.
- There are two types of media:
    1. Guided media
    2. Un guided media

| GUIDED MEDIA	UNGUIDED MEDIA
The signal requires a physical path for transmission.	The signal is broadcasted through air or sometimes water.
It is called wired communication or bounded transmission media.	It is called wireless communication or unbounded transmission media.
It provides direction to signal for travelling.	It does not provide any direction.
Twisted pair cable, coaxial cable and fiber optic cable.	Radio wave, microwave and infrared.

Twisted pair:

- Twisted pair is a physical media made up of a pair of cables twisted with each other.
- A twisted pair consists of two insulated copper wires arranged in a regular spiral pattern.
- Increasing the number of turns per foot decreases noise interference.
- A twisted pair cable is cheap as compared to other transmission media.
- Installation of the twisted pair cable is easy, and it is a lightweight cable.
- Twisted Pair cables are used in telephone lines to provide data and voice channels.
- RJ-45 is a very common application of twisted pair cables.
- There are two types of twisted pair cable:
    1. Shielded Twisted Pair Cables (STP) :
    2. Unshielded Twisted Pair Cables (UTP) :
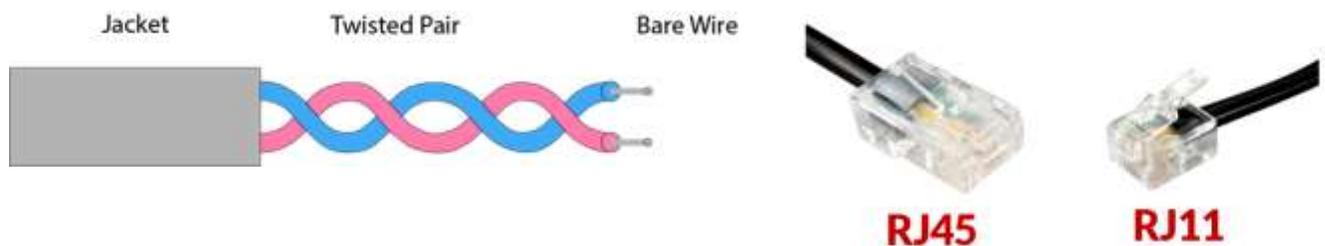
Coaxial Cable:

- Coaxial cable is very commonly used transmission media, for example, TV wire is usually a coaxial cable.
- Coaxial cable is also known as **coax.**
- It has a higher frequency as compared to twisted pair cable.
- The coaxial cables are used in Ethernet LANs and also used in MANs
- It is used in Television, Internet, CCTV, Video etc.
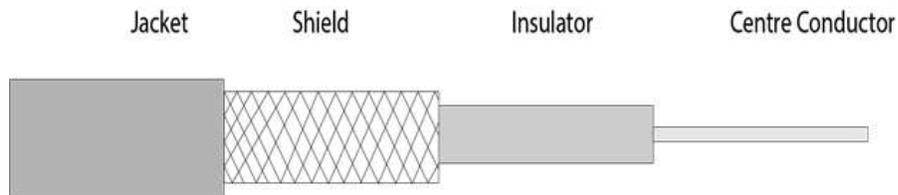
Fiber Optic:

- Fiber optic cable is a cable that uses electrical signals for communication.
- It is made up of high quality glass or plastic used to transfer digital data signal in the form of light.
- The plastic coating protects the optical fibers from heat, cold, electromagnetic interference etc.
- Fiber optics provide faster data transmission than other media.
- It is used in long distance high speed data transmission, video transmission, broadband services etc.