COMPUTER NETWORK

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Unit-1 ONESHOT + 3 PYQ Solutions

Topics

- Basics of Computer Network
- Categories of Networks.
- Internet Service providers
- Network Structure and Architecture.
- OSI Reference Model - 2018-19, 2022-23
- TSP/IP Protocol Suite
- Network Devices and Components - 2022-23

Physical Layer

- Network Topology - 2018-19, 21-22, 22-23
- Types of Connection
- Transmission Media.
- Signal Transmission and Encoding - 2018-19
- Network performance
- Switching Techniques and Multiplexing.

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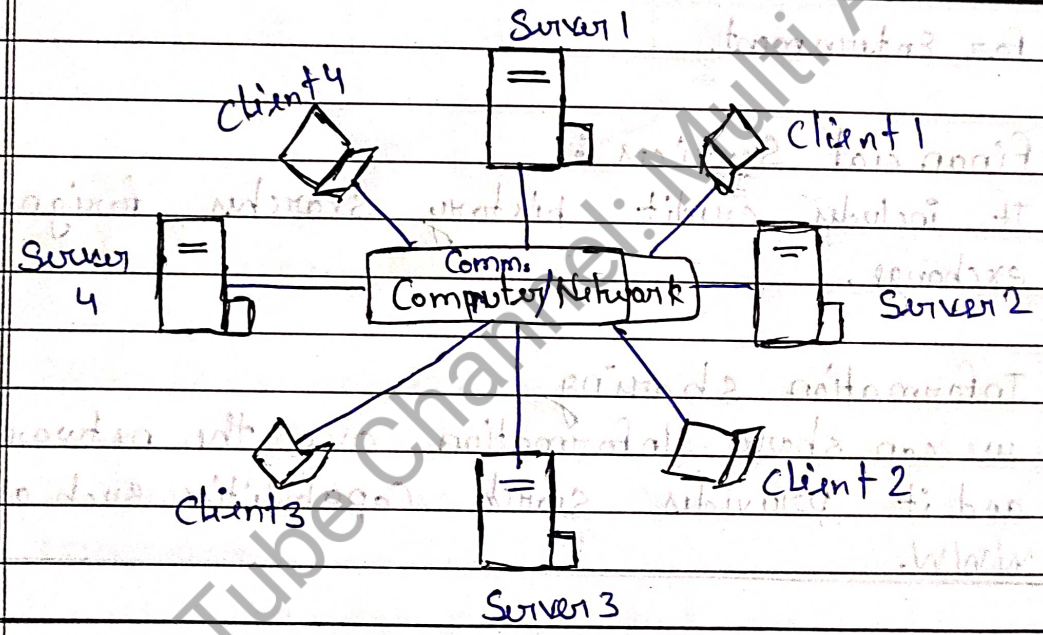
What is Computer Network?

→ 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 divices.



Goals of Computer Network

→ Cost Reduction → by sharing hardware & softwar Resources.
→ High Reliability → by having multiple supply.
→ High Flexibility
→ powerful Communication Medium.
→ Data Access is fast
→ Reliability and Redundancy → ~~Fund~~ Redundant system in case of failure.

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→ Applications of Computer Network :-

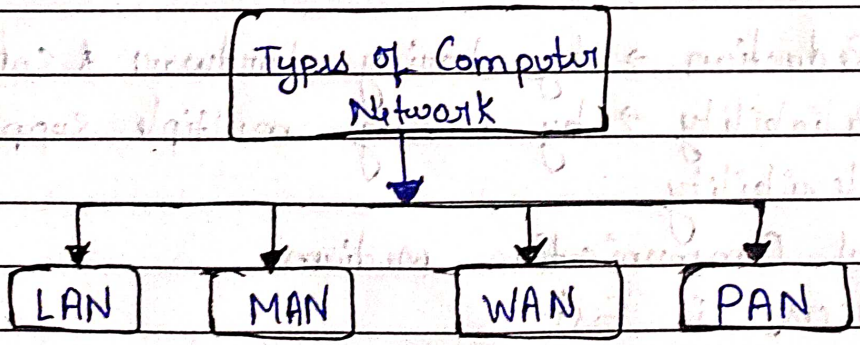
① Business Applications :
→ Resource sharing
→ providing communication medium
→ doing business electronically [E-commerce]

② Home Network Applications :
→ Access to Remote information
→ Person to Person Communication
→ for Enternment.

③ Financial Services :
→ It includes credit history searchs, foreign exchange.

④ Information sharing
→ we can share information over the network and it provides search capabilities such as WWW.

→ Categories of networks.



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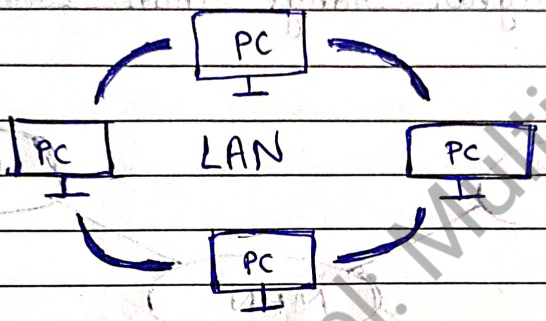
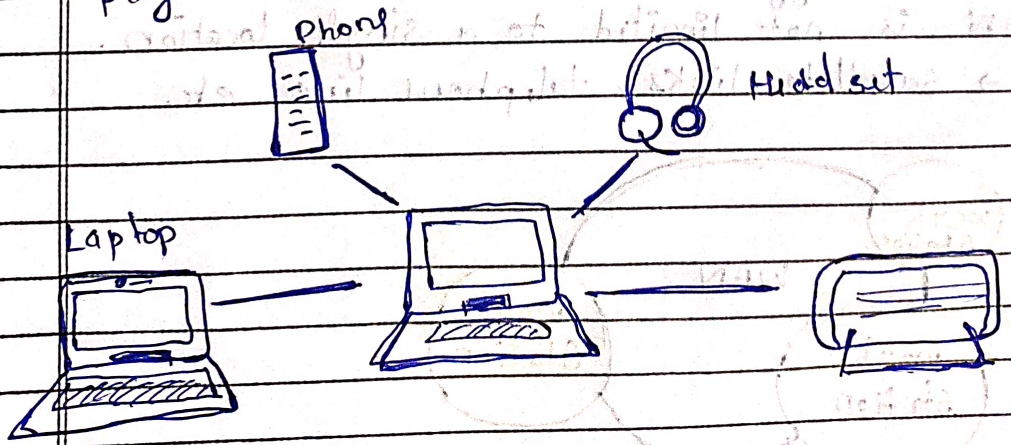
LAN (Local Area Network)

→ LAN is a group of computers connected to each other in a small area such as building, office.
→ Connecting two or more personal computers
→ less costly and data transmission extremely faster.
→ LAN provides higher security.



PAN (Personal Area Network)

→ PAN is a network arranged within an individual person, typically within a range of 10 meters.
→ Thomas Zimmerman who bring PAN first time.
→ ~~PAN that~~
→ Personal computer devices that are used to develop the PAN are the laptop, mobile, media player and play station.



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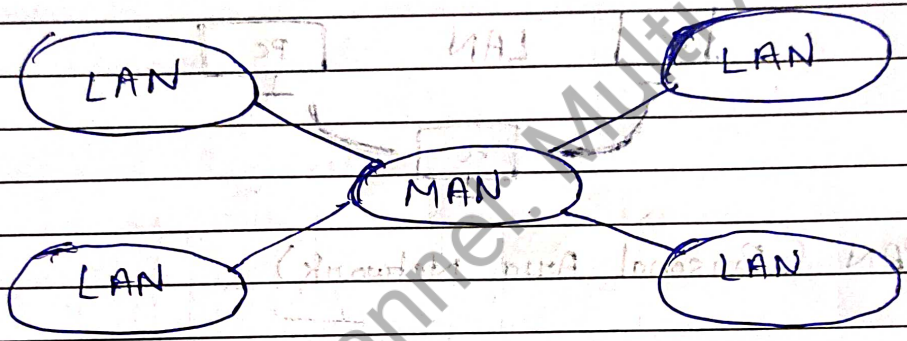
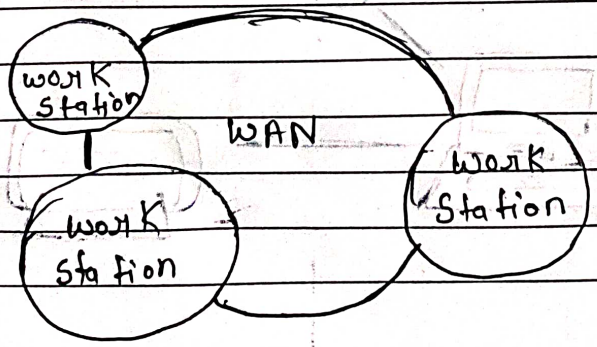
MAN (Metropolitan Area Network)

→ A MAN 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.
→ It has a higher range than Local Area Networks (LAN).



WAN → (Wide Area Network)

→ A wide Area Network is a network that extends over a large geographical area such as states or countries.
→ WAN is bigger than the LAN
→ WAN is not limited to a single location.
→ e.g → satellite links, telephone line etc.



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Organization of Internet

→ Internet is hierarchy structure of networks that allows connection over of two internet connected devices, both being at diff. geographical locations.

→ Every computer that is connected to internet has a unique address (IP address → IP → Internet protocol)

→ address is in the form of nnn.nnn.nnn.nnn where nnn can be any number in the range from 0 to 225.

ISP (Internet Service Provider)

→ An ISP make it possible for customers to access the Internet while also provide additional services such as email, web hosting etc.

→ internet connection types such as, cables and fibers

ISPs are grouped into the following three tiers:

1. Tier 1 ISPs :
   - Global reach, extensive infrastructure
   - Negotiate with other Tier 1s, sell to Tier 2s.
2. Tier 2 ISPs :
   - Regional / national operation.
   - Connect Tier 1s and Tier 3s
3. Tier 3 ISPs :
   - focus on local markets, lease from higher tiers.

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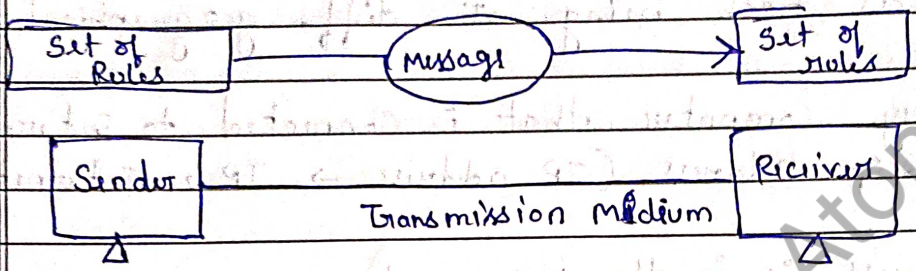
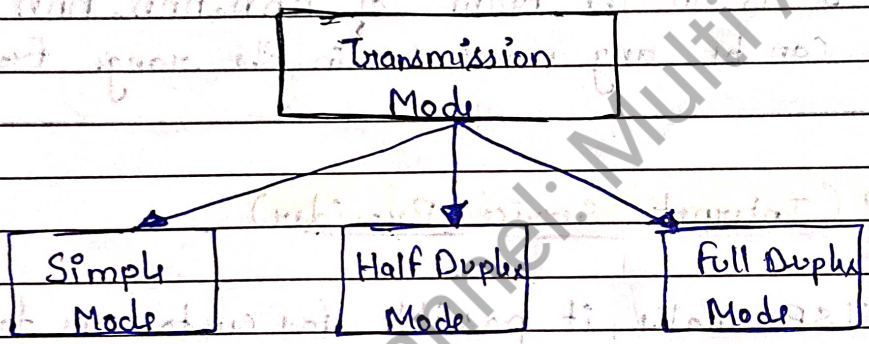
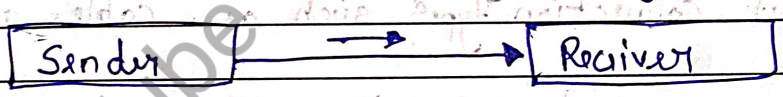
Data Communication ⇒ A process of exchanging data or info in case of computer networks. this exchange is done b/w two devices over a transmission medium.



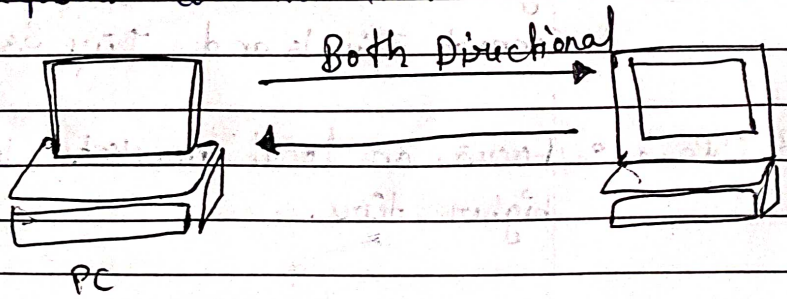


1. Simple Mode : Unidirectional e.g → Loudspeaker.



2. Half Duplex Mode : Bidirectional flow of data but in one direction at a time. e.g → Walkie-talkie.

3. Full Duplex Mode : Communication in both directions is required all the time.



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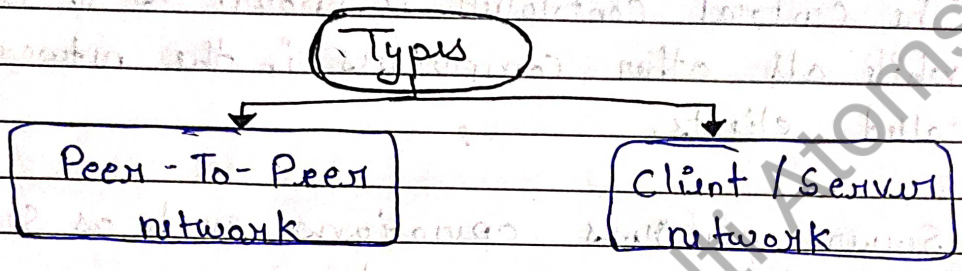
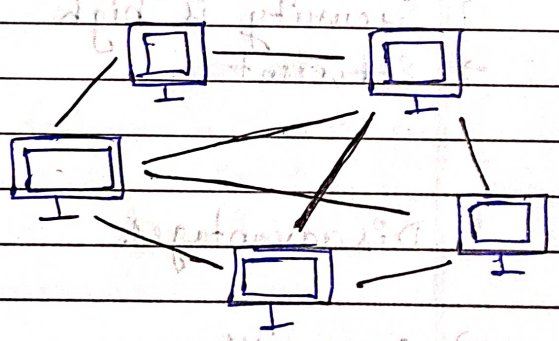
Network Structure and Architecture

→ Computer Network Architecture is defined as the physical and logical design of the software, hardware, protocols and media of the transmission of data.
→ how computers are organized.



1. Peer - To - Peer network

→ It is a network in which all the computers are linked together with equal privilege and responsibilities for processing the data.
→ useful for small environments (10 computers)
→ No dedicated server.



Advantages :

→ less costly.
→ If one system stop other system don't ~~don~~ stop.
→ easy to set-up

Disadvantages

→ not contain the centralized system.
→ Cannot backup and data is in diffrent locations
→ Security issue.

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Client / Server Network

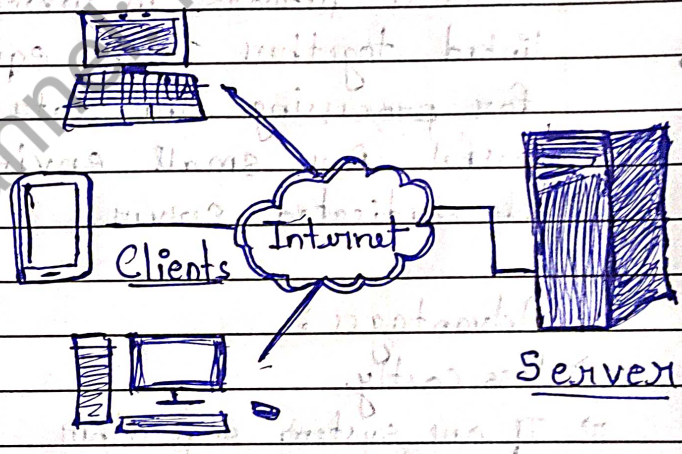
→ It is a network model designed for the end users called clients, to access resources such as songs, video, etc. from Server (central computer).

→ The central controller is known as a Server while all other computers in the network are called clients.

→ Server performs operations such as security and network management.

Advantages :

→ centralized system.
→ backup easily.
→ Security is high
→ Efficient



Disadvantages.

→ expensive
→ required a dedicated network administrator.

Layering

→ Layering means decomposing the problem into more manageable components (layers).

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Layering Principles

① The first principle dictates that if we want bidirectional Comm^n, each layer should be able to perform two opposite tasks, one in each direction.

② The second principle is that the two objects under each layer at both sites should be identical.

Services offered by Layers.

① Connection - oriented service :
(telephone System)
→ Establish a connection
→ Use the connection
→ Release the connection

② Connection less Service :

→ There is no guarantee to follow the same path of Sender - Receiver and Receiver to Sender.

Services Primitives (operations)

Connection Oriented → ① LISTEN
② CONNECT
③ RECEIVE
④ SEND
⑤ DISCONNECT

Connection less → UNIDATA
→ FACILITY / REPORT.

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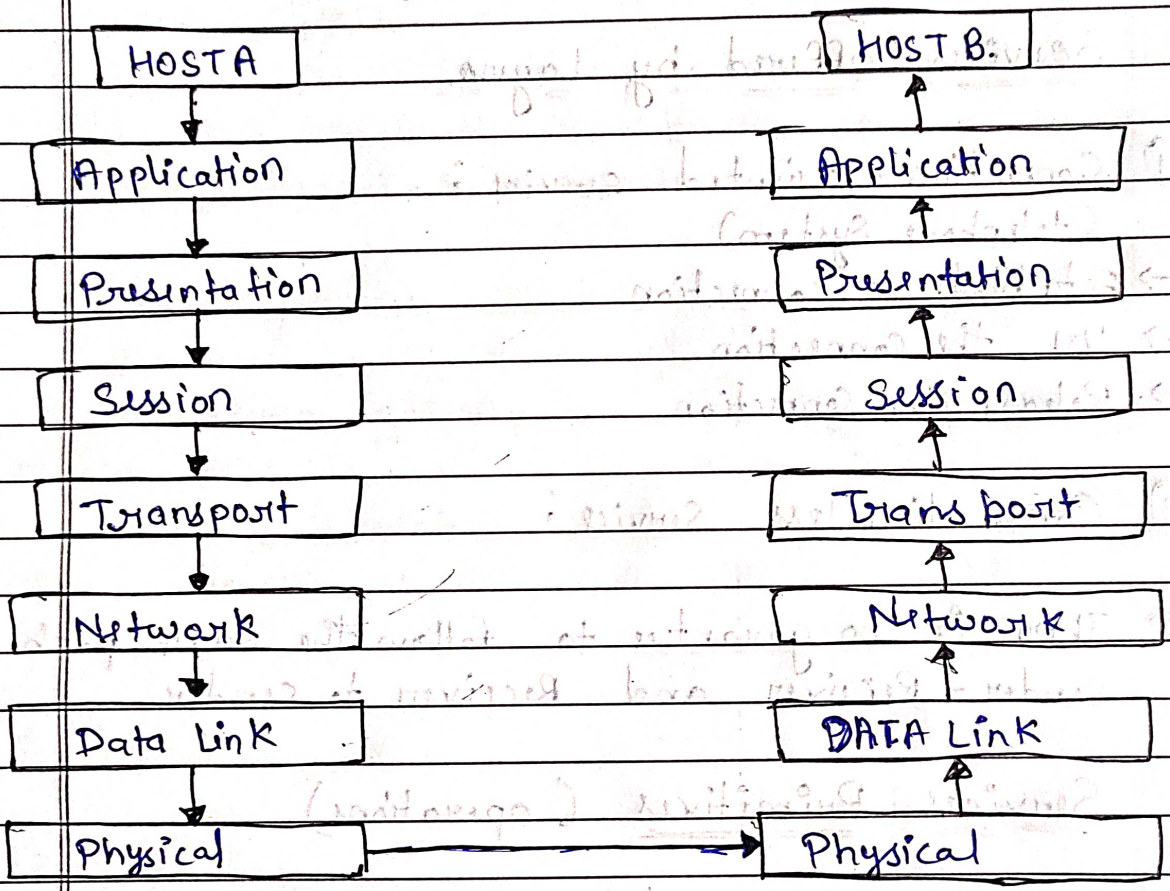
The OSI Reference Model

→ OSI reference model is a seven layer architecture which defines seven levels in a complete communication system.

→ It is designed to deal with open systems i.e the systems which are open for communication with other systems.



① Application layer :

→ Provides services directly to end-user application

→ E.g → HTTP, FTP, SMTP etc.

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2. Presentation layer:
→ prepares data for the application layer.
→ Handles data encoding, encryption and compression.

3. Session Layer:
→ Establishes, manages and terminates connections (sessions) between applications.
→ manages checkpoints for data recovery.

4. Transport Layer:
→ Segments and reassembles data into smaller packets.
→ Ensures error-free, in-sequence delivery of data.

5. Network layer:
→ Handles routing and forwarding of data packets b/w different networks.
→ Determines the best path for data transmission using logical addressing.

6. Data Link Layer:
→ Ensures reliable transmission of data frames b/w directly connected nodes.
→ Provides error detection and correction.

7. Physical Layer:
→ Deals with the physical connection between devices
→ Defines hardware specifications for transmitting data over a medium.

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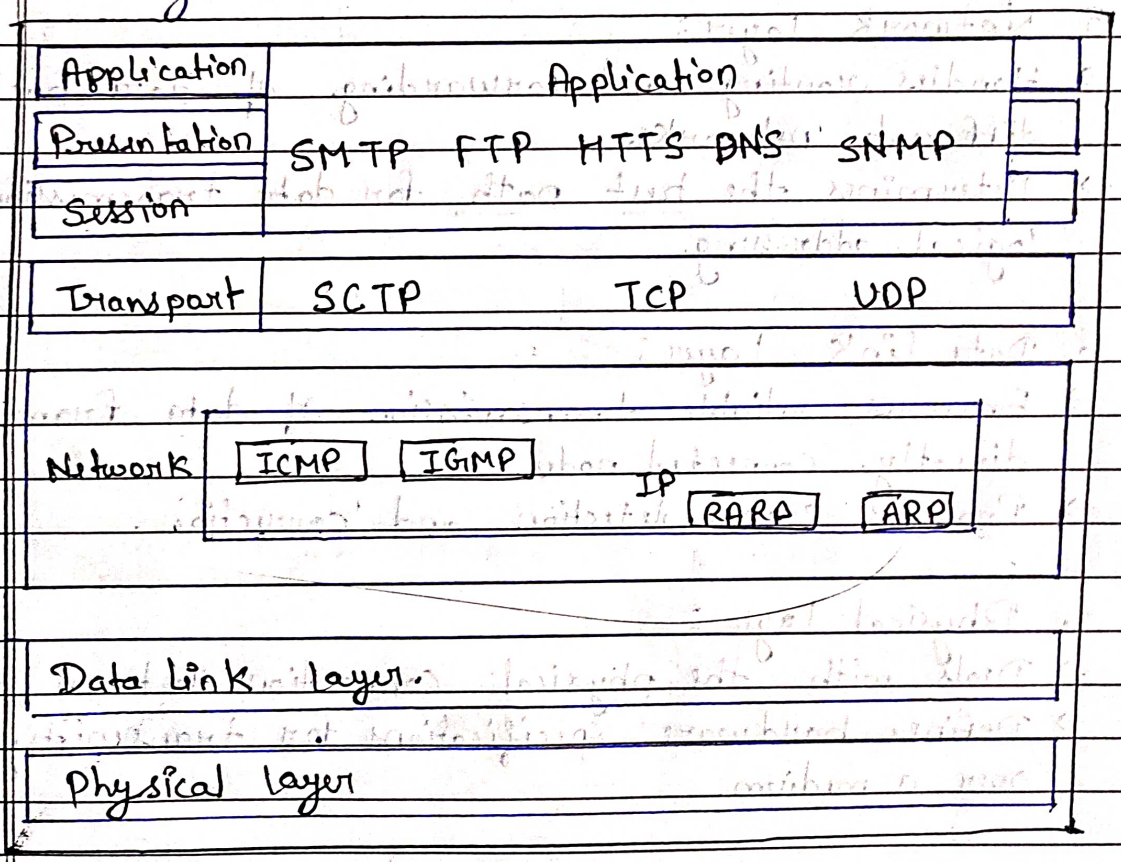
TCP/IP Protocol Suite

→ The TCP/IP protocol suite consists of five layers : physical, data link, network, transport and application.

→ The first four layers provide physical standards, network interface, internetworking, and transport functions that correspond to the first four layers of the OSI MODEL.

→ The three topmost layers in the OSI model, however, are represented in TCP/IP by a single layer called the application layer as shown in figure.



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1. Physical and Data Link layers:

→ At these layers, TCP/IP does not define any specific protocol.
→ It supports all of the standard and proprietity protoco

2. Internet / Network layer:

→ It defines the protocols which are responsible for the logical transmission of data over the entire network.
- IP = Internet Protocol responsible for delivering packets.
- ICMP = Internet Control Message Protocol encapsulate datag
- ARP = Address Resolution Protocol → find the hardware address of a host from a known IP Address.

3. Transport Layer:

→ These protocols exchange data receipt acknowledgments and retransmit missing packets to ensure that packets arrive in order and without error

a. UDP (User Datagram Protocol) → adds only port addresses, checksum error control, and length information to the data from the upper layer
b. TCP (Transmission Control Protocol) → provides full transport layer services to application.

c. Stream Control Transmission Protocol (SCTP): It provides support for newer applications such as voice over the internet.

4. Application Layer :
→ Many protocols like Simple mail Transfer Protocol, File Transfer Protocol, HTTP, DNS, SNMP, etc are defined at application layer.

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Network Devices and Components.

1. HUB :
→ It is the simplest of these devices.
→ Hubs cannot filter data.
→ do not have intelligence to find out best path.
→ used on small networks.

2. Bridge :
→ It is more complex than hub. ↑ physical address.
→ It maintains MAC address table for both LAN segments.
→ It has a single incoming and outgoing port.
→ looks at the destination

3. Switch :
→ It has multiple ports.
→ can perform error checking before forwarding data.
→ very efficient
→ large networks use switches.

④ Router :

→ like a switch forwards packets based on address.
→ Supports diffirent WAN technologies but switches do not.
→ Wireless Routers have Access Point built in.
→ shared board band internet Connection.

⑤ WAP

→ wireless Access point bridges wireless and wired traffic.
→ allows computers to Connect to LAN in a wireless design
→ wired and wireless devices work to communicate with each other.

Introductory Concepts finish.

physical layer :

→ Network Topology, Types of Connection — 2018-19, 2021-22, 2022-23
→ Transmission Media.
→ Signal Transmission and Encoding — 2018-19
→ Network Performance and Transmission Impairment
→ Switching Techniques and Multiplexing.

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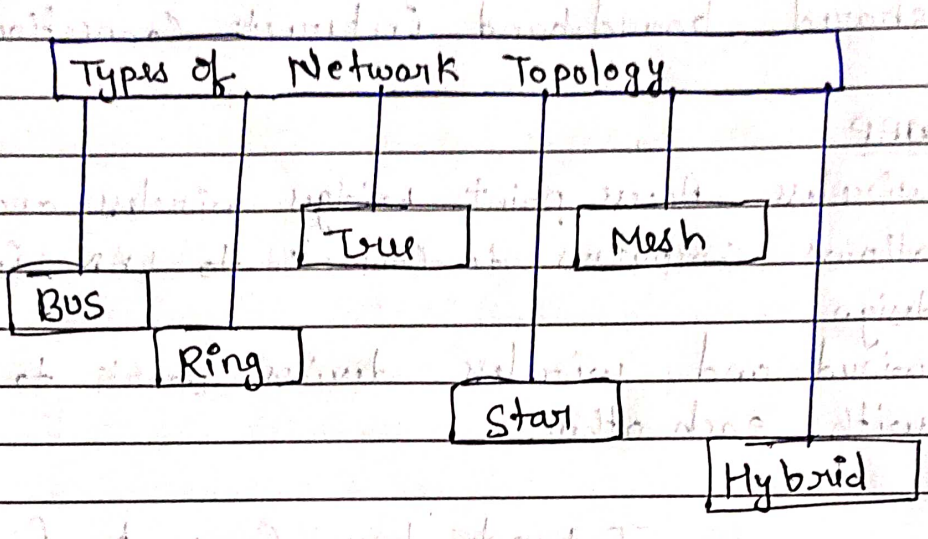
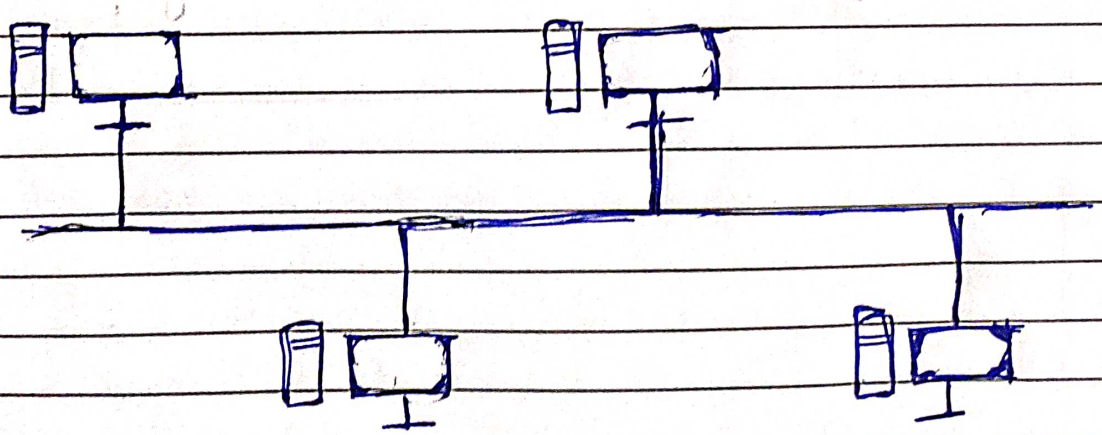
Network Topology :- The physical arrangement of the computer system, which is connected to each other via communication medium is called topology.



① Bus Topology

It is a type of network topology in which all devices are connected to a single cable called a "bus". This cable serves as a shared communication medium, allowing all devices on the network to receive the same signal simultaneously.



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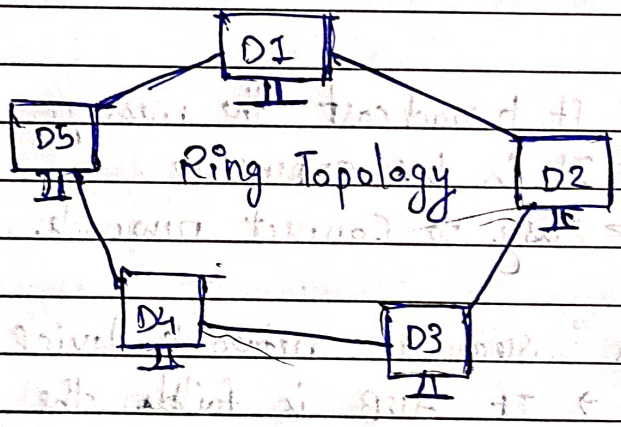
Advantages → 1. Easy to add / remote nodes in network
2. It is less Expensive.

Disadvantages → If the cable is fail then the entire network will be failed.
→ message can not send private.

2. Ring Topology

→ In this devici connections create a closed circular data path. devices in a ring topology are called a ring network.



Advantages. 1. form a strong lans network.
2. Each and every node can share data with another node.

Disadvantage. 1. It is difficult task to add some new node.

→ If we want to send data from a sender to destination machine then data will un necessary passed to all nodes.

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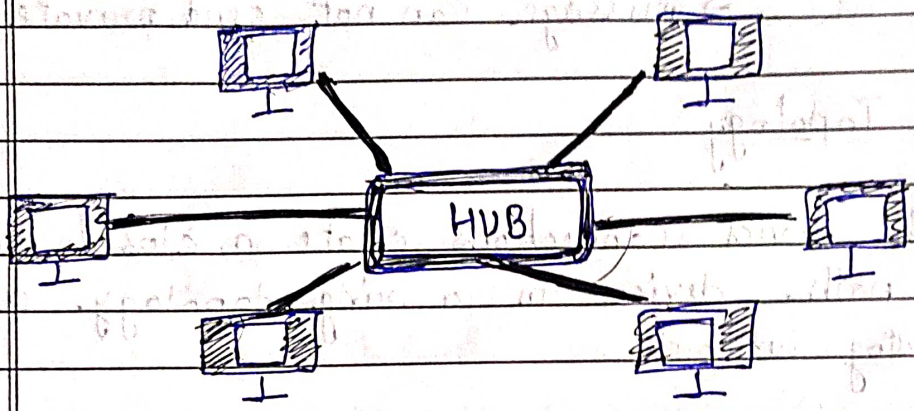
③ Star Topology

Each network component is physically connected to a central node such as router, hub or Switch.

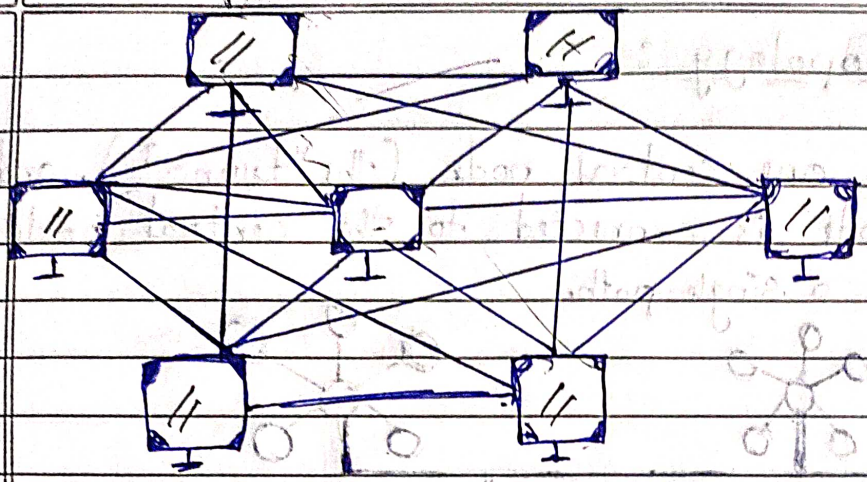


Advantage = It broadcast the message
= It is less expensive
= Easy to connect new node.

Disadvantage : require network device
→ If HUB is failed the entire network will be failed.

④ Mesh Topology

→ every computer is directly connected with eachother, so we can directly send the data to the destination machine without going to intermediate machine.

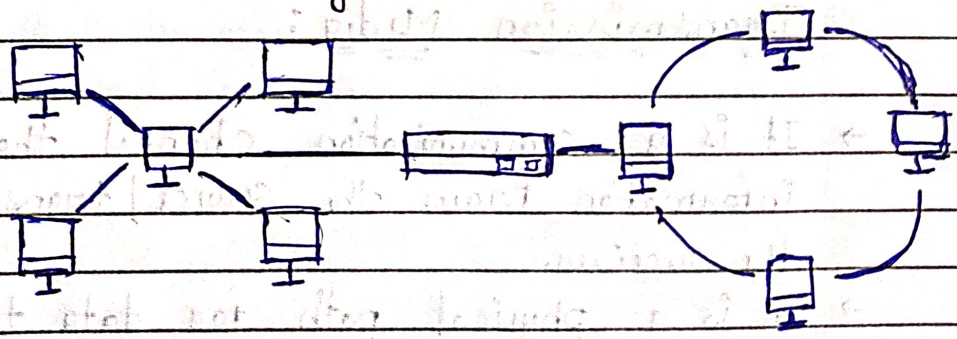


Advantages ⇒ In this ~~prdu~~ private message is send.
⇒ It provide point to point connection.

Disadvantage ⇒ It is very difficult to add some new node.

⑤ Hybrid Topology

→ It is a type of network topology that combines two or more network topologies, including ring, bus and mesh topologies.



Advantage : Can be modified as per requirement
It is extremely flexible.

Disadvantage : → It is a type of network. Expensive.
→ design is very complex.

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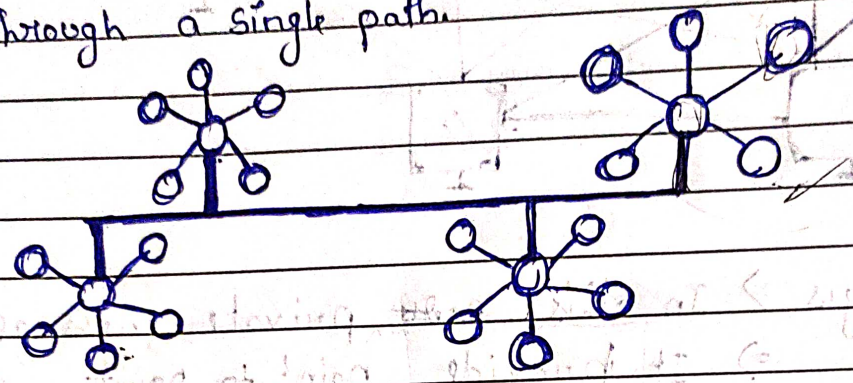
⑥ Tree Topology :-

→ In this one central node (the "trunk"), and each node is connected to the central node through a single path.

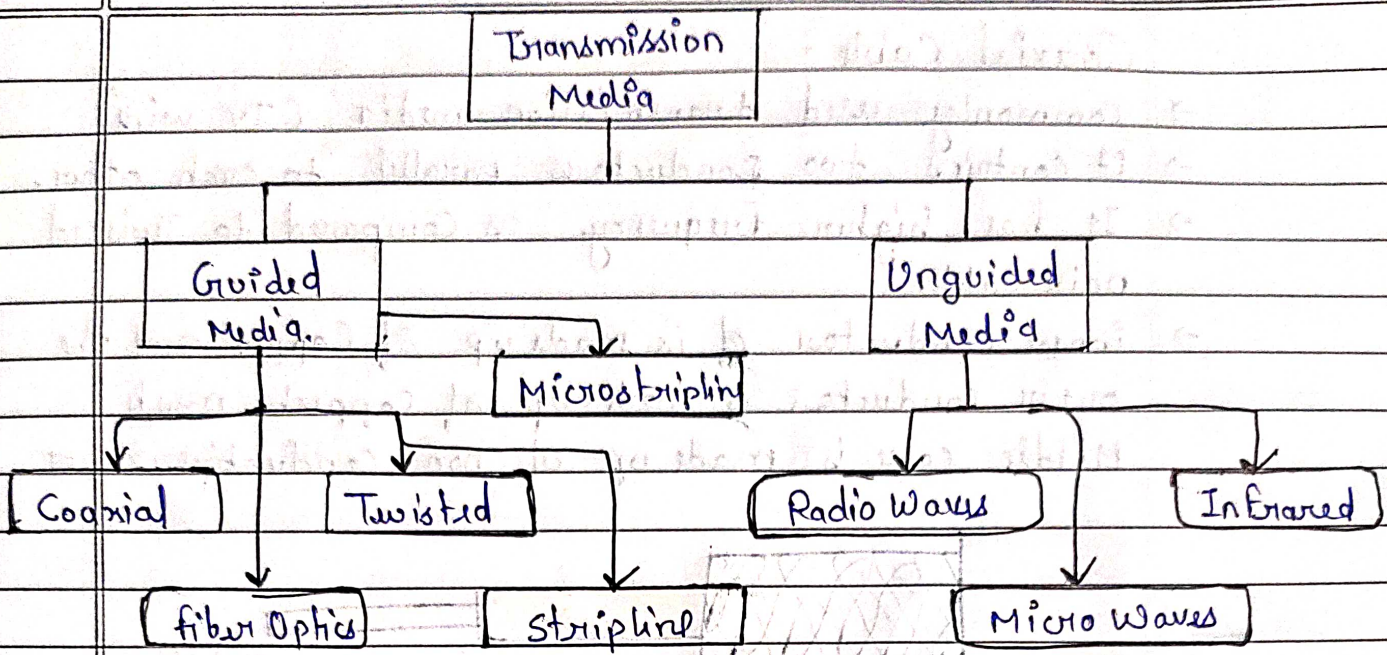


Advantage → It can support a large number of nodes
→ It can be easily expanded.

Disadvantage → it hard to identify where the issue is located.
→ If one node goes down, it can affect the entire network.

Transmission Media :

→ It is a communication channel that transmits information from the source / transmitter to the receiver.
→ It is a physical path for data transfer through electromagnetic signals.



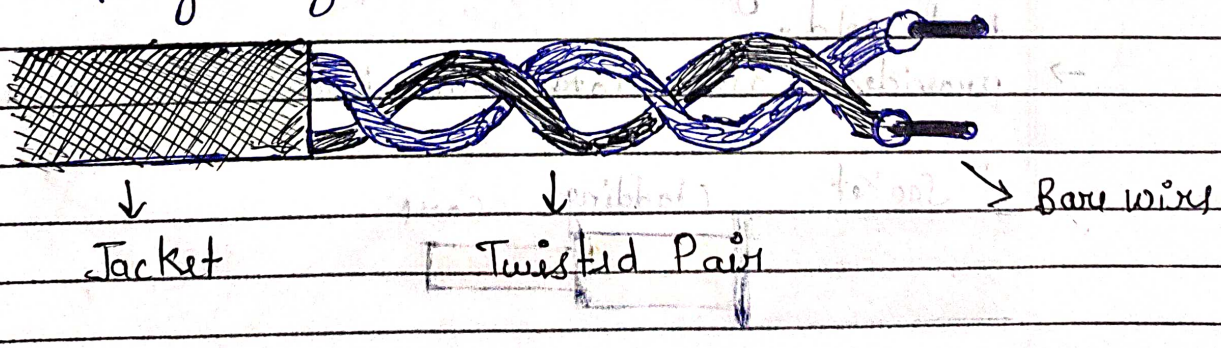
1. Guided Media : It is also referred to as Wired or Bounded transmission media. Signals being transmitted are directed and confined in a narrow pathway by using physical links.

- High Speed
- Secure

Twisted Pair : It is a physical media made up of a pair of cables twisted with each other.

→ It is cheap and lightweight cable.

→ Frequency rang 0 to 3.5KHz.



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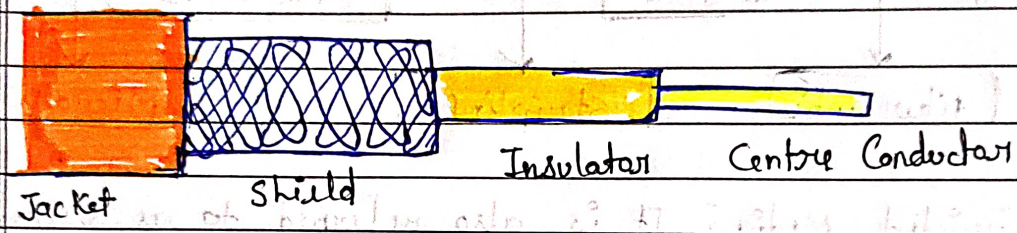
Coaxial Cable:

→ Commonly used transmission media (TV wire)
→ it contains two conductors parallel to each other.
→ It has higher frequency as compared to Twisted pair cable.
→ inner conductor of is made up of Copper and the outer conductor is made-up of Copper mesh Middle core is made up of non-conductive cover.



Advantages ⇒ Speed is high and higher bandwidth.
Disadvantages ⇒ more expensive then twisted pair.

Fibre Optic Cable:

→ It is a cable that uses electrical signals for Comm".
→ It holds the optical fibres coated in plastic that are used to send the data by pulses of light.
→ plastic coating protects the optical fibres from heat, cold.
→ provides faster data transmission than Copper Wires.

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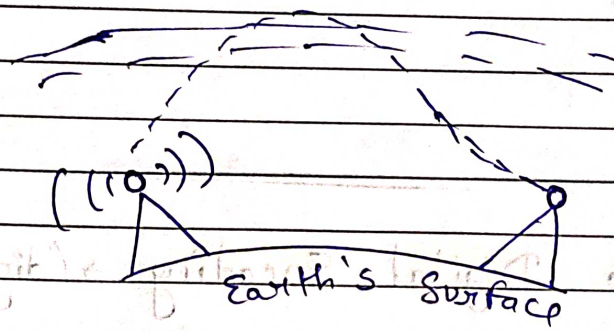
2. Unguided Transmission : It transmits the electromagnetic waves without using any physical medium. Therefore it is also known as wireless transmission.

Radio waves :

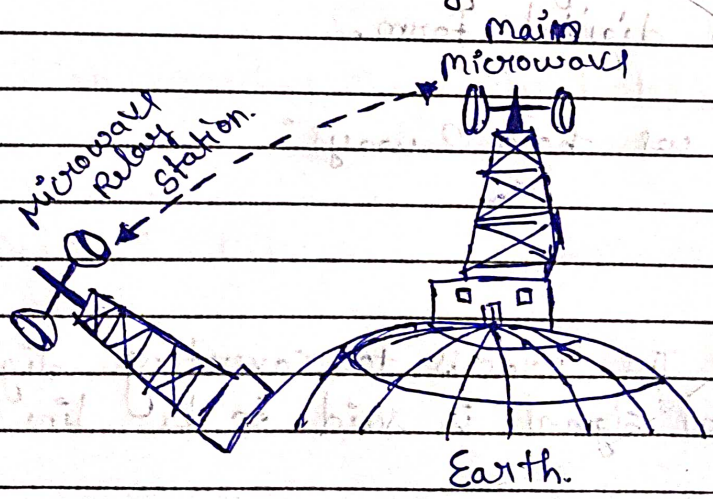
→ Radio waves are the electromagnetic waves that are transmitted in all the directions of free space.
→ The range in frequencies of 3Khz to 1Ghz.
→ e.g → FM radio.



→ Used for WAN
→ Higher transmission Rate.

Microwaves : Sending and receiving information using a microwave is known as microwave transmission.

→ widely used for point-to-point communications.
→ cheaper than using cables



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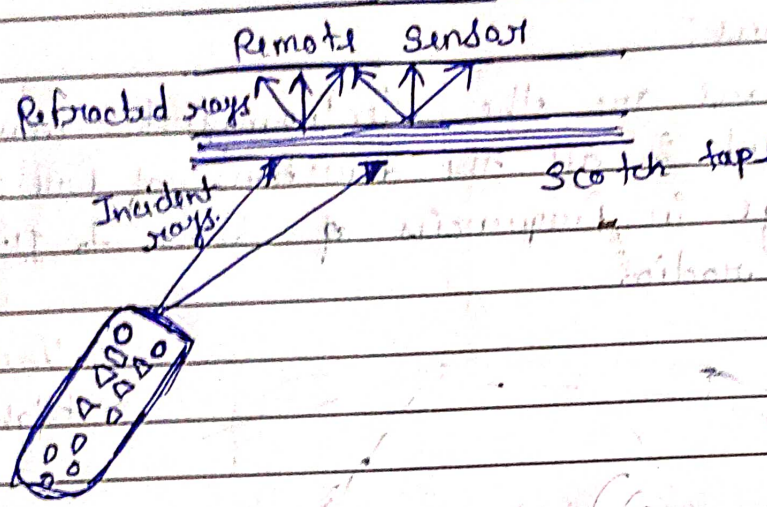
8 Infrared:

→ used for communication over short ranges, such as two cell phones, TV remote, etc.



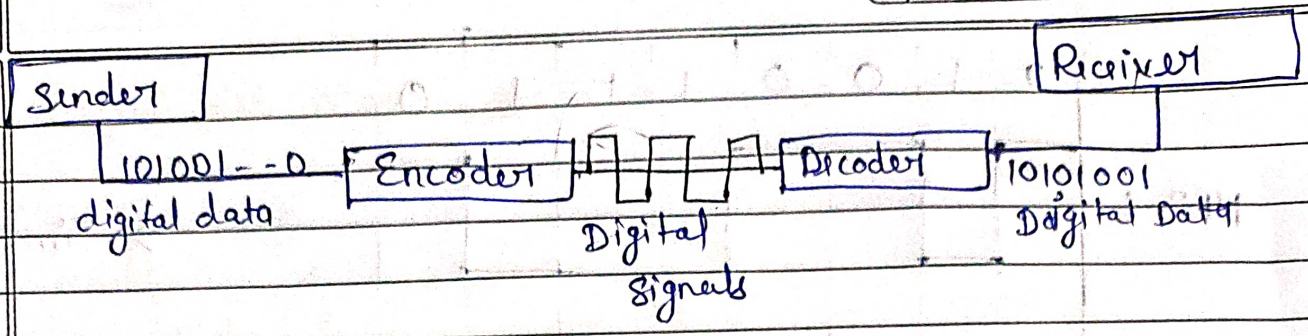
Digital to Digital Encoding → (digital data into digital signal)

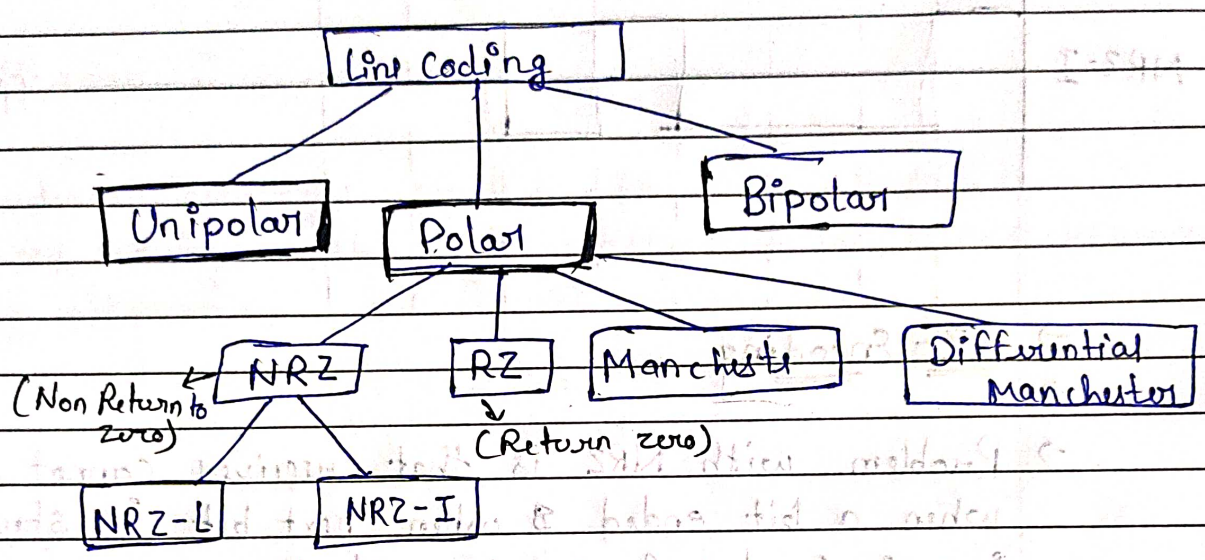
→ Data & information can be stored in 2 ways Analog and Digital.

→ To transmit data digitally, it needs to be first converted to digital form.

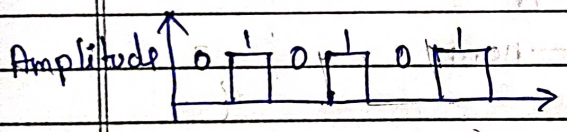
→ for conversion we have 2 ways:
* Line Coding
* Block Coding.

Line Coding ⇒ The process for converting digital data into digital signal is said to be line coding.





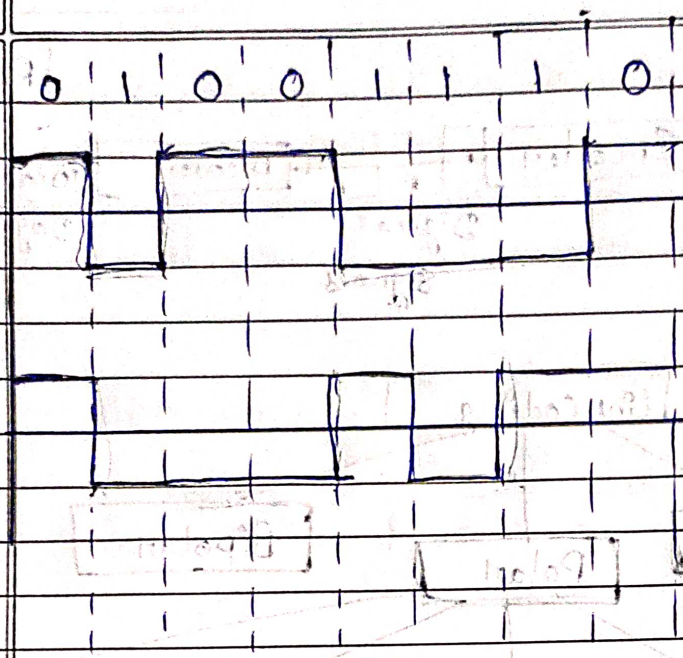
① Unipolar Encoding → Use Single voltage level to represent data
1 → high voltage and 0 → no voltage.



② Polar Encoding → uses multiple voltage levels to represent binary values.

→ NRZ → It uses 2 different voltage levels.

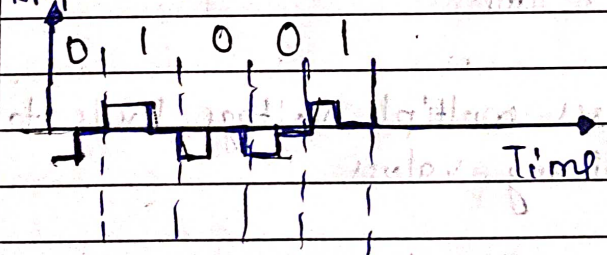
It has 2 variants:
→ NRZ-L (Levels Signals)
→ NRZ-I (Signals gets inverted)



→ RZ- Encoding

→ Problem with NRZ is that receiver cannot conclude when a bit ended & when next bit is started, in case Sender & receiver clock are not Synchro-nized.

+voltage — 1
-voltage — 0
Zero voltage — none.



→ Manchester :-

This encoding scheme is a combination of RZ and NRZ-L. Bit time is divided in two halves.

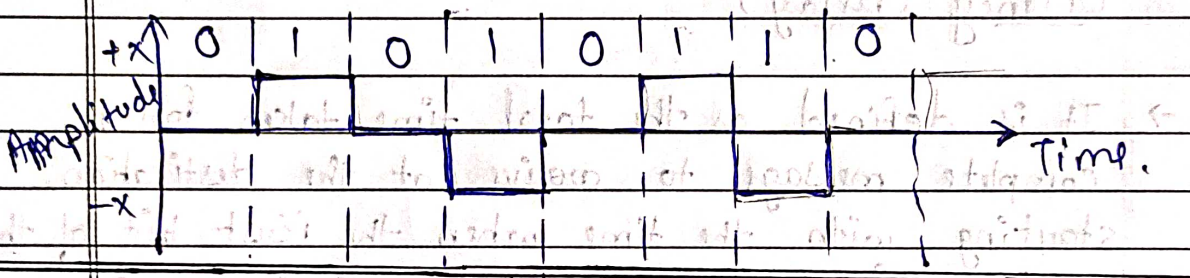
→ It transits in the middle of the bit & changes phase when a different bit is Encountered.

→ Differential Manchester :-

This Encoding Scheme is a combination of RZ and NRZ-I. It also transits at the middle of the bit but change phase only 1 is encountered.

③ Bipolar Encoding :-

It uses 3 voltage levels, +ve, -ve & zero.
Zero voltage represents binary 0 & bit 1 is represented by alternating +ve & -ve voltages.



Network Performance

→ To estimate the performance of the network, we should consider following 4 terminologies :-

- Bandwidth.
- Throughout.
- Latency (Delay).
- Bandwidth * Delay Product.

Bandwidth ⇒ In networking, we use the term bandwidth in two contexts :

- The first, bandwidth in hertz, (no. of vibration per second) refers to the range of frequencies in a composite signal.

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- The second, bandwidth in bits per second, refers to the speed of bit transmission in a channel or link.

Throughout:

→ It is the number of messages successfully transmitted per unit time.
→ bits per second, Kilobytes per second, megabytes per second and gigabytes per second.

Latency (Delay)

→ It is defined as the total time taken for a complete message to arrive at the destination, starting with the time when the first bit of the message is sent out from the source and ending with the time when the last bit of the message is delivered at the destination
→ measured in milliseconds (ms).

Latency = Propagation Time + Transmission Time + Queuing Time + Processing Delay.

① P.T = $\frac{\text{Distance}}{\text{Propagation Speed}}$, ② T.T = $\frac{\text{Message Size}}{\text{Bandwidth}}$

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Bandwidth - delay product

It is a measurement of how many bits can fill up a network link. It gives the maximum amount of data that can be transmitted by the Sender at a given time before waiting for acknowledgment.

Transmission Impairment

When a signal transmit from one medium to other, the signal that is received may differ from the signal that is transmitted due to various impairments.

1) Attenuation :- "It refers to lose of Energy by a Signal time"
   → for compensat we can use amplifire

2) Distortion :- "means signal changes its form or shape".

3) Noise :- The random or unwanted signal that mixes up with the original signal is called noise.

   → There are Several types of noise such as induced, thermal, cross talk and implust noise which may corrupt the signal.

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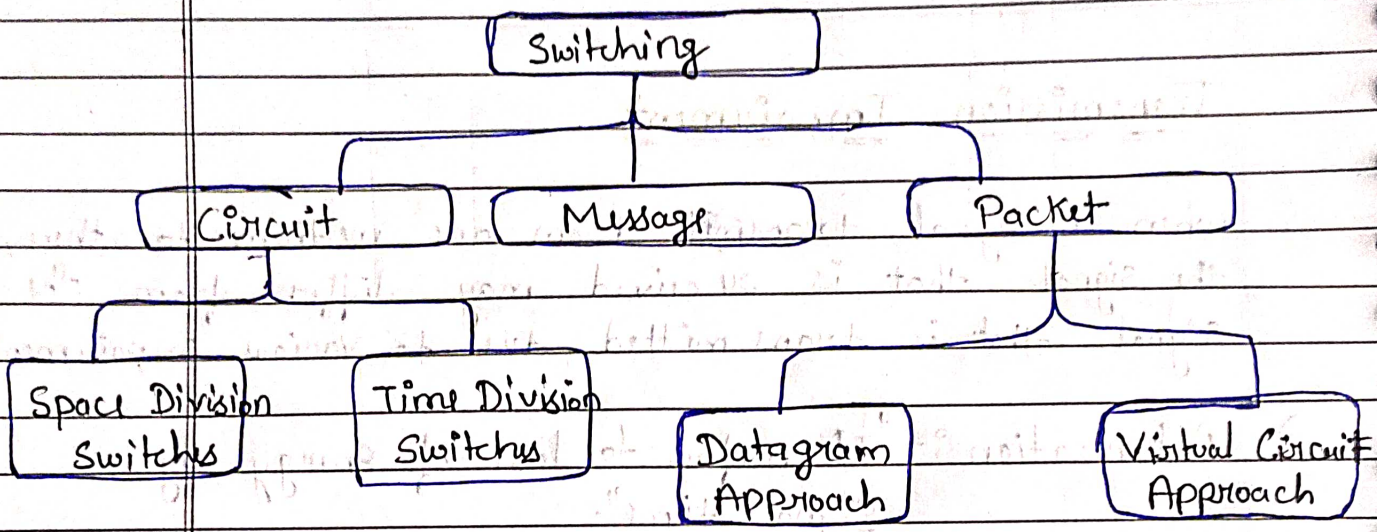
Switching Techniques

→ It is the process of transferring data packets from one device to another in a network, or from one network to another, using specific devices called switches

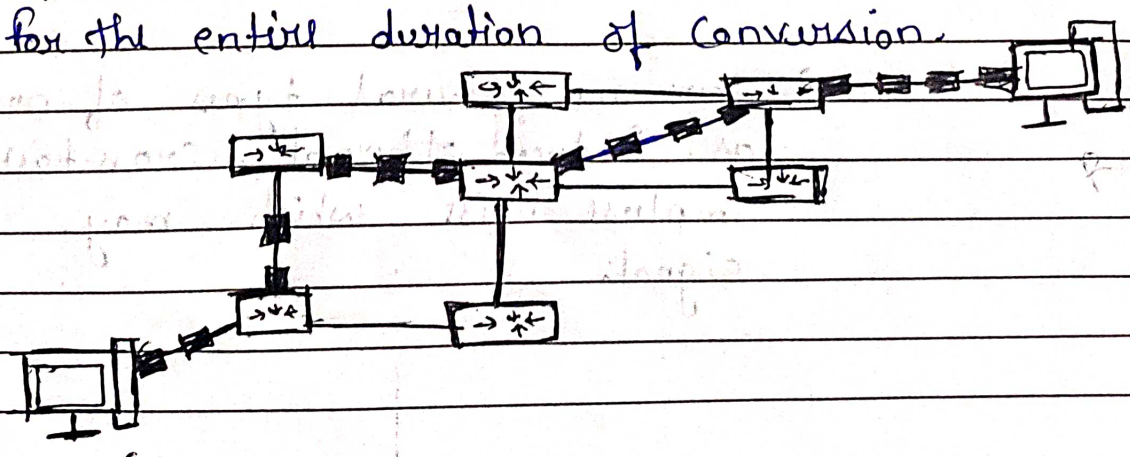


① Circuit Switching

→ When two nodes communicate with eachother over a dedicated communication path, it is called circuit switching.

→ A dedicated path is established between the Sender and the receiver which is maintained for the entire duration of conversion.

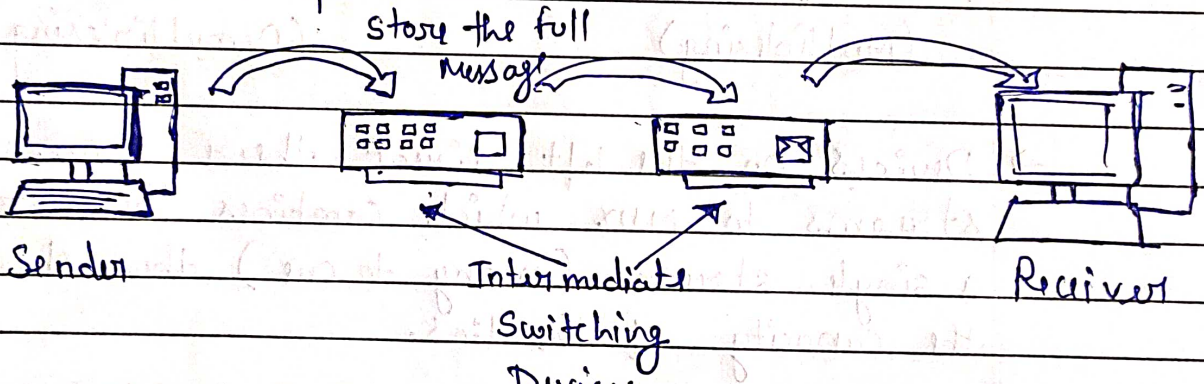
→



→ Circuit switching was designed for voice applicatio
→ e.g → Telephone.

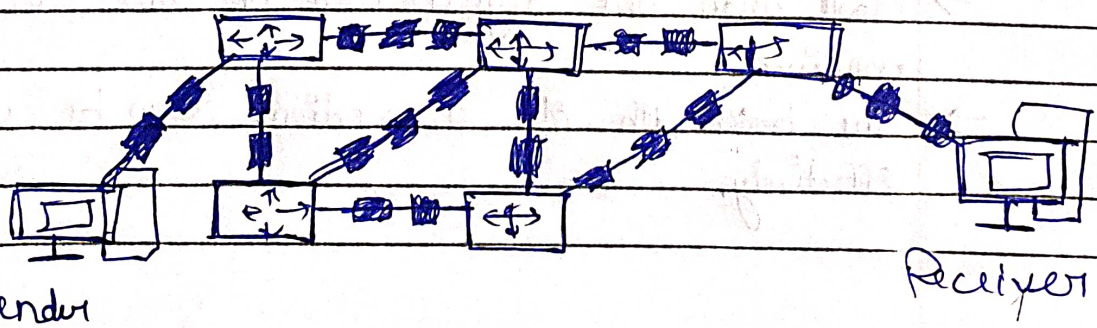
2. Message Switching :

→ This technique was somewhere in middle of circuit switching and packet switching..
→ the whole message is treated as a data unit and transferred in its entirety.
→ first receives the whole message and buffers it until there are resources available to transfer it to the next hop.



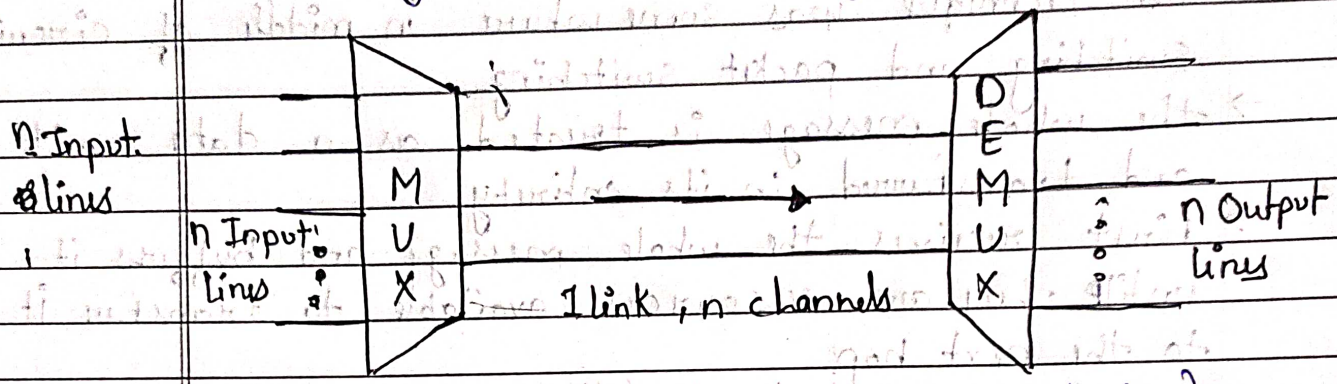
3. Packet Switching

→ The entire message is broken into small chunks called packets. The switching info. is added in the header of each packet and transmitted independently.
→ packets are stored and forwarded according to their priority to provide quality of service.



Multiplexing

→ Multiplexing is the set of techniques that allows the simultaneous transmission of multiple signals across a single data link.



(Multiplexing) (Demultiplexing)

→ Devices on the left direct their transmission streams to MUX which combines them into a single stream (many to one) thus sharing the capacity of the link.

→ Receiving end, demultiplexer separates the single stream back into its component transmissions (one to many) & directs them to their intended Receiving Devices.

Advantages

→ More than one signal can be sent over a single medium.

→ The bandwidth of a medium can be utilized effectively.

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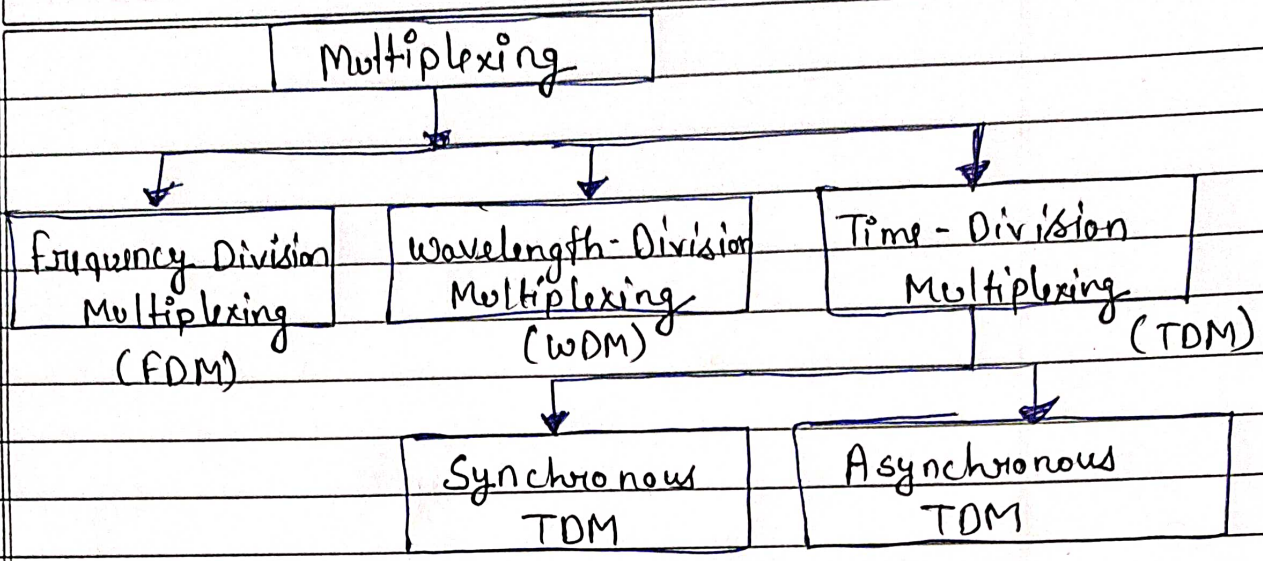

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