

# ACMT Group of College

**Polytechnic- 2<sup>nd</sup> Year/ 3<sup>rd</sup> Sem**

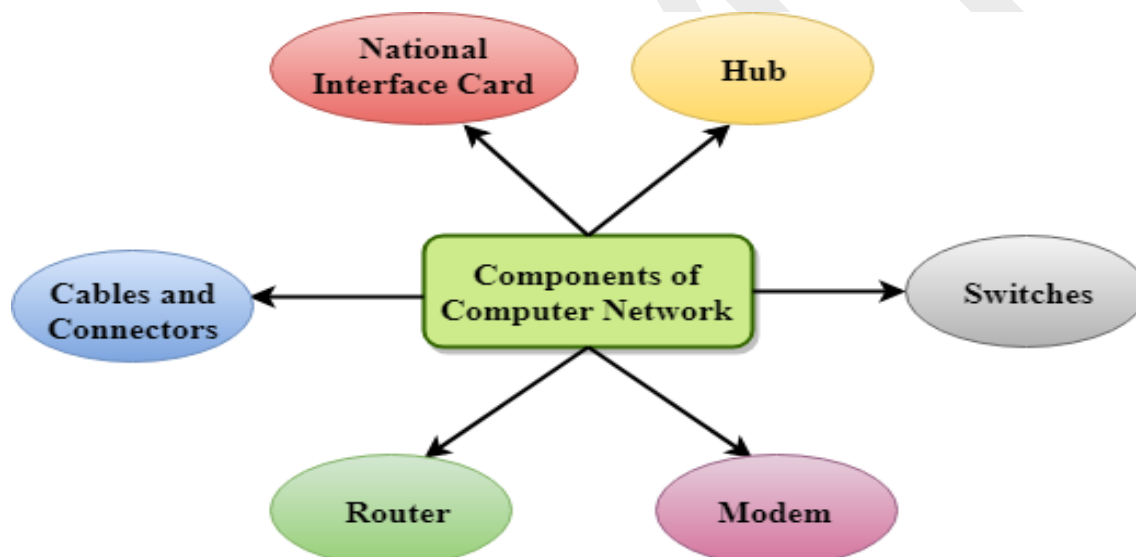


## Computer Network Notes

## Computer Network

- A computer network is a set of devices connected through links. A node can be computer, printer, or any other device capable of sending or receiving the data. The links connecting the nodes are known as communication channels.
- Computer Network is a group of computers connected with each other through wires, optical fibres or optical links so that various devices can interact with each other through a network.
- The aim of the computer network is the sharing of resources among various devices.
- In the case of computer network technology, there are several types of networks that vary from simple to complex level.

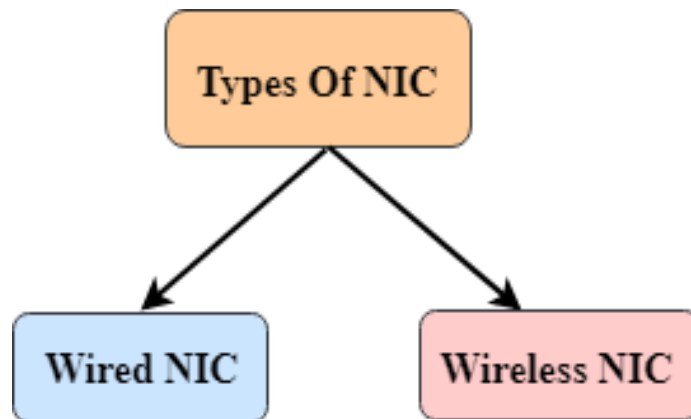
### Components of Computer Network:



### Major components of a computer network are:

#### 1) NIC

- NIC stands for network interface card.
- NIC is a hardware component used to connect a computer with another computer onto a network
- It can support a transfer rate of 10,100 to 1000 Mb/s.
- The MAC address or physical address is encoded on the network card chip which is assigned by the IEEE to identify a network card uniquely.
- The MAC address is stored in the PROM (Programmable read-only memory).

**There are two types of NIC:****a) Wired NIC****b) Wireless NIC****a) Wired NIC:**

The Wired NIC is present inside the motherboard. Cables and connectors are used with wired NIC to transfer data.

**b) Wireless NIC:**

The wireless NIC contains the antenna to obtain the connection over the wireless network. For example, laptop computer contains the wireless NIC.

**2) Hub**

- A Hub is a hardware device that provides a central point for cables in a network.
- Hub is also known as multi-station access unit (MAU).
- It usually has ports for 8-12 devices.
- It is common connection point for devices in a network.
- The process used by the Hub consumes more bandwidth and limits the amount of communication. Nowadays, the use of hub is obsolete, and it is replaced by more advanced computer network components such as Switches, Routers.

### 3) Switch

- A Switch is a hardware device that connects multiple devices on a computer network.
- A Switch contains more advanced features than Hub.
- The Switch contains the updated table that decides where the data is transmitted or not.
- Switch delivers the message to the correct destination based on the physical address present in the incoming message.
- A Switch does not broadcast the message to the entire network like the Hub.

### 4) Router

- A router is a hardware device which is used to connect a LAN with an internet connection. It is used to receive, analyze and forward the incoming packets to another network.
- A router works in a **Layer 3 (Network layer)** of the OSI Reference model.
- A router forwards the packet based on the information available in the routing table.
- It determines the best path from the available paths for the transmission of the packet.

### 5) Modem

- A modem is a hardware device that allows the computer to connect to the internet over the existing telephone line.
- It stands for Modulator/Demodulator. It converts the digital signal into an analog signal.
- A modem is not integrated with the motherboard rather than it is installed on the PCI slot found on the motherboard.

Based on the differences in speed and transmission rate, a modem can be classified in the following categories:

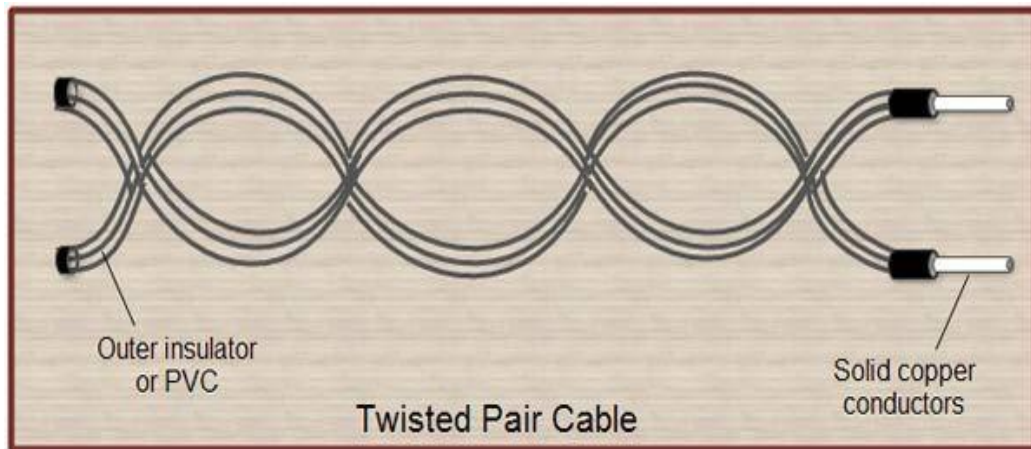
- **Standard PC modem or Dial-up modem**
- **Cellular Modem**
- **Cable modem**

### 6) Cables and Connectors

Cable is a transmission media used for transmitting a signal.

There are three types of cables used in transmission:

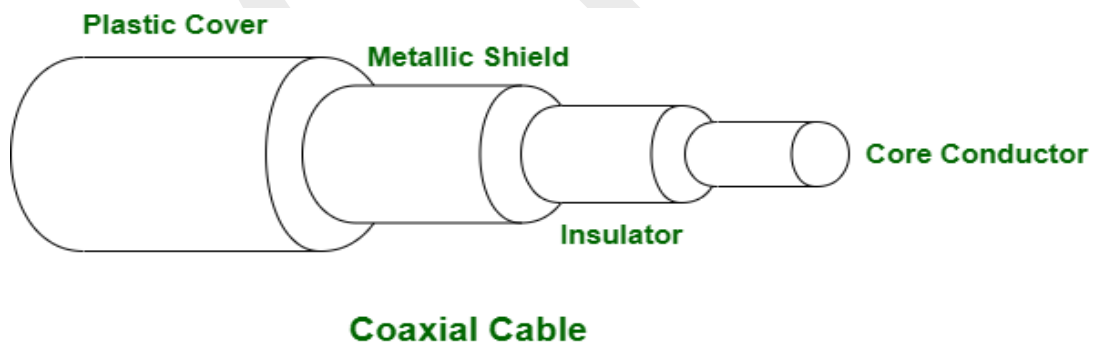
- **Twisted pair cable**



**Fig.: Twisted Pair Cable**

Twisted pair cabling is a type of wiring in which two conductors of a single circuit are twisted together for the purposes of improving electromagnetic compatibility.

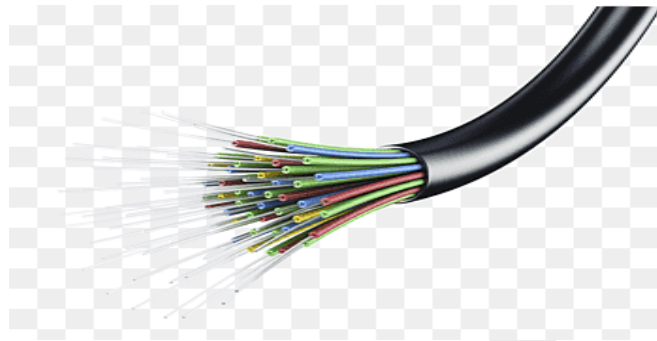
- **Coaxial cable**



**Fig.: Coaxial cable**

Coaxial cable is a type of copper cable specially built with a metal shield and other components engineered to block signal interference. It is primarily used by cable TV companies to connect their satellite antenna facilities to customer homes and businesses.

- **Fibre-optic cable**



**Fig.: Fibre-Optic Cable**

A fibre-optic cable, also known as an optical-fibre cable, is an assembly similar to an electrical cable, but containing one or more optical fibres that are used to carry light. The optical fibre elements are typically individually coated with plastic layers and contained in a protective tube suitable for the environment where the cable is used.

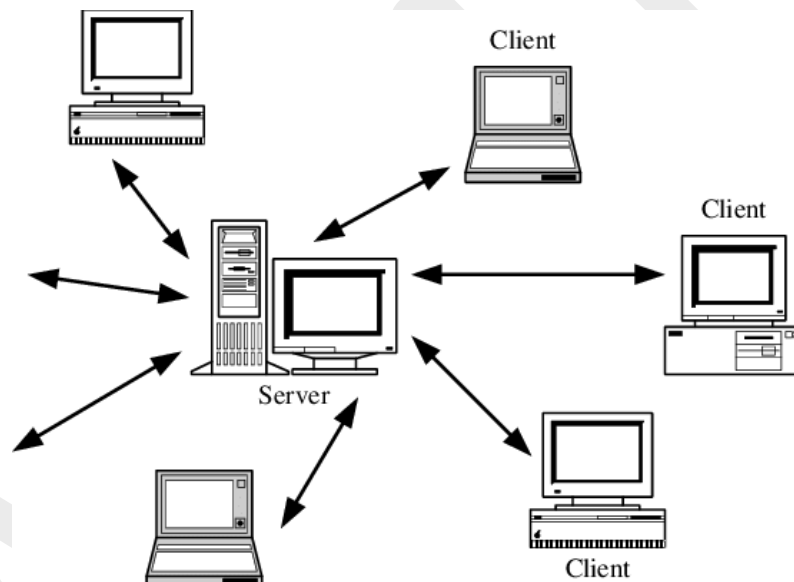
## Uses of Computer Network

- **Resource sharing:**

Resource sharing is the sharing of resources such as programs, printers, and data among the users on the network without the requirement of the physical location of the resource and user.

- **Server-Client model:**

Computer networking is used in the **server-client model**. A server is a central computer used to store the information and maintained by the system administrator. Clients are the machines used to access the information stored in the server remotely.



**Fig.: Server Client Model**

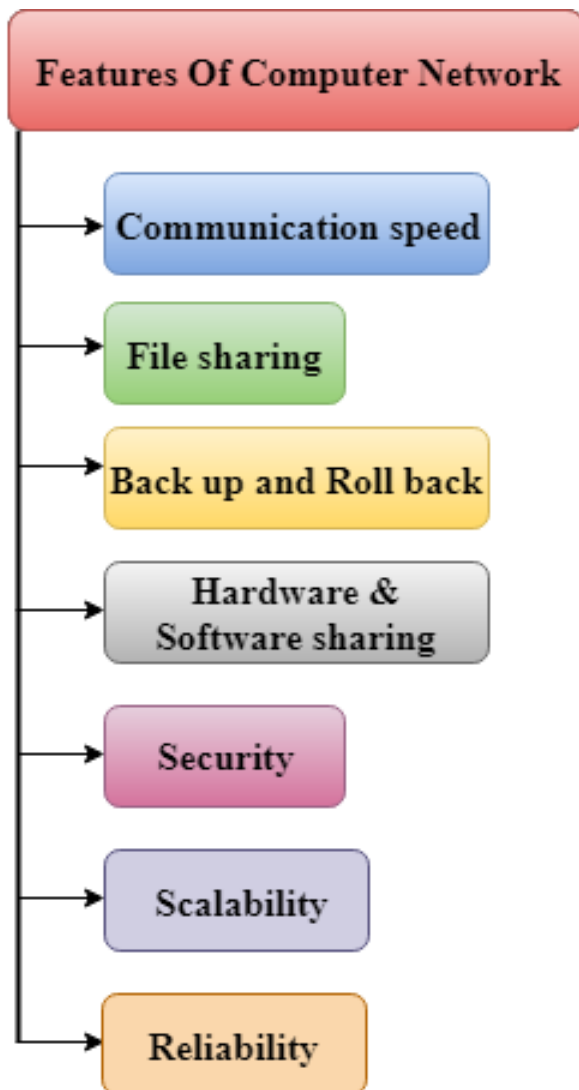
- **Communication medium:**

Computer network behaves as a communication medium among the users. For example, a company contains more than one computer has an email system which the employees use for daily communication.

- **E-commerce:**

Computer network is also important in businesses. We can do the business over the internet. For example, amazon.com is doing their business over the internet, i.e., they are doing their business over the internet.

## Features of Computer network:



### 1. Communication speed:

Network provides us to communicate over the network in a fast and efficient manner. For example, we can do video conferencing, email messaging, etc. over the internet. Therefore, the computer network is a great way to share our knowledge and ideas.

### 2. File sharing:

File sharing is one of the major advantages of the computer network. Computer network provides us to share the files with each other.



### **3. Back up and Roll back is easy:**

The files are stored in the main server which is centrally located. Therefore, it is easy to take the back up from the main server.

### **4. Software and Hardware sharing:**

We can install the applications on the main server, therefore, the user can access the applications centrally. So, we do not need to install the software on every machine. Similarly, hardware can also be shared.

### **5. Security:**

Network allows the security by ensuring that the user has the right to access the certain files and applications.

### **6. Scalability:**

Scalability means that we can add the new components on the network. Network must be scalable so that we can extend the network by adding new devices. But, it decreases the speed of the connection and data of the transmission speed also decreases, this increases the chances of error occurring. This problem can be overcome by using the routing or switching devices.

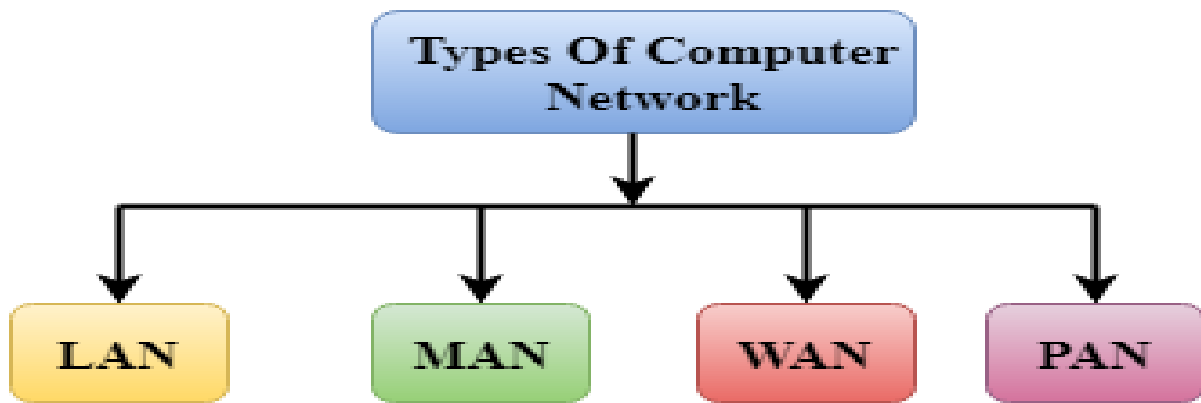
### **7. Reliability:**

Computer network can use the alternative source for the data communication in case of any hardware failure.

### **Computer Network Types:**

A computer network is a group of computers linked to each other that enables the computer to communicate with another computer and share their resources, data, and applications.

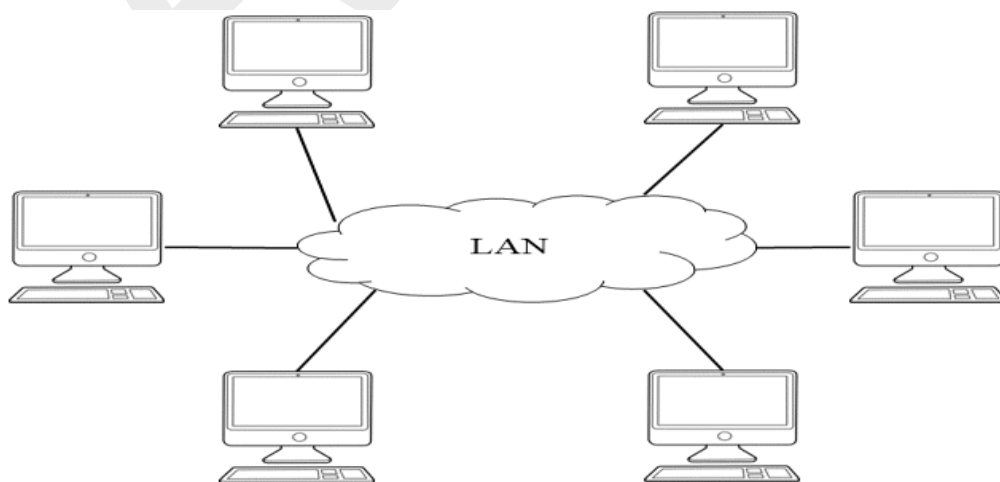
A computer network can be categorized by their size. A **computer network** is mainly of **four types**:



- **LAN(Local Area Network)**
- **PAN(Personal Area Network)**
- **MAN(Metropolitan Area Network)**
- **WAN(Wide Area Network)**

### 1. LAN (Local Area Network)

- Local Area Network is a group of computers connected to each other in a small area such as building, office.
- LAN is used for connecting two or more personal computers through a communication medium such as twisted pair, coaxial cable, etc.
- It is less costly as it is built with inexpensive hardware such as hubs, network adapters, and Ethernet cables.
- The data is transferred at an extremely faster rate in Local Area Network.
- Local Area Network provides higher security.
- A LAN network is limited to b/w 100-1000mbps.



**Fig.: Local Area Network (LAN)**

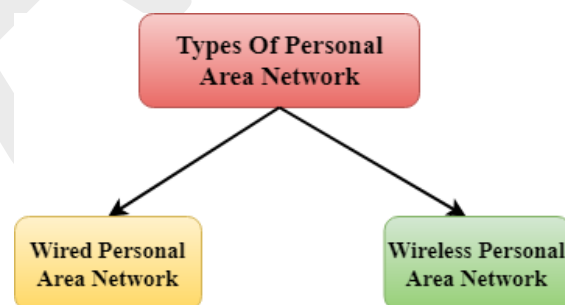
## 2. PAN (Personal Area Network)

- Personal Area Network is a network arranged within an individual person, typically within a range of 10 meters.
- Personal Area Network is used for connecting the computer devices of personal use is known as Personal Area Network.
- **Thomas Zimmerman** was the first research scientist to bring the idea of the Personal Area Network.
- Personal Area Network covers an area of **30 feet**.
- Personal computer devices that are used to develop the personal area network are the laptop, mobile phones, media player and play stations.



**Fig.: Personal Area Network (PAN)**

**There are two types of Personal Area Network:**



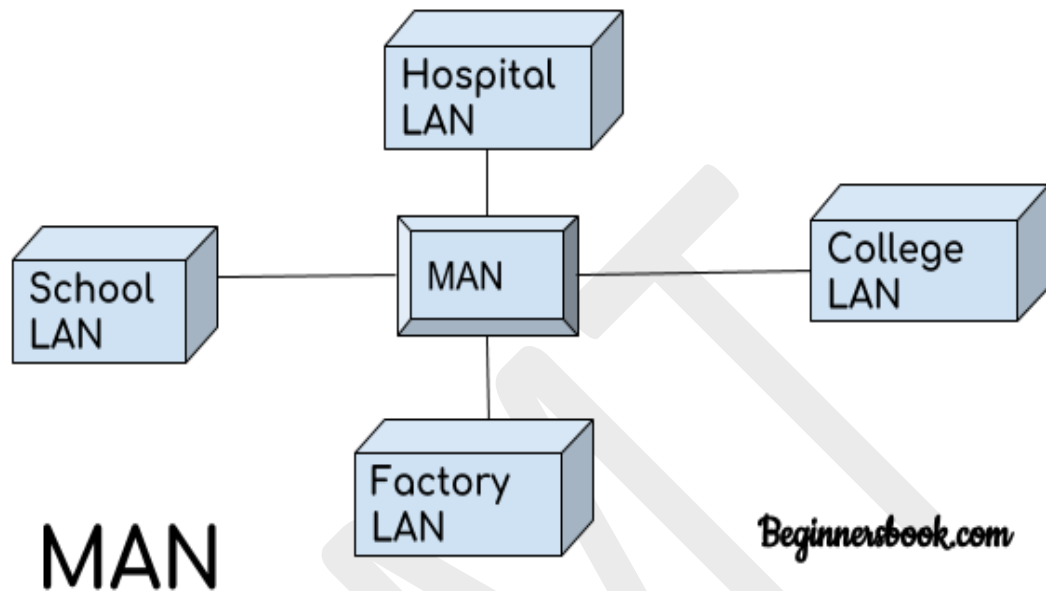
### a) Wireless Personal Area Network:

Wireless Personal Area Network is developed by simply using wireless technologies such as Wi-Fi, Bluetooth. It is a low range network.

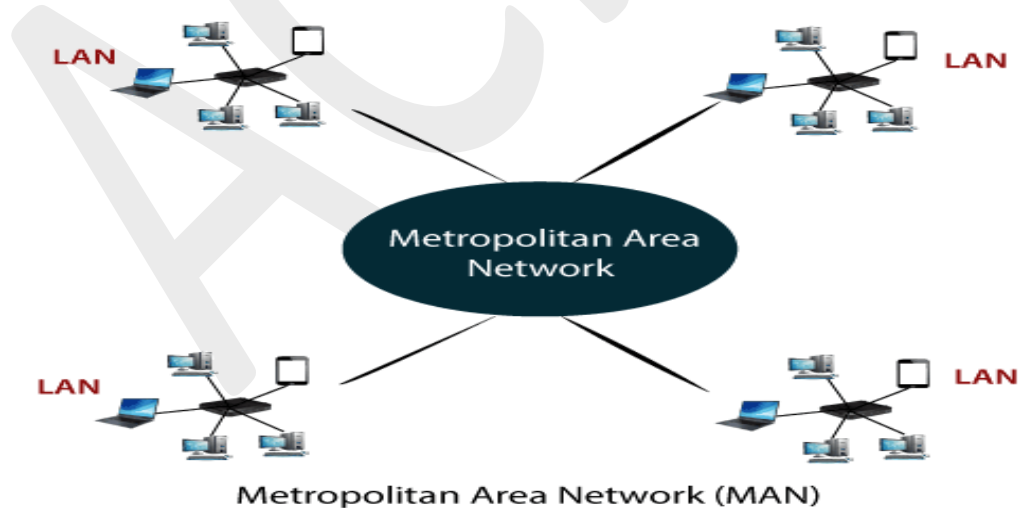
## b) Wired Personal Area Network:

Wired Personal Area Network is created by using the USB.

## 3. MAN (Metropolitan Area Network)



**Fig. 1: Metropolitan Area Network (MAN)**



**Fig 2: Metropolitan Area Network (MAN)**

- A Metropolitan area network is a network that covers a larger geographic area by interconnecting a different LAN to form a larger network.
- Government agencies use MAN to connect to the citizens and private industries.

- In MAN, various LANs are connected to each other through a telephone exchange line.
- The most widely used protocols in MAN are RS-232, Frame Relay, ATM, ISDN, OC-3, ADSL, etc.
- It has a higher range than Local Area Network (LAN).

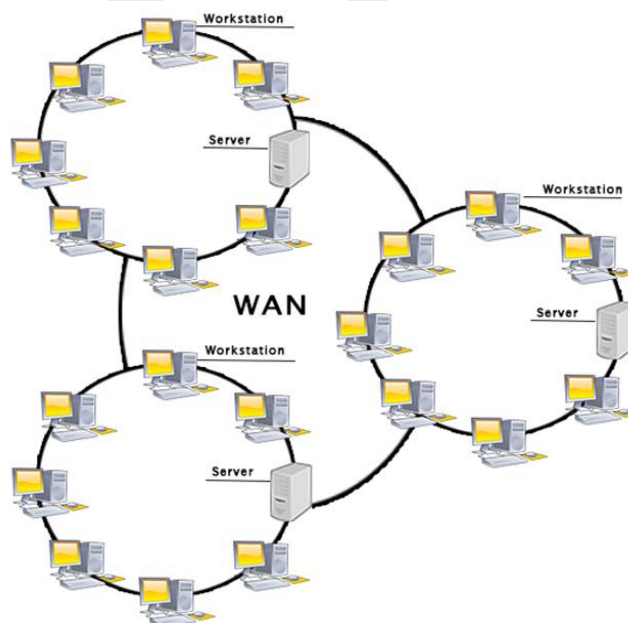
### Uses of Metropolitan Area Network:

- MAN is used in communication between the banks in a city.
- It can be used in an Airline Reservation.
- It can be used in a college within a city.
- It can also be used for communication in the military.

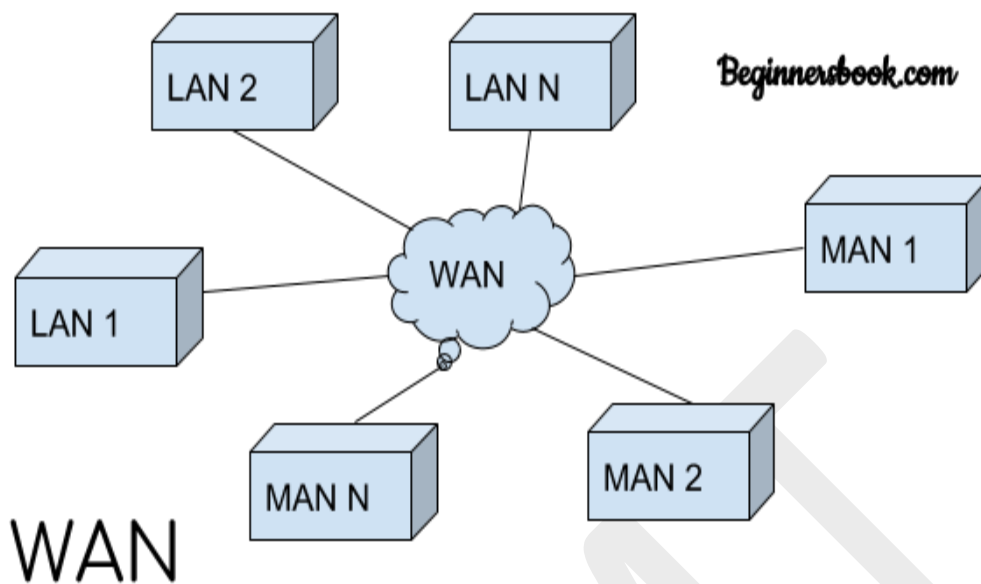
### 4. WAN (Wide Area Network)

- A Wide Area Network is a network that extends over a large geographical area such as states or countries.
- A Wide Area Network is quite bigger network than the LAN.
- A Wide Area Network is not limited to a single location, but it spans over a large geographical area through a telephone line, fibre optic cable or satellite links.
- The internet is one of the biggest WAN in the world.

A Wide Area Network is widely used in the field of Business, government, and education.



**Fig.1: Wide Area Network (WAN)**

**Other Diagram:****Fig.2: Wide Area Network (WAN)****Advantages of Wide Area Network:**

- **Geographical area:** A Wide Area Network provides a large geographical area. Suppose if the branch of our office is in a different city then we can connect with them through WAN. The internet provides a leased line through which we can connect with another branch.
- **Centralized data:** In case of WAN network, data is centralized. Therefore, we do not need to buy the emails, files or back up servers.
- **Get updated files:** Software companies work on the live server. Therefore, the programmers get the updated files within seconds.
- **Exchange messages:** In a WAN network, messages are transmitted fast. The web application like Face book, Whatsapp, and Skype allows you to communicate with friends.
- **Sharing of software and resources:** In WAN network, we can share the software and other resources like a hard drive, RAM.
- **Global business:** We can do the business over the internet globally.
- **High bandwidth:** If we use the leased lines for our company then this gives the high bandwidth. The high bandwidth increases the data transfer rate which in turn increases the productivity of our company.

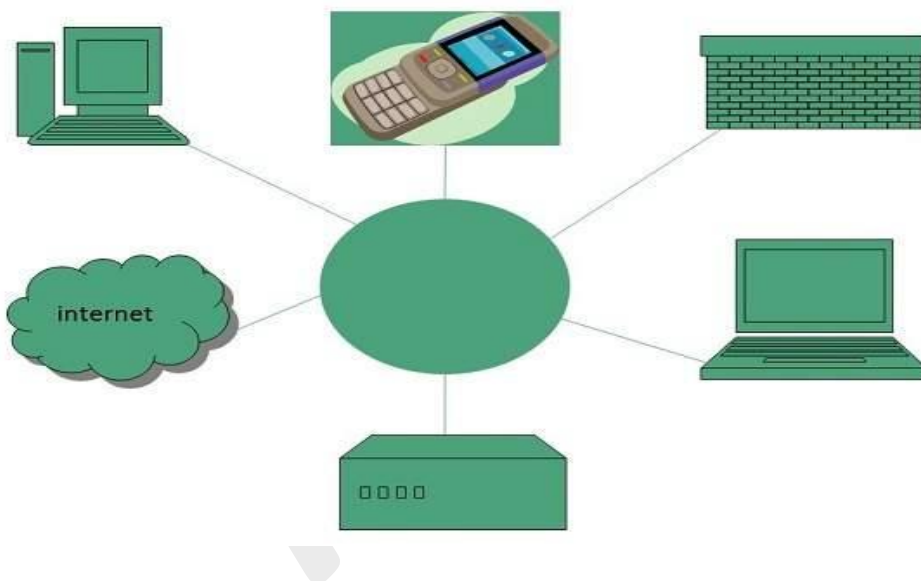
## Disadvantages of Wide Area Network:

- **Security issue:** A WAN network has more security issues as compared to LAN and MAN network as all the technologies are combined together that creates the security problem.
- **Needs Firewall & antivirus software:** The data is transferred on the internet which can be changed or hacked by the hackers, so the firewall needs to be used. Some people can inject the virus in our system so antivirus is needed to protect from such a virus.
- **High Setup cost:** An installation cost of the WAN network is high as it involves the purchasing of routers, switches.
- **Troubleshooting problems:** It covers a large area so fixing the problem is difficult.

## ARPANET

- The origin of Internet devised from the concept of **Advanced Research Project Agency Network (ARPANET)**.
- **ARPANET** was developed by United States Department of Defence.
- Basic purpose of ARPANET was to provide communication among the various bodies of government.
- Initially, there were only four nodes, formally called **Hosts**.
- In 1972, the **ARPANET** spread over the globe with 23 nodes located at different countries and thus became known as **Internet**.
- By the time, with invention of new technologies such as TCP/IP protocols, DNS, WWW, browsers, scripting languages etc.,
- Internet provided a medium to publish and access information over the web.

## Internet



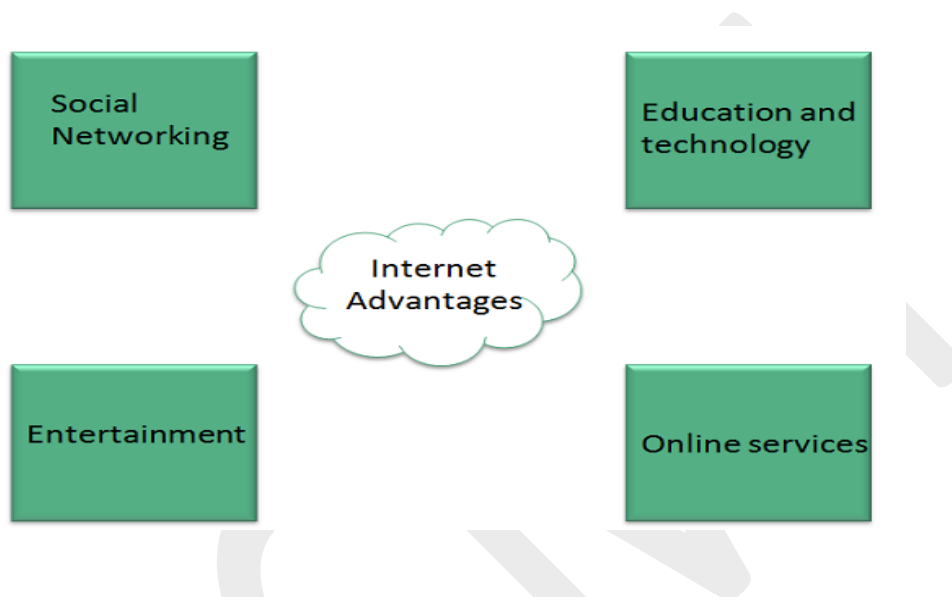
**Fig.: Internet**

- Internet is defined as an Information super Highway, to access information over the web. However, it can be defined in many ways as follows:
- Internet is a world-wide global system of interconnected computer networks.
- Internet uses the standard Internet Protocol (TCP/IP).
- Every computer in internet is identified by a unique IP address.



- IP Address is a unique set of numbers (such as 110.22.33.114) which identifies a computer location.
- A special computer DNS (Domain Name Server) is used to give name to the IP Address so that user can locate a computer by a name.
- Internet is accessible to every user all over the world.

## Advantages of Internet:



**Fig.: Advantages of Internet**

Internet allows us to communicate with the people sitting at remote locations.

### 1) Social Networking:

There are various apps available on the web that uses Internet as a medium for communication. One can find various social networking sites such as:

- Facebook
- Twitter
- Yahoo
- Google+
- Flickr
- Orkut

### 2) Education and Technology:

Internet allow us to use many services provide such as technology, health and science, social studies, information technology, etc.

### 3) Entertainment:

Apart from communication and source of information, internet also serves a medium for entertainment. Following are the various modes for entertainment over internet.

- Online Games
- Online Television
- Online Songs
- Online Videos
- Social Networking Apps

### 4) Online Services

Internet allows us to use many services like:

- Internet Banking
- Matrimonial Services
- Online Shopping
- Online Ticket Booking
- Online Bill Payment
- Data Sharing
- E-mail

### 5) E- Commerce

Internet provides concept of electronic commerce that allows the business deals to be conducted on electronic systems.

### Disadvantages of Internet:



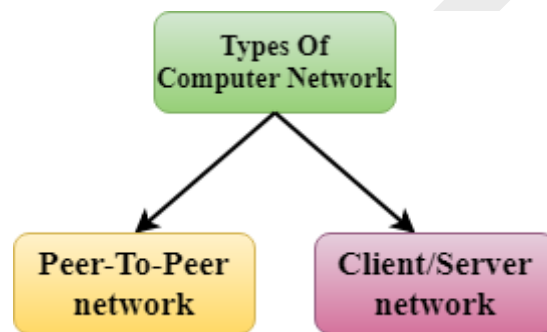
**Fig.: Disadvantages of Internet**

- 1. Threat to personal information:** There are always chances to lose personal information such as name, address, credit card number. Therefore, one should be very careful while sharing such information. One should use credit cards only through authenticated sites.
- 2. Spamming:** Spamming corresponds to the unwanted e-mails in bulk. These e-mails serve no purpose and lead to obstruction of entire system.
- 3. Cyber Crime:** Also a biggest threat on internet is pornography. There are many pornographic sites that can be found, letting your children to use internet which indirectly affects the children healthy mental life.
- 4. Virus Attack:** Virus can easily be spread to the computers connected to internet. Such virus attacks may cause your system to crash or your important data may get deleted.

## Computer Network Architecture

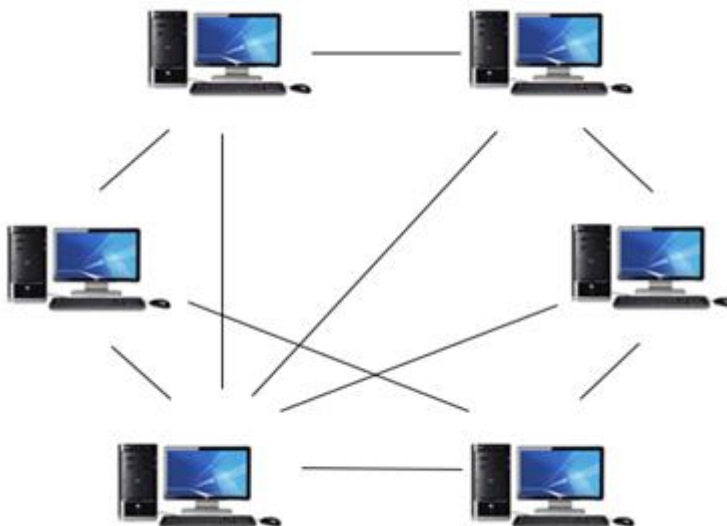
Computer Network Architecture is defined as the physical and logical design of the software, hardware, protocols, and media of the transmission of data. Simply we can say that how computers are organized and how tasks are allocated to the computer.

**The two types of network architectures are used:**



- **Peer-To-Peer network**
- **Client/Server network**

### **1. Peer-To-Peer network**



**Fig.: Peer-To-Peer Network**

- Peer-To-Peer network is a network in which all the computers are linked together with equal privilege and responsibilities for processing the data.
- Peer-To-Peer network is useful for small environments, usually up to 10 computers.
- Peer-To-Peer network has no dedicated server.
- Special permissions are assigned to each computer for sharing the resources, but this can lead to a problem if the computer with the resource is down.

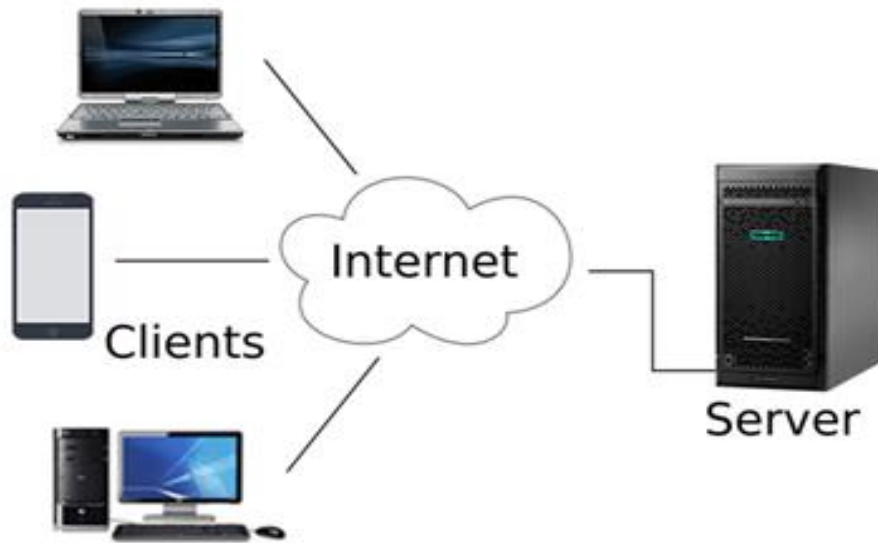
### **Advantages of Peer-To-Peer Network:**

- It is less costly as it does not contain any dedicated server.
- If one computer stops working but, other computers will not stop working.
- It is easy to set up and maintain as each computer manages itself.

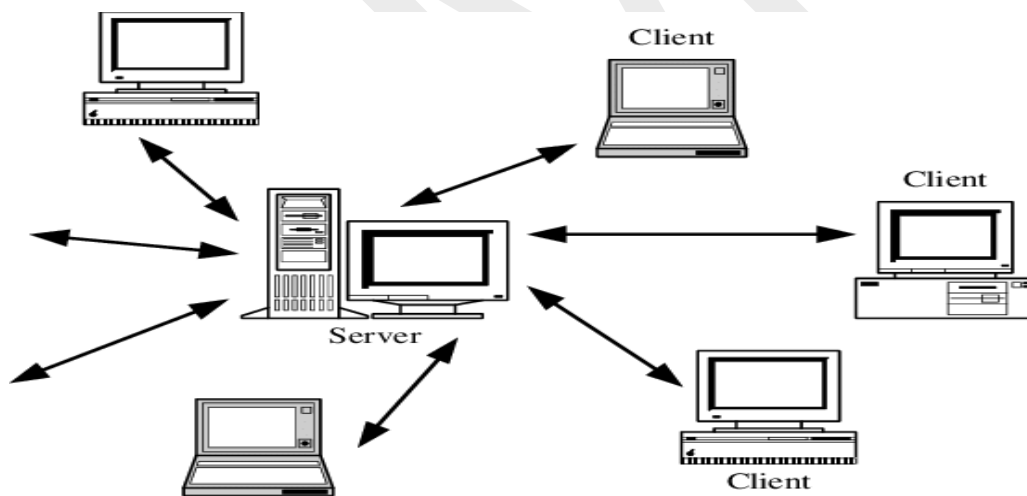
### **Disadvantages of Peer-To-Peer Network:**

- In the case of Peer-To-Peer network, it does not contain the centralized system. Therefore, it cannot back up the data as the data is different in different locations.
- It has a security issue as the device is managed itself.

## 2. Client/Server Network



**Fig. 1: Client/Server Model**



**Fig. 2: Client/ Server Model**

- Client/Server network is a network model designed for the end users called clients, to access the resources such as songs, video, etc. from a central computer known as Server.
- The central controller is known as a **server** while all other computers in the network are called **clients**.
- A server performs all the major operations such as security and network management.

- A server is responsible for managing all the resources such as files, directories, printer, etc.
- All the clients communicate with each other through a server.

### **Advantages of Client/Server network:**

- A Client/Server network contains the centralized system. Therefore we can back up the data easily.
- A Client/Server network has a dedicated server that improves the overall performance of the whole system.
- Security is better in Client/Server network as a single server administers the shared resources.
- It also increases the speed of the sharing resources.

### **Disadvantages of Client/Server network:**

- Client/Server network is expensive as it requires the server with large memory.
- A server has a Network Operating System (NOS) to provide the resources to the clients, but the cost of NOS is very high.
- It requires a dedicated network administrator to manage all the resources.

### **Internetwork**

- An internetwork is defined as two or more computer network LANs or WAN or computer network segments are connected using devices, and they are configured by a local addressing scheme. This process is known as **internetworking**.
- An interconnection between public, private, commercial, industrial, or government computer networks can also be defined as **internetworking**.
- An internetworking uses the **internet protocol**.
- The reference model used for internetworking is **Open System Interconnection (OSI)**.

### **Types of Internetwork:**

#### **1. Extranet:**

- An extranet is a communication network based on the internet protocol such as **Transmission Control protocol** and **internet protocol**.

- It is used for information sharing. The access to the extranet is restricted to only those users who have login credentials.
- An extranet is the lowest level of internetworking.
- It can be categorized as **MAN**, **WAN** or other computer networks. An extranet cannot have a single **LAN**; at least it must have one connection to the external network.

## 2. Intranet:

- An intranet is a private network based on the internet protocol such as **Transmission Control protocol** and **internet protocol**.
- An intranet belongs to an organization which is only accessible by the **organization's employee** or members.
- The main aim of the intranet is to share the information and resources among the organization employees.
- An intranet provides the facility to work in groups and for teleconferences.

### Intranet advantages:

- **Communication:** It provides a cheap and easy communication. An employee of the organization can communicate with another employee through email, chat.
- **Time-saving:** Information on the intranet is shared in real time, so it is time-saving.
- **Collaboration:** Collaboration is one of the most important advantages of the intranet. The information is distributed among the employees of the organization and can only be accessed by the authorized user.
- **Platform independency:** It is a neutral architecture as the computer can be connected to another device with different architecture.
- **Cost effective:** People can see the data and documents by using the browser and distributes the duplicate copies over the intranet. This leads to a reduction in the cost.

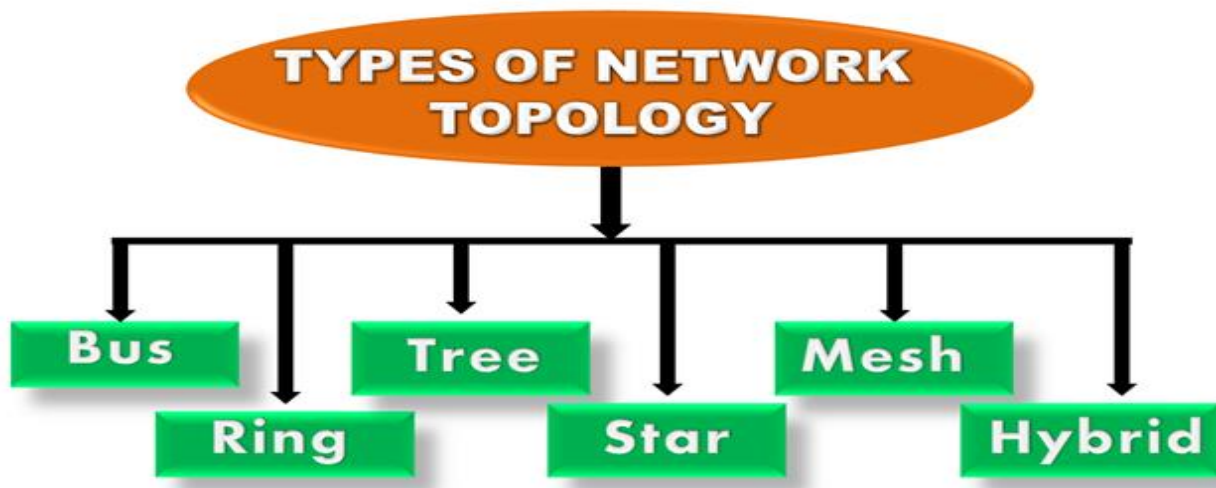


## Topology

Topology defines the structure of the network of how all the components are interconnected to each other.

There are two types of topology: physical and logical topology.

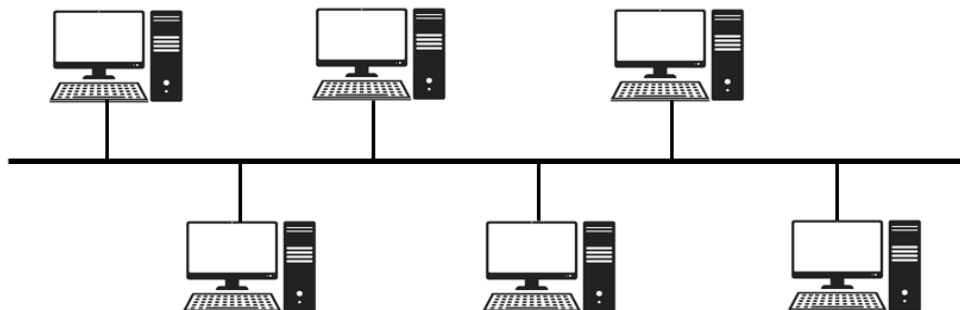
Physical topology is the geometric representation of all the nodes in a network.



**Fig.: Types of Topology**

### a. Bus Topology

Bus Topology



**Fig.: Bus Topology**

- A bus network is a network architecture in which there is a single central cable to which all devices are attached.
- The central cable is called a bus.
- The bus transmits data in both directions.
- Only one device can transmit at a time.
- It is easy to add/remove devices from a bus network. It is also an inexpensive topology. Failure of one device does not affect another device.

### **Advantages of Bus topology:**

- **Low-cost cable:** In bus topology, nodes are directly connected to the cable without passing through a hub. Therefore, the initial cost of installation is low.
- **Moderate data speeds:** Coaxial or twisted pair cables are mainly used in bus-based networks that support up to 10 Mbps.
- **Familiar technology:** Bus topology is a familiar technology as the installation and troubleshooting techniques are well known, and hardware components are easily available.
- **Limited failure:** A failure in one node will not have any effect on other nodes.

### **Disadvantages of Bus topology:**

- **Extensive cabling:** A bus topology is quite simpler, but still it requires a lot of cabling.
- **Difficult troubleshooting:** It requires specialized test equipment to determine the cable faults. If any fault occurs in the cable, then it would disrupt the communication for all the nodes.
- **Signal interference:** If two nodes send the messages simultaneously, then the signals of both the nodes collide with each other.
- **Reconfiguration difficult:** Adding new devices to the network would slow down the network.
- **Attenuation:** Attenuation is a loss of signal leads to communication issues. Repeaters are used to regenerate the signal.

## Ring Topology



**Fig.: Ring Topology**

- A ring network is a topology where each device is connected to two others, so as to create a ring or closed loop.
- Data transmitted on a network travels in one direction on the ring from device to device until it reaches its destination.
- It has no terminated ends, i.e., each node is connected to other node and having no termination point.

### **Advantages of Ring topology:**

- **Network Management:** Faulty devices can be removed from the network without bringing the network down.
- **Product availability:** Many hardware and software tools for network operation and monitoring are available.
- **Cost:** Twisted pair cabling is inexpensive and easily available. Therefore, the installation cost is very low.
- **Reliable:** It is a more reliable network because the communication system is not dependent on the single host computer.

### **Disadvantages of Ring topology:**

- **Difficult troubleshooting:** It requires specialized test equipment to determine the cable faults. If any fault occurs in the cable, then it would disrupt the communication for all the nodes.

- **Failure:** The breakdown in one station leads to the failure of the overall network.
- **Reconfiguration difficult:** Adding new devices to the network would slow down the network.
- **Delay:** Communication delay is directly proportional to the number of nodes. Adding new devices increases the communication delay.

## Star Topology



**Fig.: Star Topology**

- A Star topology, in its simplest form, consists of one central, hub or central computer, which acts as a router to transmit messages.
- All data passes through the hub.
- Coaxial cable or RJ-45 cables are used to connect the computers.
- If a device fails, there is no effect on the network, only if the hub fails will network be affected.
- Hubs or Switches are mainly used as connection devices in a **physical star topology**.

## Advantages of Star topology

- **Network control:** Complex network control features can be easily implemented in the star topology. Any changes made in the star topology are automatically accommodated.
- **Limited failure:** As each station is connected to the central hub with its own cable, therefore failure in one cable will not affect the entire network.

- **Familiar technology:** Star topology is a familiar technology as its tools are cost-effective.
- **Easily expandable:** It is easily expandable as new stations can be added to the open ports on the hub.
- **Cost effective:** Star topology networks are cost-effective as it uses inexpensive coaxial cable.
- **High data speeds:** It supports a bandwidth of approx 100Mbps. Ethernet 100BaseT is one of the most popular Star topology networks.

### Disadvantages of Star topology

- **A Central point of failure:** If the central hub or switch goes down, then all the connected nodes will not be able to communicate with each other.
- **Cable:** Sometimes cable routing becomes difficult when a significant amount of routing is required.

### Tree Topology



**Fig.: Tree Topology**

- Tree topology combines the characteristics of bus topology and star topology.
- A tree topology is a type of structure in which all the computers are connected with each other in hierarchical fashion.
- The top-most node in tree topology is known as a root node, and all other nodes are the descendants of the root node.

- There is only one path exists between two nodes for the data transmission. Thus, it forms a parent-child hierarchy.

### **Advantages of Tree Topology**

- **Support for broadband transmission:** Tree topology is mainly used to provide broadband transmission, i.e., signals are sent over long distances without being attenuated.
- **Easily expandable:** We can add the new device to the existing network. Therefore, we can say that tree topology is easily expandable.
- **Easily manageable:** In tree topology, the whole network is divided into segments known as star networks which can be easily managed and maintained.
- **Limited failure:** The breakdown in one station does not affect the entire network.
- **Point-to-point wiring:** It has point-to-point wiring for individual segments.

### **Disadvantages of Tree Topology**

- **Difficult troubleshooting:** If any fault occurs in the node, then it becomes difficult to troubleshoot the problem.
- **High cost:** Devices required for broadband transmission are very costly.
- **Failure:** A tree topology mainly relies on main bus cable and failure in main bus cable will damage the overall network.
- **Reconfiguration difficult:** If new devices are added, then it becomes difficult to reconfigure.

## Mesh Topology



**Fig.: Mesh Topology**

- Mesh technology is an arrangement of the network in which computers are interconnected with each other through various redundant connections.
- There are multiple paths from one computer to another computer.
- It does not contain the switch, hub or any central computer which acts as a central point of communication.
- The Internet is an example of the mesh topology.
- Mesh topology is mainly used for WAN implementations where communication failures are a critical concern.
- Mesh topology is mainly used for wireless networks.

### **Advantages of Mesh topology:**

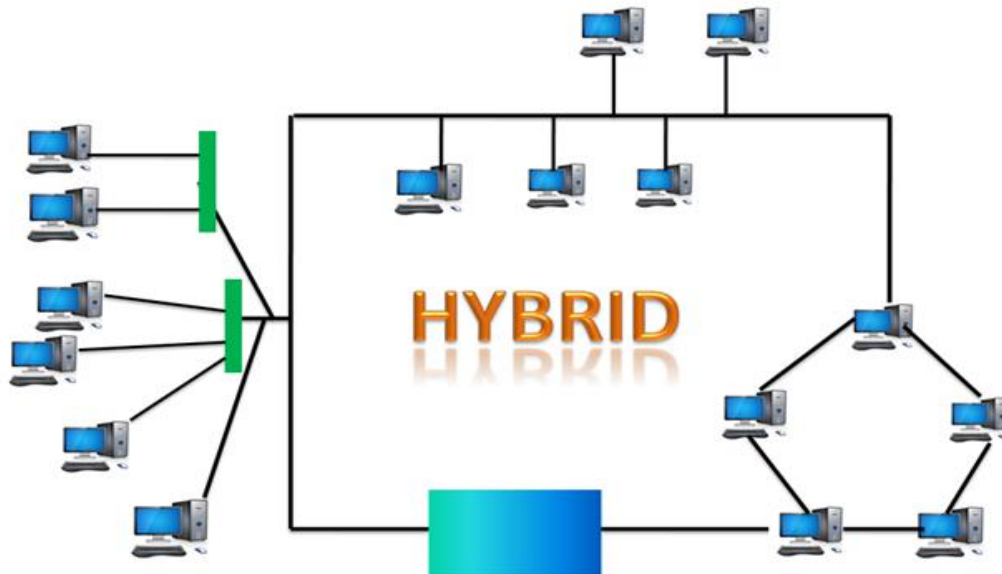
- **Reliable:** The mesh topology networks are very reliable as if any link breakdown will not affect the communication between connected computers.
- **Fast Communication:** Communication is very fast between the nodes.
- **Easier Reconfiguration:** Adding new devices would not disrupt the communication between other devices.

### **Disadvantages of Mesh topology**

- **Cost:** A mesh topology contains a large number of connected devices such as a router and more transmission media than other topologies.

- **Management:** Mesh topology networks are very large and very difficult to maintain and manage. If the network is not monitored carefully, then the communication link failure goes undetected.
- **Efficiency:** In this topology, redundant connections are high that reduces the efficiency of the network.

## Hybrid Topology



**Fig.: Hybrid Topology**

- The combination of various different topologies is known as **Hybrid topology**.
- A Hybrid topology is a connection between different links and nodes to transfer the data.
- When two or more different topologies are combined together is termed as Hybrid topology and if similar topologies are connected with each other will not result in Hybrid topology. For example, if there exist a ring topology in one branch of ICICI bank and bus topology in another branch of ICICI bank, connecting these two topologies will result in Hybrid topology.

## Advantages of Hybrid Topology

- **Reliable:** If a fault occurs in any part of the network will not affect the functioning of the rest of the network.
- **Scalable:** Size of the network can be easily expanded by adding new devices without affecting the functionality of the existing network.



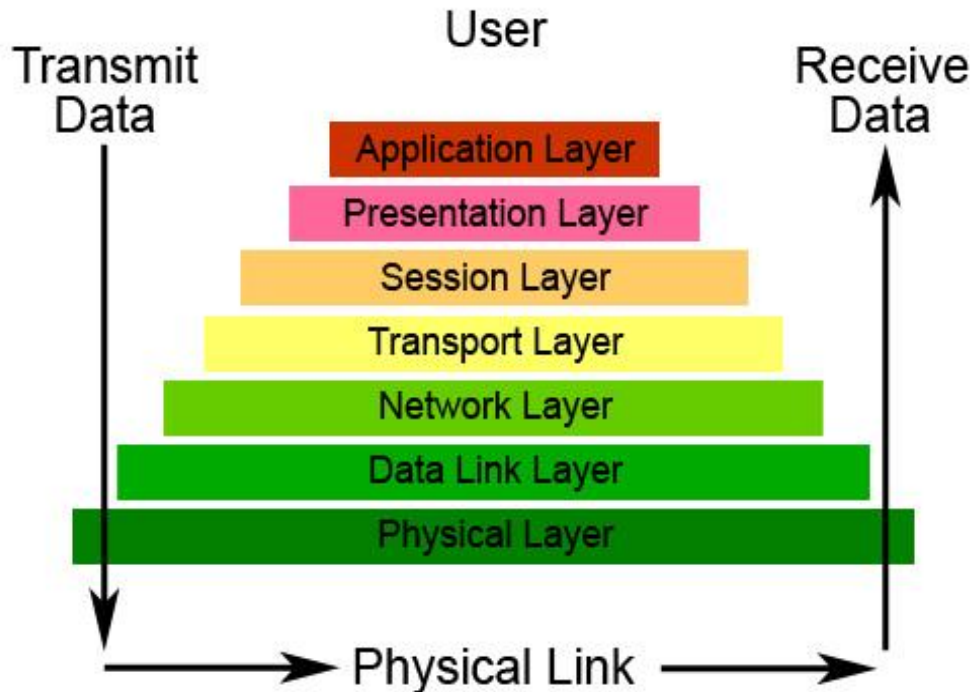
- **Flexible:** This topology is very flexible as it can be designed according to the requirements of the organization.
- **Effective:** Hybrid topology is very effective as it can be designed in such a way that the strength of the network is maximized and weakness of the network is minimized.

### **Disadvantages of Hybrid topology**

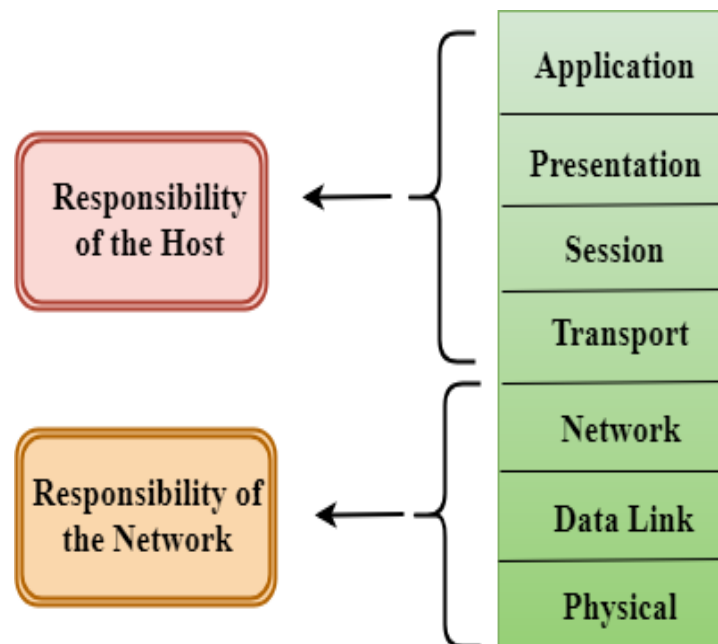
- **Complex design:** The major drawback of the Hybrid topology is the design of the Hybrid network. It is very difficult to design the architecture of the Hybrid network.
- **Costly Hub:** The Hubs used in the Hybrid topology are very expensive as these hubs are different from usual Hubs used in other topologies.
- **Costly infrastructure:** The infrastructure cost is very high as a hybrid network requires a lot of cabling, network devices, etc.

## OSI Model

# The Seven Layers of OSI



- OSI stands for **Open System Interconnection** is a reference model that describes how information from a software application in one computer moves through a physical medium to the software application in another computer.
- OSI consists of seven layers, and each layer performs a particular network function.
- OSI model was developed by the International Organization for Standardization (ISO) in 1984, and it is now considered as an architectural model for the inter-computer communications.
- OSI model divides the whole task into seven smaller and manageable tasks. Each layer is assigned a particular task.
- Each layer is self-contained, so that task assigned to each layer can be performed independently.



### Characteristics of OSI Model:

- The OSI model is divided into two layers: upper layers and lower layers.
- The upper layer of the OSI model mainly deals with the application related issues, and they are implemented only in the software. The application layer is closest to the end user. Both the end user and the application layer interact with the software applications. An upper layer refers to the layer just above another layer.
- The lower layer of the OSI model deals with the data transport issues. The data link layer and the physical layer are implemented in hardware and software. The physical layer is the lowest layer of the OSI model and is closest to the physical medium. The physical layer is mainly responsible for placing the information on the physical medium.

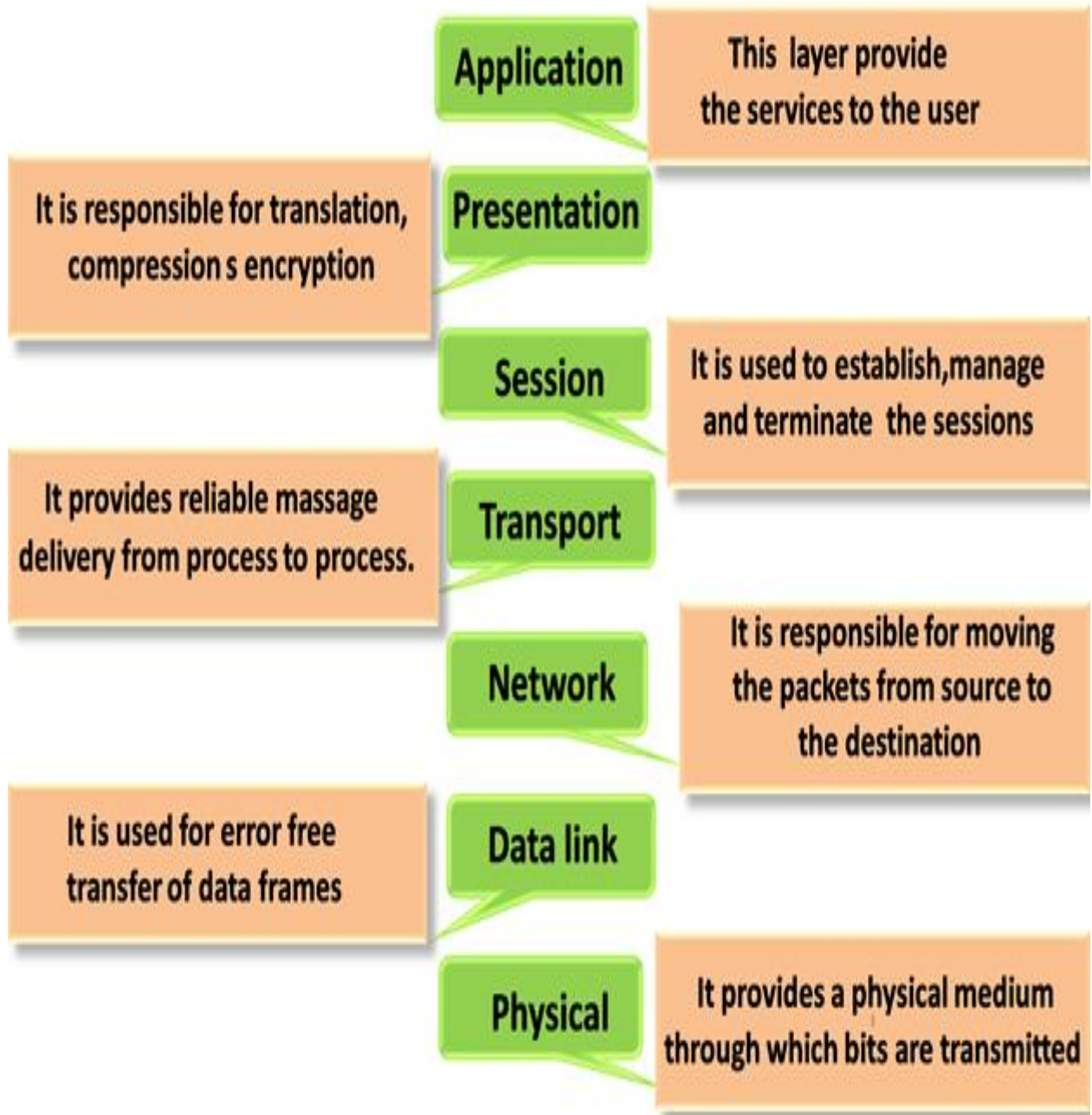
### Functions of the OSI Layers

There are the seven OSI layers. Each layer has different functions.

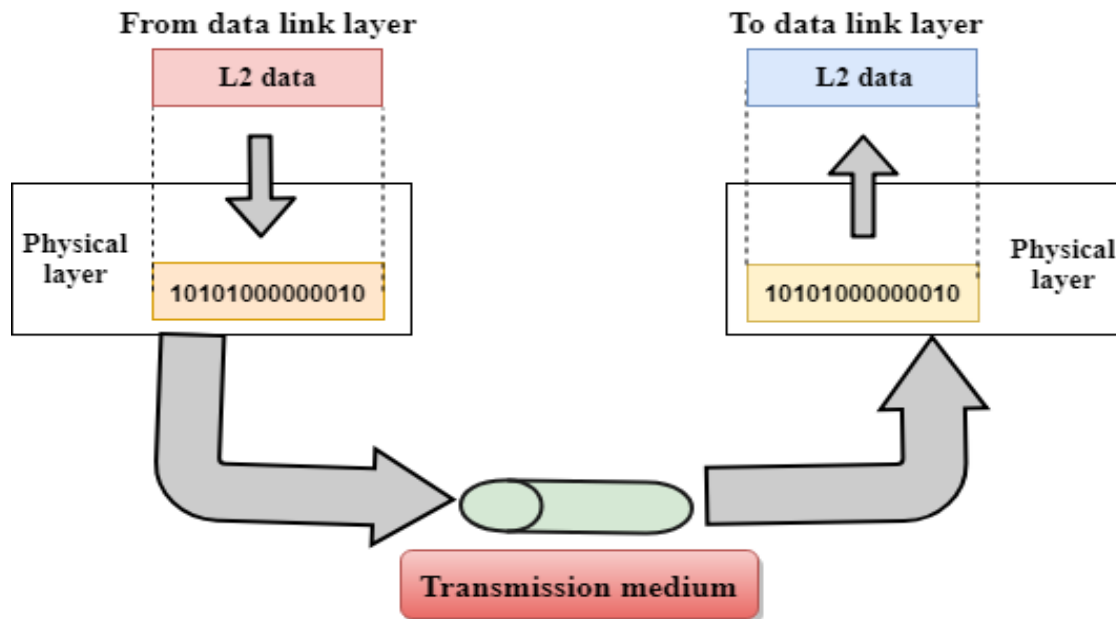
Lists of seven layers are given below:

1. Physical Layer
2. Data-Link Layer
3. Network Layer
4. Transport Layer
5. Session Layer
6. Presentation Layer

## 7. Application Layer



## Physical Layer:



- The main functionality of the physical layer is to transmit the individual bits from one node to another node.
- It is the lowest layer of the OSI model.
- It establishes, maintains and deactivates the physical connection.
- It specifies the mechanical, electrical and procedural network interface specifications.
- It is also known as Lower Layer or hardware layers.
- Hub, Repeater, Modem, Cables are Physical Layer devices.

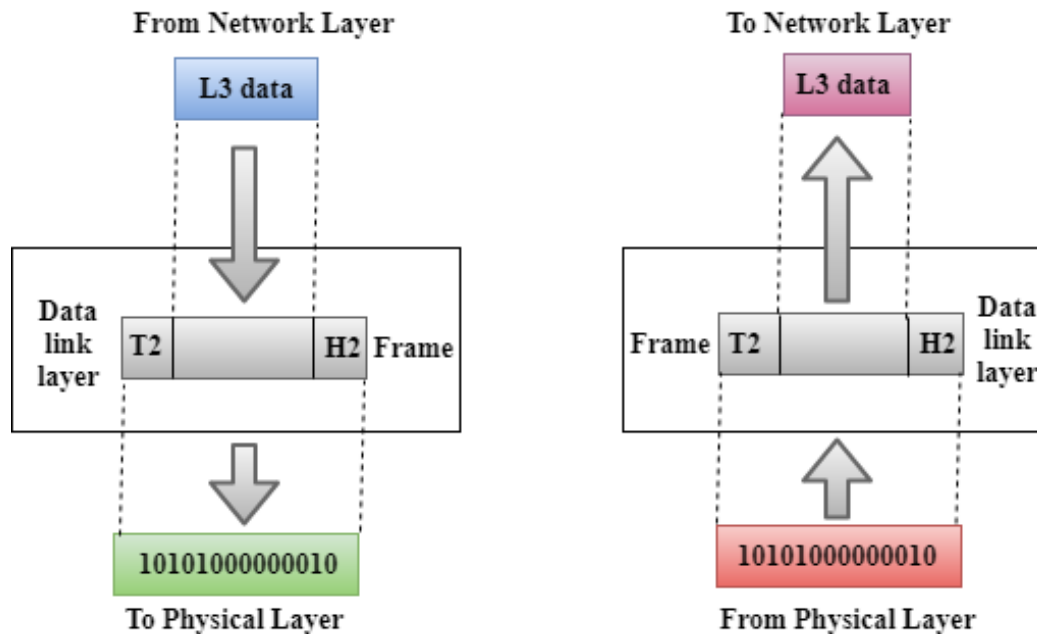
### The Functions of physical layer are-

The functions of the physical layer are:

1. **Bit synchronization:** The physical layer provides the synchronization of the bits by providing a clock. This clock controls both sender and receiver thus providing synchronization at bit level.
2. **Bit rate control:** The Physical layer also defines the transmission rate i.e. the number of bits sent per second.
3. **Physical topologies:** Physical layer specifies the way in which the different, devices/nodes are arranged in a network i.e. bus, star, or mesh topology.

4. **Transmission mode:** Physical layer also defines the way in which the data flows between the two connected devices. The various transmission modes possible are simplex, half-duplex and full-duplex.

### Data-Link Layer



- The data link layer is responsible for the node-to-node delivery of the message. The main function of this layer is to make sure data transfer is error-free from one node to another, over the physical layer.
- It is mainly responsible for the unique identification of each device that resides on a local network.
- **Data Link Layer is divided into two sub layers:**
  - **Logical Link Control Layer**
    - It is responsible for transferring the packets to the Network layer of the receiver that is receiving.
    - It identifies the address of the network layer protocol from the header.
    - It also provides flow control.
  - **Media Access Control Layer**
    - A Media access control layer is a link between the Logical Link Control layer and the network's physical layer.
    - It is used for transferring the packets over the network.

Packet in Data Link layer is referred to as **Frame**.

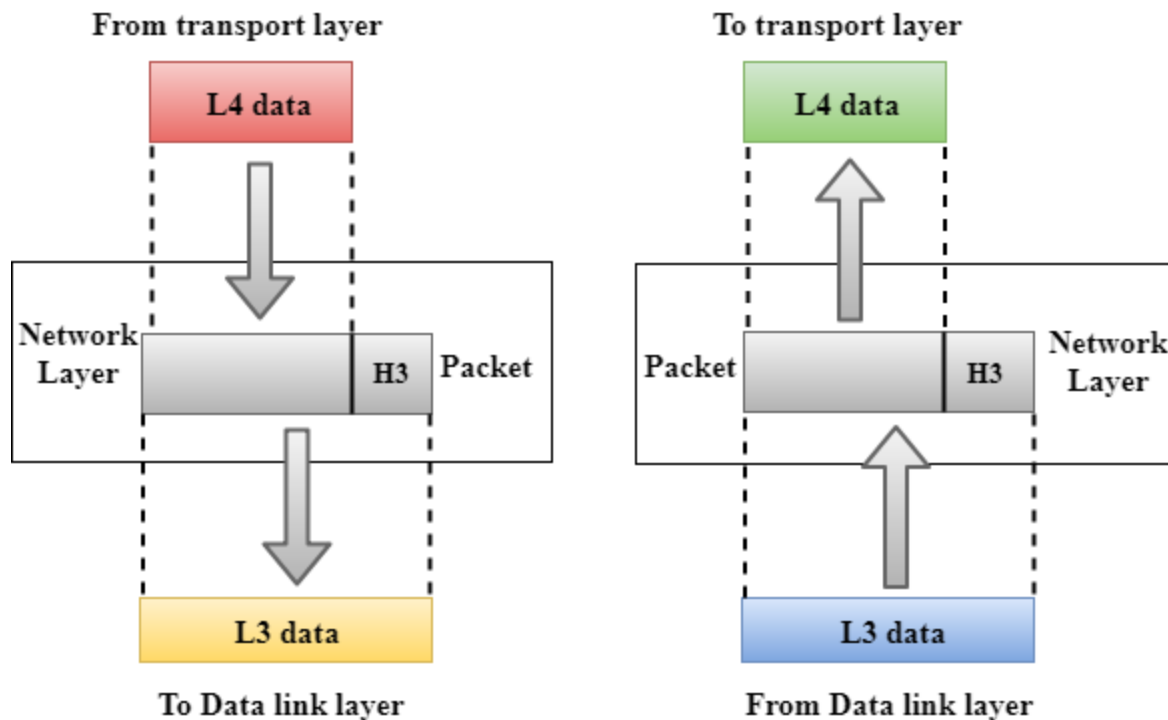
\*\* Data Link layer is handled by the NIC (Network Interface Card) and device drivers of host machines.

\*\*\* Switch & Bridge are Data Link Layer devices.

**The functions of the Data Link layer are:**

1. **Framing:** Framing is a function of the data link layer. It provides a way for a sender to transmit a set of bits that are meaningful to the receiver. This can be accomplished by attaching special bit patterns to the beginning and end of the frame.
2. **Physical addressing:** After creating frames, the Data link layer adds physical addresses (MAC address) of the sender and/or receiver in the header of each frame.
3. **Error control:** Data link layer provides the mechanism of error control in which it detects and retransmits damaged or lost frames.
4. **Flow Control:** The data rate must be constant on both sides else the data may get corrupted thus; flow control coordinates the amount of data that can be sent before receiving acknowledgement.
5. **Access control:** When a single communication channel is shared by multiple devices, the MAC sub-layer of the data link layer helps to determine which device has control over the channel at a given time.

## Network Layer



- It is a layer 3 that manages device addressing, tracks the location of devices on the network.
- It determines the best path to move data from source to the destination based on the network conditions, the priority of service, and other factors.
- The Data link layer is responsible for routing and forwarding the packets.
- Routers are the layer 3 devices; they are specified in this layer and used to provide the routing services within an internetwork.
- The protocols used to route the network traffic are known as Network layer protocols. Examples of protocols are IP and Ipv6.
- Network layer is implemented by networking devices such as routers.

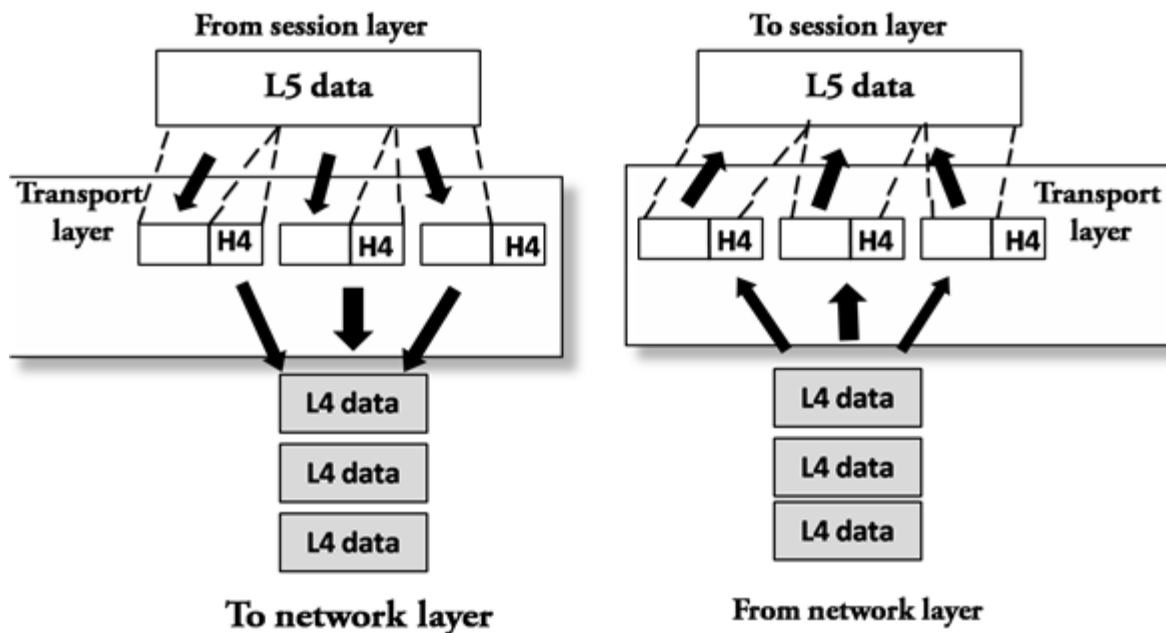
### The functions of the Network layer are:

1. **Routing:** The network layer protocols determine which route is suitable from source to destination. This function of the network layer is known as routing.
2. **Logical Addressing:** In order to identify each device on internetwork uniquely, the network layer defines an addressing scheme. The sender & receiver's IP addresses are placed in the header by the network layer. Such an address distinguishes each device uniquely and universally.

\* *Segment* in Network layer is referred to as **Packet**.



## Transport Layer



- The Transport layer is a Layer 4 ensures that messages are transmitted in the order in which they are sent and there is no duplication of data.
- The main responsibility of the transport layer is to transfer the data completely.
- It receives the data from the upper layer and converts them into smaller units known as segments.
- This layer can be termed as an end-to-end layer as it provides a point-to-point connection between source and destination to deliver the data reliably.

**The two protocols used in this layer are:**

- **Transmission Control Protocol**
  - It is a standard protocol that allows the systems to communicate over the internet.
  - It establishes and maintains a connection between hosts.
  - When data is sent over the TCP connection, then the TCP protocol divides the data into smaller units known as segments. Each segment travels over the internet using multiple routes, and they arrive in different orders at the destination. The transmission control protocol reorders the packets in the correct order at the receiving end.
- **User Datagram Protocol**
  - User Datagram Protocol is a transport layer protocol.

- It is an unreliable transport protocol as in this case receiver does not send any acknowledgment when the packet is received, the sender does not wait for any acknowledgment. Therefore, this makes a protocol unreliable.

### **The functions of the transport layer are:**

- 1. Segmentation and Reassembly:** This layer accepts the message from the (session) layer, breaks the message into smaller units. Each of the segments produced has a header associated with it. The transport layer at the destination station reassembles the message.
- 2. Service Point Addressing:** In order to deliver the message to the correct process, the transport layer header includes a type of address called service point address or port address. Thus by specifying this address, the transport layer makes sure that the message is delivered to the correct process.

### **The services provided by the transport layer:**

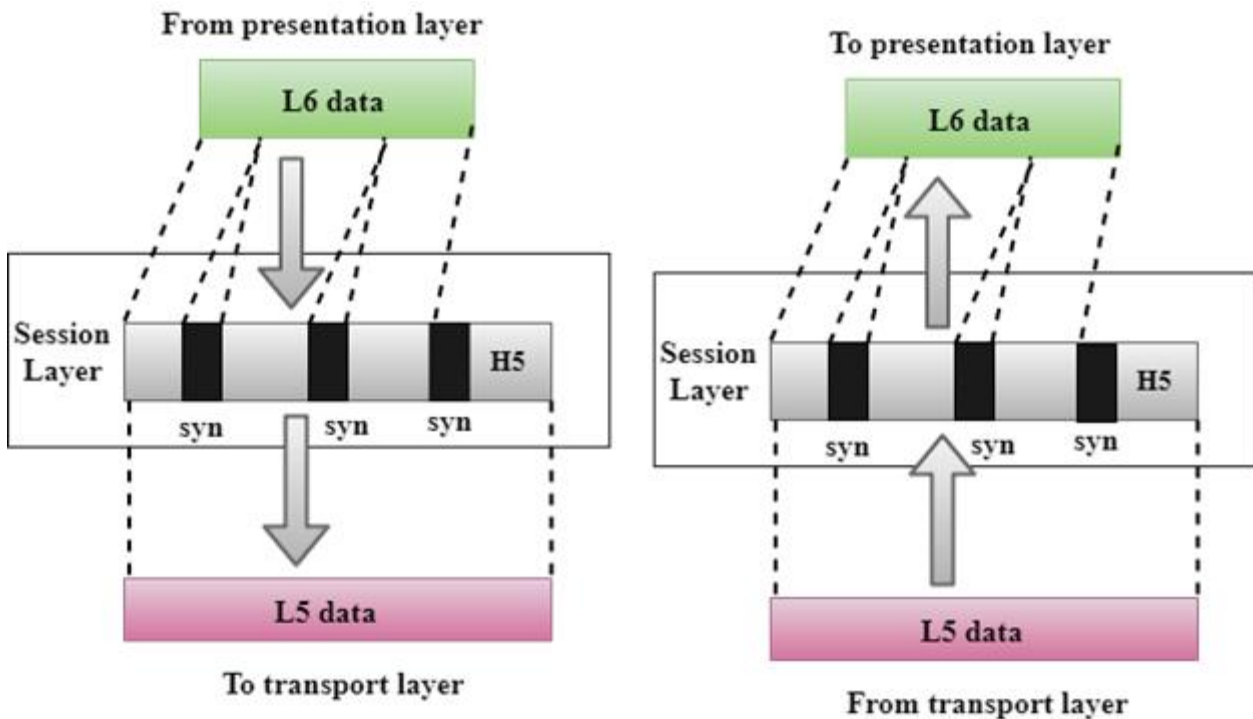
- 1. Connection-Oriented Service:** It is a three-phase process that includes
  - Connection Establishment
  - Data Transfer
  - Termination / disconnection
 In this type of transmission, the receiving device sends an acknowledgement, back to the source after a packet or group of packets is received. This type of transmission is reliable and secure.
- 2. Connectionless service:** It is a one-phase process and includes Data Transfer. In this type of transmission, the receiver does not acknowledge receipt of a packet. This approach allows for much faster communication between devices. Connection-oriented service is more reliable than connectionless Service.

\* *Data in the Transport Layer is called as **Segments**.*

\*\* *Transport layer is operated by the Operating System. It is a part of the OS and communicates with the Application Layer by making system calls.*

*Transport Layer is called as **Heart of OSI** model.*

## Session Layer



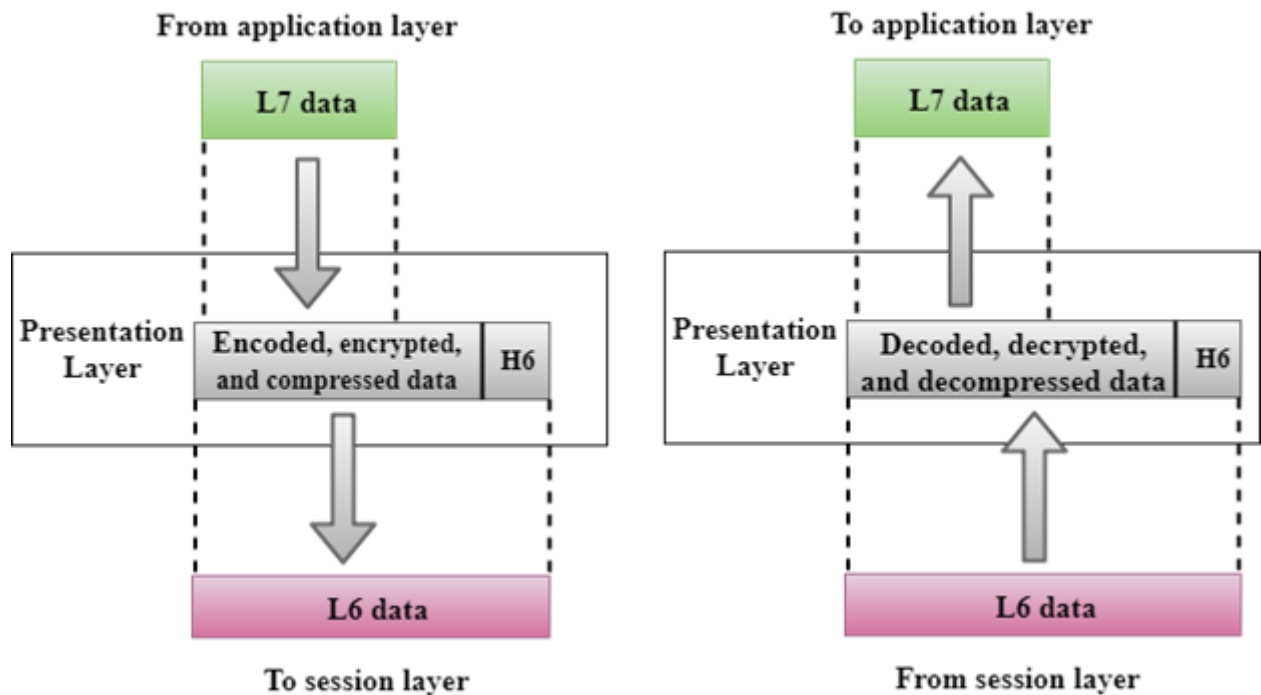
- It is a layer 3 in the OSI model.
- The Session layer is used to establish, maintain and synchronizes the interaction between communicating devices.

### The functions of the session layer are:

- 1. Session establishment, maintenance, and termination:** The layer allows the two processes to establish, use and terminate a connection.
- 2. Synchronization:** This layer allows a process to add checkpoints which are considered synchronization points into the data. These synchronization points help to identify the error so that the data is re-synchronized properly, and ends of the messages are not cut prematurely and data loss is avoided.
- 3. Dialog Controller:** The session layer allows two systems to start communication with each other in half-duplex or full-duplex.

*\*\*All the below 3 layers(including Session Layer) are integrated as a single layer in the TCP/IP model as "Application Layer".*  
*\*\*Implementation of these 3 layers is done by the network application itself. These are also known as **Upper Layers** or **Software Layers**.*

## Presentation Layer

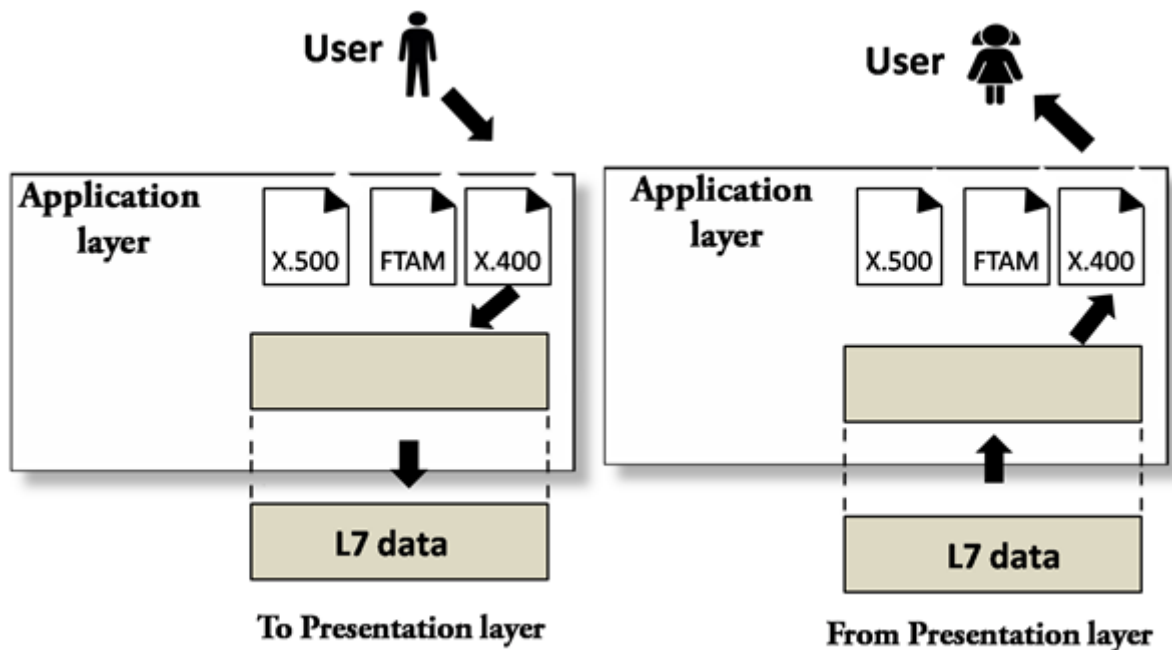


- A Presentation layer is mainly concerned with the syntax and semantics of the information exchanged between the two systems.
- It acts as a data translator for a network.
- This layer is a part of the operating system that converts the data from one presentation format to another format.
- The Presentation layer is also known as the syntax layer.

**The functions of the presentation layer are:**

- 1. Translation:** For example, ASCII to EBCDIC.
- 2. Encryption/ Decryption:** Data encryption translates the data into another form or code. The encrypted data is known as the cipher text and the decrypted data is known as plain text. A key value is used for encrypting as well as decrypting data.
- 3. Compression:** Reduces the number of bits that need to be transmitted on the network.

## Application Layer



- An application layer serves as a window for users and application processes to access network service.
- It handles issues such as network transparency, resource allocation, etc.
- An application layer is not an application, but it performs the application layer functions.
- This layer provides the network services to the end-users.

**The functions of the Application layer are:**

1. Network Virtual Terminal
2. FTAM-File transfer access and management
3. Mail Services
4. Directory Services