Welcome

Basics of computer network

Unit 1 – data communication & network models

Unit 2 – Error detection, correction and data link control

Unit 3 – multi-Access mechanism and Ethernet standards

Unit 4 – Network Layer : services and Addressing

Unit 5 – Network Layer :Routing Protocols

Unit 6 – Transport LAYER – SERVICES AND PROTOCOLS

Introduction to communication theory

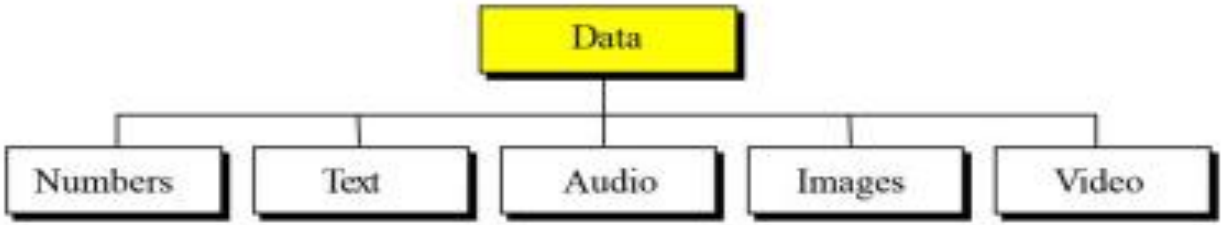
- Basics of data communication
- Components of data communication system
- Data communication system
- Analog & digital signals
- Analog signals
- Digital signals
- Signal conversion methods
- A to D conversion
- Pulse code modulation
- Delta modulation
- D to A conversion
- Amplitude shift keying (ASK)
- Frequency shift keying (FSK)
- Phase shift keying (PSK)
- A to A conversion
- Amplitude Modulation (AM)
- Frequency modulation (FM)

. phase modulation(PM)
.Digital to digital conversion
. bandwidth utilization
.some important definitions
.data rate limits
.introduction to multiplexing
.frequency division multiplexing
.synchronous time division multiplexing
. statistical (Asynchronous) TDM
.Wavelength Division multiplexing
.A network
.Noise
.types of internal noise
.theorems in data communication

Data :- data is defined as information.

Which is stored in digital form

Different types of data (Fig. 2.1)



The computer industry uses the term "**MULTIMEDIA**" to define information that contains numbers, text, images, audio and video.

Data Communication:- it is defined as the exchange of data between a sources and destination by using transmission medium like (wired or wireless) medium

Characteristics of data communication system 8 marks

1.Delivery - The system must deliver data to the exact destination.

e.g. A –> B – C

2.Accuracy – In (DCS) it must be deliver data to the receiver without being altered or damaged.

e.g. A(100) -> B(100)

3.Timeliness – it must deliver data in a timely manner.

Delayed delivery can make the data useless to the receiver.

Components of data communication system 8 marks

Five components :

1. **Message** :- message is information or data which is to be sent from sender to the receiver e.g. sound, text,number,picture, video
2. **Sender** :- sender is device which send message over the medium e.g. video camera, telephone, work station etc.
3. **Medium** :- it is actual path

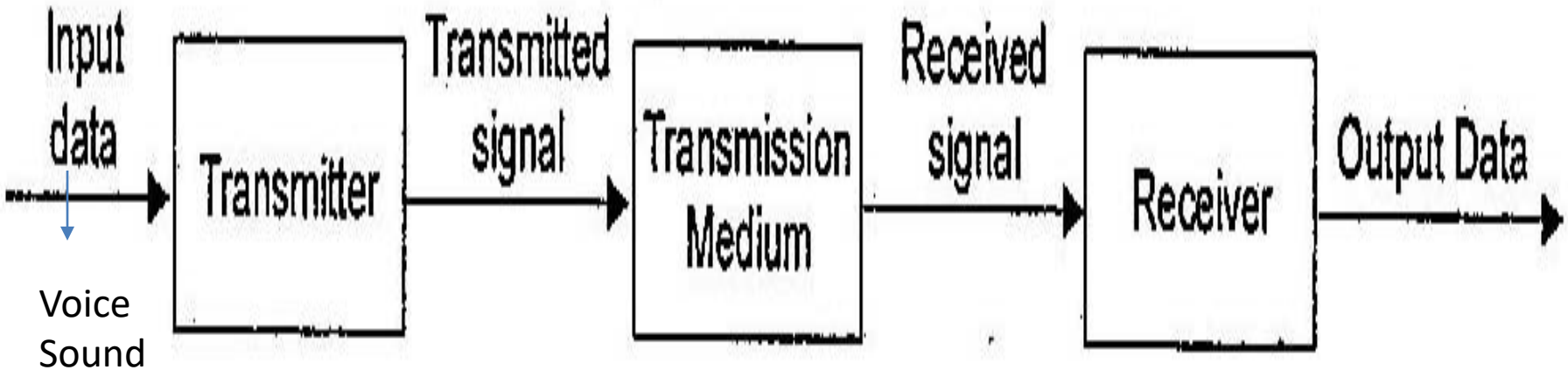
   e.g. co-axial cable, twisted pair cable, fiber optic cable, radio waves, satellite communication
4. **Receiver** :- It is device which receives the message and reproduces it

   e.g. work station, telephone handset, TV receiver etc.
5. **Protocol :-** It is set of rules agreed by the sender & receiver

   protocol govern the exchange of data in true sense.

   e.g . TCP/IP ,UDP,FTP,HTP

Data communication system



- Voice
- Sound
- Text
- Image
- video

Simple Data Communicative System

Data communication system working

communication :- In communication system sender sends message to the receiver through the communication channel called as communication

- **Input data** :- It is input message like Voice, Sound,Text,Image,video etc.
- **Transmitter** :- It is an electronic device that accept signals or data in analog form & it convert into digital form
- It is use for amplifier
- Amplifier - it is use to convert the low frequency to high frequency

- **Transmission medium :-** It is a physical path between the transmitter and the receiver.
- It is channel which data is send from one place to another place
- wired transmission media
- wireless transmission media

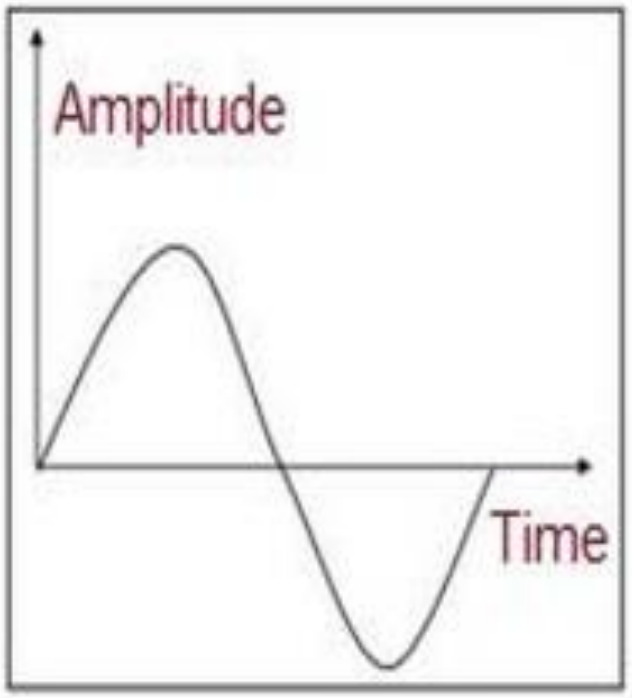
- **Receiver :-** It is device that receive the digital signals from transmission medium &convert it into the analog signal
- **Output :-** it is original message that produced after the whole process.

Analog signal 6 marks

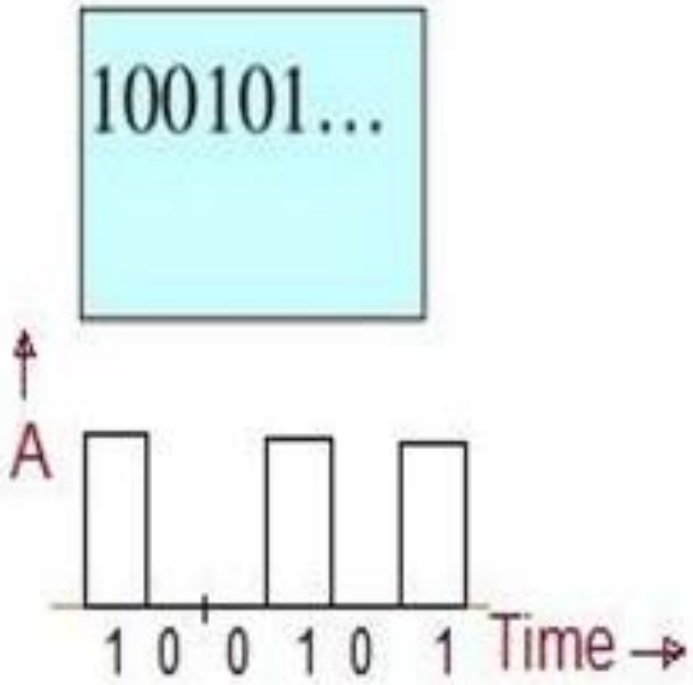
Analog signal :- Analog signal is a continuous signal which represents physical measurements.

- Analog signals are commonly used in communication systems that convey voice, data, image, signal, or video information using a continuous signal.

E.g. Human voice, Thermometer, etc.



Analog Signal



Digital Signal

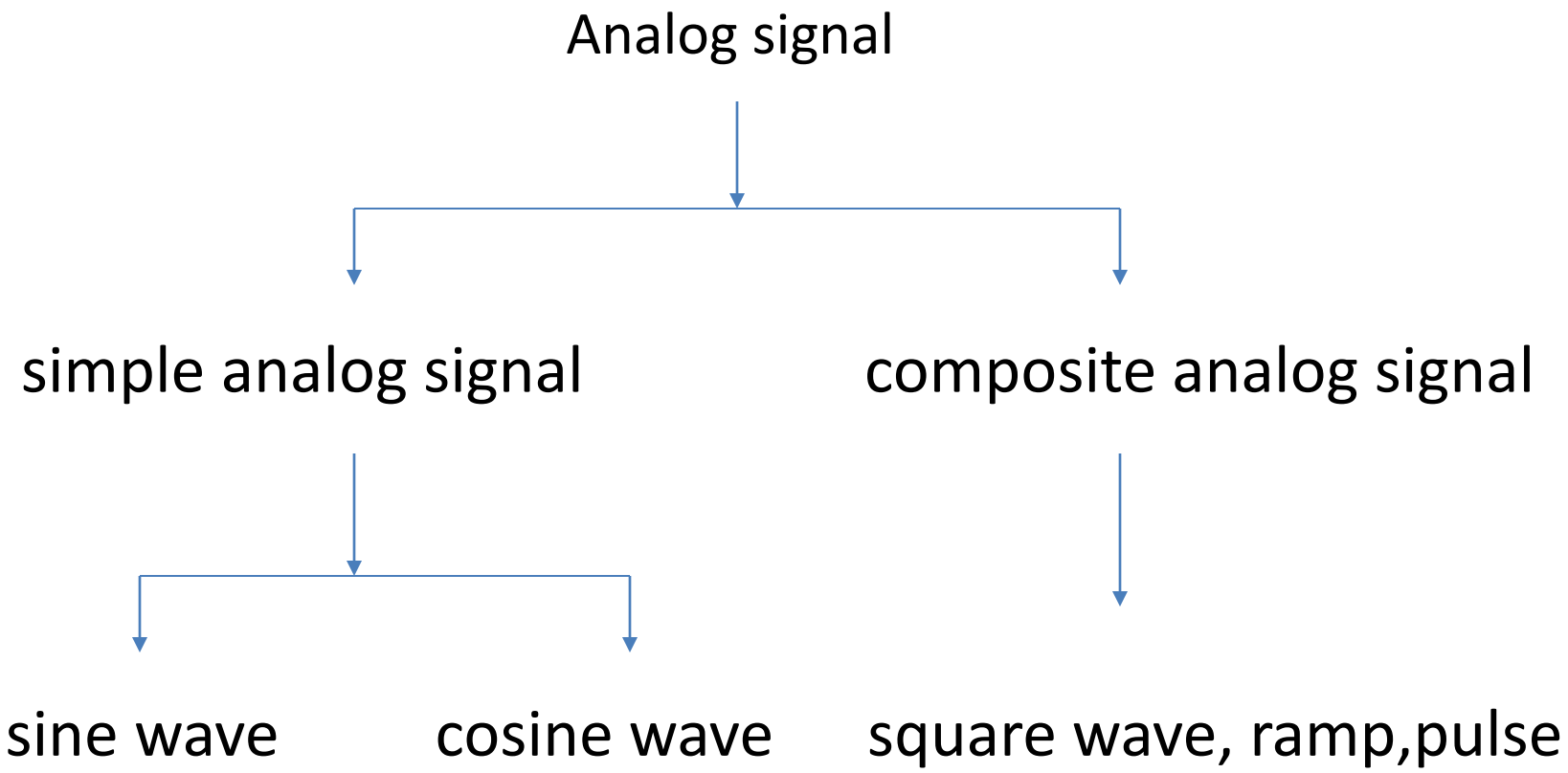


fig :- classification of Analog signals

simple analog signal :-

- It is basic analog signal
- It is used to build other composite signals
- it is analog signal which can not be decomposed into simpler signal

e.g. sine wave & cosine waves

composite analog signal :-

A composed analog signal is made of multiple sine or cosine waves of different amplitude.

e.g . square wave, triangular wave, ramp, pulse etc.

Advantages of Analog signal

- Analog signals are easier to process.
- Analog signals best suited for audio and video transmission.
- Analog signals are much higher density, and can present more refined information.
- Analog signals use less bandwidth than digital signals.

Disadvantages of Analog signal

- Analog wire is expensive and not easily portable.
- It is quite difficult to synchronize analog sound.
- Quality is definitely lost.
- Data can become corrupted in analog signals.
- It Offers poor multi-user interfaces.

n.

Digital signal :- it represents data as a sequence of discrete values; at any given time

E.g. Inductors, capacitors, radio-frequency

Advantages of digital signal :

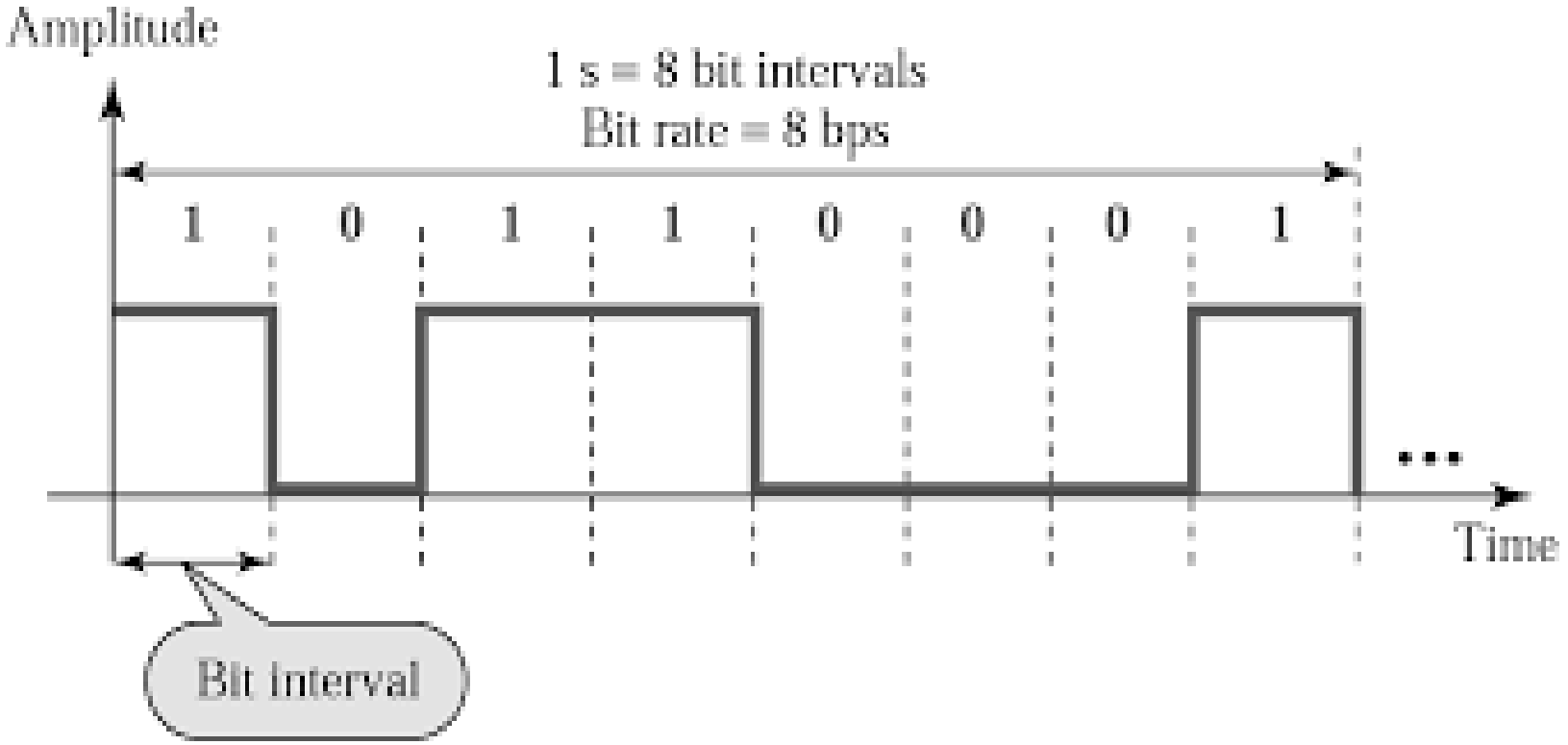
- Digital signal processing is more flexible
- Digital systems are more accurate
- Digital signals can be transmitted over long distances.
- Digital signal processing is more secure because digital information can be easily encrypted and compressed.

Disadvantages of digital signal

- Processor speed is limited.
- Systems and processing is more complex.
- Digital transmission systems are not compatible to older analog transmission systems.
- Digital signals use high bandwidth.
- Bit errors are possible.
- Processing is complex.

Bit Interval :- The bit interval is the time required to send one single bit .

- Bit interval is referred to as the time needed to transfer one signal bit.



Bit Rate (data rate) :- bit rate is defined as number of bits transmitted in one second

Relation between bit rate and bit interval is

Bit rate = 1/ bit interval

Bit rate is also called as signaling rate

Bit length :- distance one bit occupies on the transmission medium

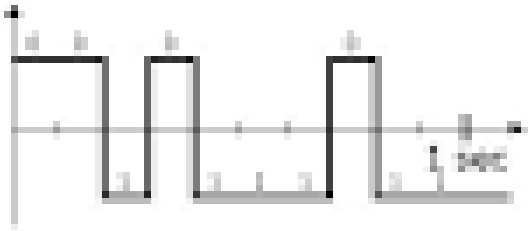
Bit length = propagation speed* bit duration

It is measured in meters

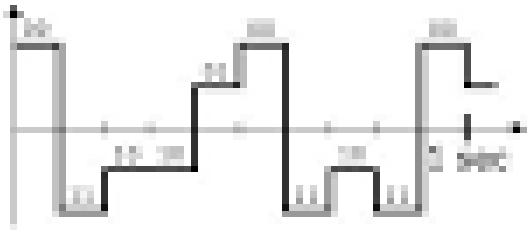
- **Baud rate** -A baud rate can be defined as number of signal units per second.

Baud and Bit Rate

- **Baud** → How many times a signal changes per second
- **Bit rate** → How many bits can be sent per time unit (usually per second)
- Bit rate is controlled by baud and number of signal levels



Baud = 10
Bit rate = 10 bps



Baud = 10
Bit rate = 20 bps

Bit Rate = Baud rate x the number of bit per baud

6 marks

Example 1

An analog signal carries 4 bits in each signal unit. If 1000 signal units are sent per second, find the baud rate and the bit rate

Solution

Baud rate = 1000 bauds per second (baud/s)
Bit rate = 1000 x 4 = 4000 bps

e.g. A system send a signal that can assume 8 different voltage levels. It send 400 of these signals per second .what are the baud and bit rates?

2^1=2

8 voltage level 2^2=4

Formula - 2^n 2^3=8

8 = 2^3 –no of bits per voltage level is 3

Each voltage level represent one symbol

Baud rate = symbol rate

Baud rate = 400 symbols/sec

We are using 3 bit to represent each symbol

bit rate = 3*symbol rate

= 3* 400 = 1200 bit /sec- answer

Signal conversion method

1. Digital data, digital signal (D to D conversion)
2. Analog data, digital signal(A to D conversion)
3. Digital data, analog signal(D to A conversion)
4. Analog data, analog signal (A to A conversion)

Analog data, digital signal(A to D conversion)

Analog and digital signals are used to transmit information (any audio, video)through the electronic signals

Digitisation :- the process of converting the analog data to digital signal is known as digitisation

- It is also called A to D conversion
- In this method input analog data is convert into equivalent digital signal

three methods

1.Pulse amplitude modulation:- it is technique used in analog to digital conversion

PAM technique is not useful in data communication.

2.Pulse code modulation

3. Delta modulation

2.Pulse code modulation :- 6 marks

This system consist of three blocks

a. **Sampling**
b. **Quantizing**
c. **Encoding**

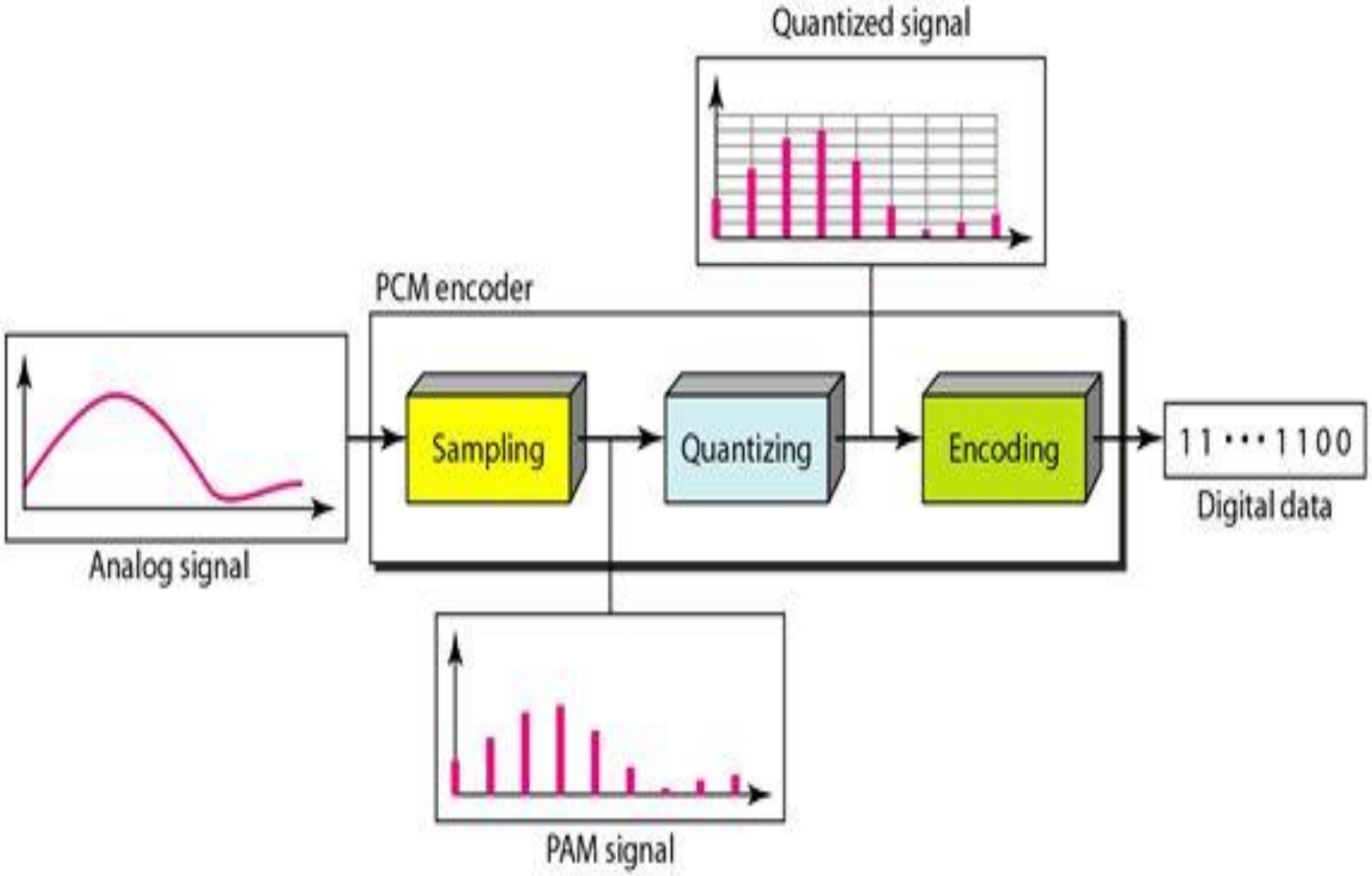
Sampling :- sampling is a process of measuring the amplitude of continuous –time signal & converting the continuous signal into discrete signal

Quantizing :- quantization is a process of approximation

- quantization process approximates each sample to its nearest standard voltage level called quantization level
- The quantization is done between the maximum amplitude value and the minimum amplitude value

Encoding :- it is process in which encoder converts each quantized sample into separate code

Analog data, digital signal(A to D conversion)



- **Applications of pulse code modulation :-**
- It is used in telephony and compact discs.

- Pulse Code Modulation is used in satellite transmission systems and space communications.

- **Advantages of pulse code modulation**

- Pulse Code Modulation is used in long-distance communication.

- The efficiency of the transmitter in PCM is high.

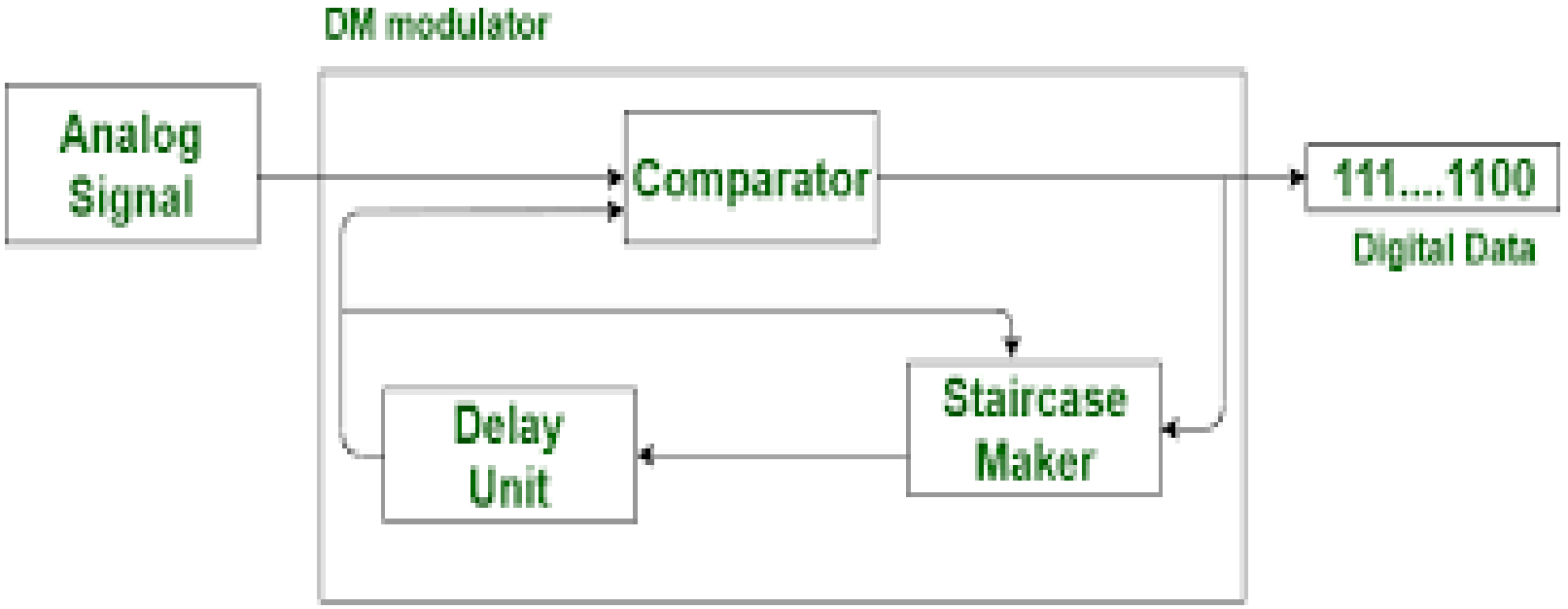
- **Disadvantages of pulse code modulation**

- The PCM (pulse code modulation) requires large bandwidth as compared to analog system.

- Encoding, decoding and quantizing circuit of PCM is very complex.

Delta modulation :- **6 marks**

Since PCM is very complex technique other technique have been develop to reduce the complexity of PCM



Block Diagram Of DM

- The process records a small positive change called delta
- If delta is positive the process records 1 else process records 0
- The modulator builds second signal that resembles staircase

Rules for output

1. If the input analog signal is higher than the last value of the staircase signal …increase delta by 1 and the bit in the digital data is 1
2. If the analog signal is lower than the last value of the staircase signal decrease delta by 1 and the bit in the digital data is 0

Analog to analog conversion/modulation (A to A)

It is representation of analog information by an analog signal

Modulation:- the process of combining audio frequency (sound waves) & radio frequency(electromagnetic frequency) waves to accomplish translation is called modulation

Components of modulation system

Modulator :- it is circuit which perform modulation

Message signal :- it is base signal to be transmit. It is low frequency signal

Carrier signal :- it is high frequency signal it is use to carry message signal

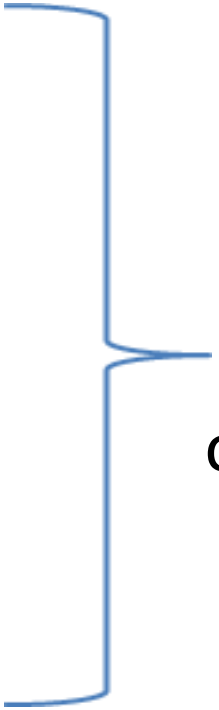
Modulated signal :- it is the carrier signal that has been acted on by information signal it is high frequency signal

Analog to analog conversion can be done in three ways

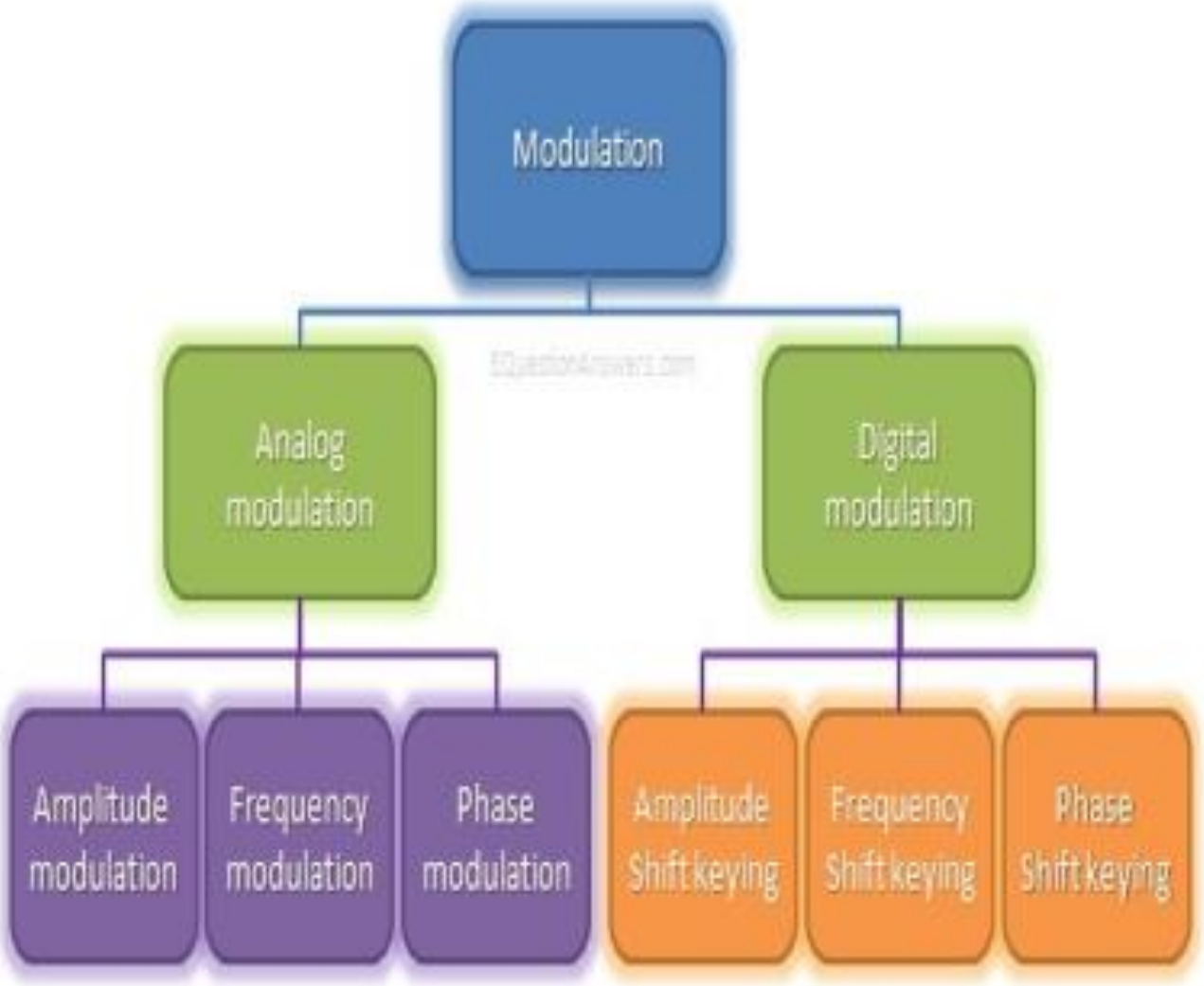
1.Amplitude modulation (AM)

2.Frequency modulation(FM))

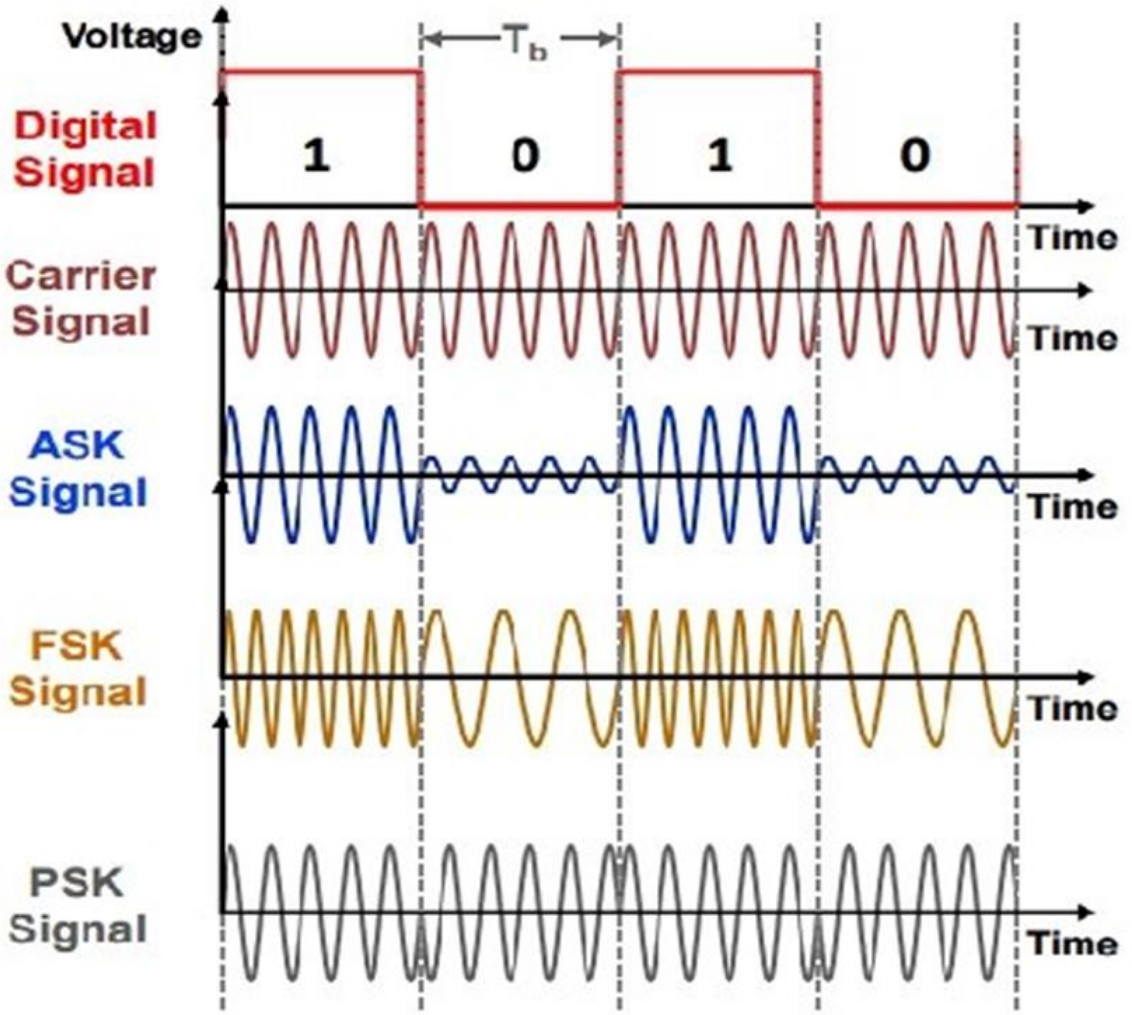
3.Phase modulation(PM)



characteristics of modulation


Modulation
Analog modulation
Digital modulation
Amplitude modulation
Frequency modulation
Phase modulation
Amplitude Shift keying
Frequency Shift keying
Phase Shift keying

Comparison between ASK, FSK and PSK



Digital data to digital signal conversion (D to D)

- Data stored in the computer is in the form of 0's and 1's to be carried from one place to the other, data is usually converted to digital signals

- This is called digital to digital conversion or encoding

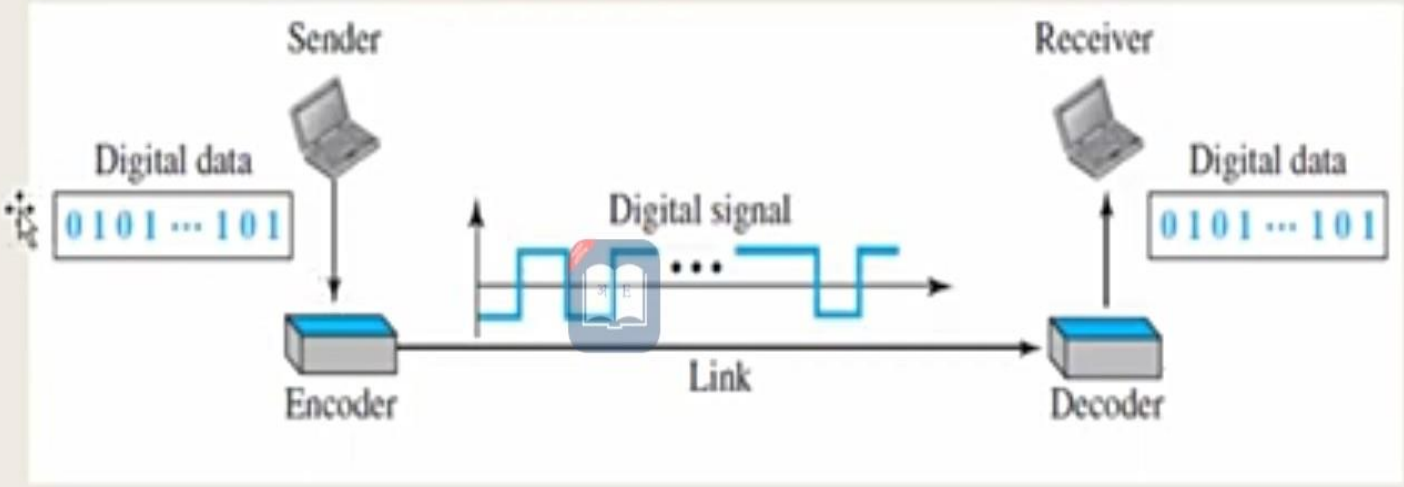
The conversion involves two techniques :

1. **line coding**
2. **Block coding**

Line Coding

- **Line coding** is the process of converting digital data to digital signals.
- We assume that data in the form of text, numbers, graphical images, audio, or video, are stored in computer memory as sequences of bits.
- Line coding converts a sequence of bits to a digital signal that denote the 1's and 0's.
- **For example** a high voltage level (+V) could represent a "1" and a low voltage level (0 or -V) could represent a "0".

Line coding and decoding

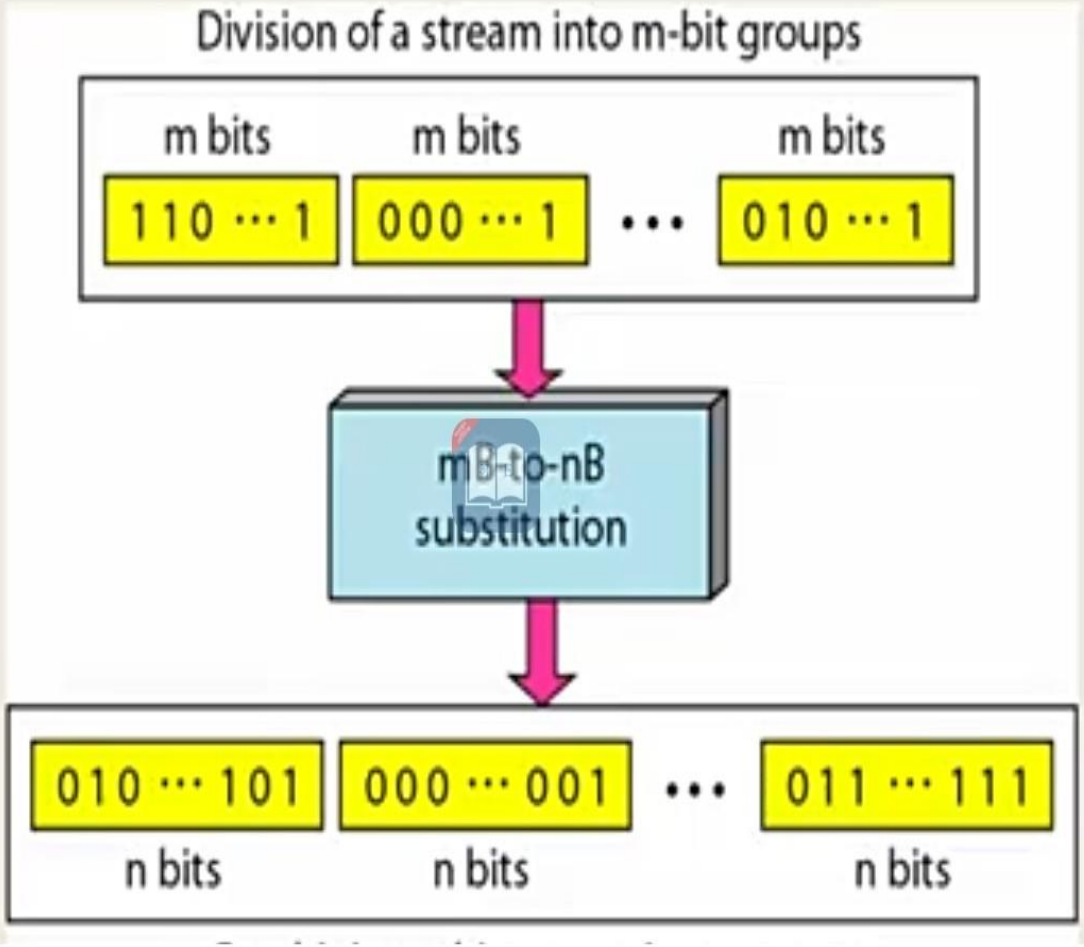


Block Coding

- For a code to be capable of error detection, we need to add redundancy, i.e., extra bits to the data bits.
- Synchronization also requires redundancy - transitions are important in the signal flow and must occur frequently.
- Block coding is done in three steps: division, substitution and combination.

Block coding is normally referred to as *m*B/*n*B coding;
it replaces each *m*-bit group with an *n*-bit group.

Block coding concept



Digital data, analog signal(D to A conversion)

- Three ways
- **ASK:- Amplitude shifting key**
- **FSK :- frequency shifting key**
- **PSK :- phase shifting key**

- **Bandwidth:**

The amount of data that can be transferred through a communication medium in a unit of time is called Bandwidth.

- **The bandwidth of digital signal is measured in bits per second or Bytes per Second.**

- **The bandwidth of analog signal is measured in cycles/seconds or Hertz.**

- **Baseband:**

Baseband is a communication technique in which digital signals are placed on the transmission line without change in modulation.

- **It means that digital signal are directly transmitted over transmission line.**
- **It transmits only one signal at a time.**
- **Digital Signal are commonly called Baseband Signal.**

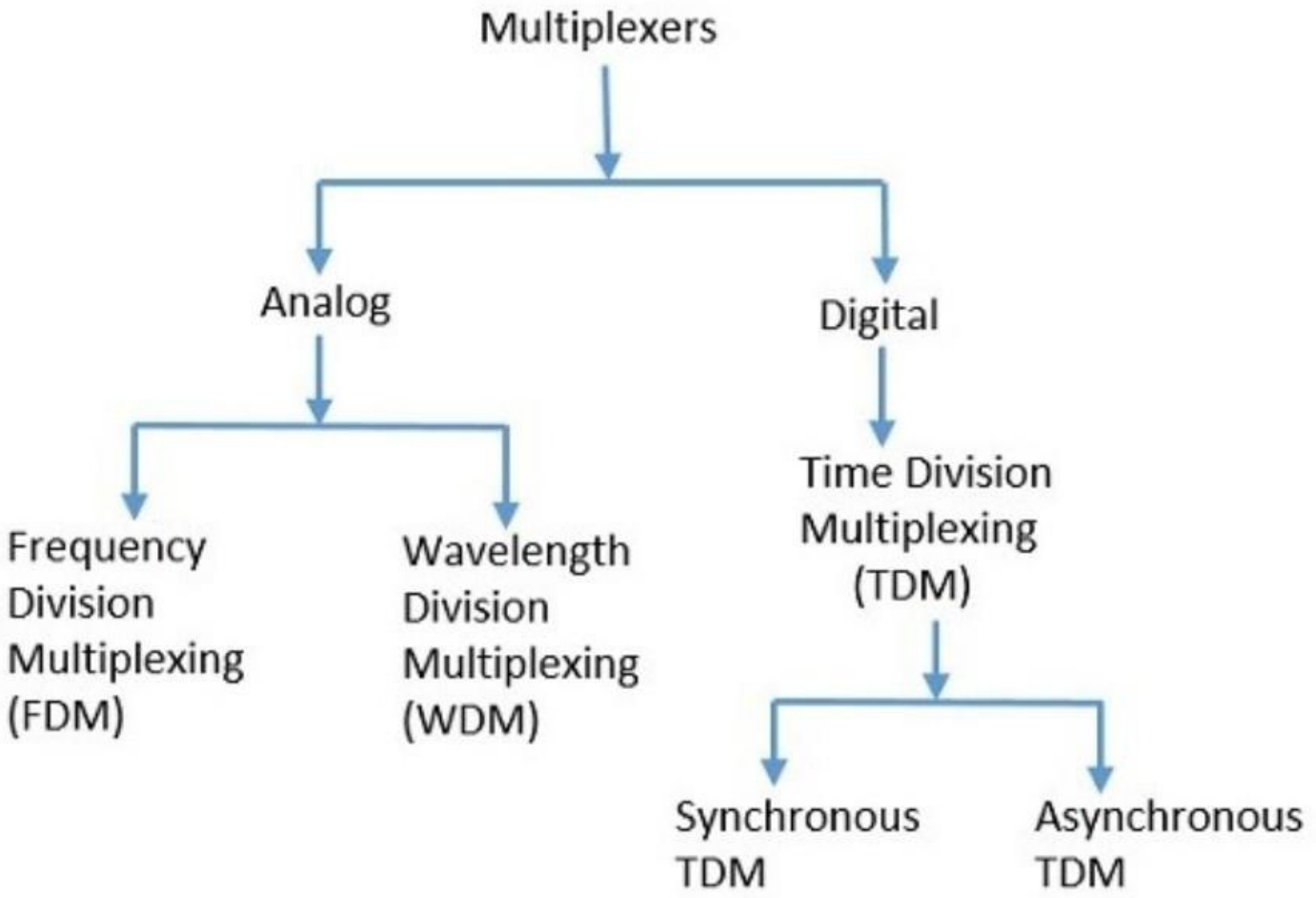
- **Broadband:**

Broadband is a technique to transmit large amount of data such as voice and video over long distance.

- **It can send data by modulating each signal onto a different frequency.**

Bandwidth utilization is the wise use of available bandwidth to achieve specific goals.

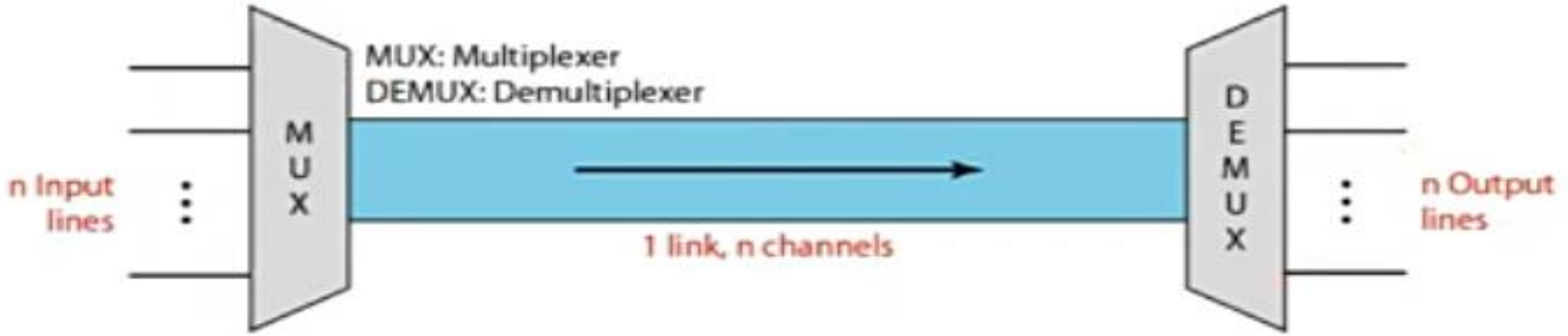
Efficiency can be achieved by multiplexing; privacy and anti-jamming can be achieved by spreading.


Multiplexers
Analog
Digital
Frequency Division Multiplexing (FDM)
Wavelength Division Multiplexing (WDM)
Time Division Multiplexing (TDM)
Synchronous TDM
Asynchronous TDM

multiplexing :- (channel sharing)

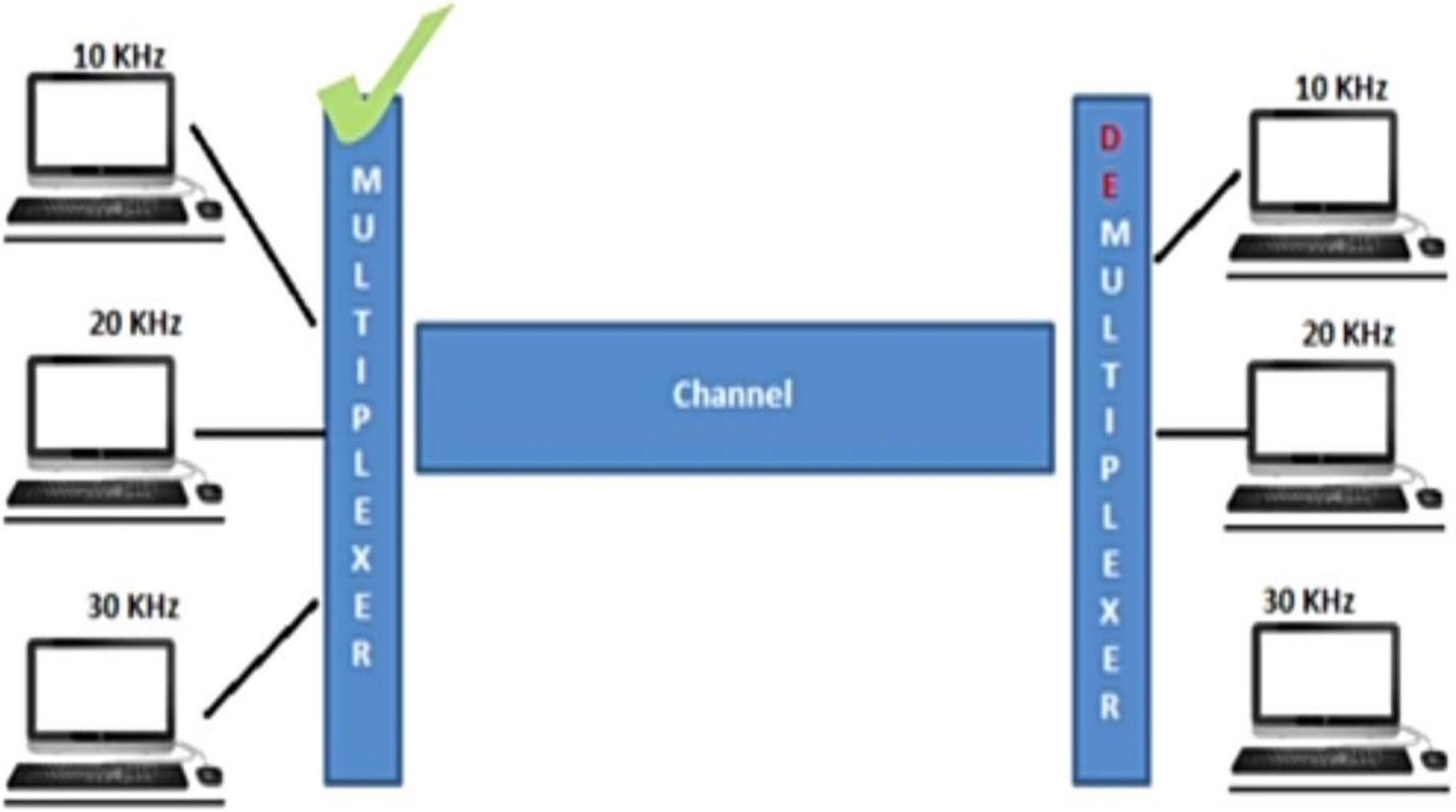
Multiplexing is the process of combining multiple signals into one signal, over a shared medium.

- Multiplexing means multiple sources but one link



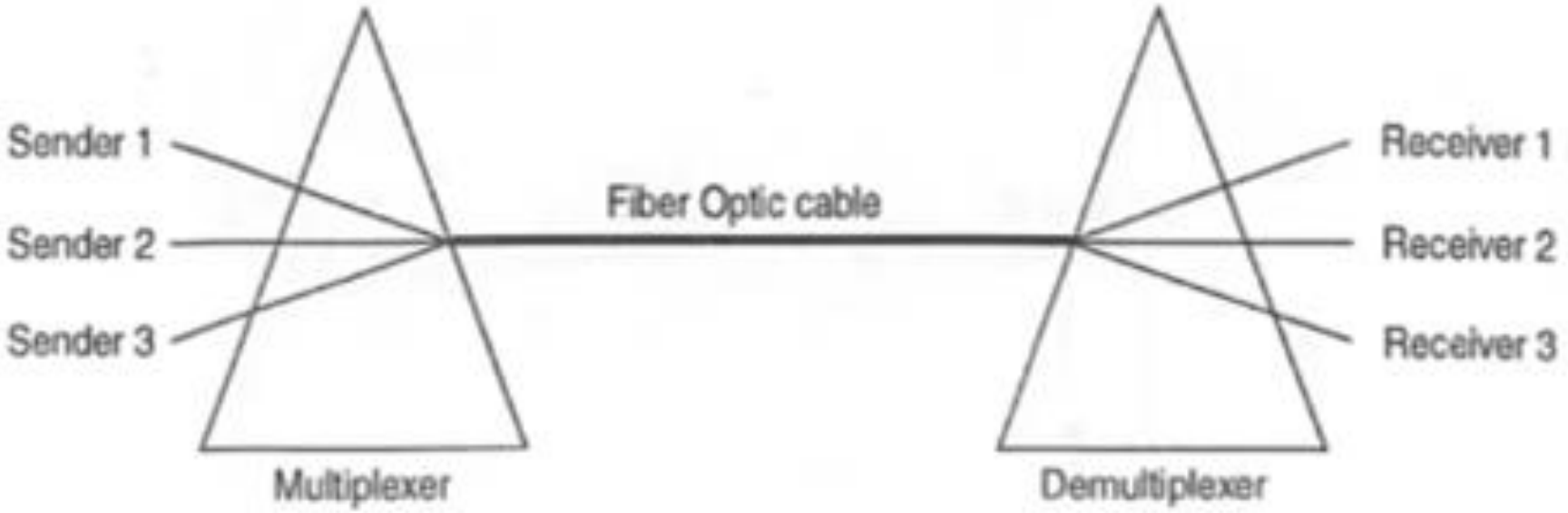
* FDM stand for Frequency Division Multiplexing Technique.
* In FDM, different frequencies will be combined as the one frequency and transmitted in the channel and at the receiver end again it will be separated as it was.
* It is totally based upon the frequency combining and division

Working of FDM



2. WAVE DIVISION MULTIPLEXING

- WDM is the analog multiplexing technique. WDM is conceptually similar to FDM, in the sense that it combines different signals of different frequencies into single composite signal and transmit it on a single link.
- In WDM the different signals are optical or light signals that are transmitted through optical fiber, as shown in figure as follows:



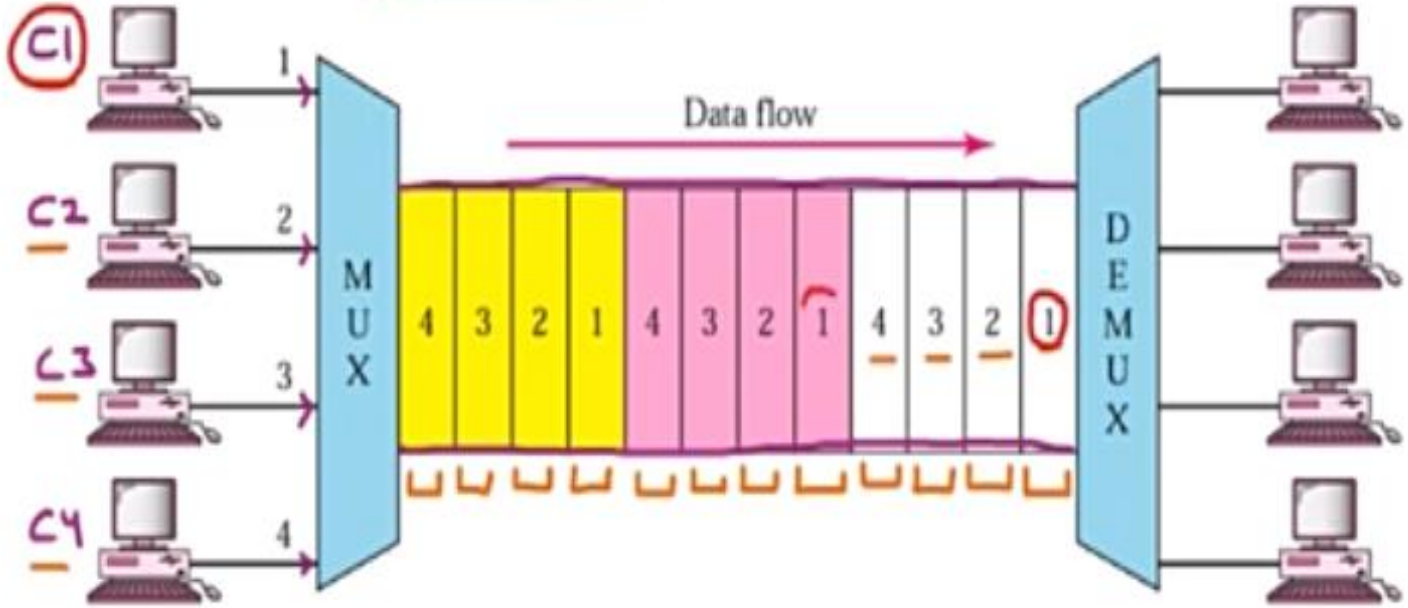
TDM

- It stands for Time Division Multiplexing Technique of Multiplexing.
- Each frame or packet of data will be allotted the time slot.
- It transmits the digital signals over the transmission network.
- It is used for high speed transmission
- It can be of two types:
    a. Synchronous TDM (with common clock signal sharing)
    b. Asynchronous TDM (without sharing common clock)

Time Division Multiplexing (TDM)

- Digital technique
- Divide channel into time

- Each device communicate in given time slot

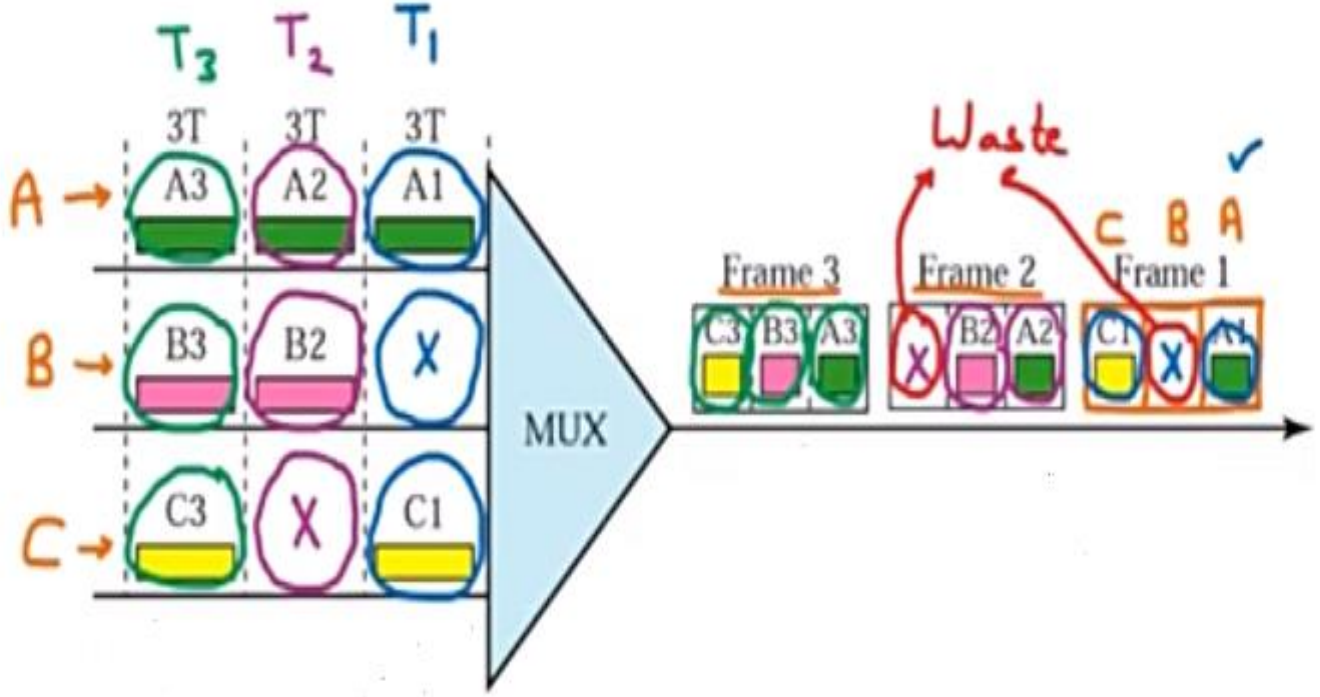


Time Division Multiplexing (TDM)

TDM are implemented in two ways

Synchronous TDM (Conventional TDM)

- Allocate exactly same time slot to each device, whether or not device has anything to send
- It waste bandwidth if time slots are left unused

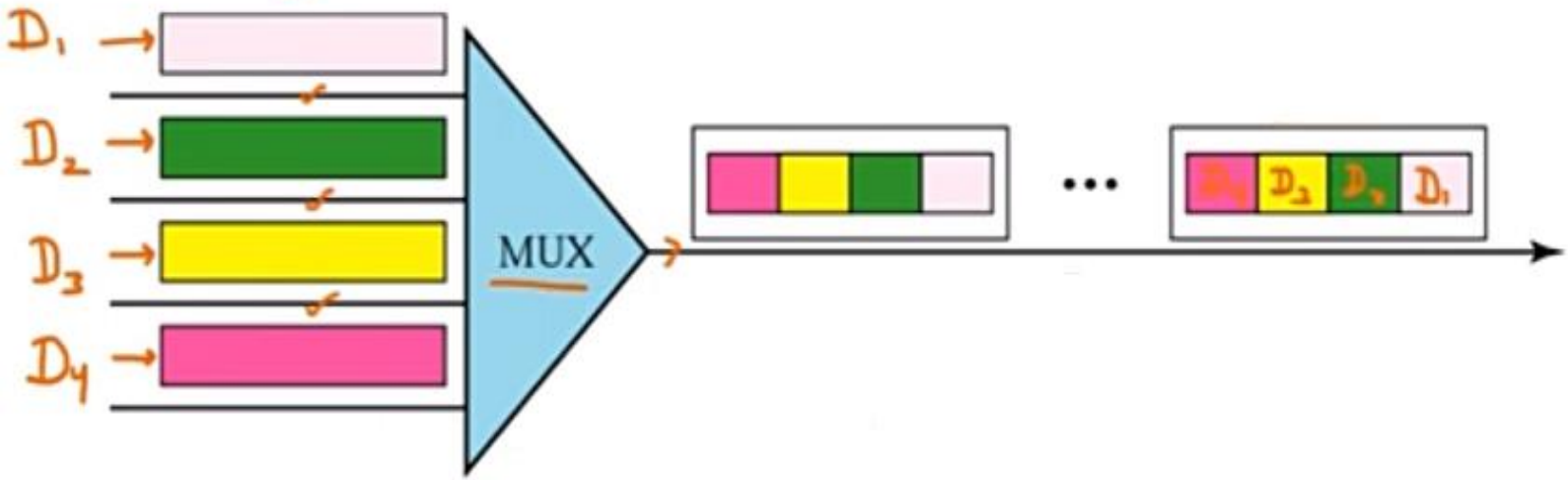


Time Division Multiplexing (TDM)

TDM are implemented in two ways

Asynchronous TDM (Statical TDM) (stat-TDM)

- Dynamically allocate time slots to active devices on First Come First Serve (FCFS) or Priority basis
- One device can be assigned greater access time slot than other
- Full use of link bandwidth



- Bandwidth - it is a measure of how much data over time a communication link can handle, its capacity

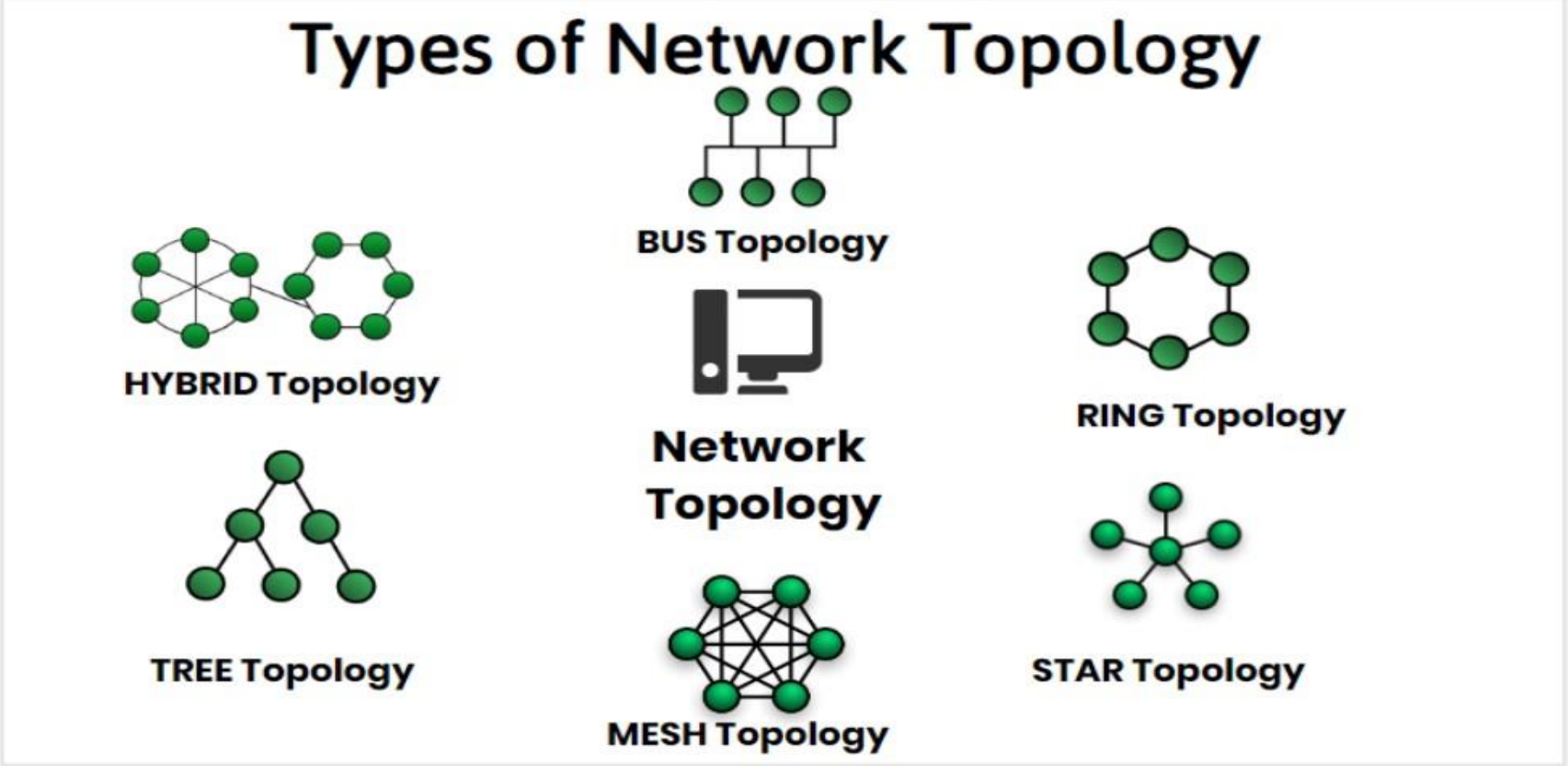
- Latency is the time it takes for a packet to get across the network, from source to destination.

- Throughput is the actual amount of data that is successfully sent/received over the communication link.

- Topology :- It is structure of network

- Physical & logical arrangement of elements called as network

Types Of network Topology :-



- **Bus topology** : In bus topology when node wants to send message over network it puts message over network & all the stations available in network.
- **CSMA** – carrier sense multiple access – it is most common access method of bus topology.
- It is used to control the data flow
- when two nodes send the messages simultaneously that time problem occurs
- There are two ways to handling the problem
- 1. **Collision detection** – it is used to detect collision
- 2. **Collision avoidance** – it is used to avoid collision by checking whether transmission media is busy or not

Advantages of bus topology

- low cost cable
- moderate data speed
- Limited failure

Disadvantages of bus topology

- Extensive cabling
- Difficult troubleshooting
- Signal interference
- Reconfiguration difficult
- Attenuation

- Ring topology – the data flow in one direction
- The nodes that receives message from previous computer will retransmit to next node
- Each node connected to other node
- The data in ring topology flow in a clockwise direction

- The most common access method of ring topology is **token passing**
- **Token passing –** in which token is passed from one node to another node
- Token – it is frame that circulate around network
- Token is used as a carrier

- **Advantages of Ring topology**
- Network management
- Product availability
- Cost
- Reliable

- **Disadvantages Of ring topology**
- Difficult troubleshooting
- Failure
- Reconfiguration difficult
- Delay

- **Star topology –**
- In which every node is connected to the central node which is called as hub

- The central computer known as server

- The peripheral devices attached to the server are known as client

- Star topology is the most popular topology in network implementation

- **Advantages of star topology**
- Efficient troubleshooting
- Network control
- Limited failure
- High data speed

- **Disadvantages of star topology**
- A central point of failure
- Cable

Tree topology

- Tree topology combines characteristics of bus topology and star topology
- In which all computers are connected with each other in hierarchical fashion
- Top most node are called root node
- All nodes are dependent on root node
- There is only one path exists between two nodes for data transmission

Characteristics of Tree Topology

- Ideal if nodes are located in groups
- Used in Wide Area Network
- Better Flexibility
- Better Scalability

Advantages of Tree Topology

- t is a combination of bus and star topology
- It provide high scalability, leaf nodes can add more nodes in the hierarchical chain
- Other nodes in a network are not affected, if one of their nodes get damaged
- It provides easy maintenance and fault identification
- Point-to-point wiring for individual segments.

Disadvantages of Tree Topology

- Large cabling is required as compared to star and bus topology
- On the failure of a hub, the entire network fails
- Tree network is very difficult to configure than other network topologies.

Mesh topology

- In which computers are interconnected with each other through various useless connection
- There are multiple path from one computer to another computer
- It does not contain switch or hub

Mesh topology is mainly used for (WAN) implementation

Types of mesh topology

1. **Full mesh topology** :- Each computer is connected to all computers

1. **Partial mesh topology** :- not all but certain computers are connected to those computers with which they communicate frequently
2. all the nodes aren't necessary to be connected with one another during a network.

Advantages of Mesh Topology :

- Failure during a single device won’t break the network.
- Fault identification is straightforward.
- It provides high privacy and security.
- A mesh doesn’t have a centralized authority.

Disadvantages of Mesh Topology

- It’s costly as compared to the opposite network topologies
- Installation is extremely difficult in the mesh
- Complex process
- Maintenance needs are challenging with a mesh

Hybrid topology :- combination of various different topologies called hybrid topology

- **When two or more different topologies are combined together is called hybrid**

But

When similar topologies are connected with each other will not result in hybrid

e.g. one branch of ICIC in ring topology & another branch of ICIC in bus topology connecting these two topologies will called hybrid topology

Advantages of hybrid topology

- It is extremely flexible.
- It is very reliable
- Error detecting and troubleshooting are easy.
- It is used to create large networks.
- The speed of the topology becomes fast when two topologies are put together.

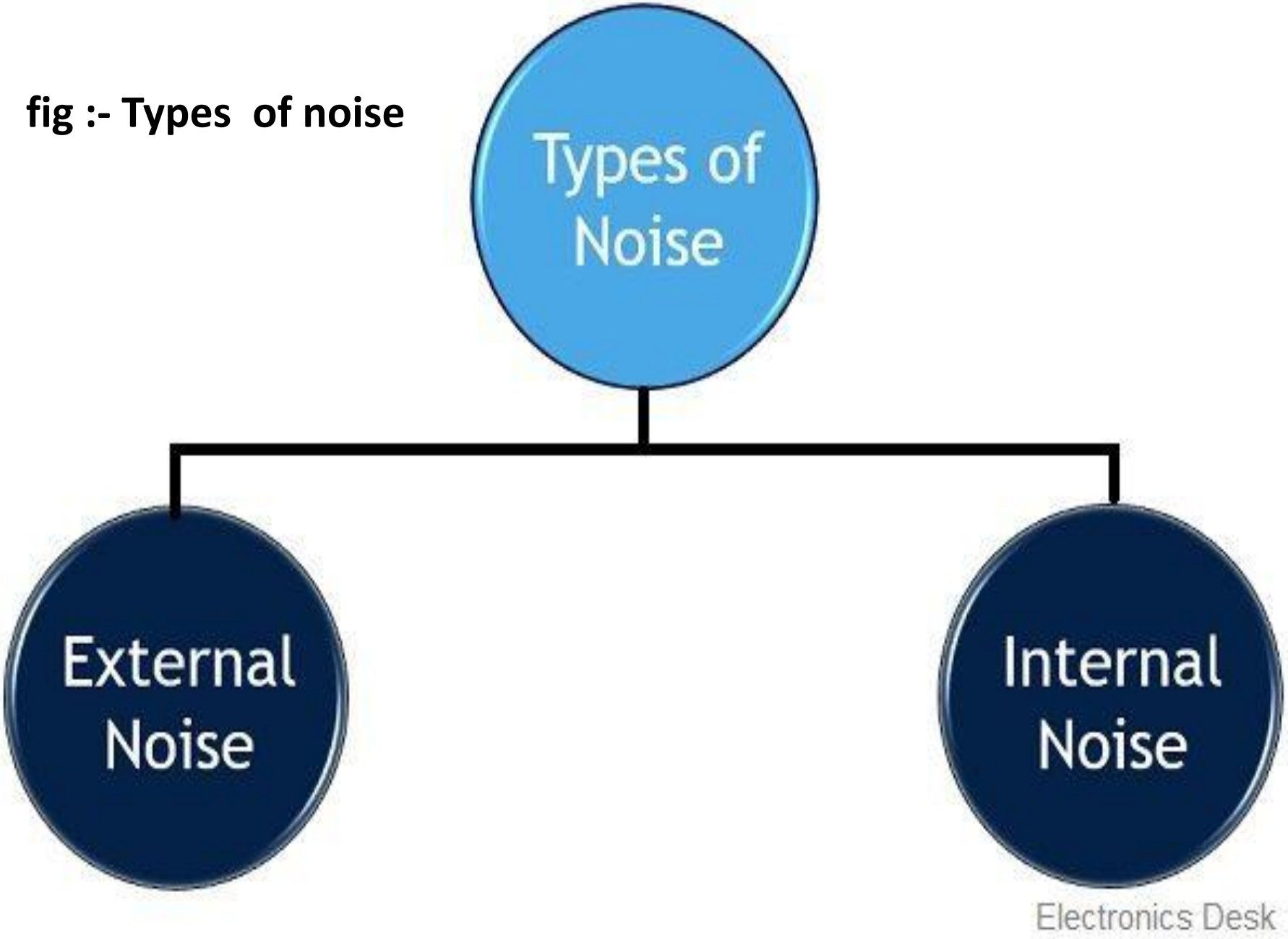
Disadvantages of hybrid topology

- It is a type of network expensive.
- The design of a hybrid network is very complex
- There is a change in the hardware to connect one topology with another topology.
- Hubs which are used to connect two distinct networks are very costly
- Installation is a difficult process.

noise is any disturbance that interfere with data transmission or communication

- Noise corrupts the quality of the signal. Below are examples of where noise can be encountered in data transmission and its common causes.
- E.g. Audio, image, or video signal Noise

fig :- Types of noise



Types of external noise & internal noise

- External Source
- This noise is produced by the external sources which may occur in the medium or channel of communication,

- Most common examples of this type of noise are –
- Atmospheric noise (due to irregularities in the atmosphere).
- solar noise
- Industrial noise.

- **Internal Source**
- This noise is produced by the receiver components while functioning. The components in the circuits, due to continuous functioning, may produce few types of noise.

- Examples -
- Transit-time noise (during transition).

- Shot noise (due to the random movement of electrons and holes).

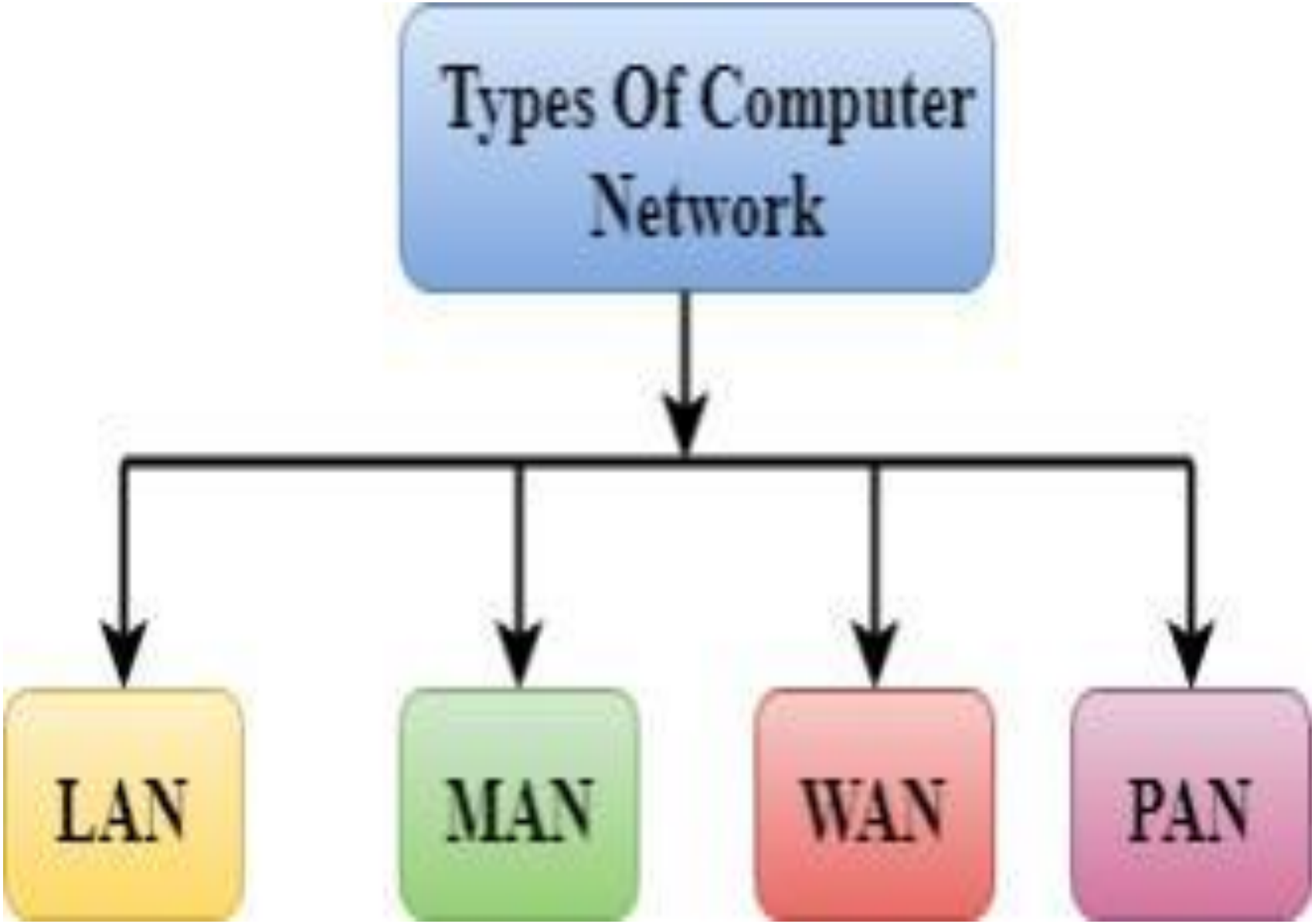
Effects of noise :-

Noise is an inconvenient feature which affects the system performance.

Network :- A network consists of two or more computers that are linked in order to share resources (such as printers and CDs), exchange files, or allow electronic communications.

Types of network :-

- Personal area network
- Local area network
- Metropolitan area network
- Campus network
- Wide area network


Types Of Computer Network
LAN
MAN
WAN
PAN

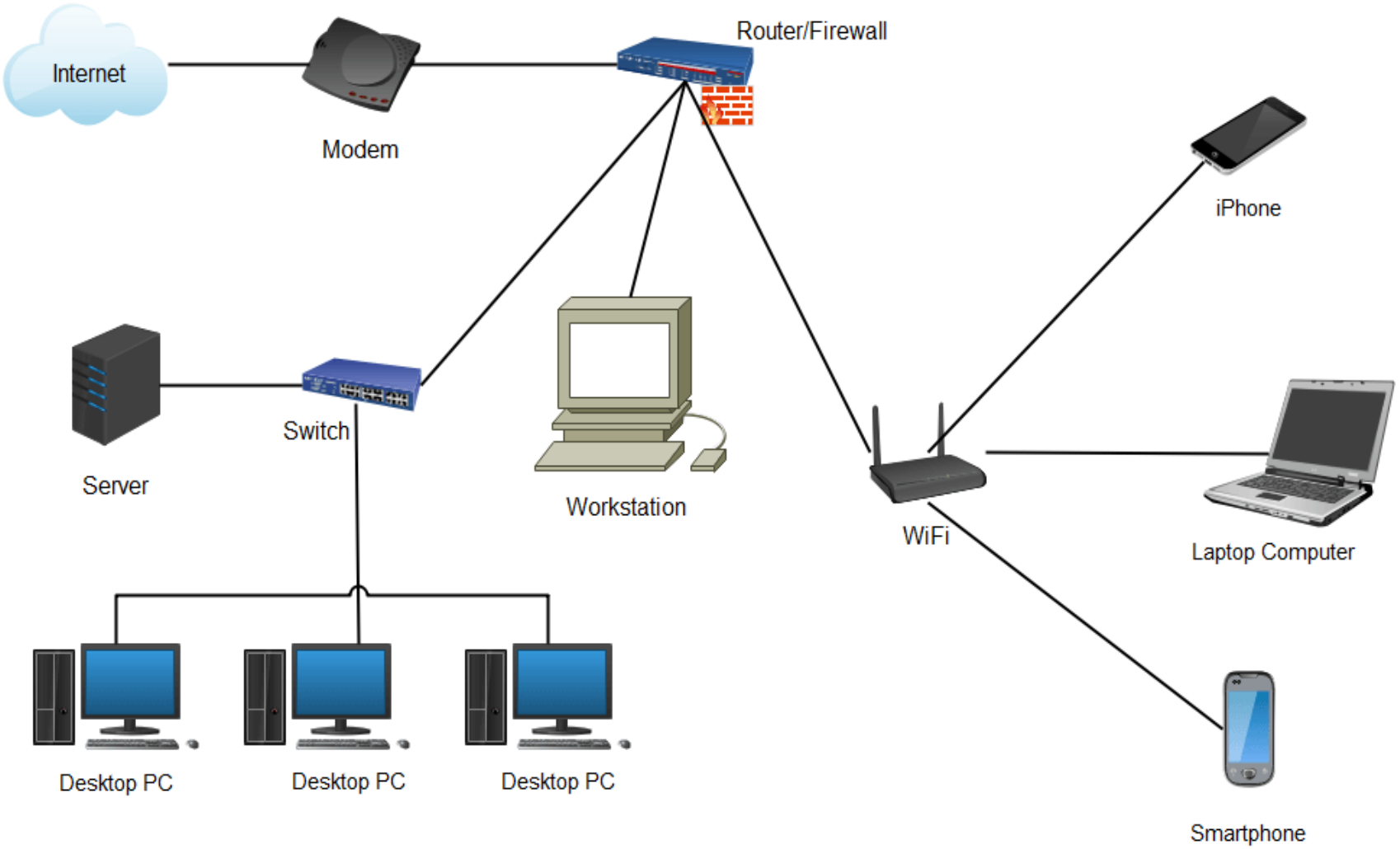
Local area network :- A local area network (LAN) is a group of computers and peripheral devices that share a common communications line or wireless link to a server within a distinct geographic area

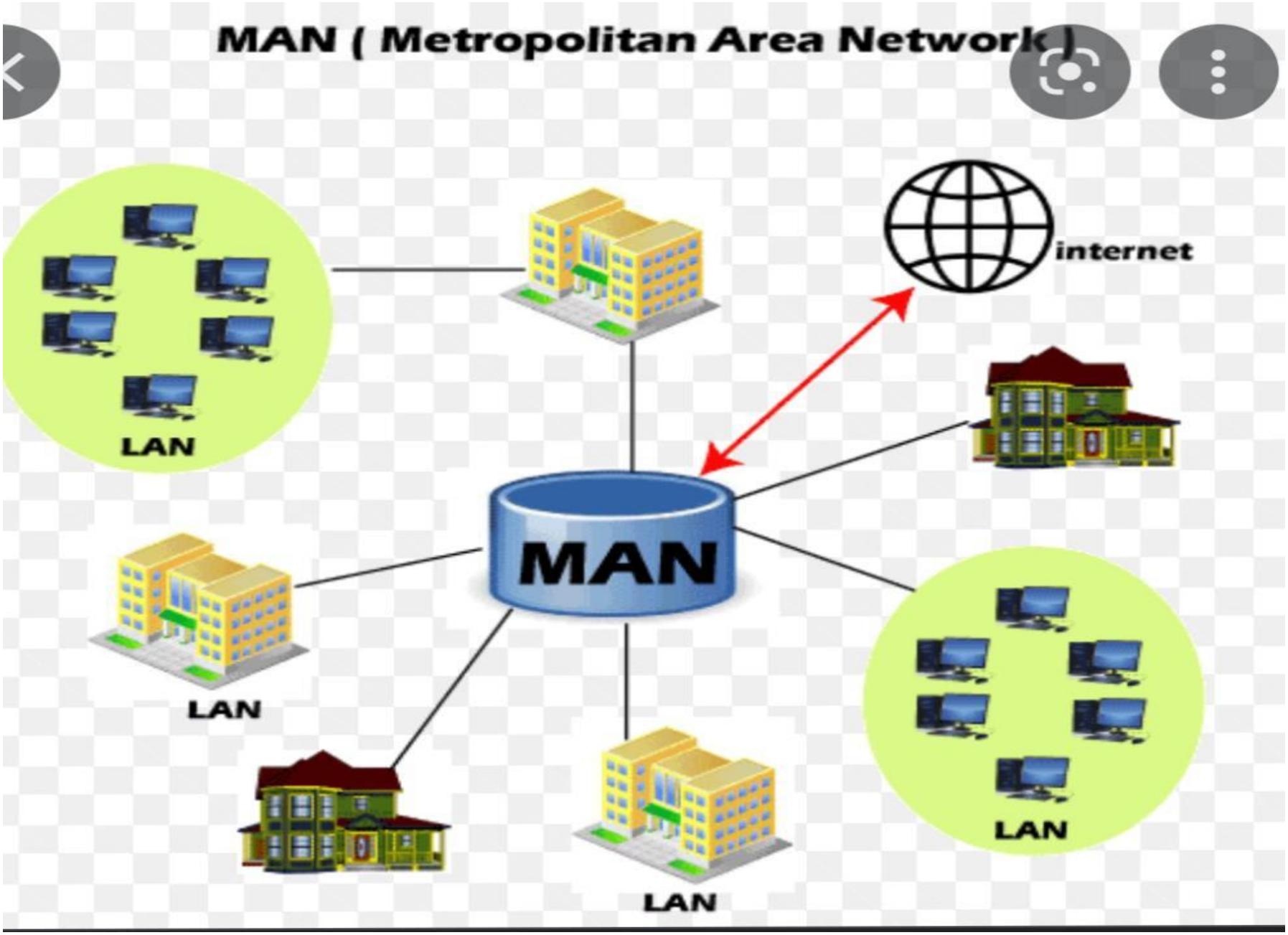
LAN is a private network that connects computers and devices within a limited area like a residence, an office, a building or a campus. On a small scale,

- **Metropolitan area network :- MAN** is a computer network
- that is larger than a single building local area network (LAN) but is located in a single geographic area that is smaller than a wide area network (WAN).

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.


Internet
Modem
Router/Firewall
iPhone
Server
Switch
Workstation
WiFi
Laptop Computer
Desktop PC
Desktop PC
Desktop PC
Smartphone


MAN (Metropolitan Area Network)
internet
LAN
MAN
LAN
LAN
LAN

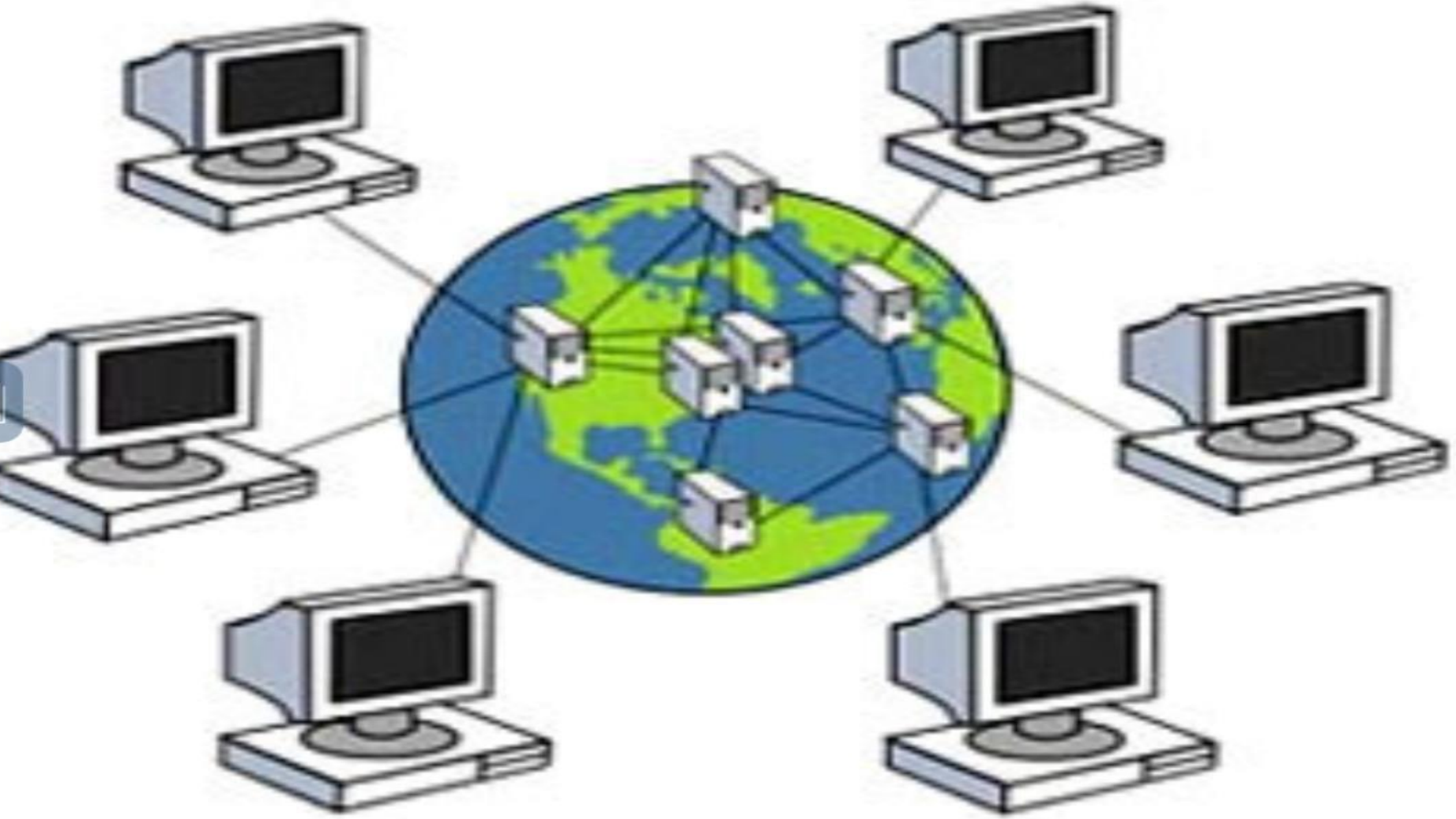
Wide area network

- 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.

- Examples Of Wide Area Network:
- **Mobile Broadband:** A 4G network is widely used across a region or country.

- **Last mile:** A telecom company is used to provide the internet services to the customers in hundreds of cities by connecting their home with fiber.

- **Private network:** A bank provides a private network that connects the 44 offices. This network is made by using the telephone leased line provided by the telecom company.



	PAN	LAN	CAN	MAN	WAN
Full Form	Personnel Area Network	Local Area Network	Campus Area Network	Metropolitan Area Network	Wide Area Network
Technology	Bluetooth, IrDA, Zigbee	Ethernet and Wi-Fi	Ethernet	FDDI, CDDI, ATM	Leased Line, Dial-Up
Range	1-100 Meter	Up to 2 KM	1-5 KM	5-50 KM	Above 50 KM
Transmission Speed	Very High	Very High	High	Average	Low
Area	Within a Room	Within office, building	Within University, Corporate offices	Within City like Mumbai	Within Countries
Ownership	Private	Private	Private	Private or Public	Private or Public
Maintenance	Very Easy	Easy	Moderate	Difficult	Very difficult
Error Rate & Cost	Very Low	Low	Moderate	High	Very High

Data rate limits

Data rate governs the speed of transmission

Data rate depends upon 3 factors

1) The bandwidth available

2) Number of levels in digital signal

3) The quality of channel – level of noise

- Channel capacity – The maximum rate at which data can be transmitted over a given communication channel under given conditions it is called channel capacity.

- It is measured in bits per second (bps).

- **Chanel capacity of two theorem**
- Two theorem for the evaluation of data rate

1) **Nyquist theorem** :- it is used for noiseless channel

2) **Shannon's theorem** :- it is used for noisy channel

Nyquist theorem :- it is important channel of transmission

- it is used for noiseless channel

Channel are the following characteristics

1) Signal to noise ratio → SNR
2) Bandwidth → decides maximum channel to carry information

maximum data rate of channel -> **R = 2BLog 2L**

C= maximum capacity

Bit Rate R = 2*bandwidth *$\log_2$(L)

- **bandwidth** – bandwidth of channel (**bandwidth is fixed quantity so can not changed)**
- **L** – it is number of signal level
- **Bit rate is the bit rate in bits per second**

Data rate is directly proportional to the number of signal level

Example 1 :- Consider a noiseless channel with a bandwidth of 2000 HZ transmitting a signal with

a) 2 signal level

b) 4 signal level

What can be the maximum bit rate ?

Bit rate = 2* bandwidth * $\mathbf{\log_2(L)}$

= 2 * 2000 *$\log_2$ (2)

Bit rate = 4000 bps

= 4 * 2000 *$\log_2$ (4)

Bit rate = 8000 bps

- **Shannon's theorem** :- it is used for noisy channel
- It state that the maximum rate at which information can be transmitted over a communication channel of specified bandwidth in the presence Of noise.

- It is an application of the noisy channels

For Noisy channel bit rate formula :-

$$\mathbf{R = B * \log_2(1+SNR)\ bits/sec}$$

- **B is the bandwidth of channel**
- **SR is received signal- to- noise ratio**
- **R is capacity or max data rate of channel in bits per second**

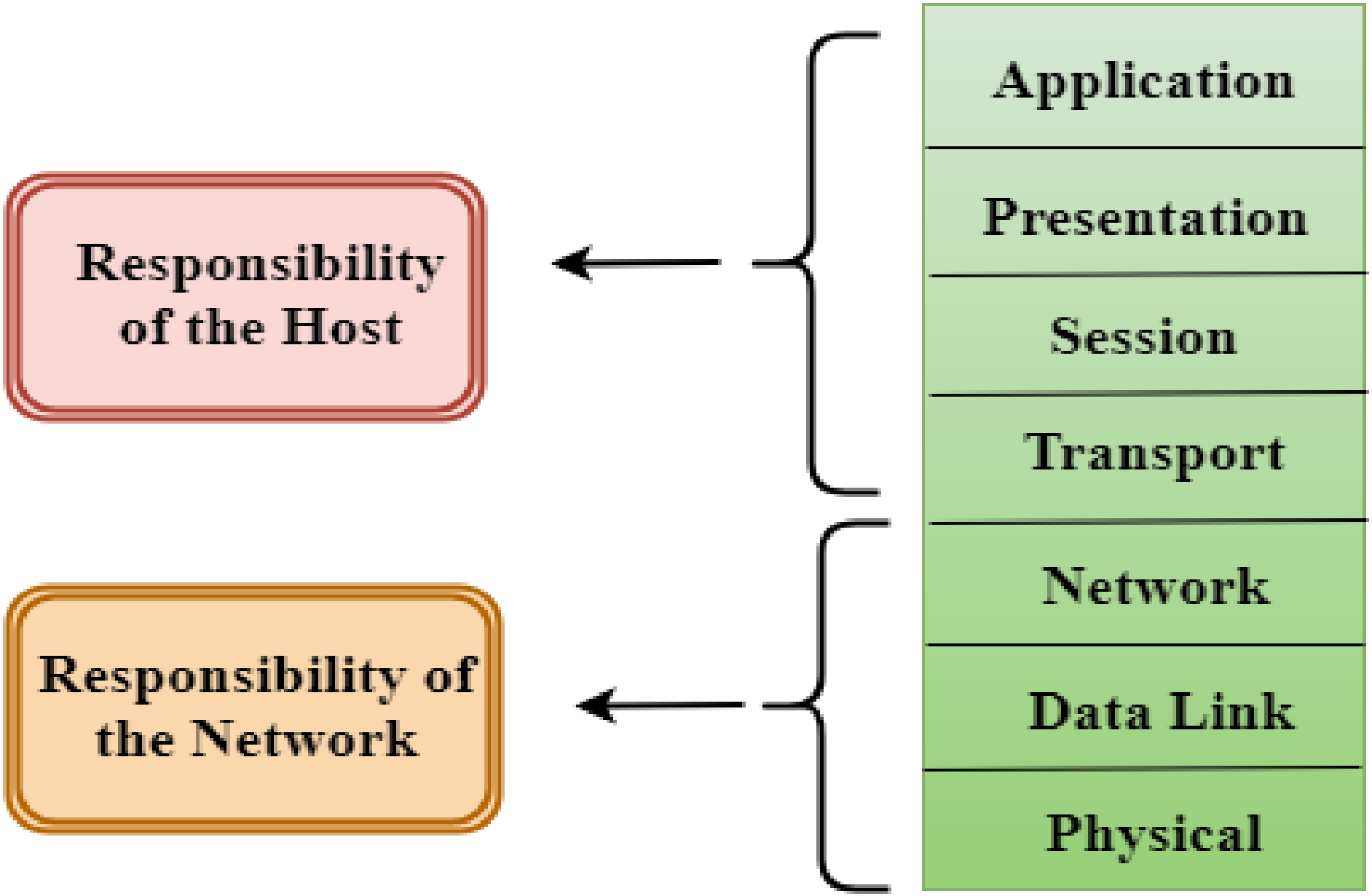
SNR =(power of signal)/(power of noise)

- OSI Model :-
- OSI stands for **Open System Interconnection**
- it is a reference model
- It describes how information from a software application in one computer moves to the software application in another computer through a physical medium.

- OSI model stands for open system interconnection
- It was developed by the International Organization for Standardization (ISO) in 1984

- OSI consists of seven layers, and each layer performs a particular network function.

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.

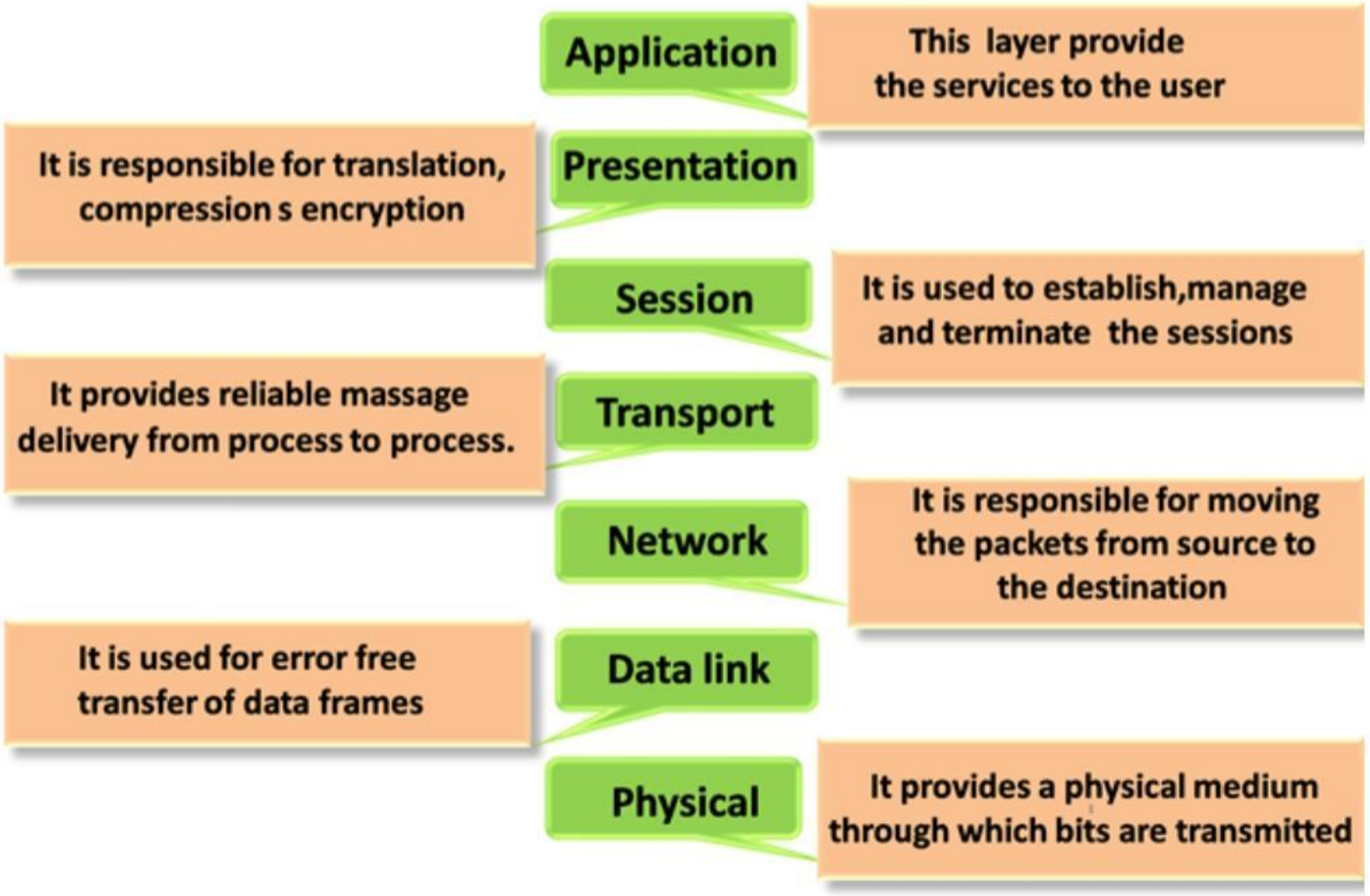
- The lower layer of the OSI model deals with the data transport issues.

- The data link layer and the physical layer are implemented in hardware and software.

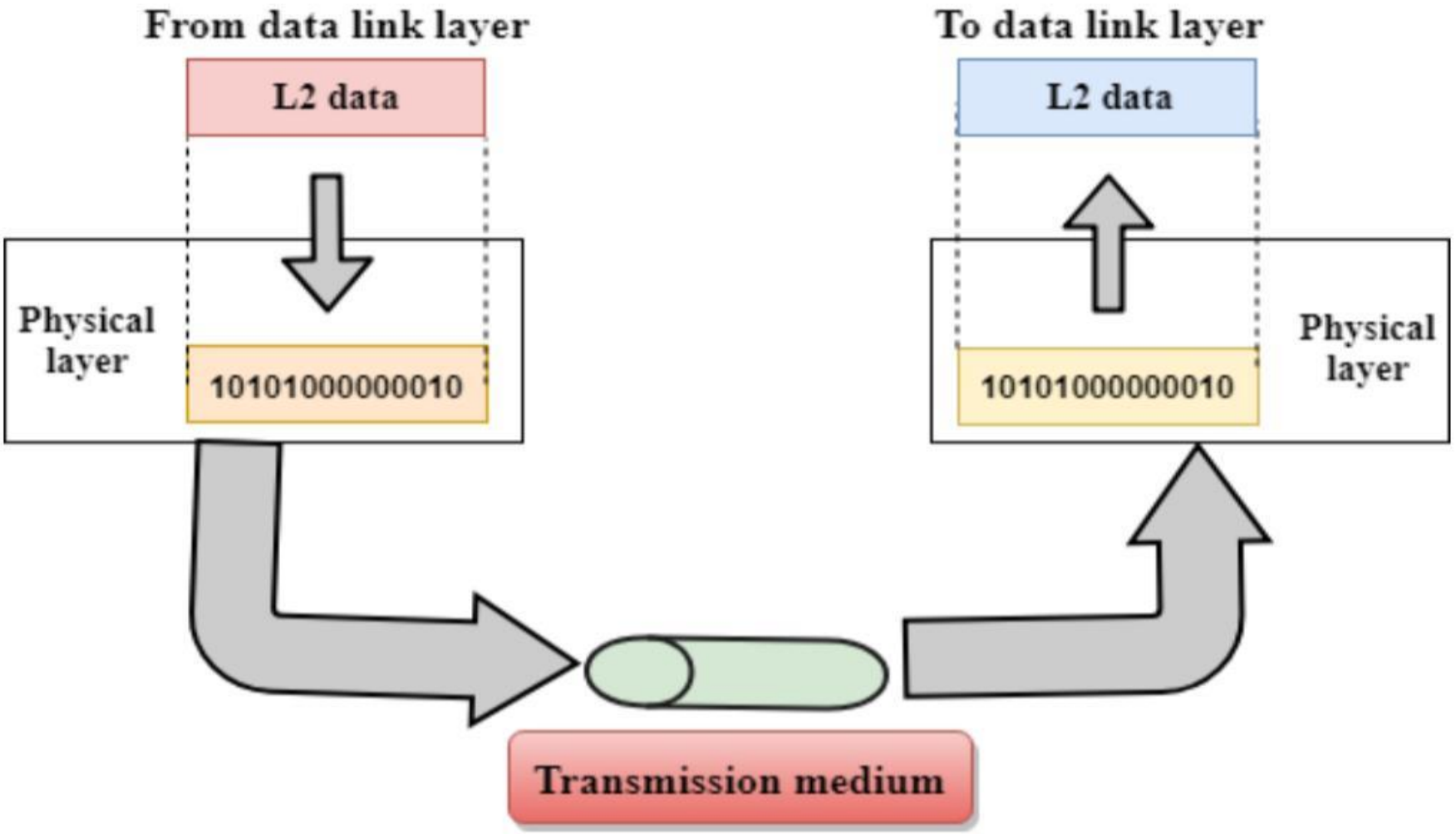
There are the seven OSI layers. Each layer has different functions. A list of seven layers are given below:

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

- Functions of the OSI Layers



Physical layer

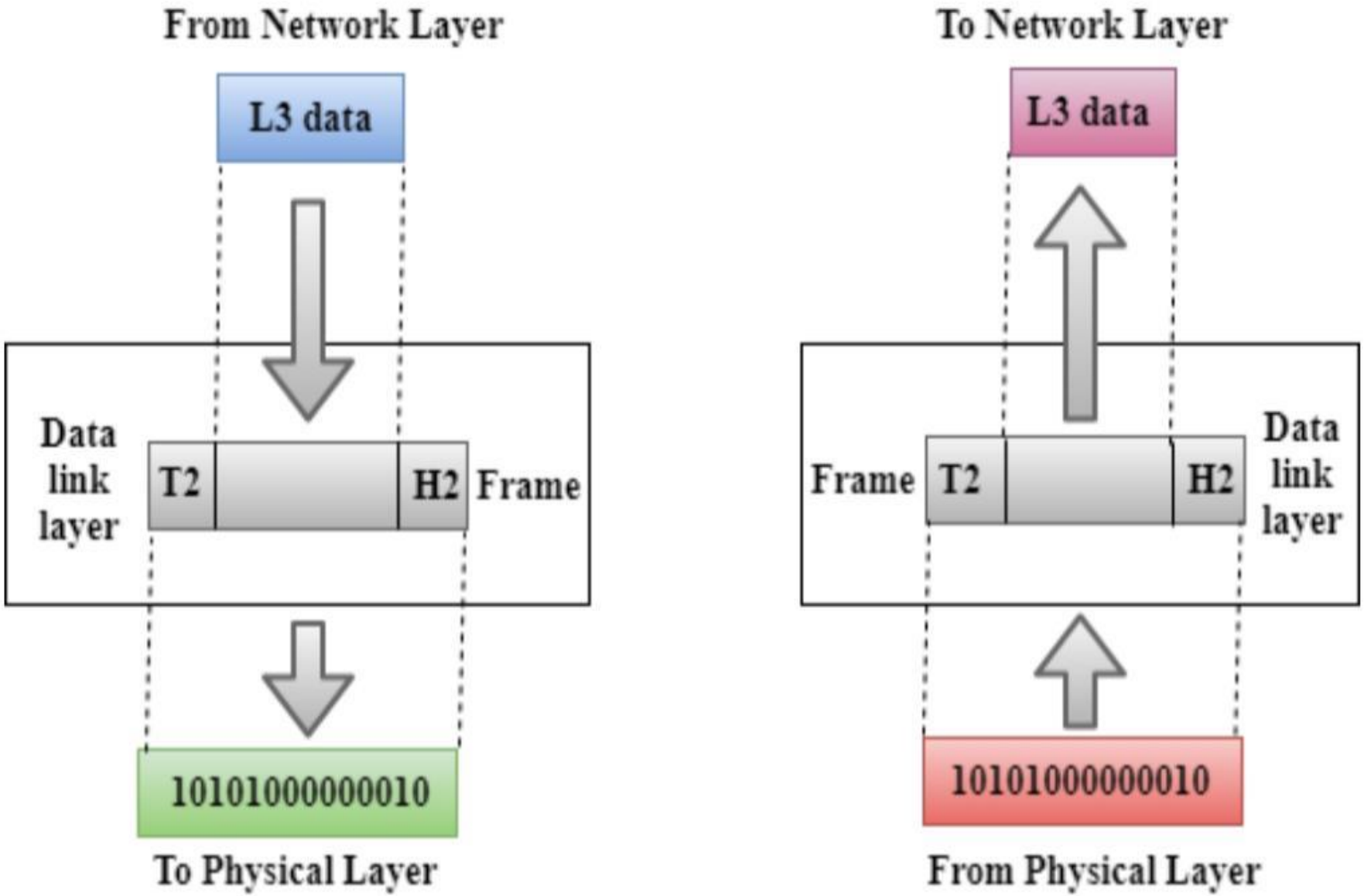


- The main functionality of the physical layer is to transmit the individual bits from one node to another node.
- It is the lowest layer of the OSI model.
- It establishes, maintains and deactivates the physical connection.

Functions of a Physical layer:

- **Line Configuration:** It defines the way how two or more devices can be connected physically.
- **Data Transmission:** It defines the transmission mode whether it is simplex, half-duplex or full-duplex mode between the two devices on the network.
- **Topology:** It defines the way how network devices are arranged.
- **Signals:** It determines the type of the signal used for transmitting the information.

- Data-Link Layer



- It contains 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

- # Functions of the Data-link layer

Framing

Physical Addressing

Flow Control:

Error Control:

Access Control:

- **Framing:** The data link layer translates the physical's raw bit stream into packets known as Frames.

- The Data link layer adds the header and trailer to the frame.

- **Physical Addressing:** The Data link layer adds a header to the frame that contains a destination address.

- The frame is transmitted to the destination address mentioned in the header.

- **Flow Control:** Flow control is the main functionality of the Data-link layer.

- It is the technique through which the constant data rate is maintained on both the sides so that no data get corrupted.

- **Error Control:** Error control is achieved by adding a calculated value CRC Redundancy Check)

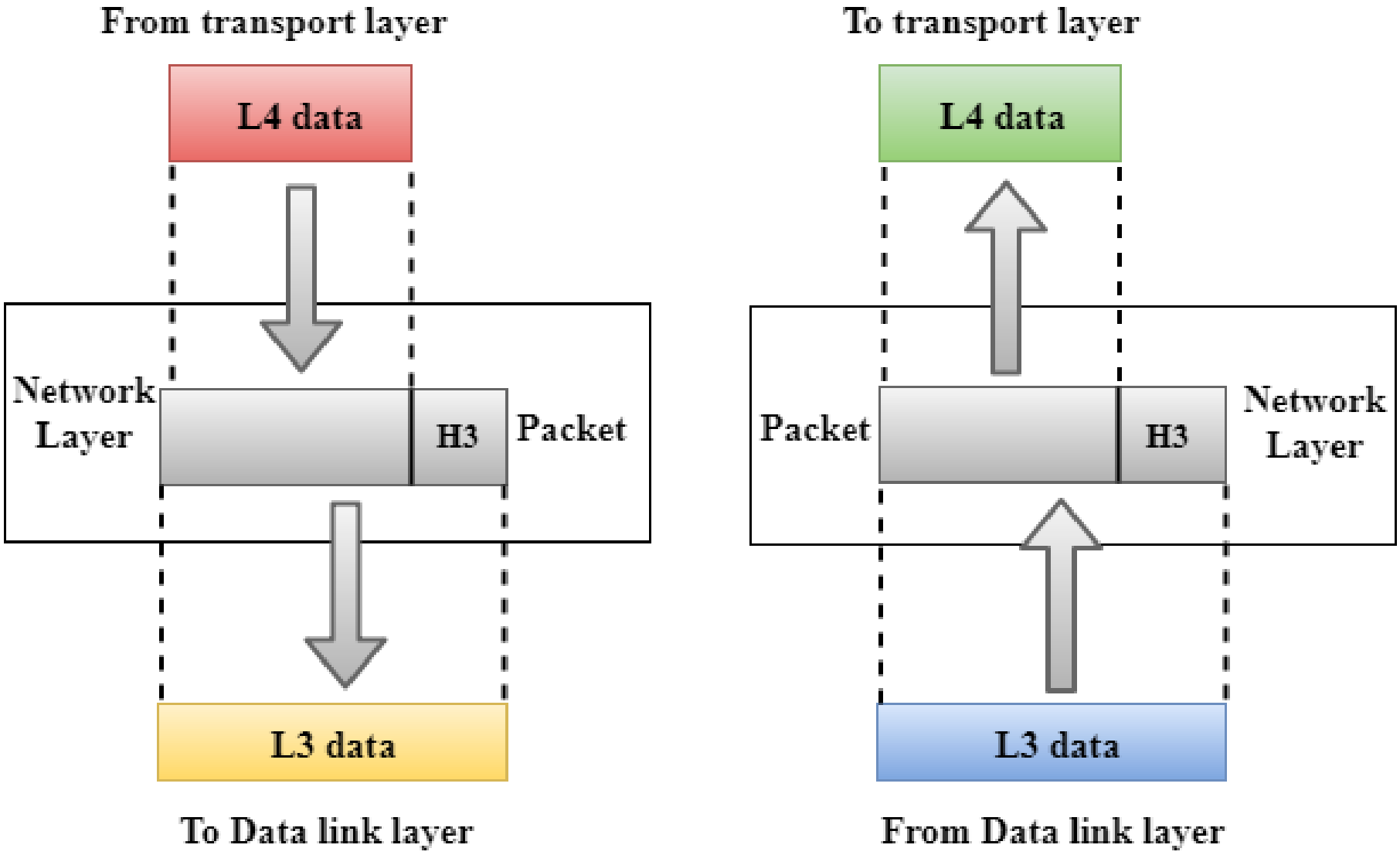
- that is placed to the Data link layer's trailer

If any error seems to occurr, then the receiver sends the acknowledgment for the retransmission of the corrupted frames.

- **Access Control:** When two or more devices are connected to the same communication channel

then the data link layer protocols are used to determine which device has control over the link at a given time.

- Network Layer



- It determines the best path to move data from source to the destination

- The Data link layer is responsible for routing and forwarding the packets.

•The protocols used to route the network traffic are known as Network layer protocols.
•Examples of protocols are IP and Ipv6.

• Functions of Network Layer:

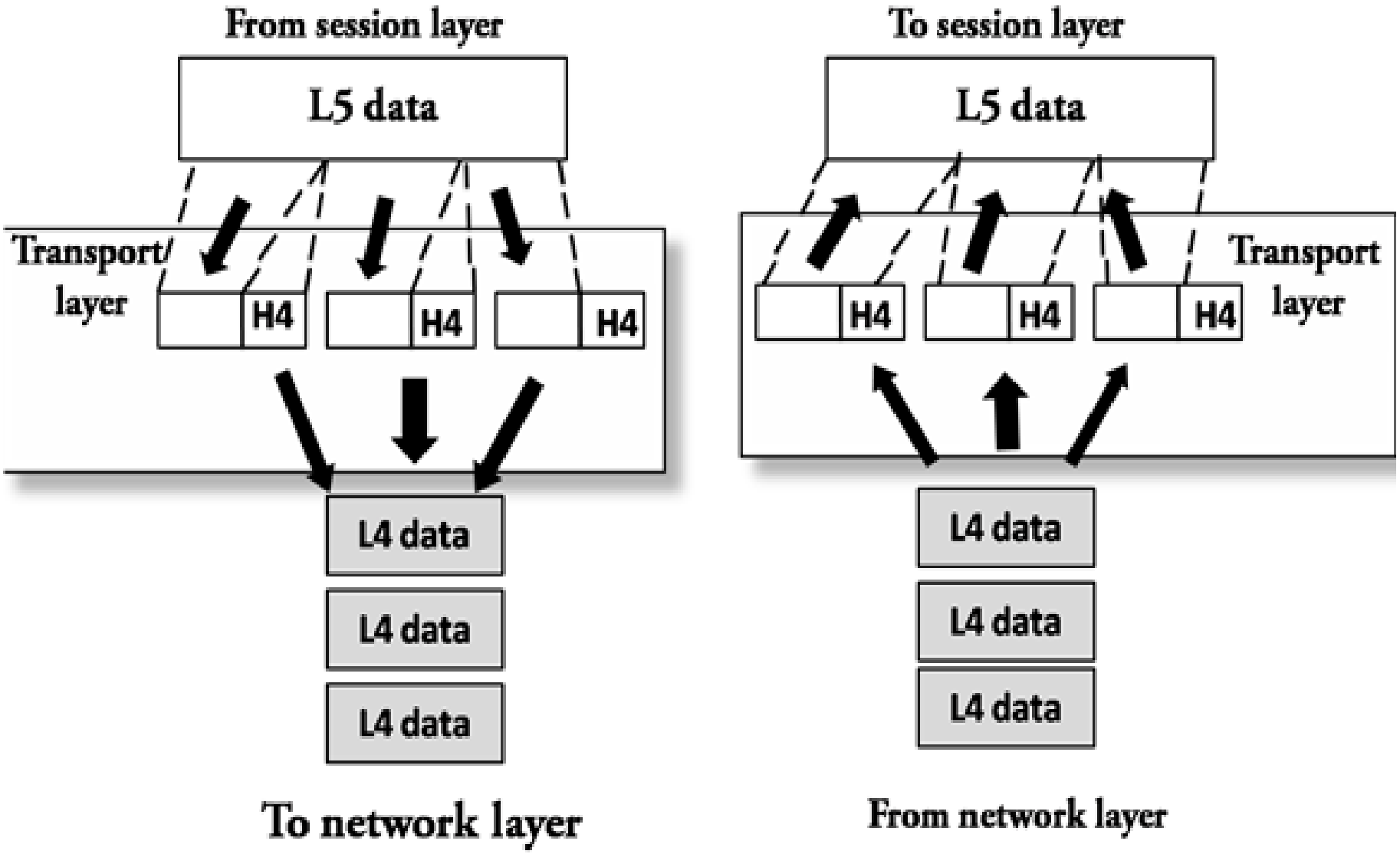
•**Internetworking:** An internetworking is the main responsibility of the network layer. It provides a logical connection between different devices.

•**Addressing**: A Network layer adds the source and destination address to the header of the frame. Addressing is used to identify the device on the internet

•**Routing**: Routing is the major component of the network layer, and it determines the best optimal path out of the multiple paths from source to the destination

•**Packetizing:** A Network Layer receives the packets from the upper layer and converts them into packets. This process is known as Packetizing. It is achieved by internet protocol (IP).

- Transport Layer



- 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.

- it provide connection between source and destination to deliver the data reliably.

The two protocols used in this layer are:

- **Transmission Control Protocol**

- **User Datagram Protocol**

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

- **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.

- # Functions of Transport Layer:

Service-point addressing:

Segmentation and reassembly

Connection control:

Flow control

Error control:

- **Service-point addressing:**

transport layer adds the header that contains the address known as a service-point address

The responsibility of the network layer is to transmit the data from one computer to another computer and

the responsibility of the transport layer is to transmit the message to the correct process.

- **Segmentation and reassembly**

When the transport layer receives the message from the upper layer, it divides the message into multiple segments, and

each segment is assigned with a sequence number that uniquely identifies each segment.

When the message has arrived at the destination, then the transport layer reassembles the message based on their sequence numbers.

- **Connection control:** Transport layer provides two services

1. **Connection-oriented service** -A connection-oriented service makes a connection with the transport layer at the destination machine before delivering the packets

In connection-oriented service, all the packets travel in the single route.

2. connectionless service - A connectionless service treats each segment as an individual packet, and

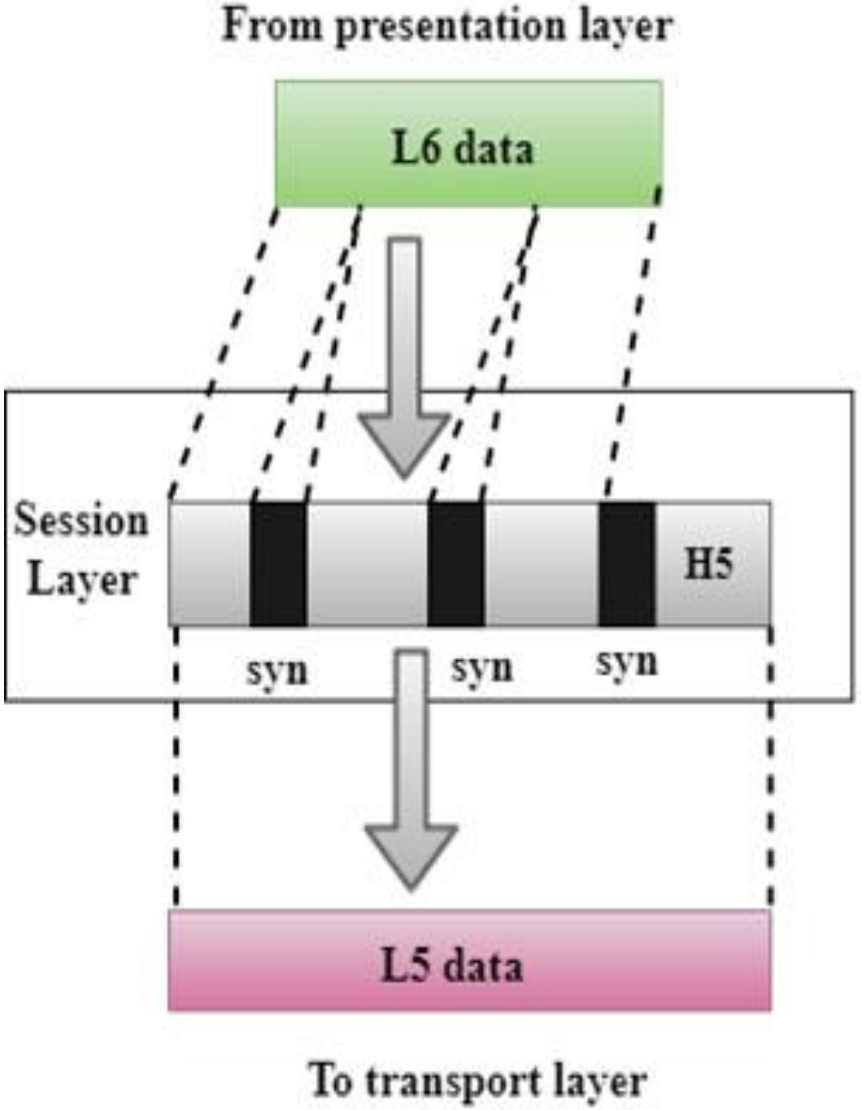
they all travel in different routes to reach the destination.

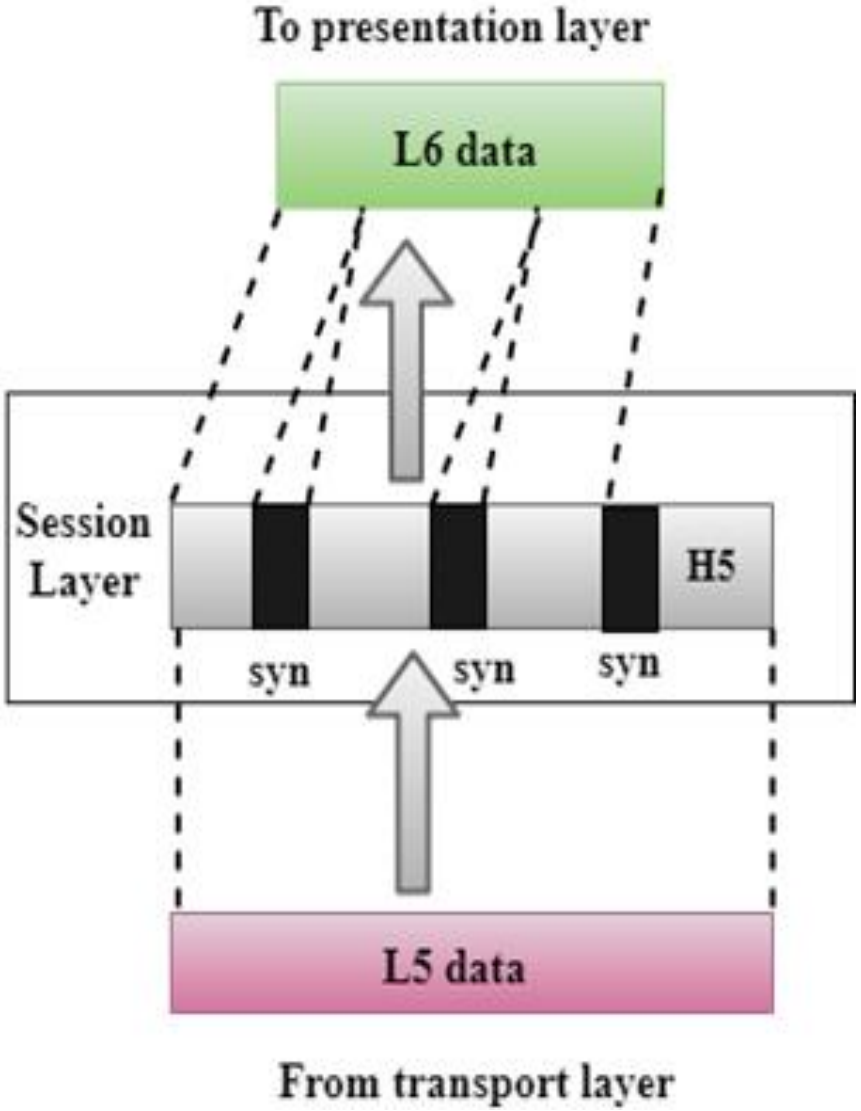
- **Flow control:** The transport layer also responsible for flow control

- **Error control:** The transport layer is also responsible for Error control.

- The sender transport layer ensures that message reach at the destination without any error.

- **Session Layer :-** The Session layer is used to establish, maintain and synchronizes the interaction between communicating devices.





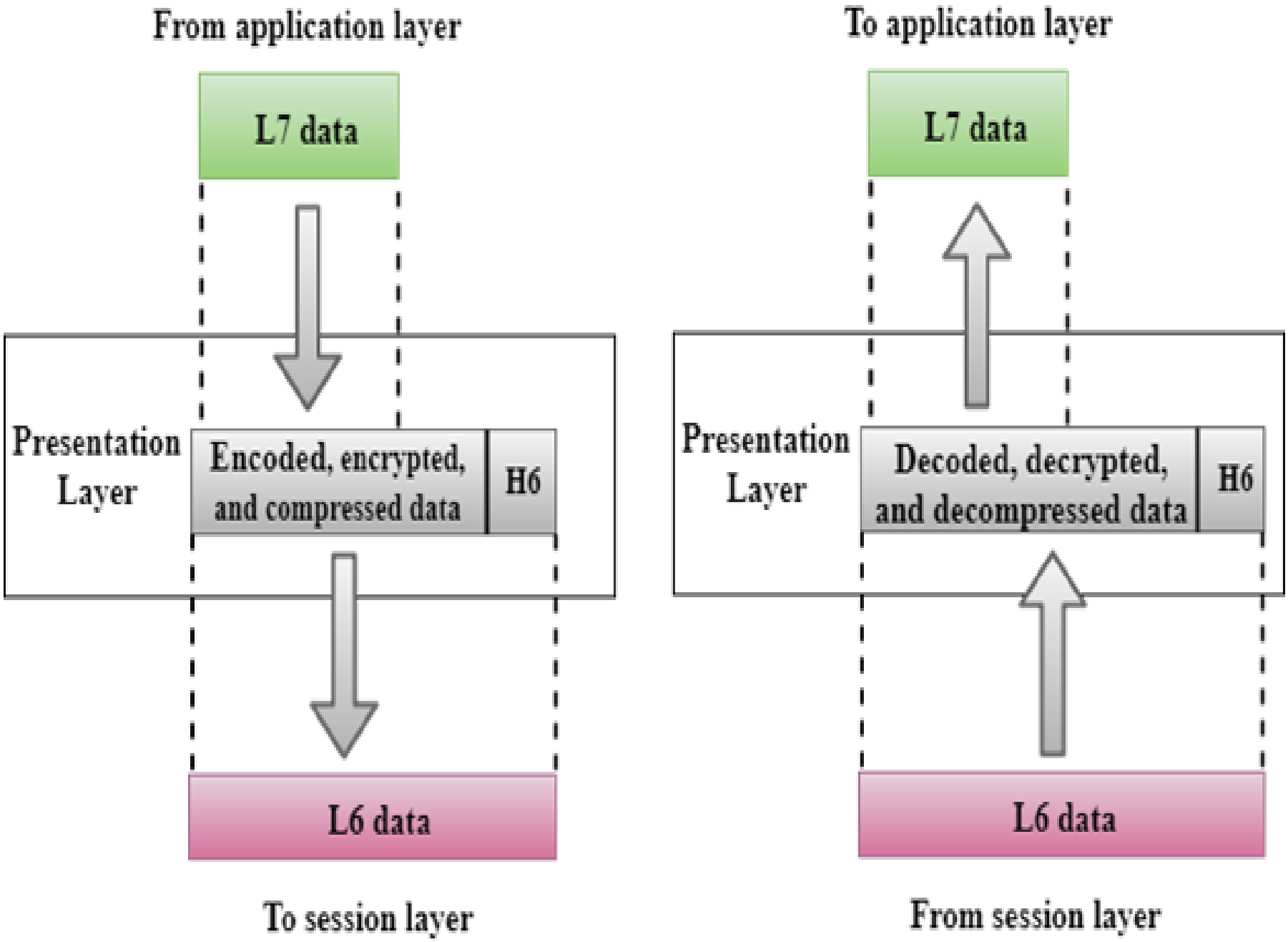
- **Functions of Session layer:**
- **Dialog control:** Session layer acts as a dialog controller that creates we can say that it allows the communication between two processes which can be either half-duplex or full-duplex.
- **Synchronization:** when transmitting the data in a sequence. If some error occurs in the middle of the transmission of data, then the transmission will take place again from the checkpoint. This process is known as Synchronization and recovery.

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.

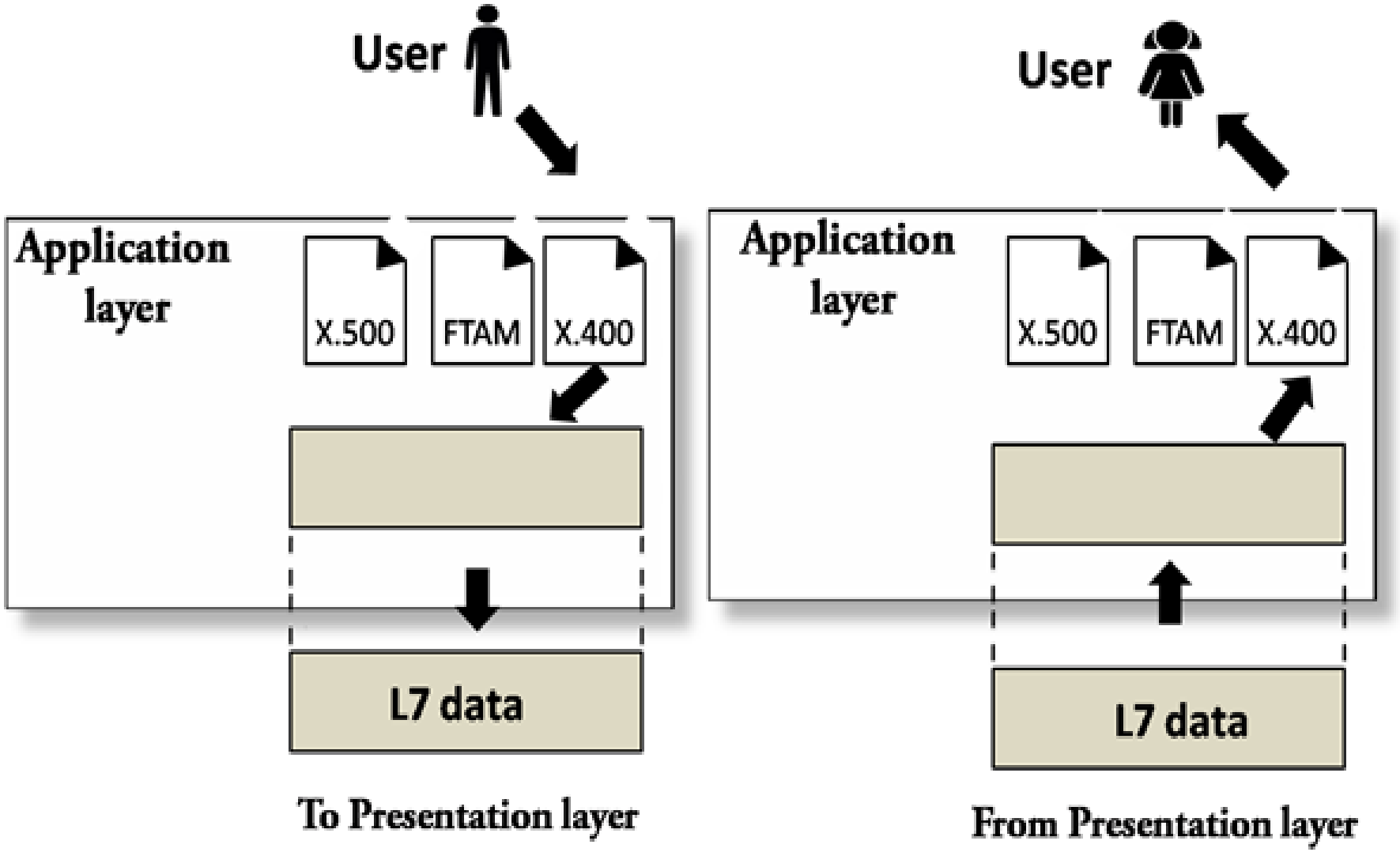
- This layer is a part of the operating system that converts the data from one presentation format to another format.


From application layer
L7 data
Presentation Layer
Encoded, encrypted, and compressed data
H6
L6 data
To session layer
To application layer
L7 data
Presentation Layer
Decoded, decrypted, and decompressed data
H6
L6 data
From session layer

Functions of Presentation layer:

- **Translation:** The processes in two systems exchange the information in the form of character strings, numbers and so on.
- Different computers use different encoding methods, the presentation layer handles the interoperability between the different encoding methods. It converts the data from sender-dependent format into a common format and changes the common format into receiver-dependent format at the receiving end.
- **Encryption:** Encryption is needed to maintain privacy. Encryption is a process of converting the sender-transmitted information into another form and sends the resulting message over the network.
- **Compression:** Data compression is a process of compressing the data, i.e., it reduces the number of bits to be transmitted. Data compression is very important in multimedia such as text, audio, video.

Application Layer



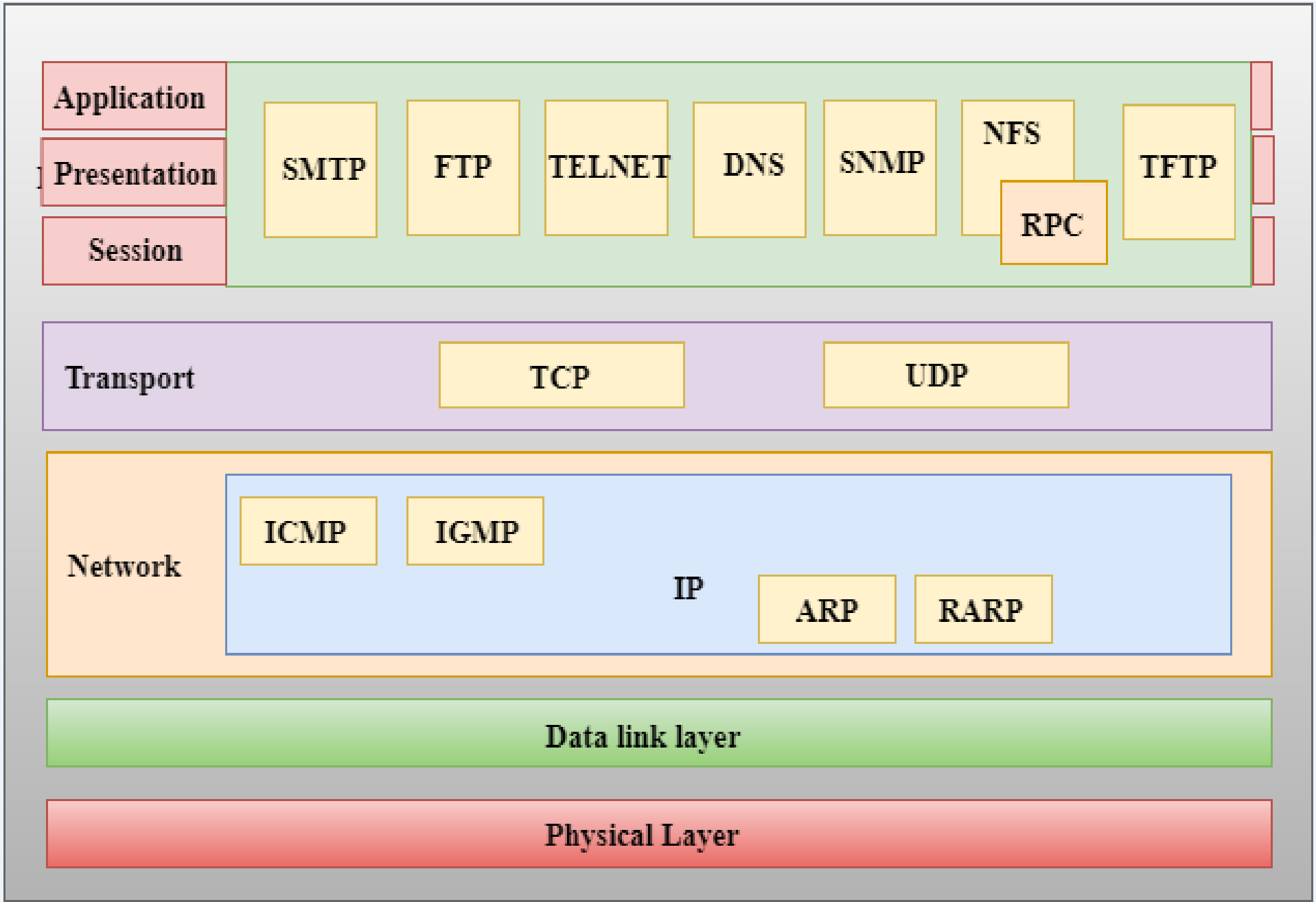
- It handles issues such as network transparency, resource allocation, etc.
- An application layer is not an application, but it performs the application layer functions.
- This layer provides the network services to the end-users.

Functions of Application layer

- **File transfer, access, and management (FTAM):** An application layer allows a user to access the files in a remote computer, to retrieve the files from a computer and to manage the files in a remote computer.
- **Mail services:** An application layer provides the facility for email forwarding and storage.
- **Directory services**: An application provides the distributed database sources and is used to provide that global information about various objects.

- TCP/IP model :- It stands for Transmission Control Protocol/Internet Protocol.
- The TCP/IP model is not exactly similar to the OSI model.
- The TCP/IP model consists of five layers: the application layer, transport layer, network layer, data link layer and physical layer.

Functions of TCP/IP Layers



Network Access Layer

- A network layer is the lowest layer of the TCP/IP model.
- A network layer is the combination of the Physical layer and Data Link layer defined in the OSI reference model.
- This layer is mainly responsible for the transmission of the data between two devices on the same network.

Internet Layer

- An internet layer is the second layer of the TCP/IP model.
- An internet layer is also known as the network layer.
- The main responsibility of the internet layer is to send the packets from any network.

Transport Layer

- The transport layer is responsible for the reliability, flow control, and correction of data which is being sent over the network.

- The two protocols used in the transport layer

1) **User Datagram protocol**

2) **Transmission control protocol**.

- **User Datagram Protocol (UDP)** It provides connectionless service and end-to-end delivery of transmission.

- It is an unreliable protocol

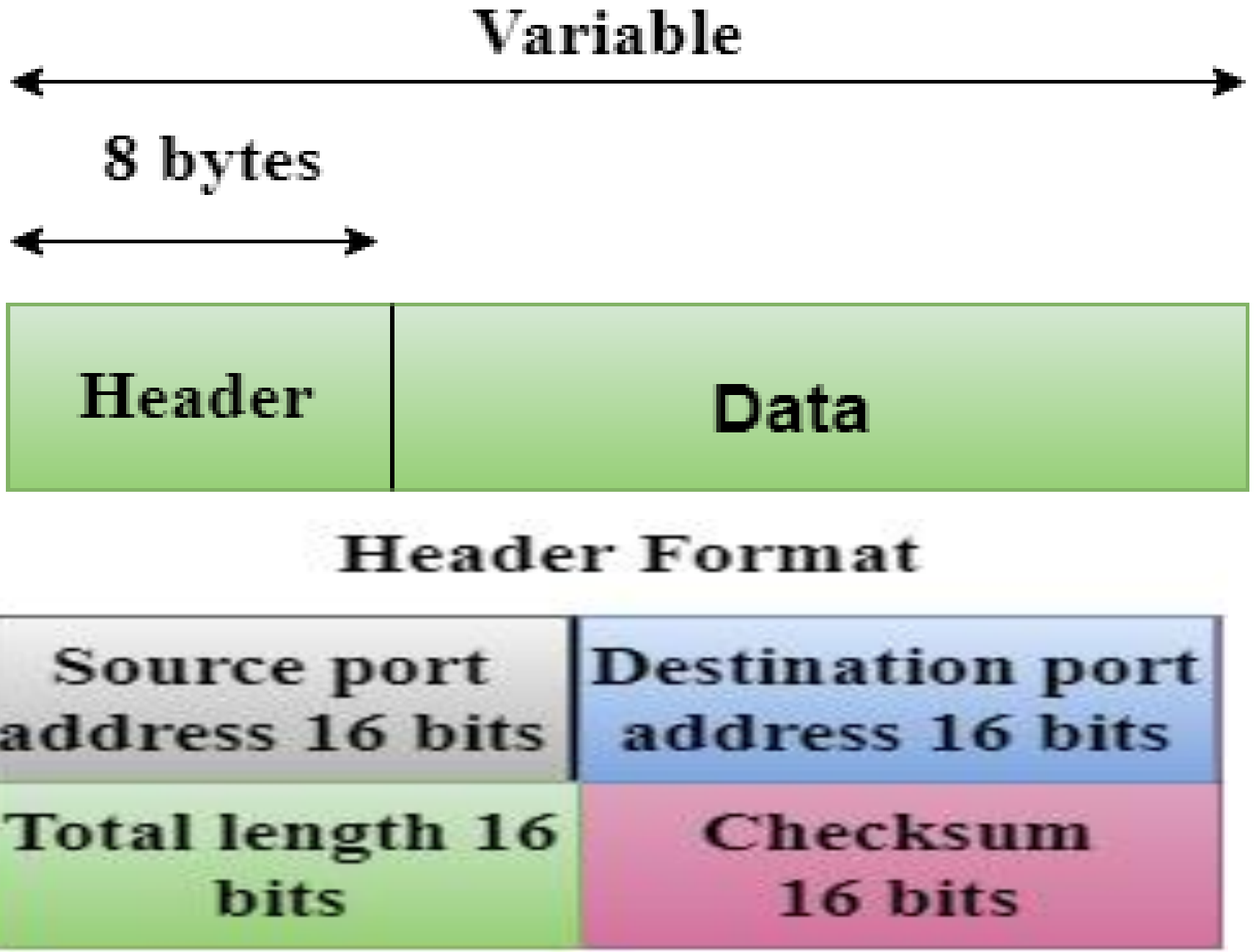
UDP consists of the following fields:

Source port address: The source port address is the address of the application program that has created the message.

Destination port address: The destination port address is the address of the application program that receives the message.

Total length: It defines the total number of bytes of the user datagram in bytes.

Checksum: The checksum is a 16-bit field used in error detection.


Variable
8 bytes
Header
Data
Header Format
Source port address 16 bits
Destination port address 16 bits
Total length 16 bits
Checksum 16 bits

Transmission control protocol :-

- It provides a full transport layer services to applications.
- It creates a virtual circuit between the sender and receiver, and it is active for the duration of the transmission.
- TCP is a reliable protocol as it detects the error and retransmits the damaged frames.
- At the sending end, TCP divides the whole message into smaller units known as segment
- each segment contains a sequence number which is required for reordering the frames to form an original message.
- At the receiving end, TCP collects all the segments and reorders them based on sequence numbers.

Application Layer

- An application layer is the topmost layer in the TCP/IP model.
- It is responsible for handling high-level protocols, issues of representation.
- This layer allows the user to interact with the application.
- When one application layer protocol wants to communicate with another application layer, it forwards its data to the transport layer.

Following are the main protocols used in the application layer:

- **HTTP:** HTTP stands for Hypertext transfer protocol. This protocol allows us to access the data over the world wide web. It transfers the data in the form of plain text, audio, video. It is known as a Hypertext transfer protocol

- **SNMP:** SNMP stands for Simple Network Management Protocol. It is a framework used for managing the devices on the internet by using the TCP/IP protocol suite.

- **SMTP:** SMTP stands for Simple mail transfer protocol. The TCP/IP protocol that supports the e-mail is known as a Simple mail transfer protocol. This protocol is used to send the data to another e-mail address.

- **DNS:** DNS stands for Domain Name System. An IP address is used to identify the connection of a host to the internet uniquely. But, people prefer to use the names instead of addresses. Therefore, the system that maps the name to the address is known as Domain Name System.

- **TELNET:** It is an abbreviation for Terminal Network. It establishes the connection between the local computer and remote computer in such a way that the local terminal appears to be a terminal at the remote system.

- **FTP:** FTP stands for File Transfer Protocol. FTP is a standard internet protocol used for transmitting the files from one computer to another computer.

Comparison of OSI & TCP/IP Model

TCP/IP	OSI
Implementation of OSI model	Reference model
Model around which Internet is developed	This is a theoretical model
Has only 4 layers	Has 7 layers
Considered more reliable	Considered a reference tool
Protocols are not strictly defined	Stricter boundaries for the protocols
Horizontal approach	Vertical approach
Combines the session and presentation layer in the application layer	Has separate session and presentation layer
Protocols were developed first and then the model was developed	Model was developed before the development of protocols
Supports only connectionless communication in the network layer	Supports connectionless and connection-oriented communication in the network layer
Protocol dependent standard	Protocol independent standard