

**THEORY & OBJECTIVE**

# COMPUTER NETWORKS

*By  
Team of  
Engineers Academy*



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# NOTES

A series of horizontal dotted lines for writing notes.



# COMPUTER NETWORK BASICS

## THEORY

### 1.1 | INTRODUCTION OF NETWORK THEORY

(i) **Network**

A network is a set of devices (nodes) connected by links. A node can be computer, printer or any other devices capable of sending and /or receiving data generated by other nodes on the network.

So network is path between or among the nodes.

(ii) **Networking**

Networking is a mechanism to connect the node and share the resource (Information).

We use same protocol for define a network.

(iii) **Protocols**

Protocols are predefined set of rules so all devices must follow these rules.

**THERE ARE TWO TYPES OF PROTOCOLS**

- (i) **Routed Protocol** : Routed protocols are carrying data.
- (ii) **Routing Protocol** : Routing protocols are carrying path information.

### 1.2 | TECHNOLOGIES IN NETWORK

#### 1.2.1 LAN

(Local area network). Is a network which is designed to operate over a small physical area such as office, building area covered : up to few kilometers.

**Data rate** : 100 to 1000 Mbps

**Topology** : Bus, star, Ring.

#### 1.2.2 MAN (METRO POLITAN AREA NETWORK)

It is a bigger version of LAN and can support both data and voice.

#### Rememberable Point

- *MAN is* distinguished by IEEE 802.6.
- Standard or it is also known as.
- Distribute queue dual Bus (DQDB)

- **Area Coverd** : Around a city (5 to 50 km)
- **Data Rate** : 155 mbps (comparitive low comparitive to LAN)
- **Topology** : Any kind.

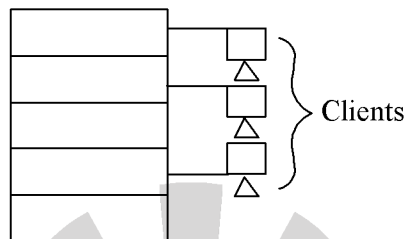
### 1.2.3 WAN(WIDE AREA NETWORK)

WAN spans large geographical area, often a country or continet, communication between different user of WAN is established using leased telephone lines or satellite links.

- **Area Covered** : Country
- **Data Rate** : Depends upon ISP provides
- **Topology** : Uses setalite and microwave relay.

## 1.3 | TYPE OF NETWORK

### 1.3.1 SERVER CLIENT NETWORK



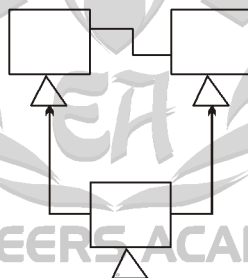
Server is a repository where all information is available.

Two clients can communicate with each other by using server only.

Server can use server operating system only.

Client can use both client operating system or compitable server operating system.

### 1.3.2 PEER TO PEER NETWORK



In whic two or more PC's are connected with each other directly.

## 1.4 | TYPE OF SERVER

- **Application Server** : Provide user Interface.
- **Web Server** : Complete website code available here.
- **Chat Server** : Use for chatting.
- **File Server** : Use for storing document, spread sheet.
- **Print Server** : Provide the synchronization among the systems for using a single printer.
- **Fax Server** : Use for Fax.
- **Mail Server** : Keeps the information of user and use for authentication.

Both are use for remote accessing.

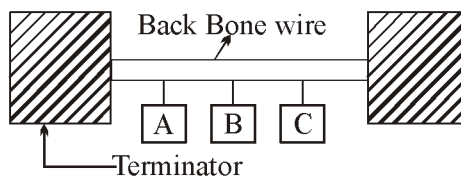
- **Telnet :** } Telnet is used for full access.
- **FTP :** } FTP is used for partial access.

Security in FTP > Security in Telnet

## 1.5 | TOPOLOGY

Topology of a network is the geometric representation of the relation ship of all the links and linking devces. There are various type of topology.

### 1.5.1 BUS TOPOLOGY

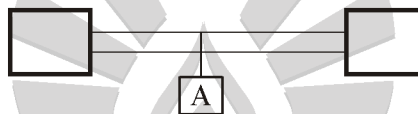


In bus topology all devices such as server, node, printer are connected to common shared cable known as *bus*.

Buses are bidirectional hence all devices are capable to send or receive signal simultaneously.

#### TERMINATOR

Terminator are used to avoid the unnecessary signals in bus topology.



If A wants to sends the data to E and E is not available at this moment of time then the packet send by A is remove from back bone or bus.

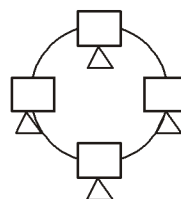
- **ADVANTAGES**

- It is used at server side.
- Easy to implement.

- **DISADVANTAGE**

- If one connection is lost then complete connection is goes.
- Traffic, Collision due to using single bus for sending and receiving data.
- We use coaxial cable and optical fiber in bus topology.

### 1.5.2 RING TOPOLOGY



Each node connected to each other forming a ring like structure.

Data packets travels from node to node as there is single path.

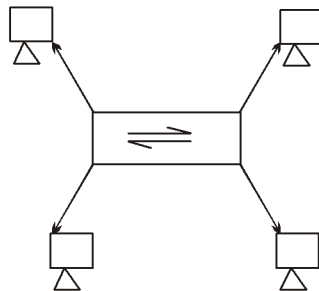
Packet travel until it finds the final destination from node to node.

**Rememberable Point**

- Repeaters are used to enhance signal in ring topology.
- Ring topology is fastest.
- Most of time the data will send in clock wise direction.

**1.5.3 STAR TOPOLOGY**

- All nodes are connected to central Hub.
- Hub routes the message from source to destination.
- It acts like repeater for data flow.



**ADVANTAGE**

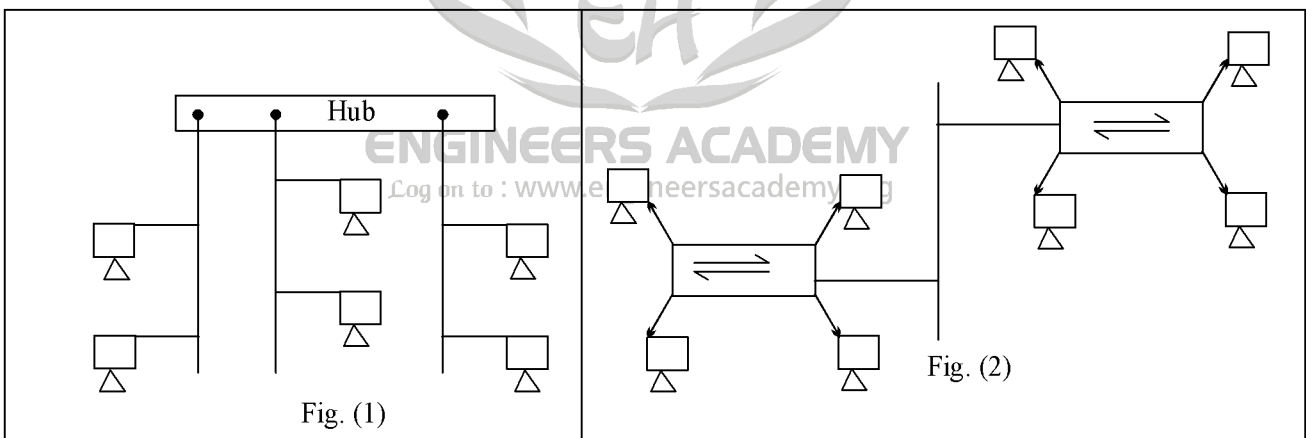
Node failure doesn't effect the network.  
Simple to detect error and fault so most preferable as comparative to ring and bus.

**DISADVANTAGE**

- (i) Hub failure can shut down whole network.
- (ii) Expensive

**1.5.4 TREE TOPOLOGY**

Central Hub or Root is connected to other lower end nodes.  
Central hub manages and functions each node.  
Root node act as server.



**ADVANTAGE**

If can use for large network.

**DISADVANTAGE**

Central Hub failure can shut down entire network.

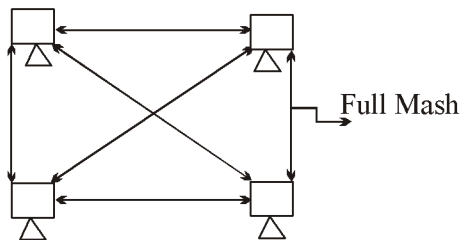


## 1.5.5 MESH TOPOLOGY

Dedicated point to point link is established between node.

### *Rememberable Point*

- It require  $\frac{n(n-1)}{2}$  link to connect n nodes.



- ADVANTAGE**  
Any node failure doesn't affect the network.  
Traffic load is very less, due to dedicated link.  
Privacy and security is maintained.  
Fault detection and isolation is easy.
- DISADVANTAGE**  
A lot of cabling and input ports are required.

## 1.5.6 HYBRID TOPOLOGY

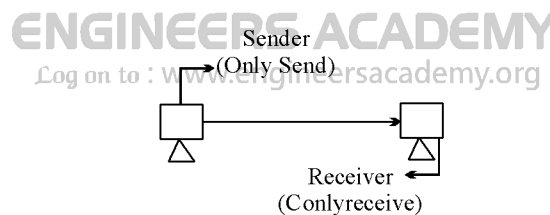
It is a combination of two or more topologies.

## 1.6 TRANSMISSION MODES

Transmission modes defines the direction of data transmission between two connected devices. These are three types.

### (i) Simplex

It is a one way communication, where data flows only in one direction from sender to receiver.



*Example:* Radio and Television :

### (ii) Half duplex

It is a two way communication, data flow in both direction but sender and receiver can't transmit and receive at the same time.

*Example:* Walkie – Talkie.

**(iii) Full Duplex**

It is also a two way communication where both sender and receiver can transmit and receive at same time.

*Example:* Telephone talk, client server communication.

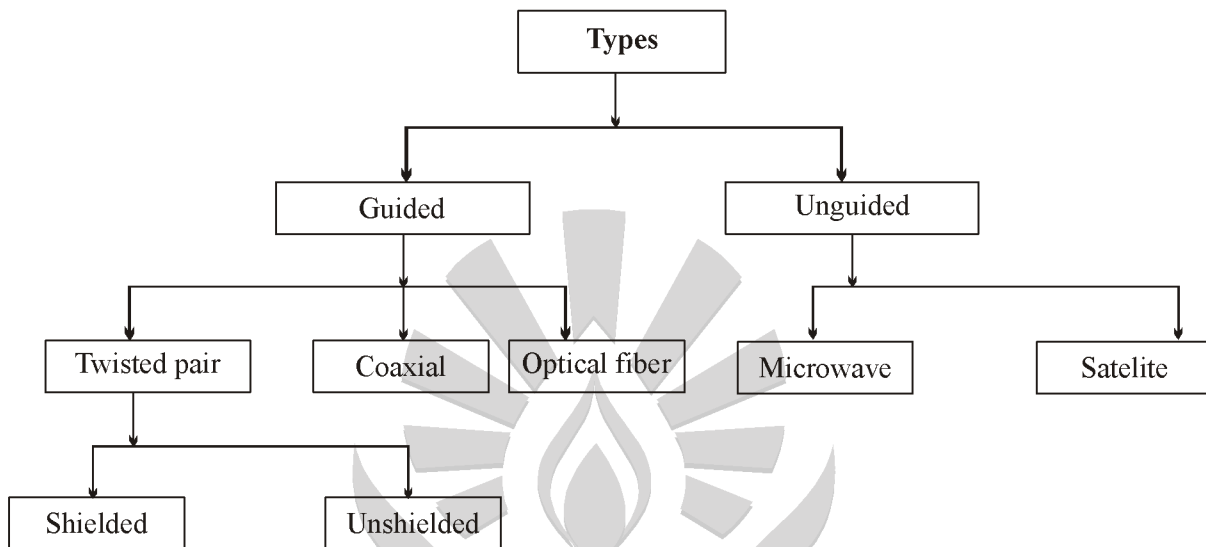
## 1.7 | TRANSMISSION MEDIA

Path way through which individual system can connect to route data signals in a network.

Transmission media makes it possible to transmit electronic signals from one computer to another.

These signals are nothing but binary pulses.

Each type of transmission media varies in its characteristics, that makes it suitable for a specific type of service. Type of transmission Media.



### 1.7.1 GUIDED TRANSMISSION MEDIA

Consist of physical connection between source and destination via wire or a cable.

**THERE ARE THREE TYPE OF GUIDED MEDIA**

**(A) TWISTED PAIR CABLE**

It is a types of wire in which the conductors are twisted together for the purpose of cancelling out electromagnetic interference (EMI) from external source.

**Shielded Twisted pair :** Use a shield as coating.

**Unshielded Twisted Pair :** Not use shield.

**Rememberable Point**

- No of twist increase the efficiency of transmission.

**Connector of Twisted Pair Cable :**

- RJ 11 → (Register Jack 11) → It support 2 pins.
- RJ 45 → (Register Jack 45) → It support 8 pins.

Categories of UTP		No. of Wire
→ Category 1	Voice Transfer	2
→ Category 2	Voice + Data	4
→ Category 3	Voice + Data	8
→ Category 4	Voice + Data	8
→ Category 5	Voice + Data	8
→ Category 6	Voice + Data	8
→ Category 6.a	Voice + Data	8
	→ Latest	

In Category (3) one feet wire have 3 twist.

**(B) COAXIAL CABLE**

Coaxial cable has a single copper conductor at its center. A plastic layer provides insulation between the center conductor and a braided metal shield.

**TYPE OF COAXIAL CABLE**

**(i) Thin Coaxial**

It is also referred to as *thin net*.

**Rememberable Point**

- It is 10 base 2 means approximate maximum segment length being 200 meters.

**(ii) Thick Coaxial**

It is also referred to as *thick net*.

**Rememberable Point**

- It is 10 base 5 refers to approximate maximum segment length being 500 meters.  
Connector for coaxial cable connector → BNC (Bay one-Neil - Concel man)

**(C) OPTICAL FIBRE**

It consist of center glass core surrounded by several layers, of protective material. It transmit light rather than signal. The centre core of fibre cables is made from glass or plastic fibers. The outer insulating jacket made of teflon or PVC. It is base on total internal reflection (TIR).

**Types**

- Single Mode
- Multimode

**1.7.2 UNGUIDED TRANSMISSION MEDIA**

Number physical connection between source and destination.

**TYPES**

**(i) Microwave**

Travels in straight line and therefore narrowly focus concentrating all the energy into a beam. Can not penetrate through building.

*Example:* Bluetooth technology.

**(ii) Satellite**

They are situated in space 22,000 miles above the equator.

Use microwave radio to prevent from atmosphere and act as microwave relay station.

They can amplify and relay microwave signals from one transmitter on the ground to another.

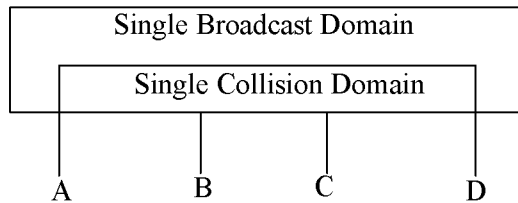
## 1.8 NETWORKING DEVICES

*Bridge, Switches, Hub* → LAN Devices

*Router, Gateway, Brouter* → WAN Devices

**1.8.1 HUB** → Hub is basically a passive devices.

↓ It has 1 collision domain and '1 Broadcasting domain.'



So if a want to sends the data to D then this data is broadcast by A so B and C also get data sent by A and they discard it.

**Rememberable Point**

- It is used for broad costing and used in physical layer.
- Hub doesn't have the physical all address because they are working in physical layer and physical address is provided by data link layer.

**TYPES OF HUB**

**(i) Passive Hub :**

In the passive hub after TTL (time to live) data is loss.

**(ii) Active Hub :**

In the active hub after TTL the signal is regeneratce.

**(iii) Intelligent Hub :**

If A want to send data to E but E is not available at this moment then after TTL the signal is not regenrate.

**Rememberable Point**

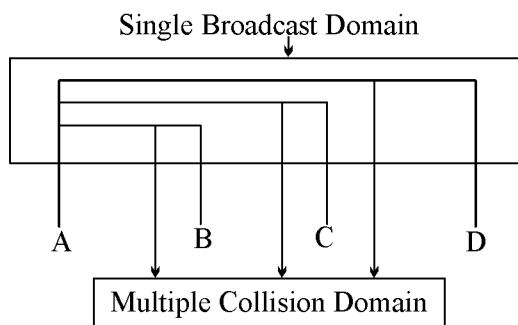
- Hub is used in half duplex mode.

Denoted as

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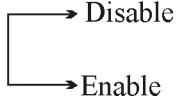
**1.8.2 SWITCH**

It have multiple collosion domain and single broad cost domain.



### Rememberable Point

- Switch is a data link layer device.
- It has both IP and MAC address.

It has two modes of operate 

**Disable mode :** No data communication is occur.

**Enable mode :** Listen, learn, Forward, discard the packet.

- Switch have max 24 port.

### TYPES OF SWITCHES

(i) **Modular (Managed) :** In which we can change no of ports.

(ii) **Non-modular (Unmanaged) :** We can't changed the no of ports.

### 1.8.3 BRIDGES

It is use to connect the two different LAN.

- **Operater in data link layer.**

### TYPE OF BRIDGES

(i) **Simple Bridge :** Connect the two different LAN's.

(ii) **Transparent :** Connect the two or more LAN and LAN devices are think that they are in a single LAN.

(iii) **Multiport Bridge :** Connects the multiple LAN.

### 1.8.4 ROUTER

It is used to connect multiple network of similar types.

It provide best path (due to IOS (Internet operating system))

- It is working in network layer.

#### (i) TYPES OF ROUTER :

##### (a) **Static Router**

System adminstrator defines the shortest path in the network by executing commands.

##### (b) **Dynamic Router**

Router it self determines the shortest path between computers in the network.

These router are mostly used then static.

Router may be wired or wireless.

#### (ii) COMPONENT OF ROUTER

**Register :** It has a single bit, and it point towards the operating system location.

**DRAM :** It is used for running configuration.

**FLASH :** Operating system is stored into the flash memory.

**NVRAM (non volatile RAM) :** Start up configuration.

**ROM :** Company name, manufacturing detail.

### 1.8.5 NETWORK INTERFACE CARD

It is circuit board or a card that allows computers to communication over a network via cable or wirelessly.

It is also known as LAN adaptor, network adaptor.

**Rememberable Point**

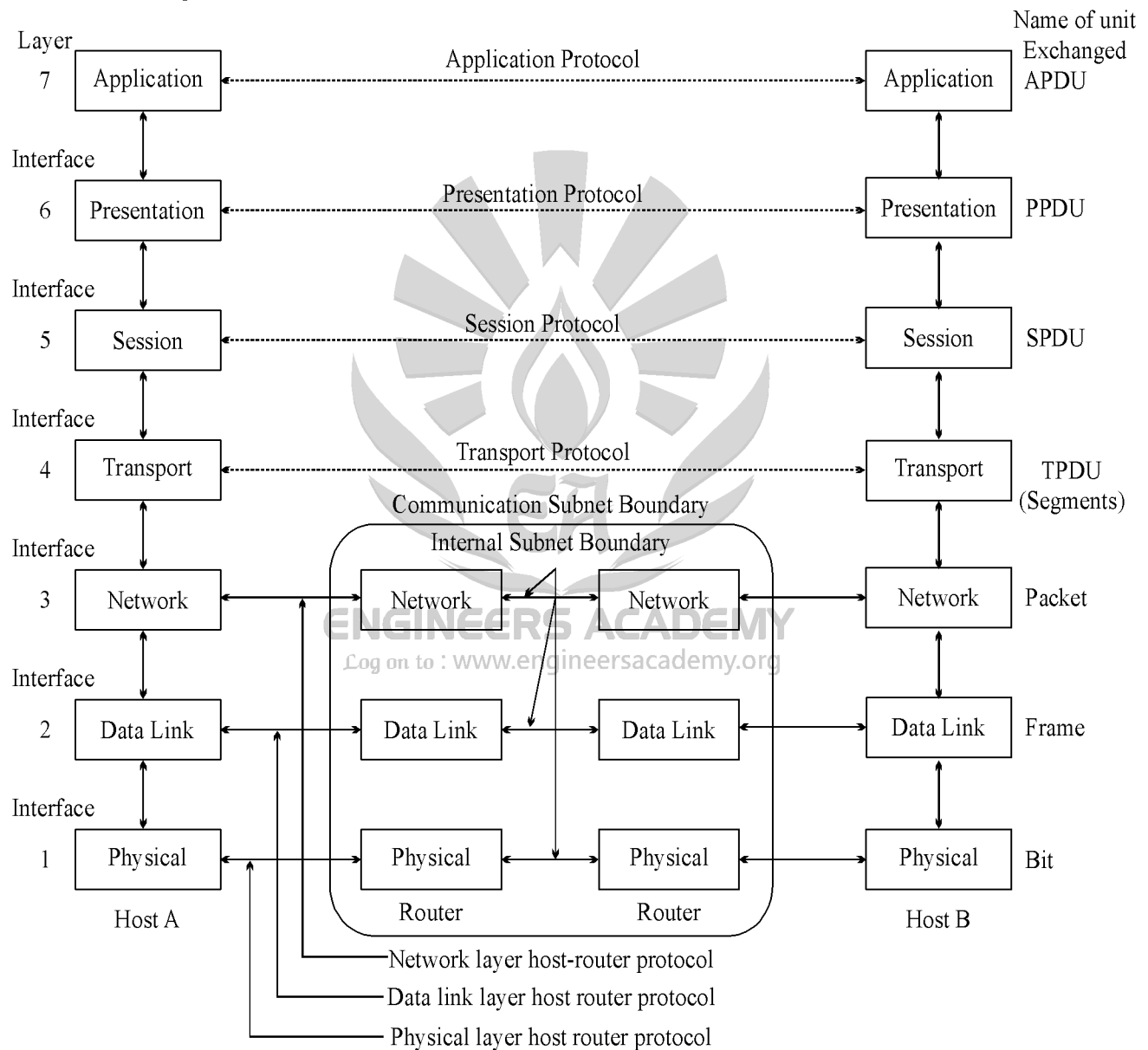
- It is operated on physical and data link layer.
  - Every NIC is assigned a unique 48-bit (MAC) address which is stored in ROM to identify themselves in a network or a LAN.  
It has both RJ-45 and BNC connector.
  - To check that NIC is properly installed or not we use the ping 127.0.0.1.
- Autonomous System :** In an autonomous system all devices follow the same rules or policy.
- We use ASBR (autonomous system border routing) in an autonomous system.

## 1.9 | OSI MODEL / (OPEN SYSTEM INTERCONNECTION MODEL)

The OSI model is a reference model developed by the international organization for standardization (ISO) in 1984. Which describes how communication should take place between two nodes in a network.

It consists of 7 separate but related layers.

Request for data moves from Top (application layer) to bottom (physical layer) and reverse happens at the receiving end.



## 1.9.1 PHYSICAL LAYER

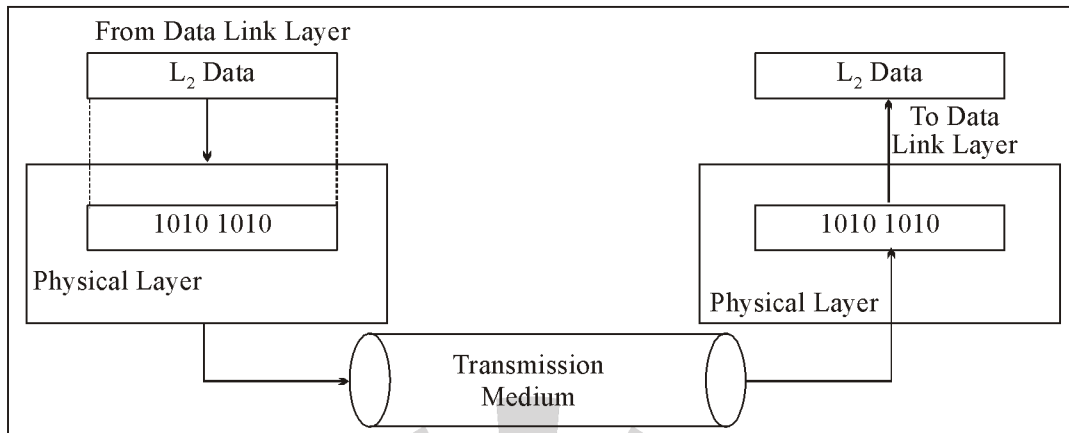
The physical layer is responsible for sending bits from one computer to another.

The physical layer coordinates the functions required to carry a bit stream over a physical medium.

It deals with the mechanical and electrical specifications of the interface and transmission media.

It also defines the procedures and function that physical devices and interfaces have to perform for transmission to occur.

The position of the physical layer with respect to the transmission medium and the data link layer is shown in figure.



The physical layer is responsible for movement of individual bits from one hop to next.

**Following are the function of the physical layer**

(i) **Physical characteristics of interfaces and media**

The physical layer defines the characteristics of interface between the devices and transmission medium.

It also defines the type of transmission medium (guided or unguided media)

(ii) **Representation of Bits**

The physical layer data consists of a stream of bits (sequence of 0's and 1's) for transmission, bits must be encoded into signal other electrical or optical.

- Physical layer define the type of encoding.

(iii) **Data Rate**

- We also call it as **transmission rate** i.e., numbers of bits sent each second is also defined by physical layer.

The physical layer defines the duration of a bit, which is how long it lasts.

(iv) **Synchronization of Bits**

The sender and receiver must not only use the same bit rate but also must be synchronized at the bit level. In other words the sender and the receiver clocks must be synchronized.

(v) **Line configuration**

The physical layer is concerned with the connection of devices for the media.

In a point to point configuration two devices are connected together through a dedicated link.

In a multipoint configuration a link is shared between two or more devices.

(vi) **Physical Topology**

The physical topology defines how devices are connected to make a network.

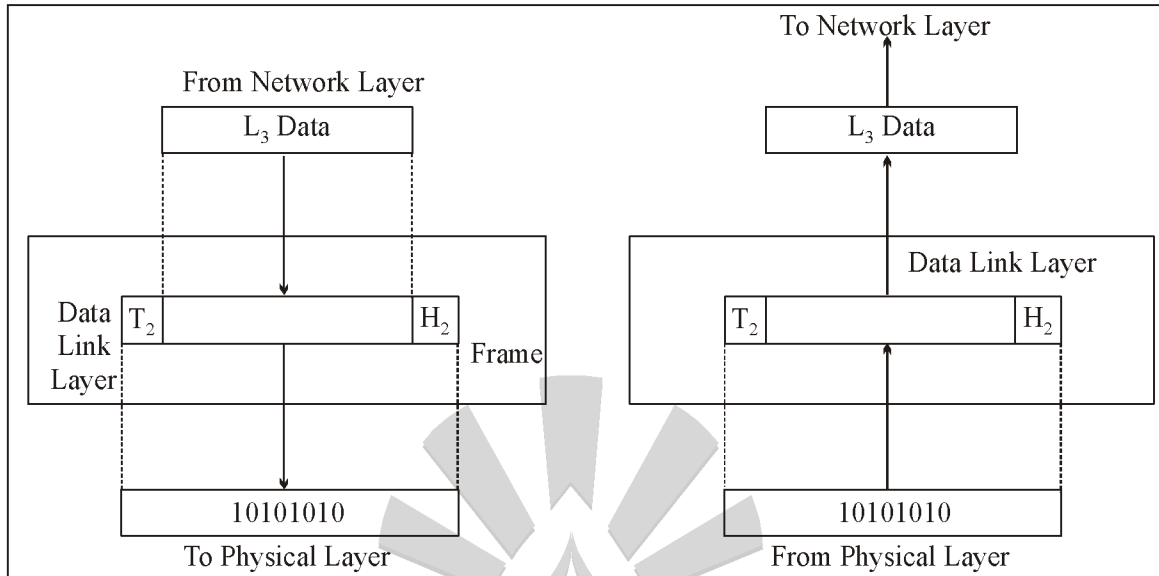
Devices are connected using a **mesh topology, star, bus, ring topology.**

**(vii) Transmission Mode**

The physical layer also defines the direction of transmission between two devices. *means simplex, half duplex, full duplex.*

**1.9.2 DATA LINK LAYER**

- It is responsible for reliable node to node delivery of the data (hop to hop)  
The data link layer transforms the physical layer, a raw transmission, facility, to reliable link.  
It make the physical layer appear error free to the upper layer (Network layer)  
The position of data link layer with respect to network and physical layer.



**FUNCTIONS OF DATA LINK LAYER**

**(i) Framing**

The data link layer divides the stream of bits received from from the network layer into manageable data units called frames.

**(ii) Physical Addressing**

If frames are to distributed to different system on the network. The data link layer adds a headers to the frame to define the sender or receiver of the frame.

If the frames is intended for a system outside the sender's network, the receiver address is the address of the connecting devices that connects the network to the next one.

**(iii) Flow Control**

If the rate at which the data is absorbed by the receiver is less then the rate produced at sender, the data link layer imposes a flow control mechanism to avoid overwhelming the receiver.

**(iv) Error Control**

The data link layer adds reliability to the physical layer by adding mechanism, to detect and retransmit damaged or lost frames.

- It is also used a mechanism to recognize duplicate frame.

**(v) Access Control**

Where two or move devices are connected to the same link, data link layer protocol are necessary to determine which devices has control over the link at any given time.



IT IS PARTIONED INTO TWO PARTS

**(i) Logical Link Control (LLC) :**

It establish and maintains links between the communicating devices.

The logical link control sublayer provides service access points (SAP's) that the other computers can refer to and use to transfer information from logical link control to network layer.

**(ii) Media Access Control (MAC) :**

It controls the way multiple devices share the same media channel.

The MAC sublayer provides shared access to the network adapter and communication directly with the network interface cards.

**1.9.3 NETWORK LAYER : PACKETS**

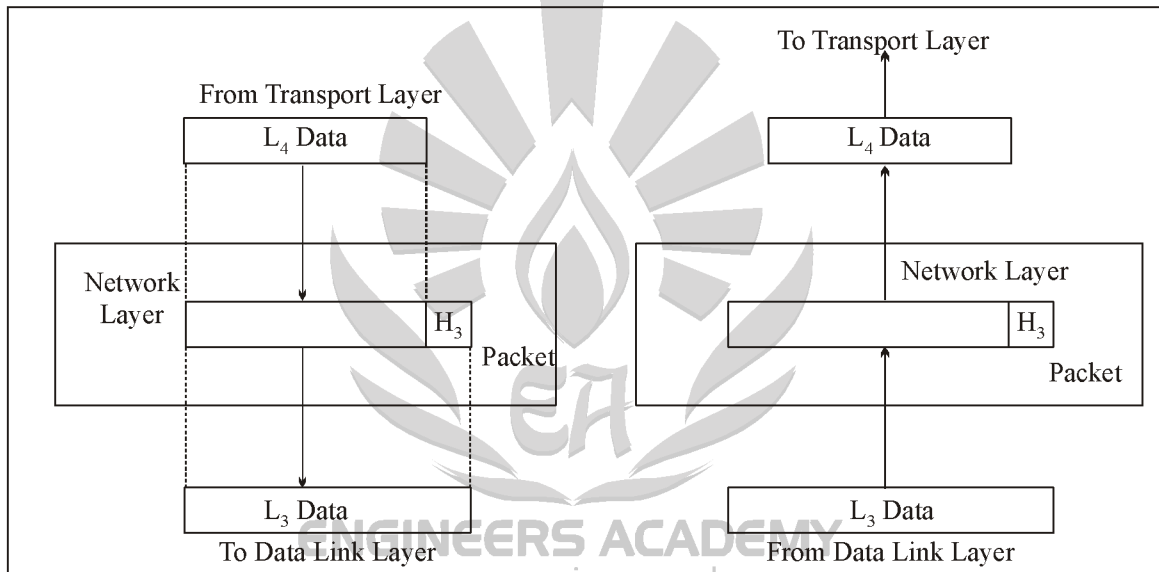
- The network layer is responsible for the source to destination delivery of a packet possibly across multiple network (links) where as the data link layer oversees the delivery of the packet between two system on the same network.

The network layer ensure that each packet gets from its point of origin to its final destination.

If two system are connected to the same link, there is usually no need for a network layer.

It the two systems are attached to different networks (links) with same connecting devices, there is often need for a network layer for source to destination delivery.

The relation ship of the network layer to the data link and transport layer is shown in figure.



**RESPONSIBILITIES OF NETWORK LAYER**

**(i) LOGICAL ADDRESSING**

The physical addressing implemented by the data link layer handles the addressing problems locally.

If the packets passes the network boundary, we need another addressing system to help to distinguish from the source and destination system.

The network layer adds a header to the packet coming from the upper layer that includes the logical address of the sender and receiver.

**(ii) ROUTING**

When independent network or links connected together to create internetworks (network to network) or a large network, the connecting devies routes the packets to their final destination.

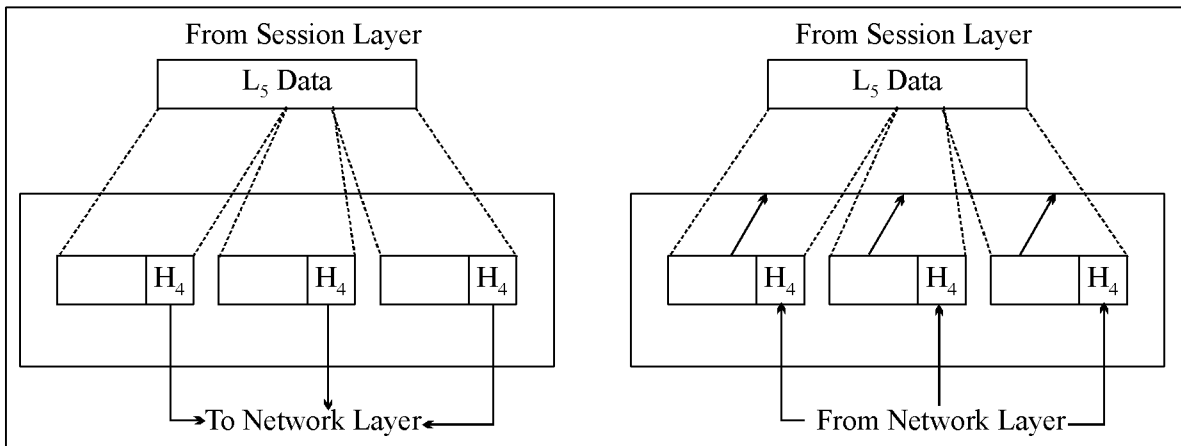
- It is connected with the circuit or packet switching.

### 1.9.4 TRANSPORT LAYER

The transport layer is responsible for *process to process* or *end to end delivery* of the entire message. A process is an application program running on the host where as the network layer oversees *source to destination* delivery of individual packet two computers on the same LAN.

#### **Rememberable Point**

- In which the data is available in the form of segments.



### TRANSPORT LAYER

#### RESPONSIBILITIES OF THE TRANSPORT LAYER

#### (1) Segmentation and Reassembly

A message is divided into transmittable segments, with each segment containing a sequence number. These no. enables the transport layer to reassemble the message correctly upon arriving at the destination and to identify and replace packets that were lost in transmission.

#### (2) Service Point Addressing

Since several programs were run on computers at the same time, for this reason, sources to destination delivery not only from one computer to the next, but also from a specific process on one computer to a specific process on the other.

- So the transport layer header must therefore include a type of address called a service point address (port address)

#### (3) Connection Control

The transport layer can be either connectionless or connection oriented.

A connectionless transport layer treats each segment as an independent packet and delivers it to the transport layer at the destination machine.

A connection oriented transport layer makes a connection with the transport layer at the destination machine first before delivering the packets. After all the data are transferred the connection is terminated.

#### (4) Flow Control

Like, the data link layer, the transport layer is responsible for flow control. The flow control at this layer is performed end to end rather than across a single link.

#### (5) Error Control

Transport layer is responsible for error control. Error control at this layer is performed process to process rather than across a single link.

The sending transport layer makes sure that the entire message arrives at the receiving transport layer with out of error (damage, loss, duplication).

- Error correction is usually achieved by re-transmission.

### 1.9.5 SESSION LAYER

The services provided by the first three layers (physical, data link, and network) are not sufficient for same processes.

- The *session layer* is the *network dialog controller*. It establishes, maintains, and synchronizes the interaction among communicating system.
- Session layer is responsible for dialog control and synchronization.

**(i) Dialog Control :**

The session layer allows two systems to enter into dialog.

It allows the communication between two processes to take place in either half duplex or full duplex mode.

**(ii) Synchronization:**

- The session layer allows a process to add *check points, or synchronization points*.

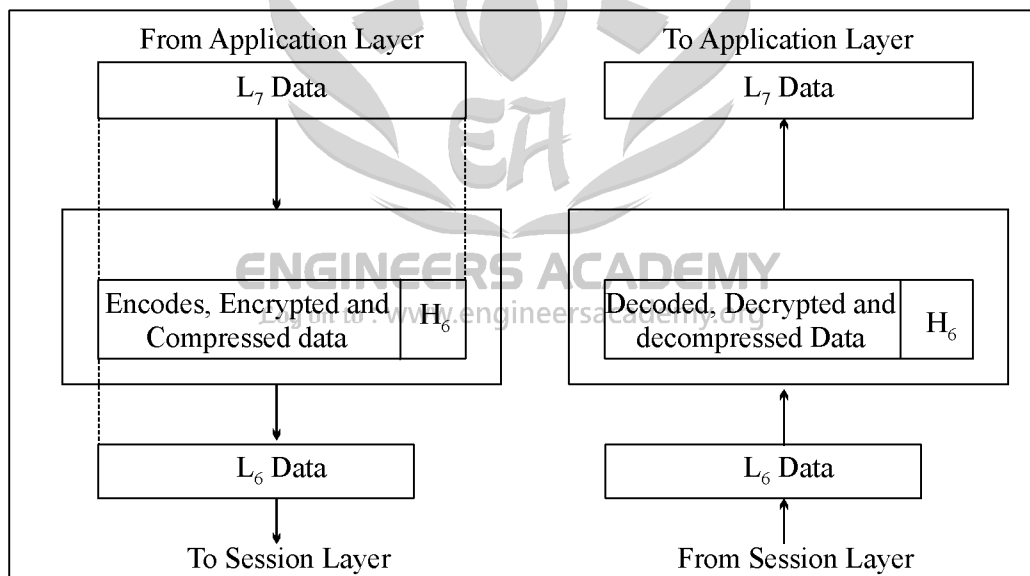
**Example:** If a system is sending a file of 2000 pages, it is advisable to insert check points after every 100 pages to ensure that each 100 page unit is received an acknowledgement independently.

In this case if a crash happens during the transmission of page 523, the only pages that need to resent after system recovery are pages 501 to 523. Page previous to 501 need not be resent.

### 1.9.6 PRESENTATION LAYER

The presentation layer is concerned with the syntax and semantics of the information exchanged between two system.

The relationship between presentation layer and the application and session layer is shown in figure.



#### RESPONSIBILITIES OF THE PRESENTATION LAYER

**(i) Translation :**

The processes in two system are usually exchanging information in the form of character, string, numbers and so on.

The information should be changed to bit stream before being transmitted. Because different computers use different encoding system, the presentation layer is responsible for inter operability between these different encoding methods.

The presentation layer at the sender changes the information from its sender-dependent format into a common format.

The presentation layer at the receiving machine changes the common format into its receiver dependent format.

**(ii) Encryption :**

To carry sensitive informations a system must be able to ensure privacy. Encryption means that the sender transforms the original information to another form and sends the resulting message, out over the network.

Decryption reverse the original process to transform the message backs to its original form.

**(iii) Comperession :**

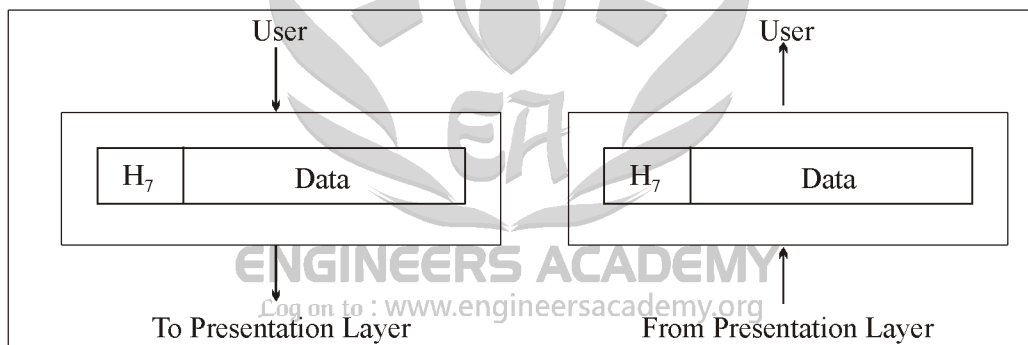
Data compression reduces the number of bits contained in the information.

Data compression becomes particularly important in the transmission of multimedia such as text, audio and video.

### 1.9.7 APPLICATION LAYER

- The application layer is responsible for providing services to the user and it provides the user interface. It is the top most layer of the OSI model. It provides services that directly support users application such as database access, email and file transfer etc. It allows applications to communication with application on other computers as though they were on the same computer.

The relationship of the application on layer to the user and presentation layer is shown in figure.



**(1) File Tranfer Access and Management (FTAM) :**

This application allows a user to access files in a remote hosts, the reterieve files from a remote computer for use in the local computer, and to manage or control files in a remote computer locally.

**(2) Network virtual Terminal :**

A network virtual terminal is a software version of a physical terminal and allows a user to log on a remote host.

To do so the application creates a software emulation of a terminal at the remote host.

The uses computer talks to the software terminal, which is turn, talks to the host and vice versa.