Week 01
Lecture 02

Elements of Data communication

Network: A network is a set of devices connected by communication links. Devices are reffered to as nodes. A node can be a computer, printer or any other device capable of sending and/or receiving data generated by other nodes on the network.

- These devices are connected by using wire and wireless transmission media. (cable or air)

Facilities of network:

Text, calls, games, communication.

Elements of communication:

Communication is nothing but the exchange of ideas, information.

1. sender 2. receiver 3. Medium

Elements of net work over networks:

- Devices: (Sender/Receiver)
- Medium: The transmission medium is the physical path by which a message travels from sender to receiver (cables, radio waves, wire etc)

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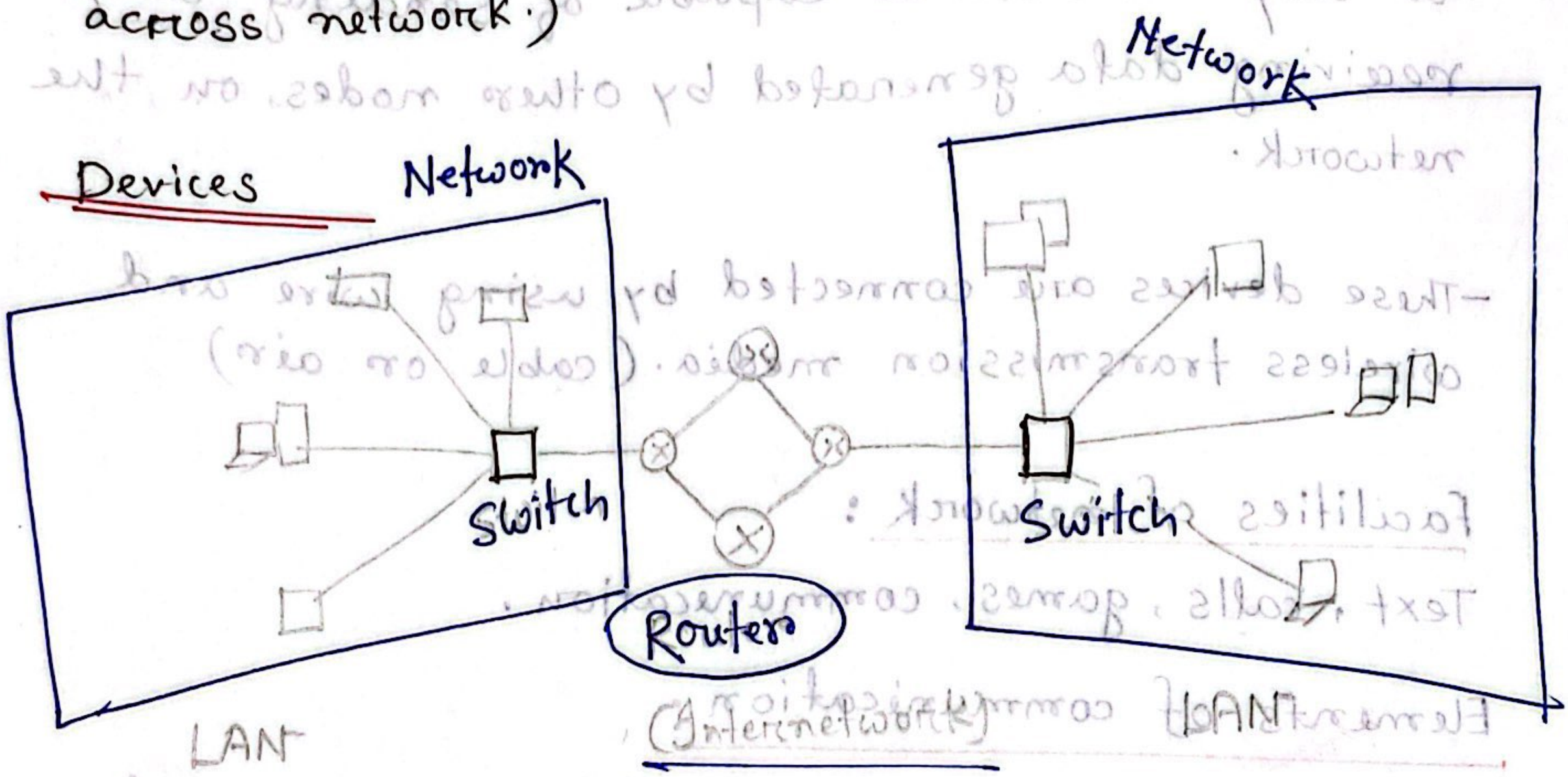
- Messages: Information that travels over the medium.
- Protocols / rules: A protocol is a set of rules that governs data communication. It represents an agreement between the communicating devices. Without protocols devices can be connected but not communicating. (Governs how messages flow across network.)



Two types of devices:

- End Devices: whatever user directly uses.
- Intermediary Devices: Devices that provide connectivity between End devices. (Router, wireless, wire)

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Network Media

- Wire mediums : LAN cables, broadband, internet cable optical fiber, coaxial cables

Data Representation :

Information today comes in different forms such as text, numbers, images, audio, video.

Text : ASCII (American Standard Code for Information Interchange (ASCII), Unicode (prevalent coding system.

Same

Alphanumeric : ASCII, UNICODE

IMAGE : JPEG, GIF, PCX, TIFF, BMP, etc.

Motion Picture : MPEG-2, Quick time, MPEG-4.

Sound : Sound Blaster, WAV, AU, MP3, etc

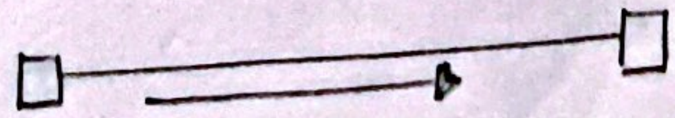
Outline graphics / fonts : PostScript, Truetype, PDF

DATA COMMUNICATION

- Data communication is the exchange of information by using a transmission Medium ~~thro~~ between devices.

- Data Flow : (Simplex, half duplex, full duplex) 3 types.

- Simplex : Data flows in only one direction. If there are two devices then the sender can only send data and the receiver can only receive data.



Keyboard

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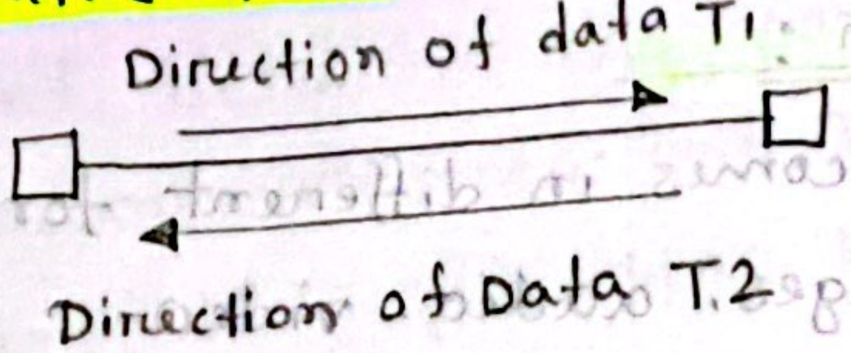
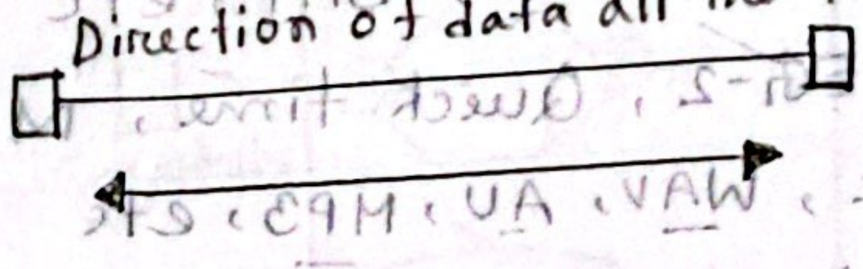
- **Half Duplex:** Both devices can send or receieve data but not at the same time, or not simultaneously.

Example: Walkie-talkie.



- **Full Duplex:** Can send data at a time or simultaneously.

Example: Voice call, vedio call



NETWORK Types

- Network types are based on the area of coverage of the networks.

- **Personal Area Network (PAN):**

A network that connects different devices within a short limited or a personal operating space. (Bluetooth)

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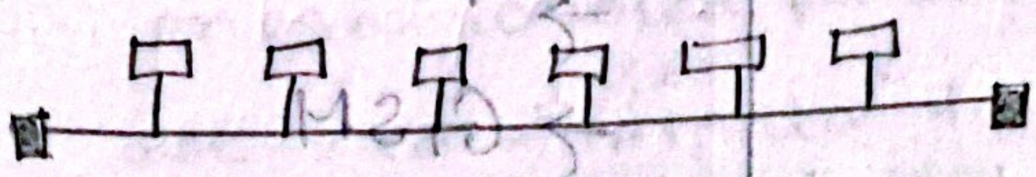
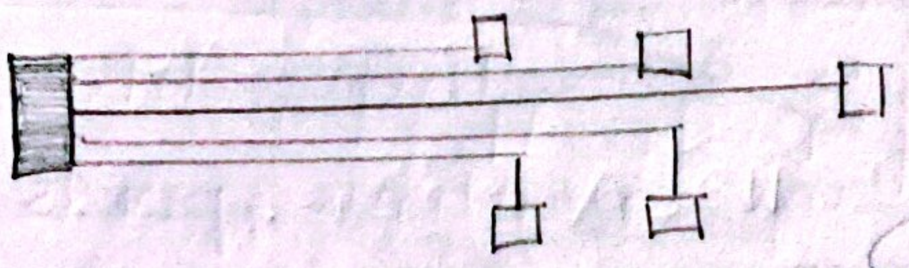
Local Area Network (LAN)

- Bigger than PAN
- Area for LAN is typically 30-50 meters
- Example : TSR , Ethernet
- Privately owned.



LAN with common cable



LAN WITH A SWITCH

Metropolitan Area Network (MAN)

- City wide network
- Up to 50 km (rural, suburban, urban area)
- WiMAX.

Wide Area Networks (WANs)

- Spans larger geographical Area.
- LANs separated by geographic distance are connected by a wide Area Network (WAN)
- PSTN , Cellular Network (GSM)

Differences between LAN and WAN

LAN	WAN
→ 30-50 meters	→ larger geographical area.
→ Local area Network	→ ~~to~~ Wide Area Network
→ Privately owned.	→ GSM
→ Ethernet.	
→ ~~LAN~~ Separated LANS are connected by WANS	

Network topology

- Network topology refers the structure of ~~a~~ how the Net is connected.
- Network topology refers to how various devices are physically or logically arranged in relation to each other.

~~Topk~~

Topology (physical)

- Mesh
- STAR
- BUS
- RING

The way how we design our network is called network topology.

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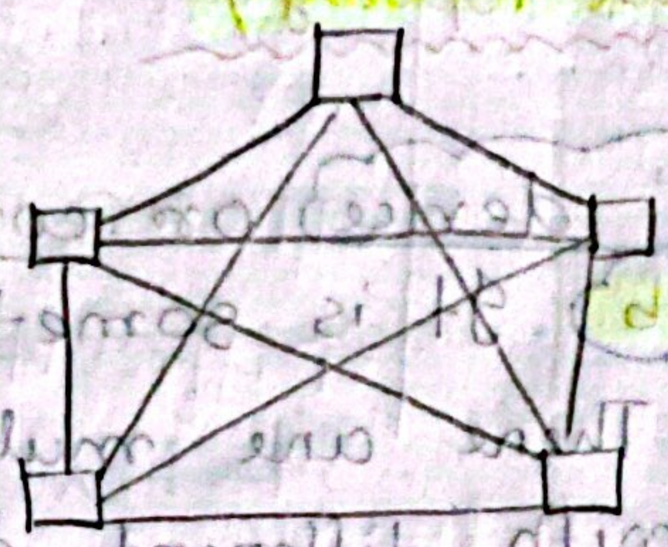
Mesh topology : All the stations are connected with one another by using point to point connections.

- Formula = $n(n-1)/2$

- Here 'n' indicates the number of the (stations) network to build a mesh topology.
- We will use this formula to find the cable numbers.



MESH TOPOLOGY

- Advantages of MESH topology

- The use of dedicated links guarantees that each connection can carry its own data load. (point to point)
- A mesh topology is robust / strong.
- If one link has problem then it won't affect other links.
- Gives proper security and privacy. (other station will not get any idea about data)
- Can easily find the fault.

(Security, not depended on others, easy fault diternmination)

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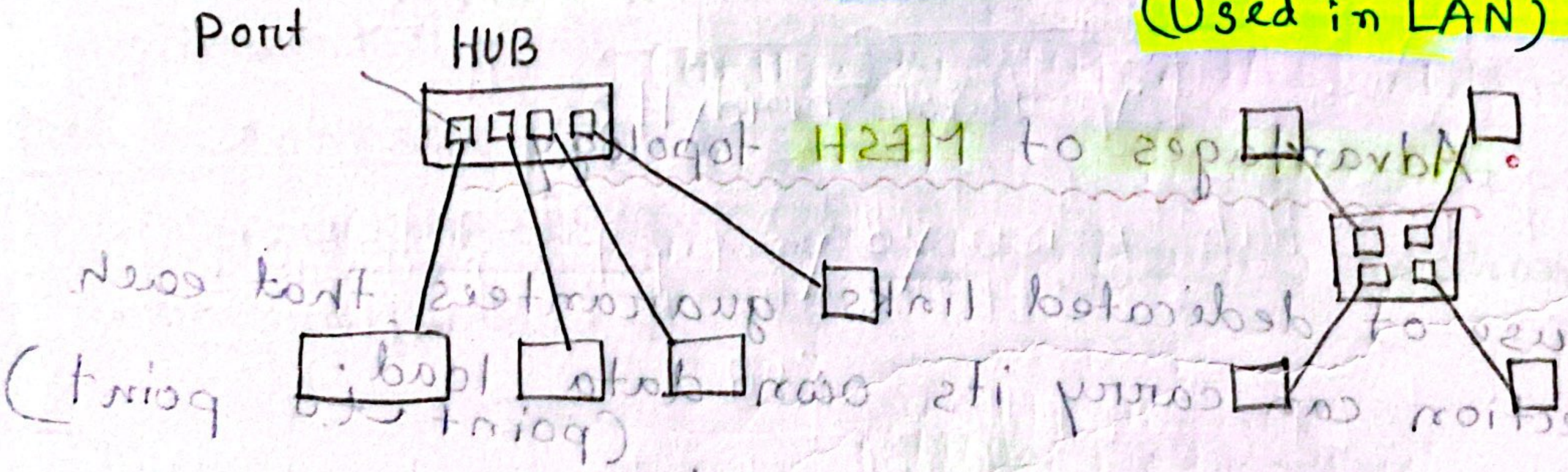
Disadvantages of Mesh topology :

- Need a lot of cables.
- Installation and reconnections are difficult.
- Need huge space
- Quite expensive.
- Reconnection tough.

Star topology

- There is a central device or controller and it is know as hub. It is something like a router or switch. There are multiple ports that are connected with different devices.

(Less expensive than mesh)
(Used in LAN)



STAR TOPOLOGY

Advantages

- Donot Need to connect all the stations with one another
- Less number of cables
- Easy to install and configure
- Robustness (if one link is affected then it's easy to find and doesn't bother others. (Strong)
- Affordable

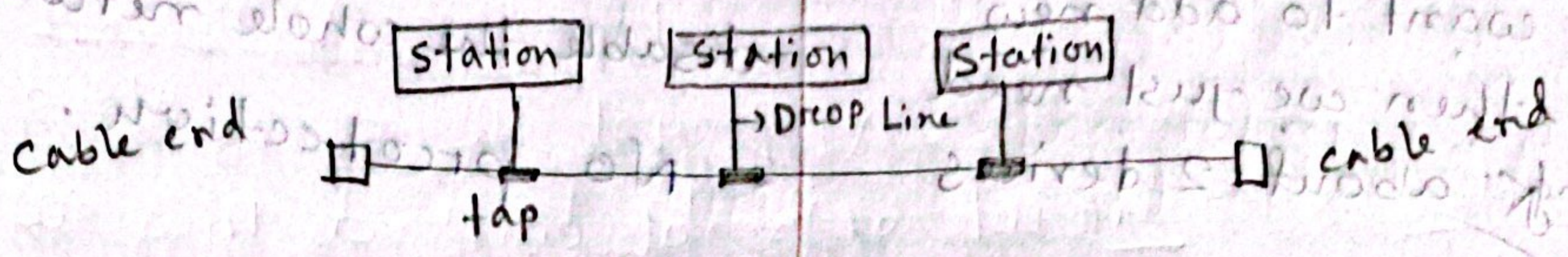
DisAdvantages

- Dependency (whole topology depends on one single point (hub)
- Needs a good numbers of cables.
- Dependent on hub (capacity
- Expensive
- High maintenance.

Bacin Haider

Bus Topology

- Simple topology
- Has a backbone connection.



Advantages

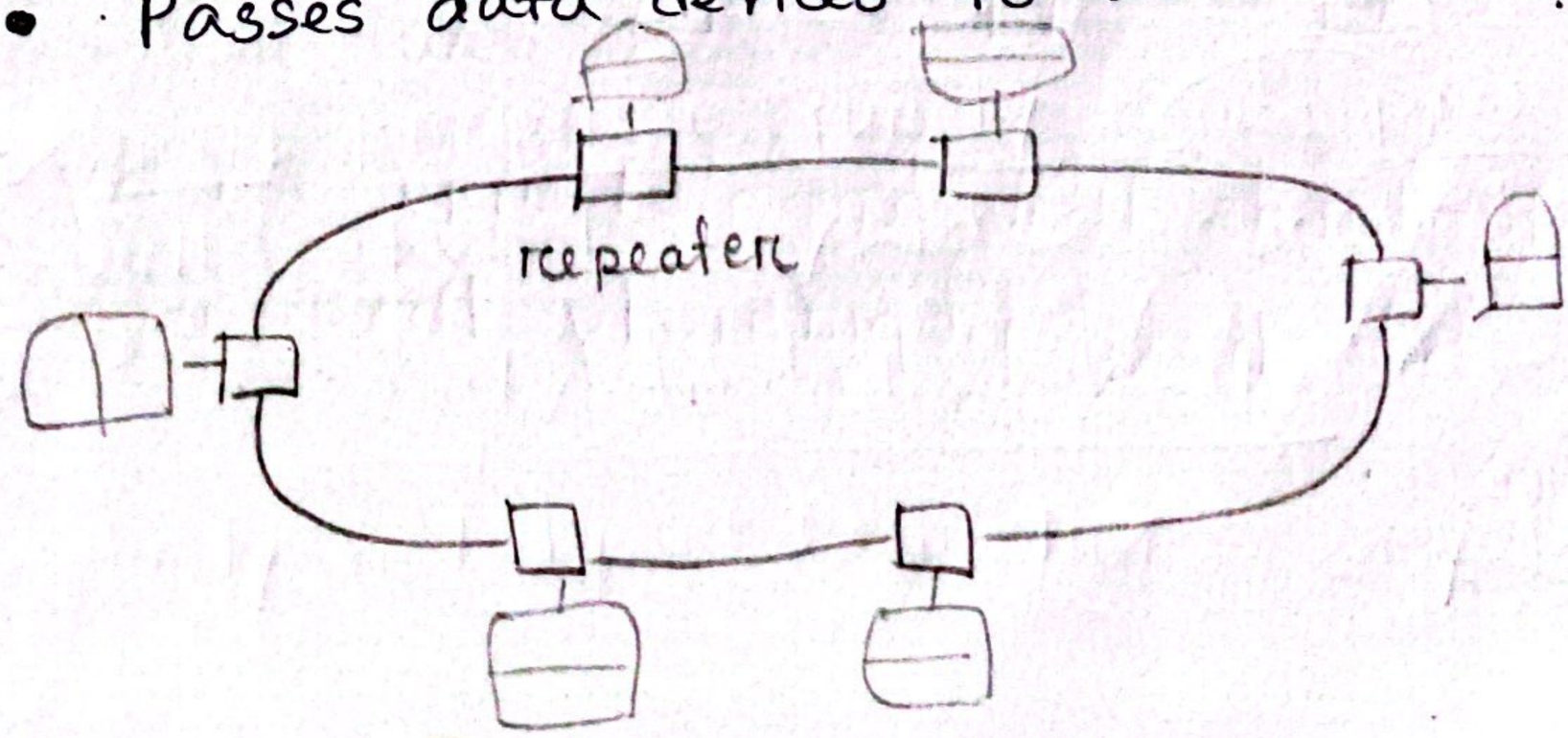
- Easy to install.
- Doesn't need more cables.
- Cheap to install.

Disadvantages

- Built in a optimal structure and can be a problem if we want to change it in future.
- If backbone has problem then it will down the whole topology.
- Difficult to add new devices.
- Difficult to find faults.
- Signal will lose energy (less power)
- Security concern.

RING Topology

- Each devices has point to point connection with only two devices on either side of it.
- Passes data devices to devices.



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RING

Advantages

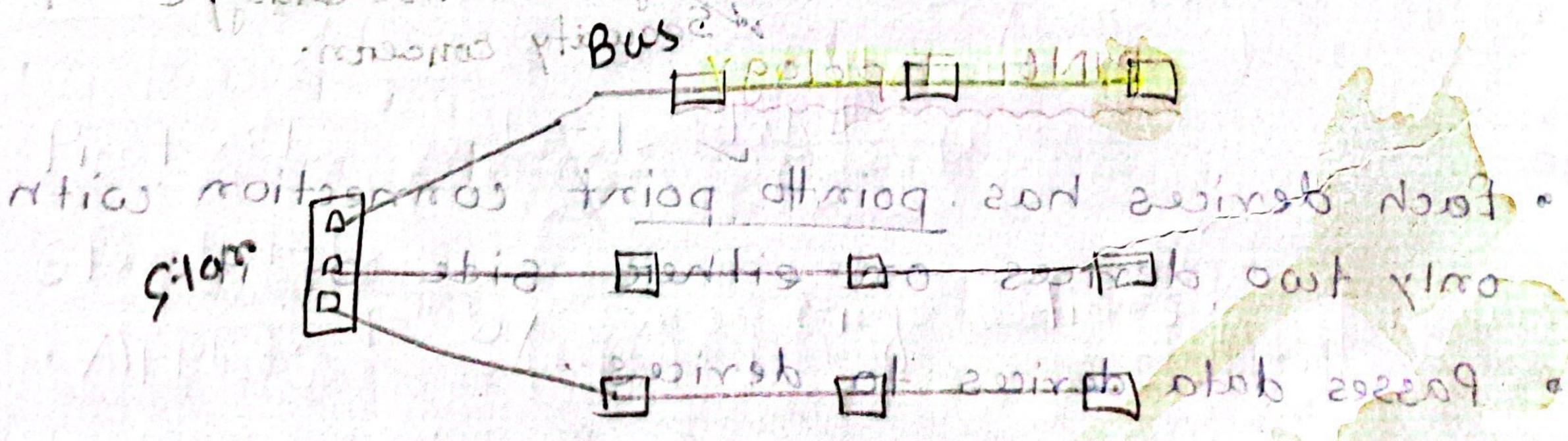
- Easy to install and reconfigure.
- If we want to add new devices then we just need to thing about 2 devices only.
- Easy to define faults:
- If one device does not receive data in time then it create alarm.
- Can use dual ring.

Disadvantages

- Unidirectional traffic
- A break in the ring will disable the whole network.
- No protection.
- ~~Expensive~~.
- More cables than bus.
- Higher response of time
- Difficult than star to add junction nodes

Hybrid Topology

- Creating a topology by using different topologies.



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Week : 2

Chapter-2

Introduction to Network Models.

Network: Network is a consists of some hard wares and softwares. If some devices which have some softwares them to communete with eath other, the whole communication will be done using the network model concept.

LAYER :

Example

If one person is calling another then,

Content layers : what kind of information they are asking for. (Exp : where is the cafe?)

Rules layer : The common rule that the receiver and sender should have. (Example: language) (waiting for our turn, Signal when finished)

Physical layer : The two person is physical layers.

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Benefits of using layer model:

- Easily find the faults.
- Changes in one specific layer do not harm others.
- Defined information.

Rules that govern communications = Protocol

- Protocol is a set of predetermined rules.
- Defines how, what and when we should communicate
- Protocol describe processes:
  1. The formal or structure of the message.
  2. How they share information (Method)
  3. How and when errors and systems messages are passed between devices.
  4. Define how the starting ~~information~~ termination should do.

Protocols and standards

Standards

- Approved by some organizations.

Categories:

- De facto: Standards that are not approved by organizations but have popularity through widespread use.

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De Jure: Standards that are ~~legalist~~ approved by officially recognized body.

(in standards we need to wait 2 seconds to understand if the signal has finished or not)

Standard Organizations:

- International Organization for standardization (ISO)
- IEEE
- ANSI
- TIA
- IETF
- ITU-T

Layered standards:

- OSI Reference model (late 1970s)
  - De Jure Standard

- ISO organization
- OSI Model

- TCP/IP protocol Model.
  - Open De facto standard
  - Governed by IETF working groups.

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7 layers of OSI Model

moving raw data across the network. Hardware

1. Physical : Dedicate the conversation of signals to binary data. (processing)
2. Data link : The mac address on how the mac is required in this layers to achieve the communication. (Data)

Primary concern : Communication between applications (Software)

3. Network : IP Addresses, devices. (Need)
4. Transport : Protocols (TCP, UDP) (to)
5. Session : Different types of synchronizations logging (seem)
6. Presentation : Encryption, comprehesion (People) translation
7. Application layer : Protocols like http, mail interfaces. (All)

All people seem to need data processing.

A → P → S → T → N → D → Phy.

APST NPPhy

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TCP/IP

- Developed by DARPA (US Defence Advanced Research Project Agency) for its packet switched network.
- Used by global Internet.
- De facto standard.

4 layers only

TCP/IP MODEL

1. Application — Application, presentation, session
2. Transport → same
3. Internet — Network
4. Network Access — Datalink, physical

OSI MODELS

- TCP layer is more complex than OSI

OSI

Sender (phone)

7. Application
6. Presentation
5. Session
4. Transport
3. Network
2. Data link
1. physical

(Media)

Receiver (PC)

A
P
S
T
N
D
Phy

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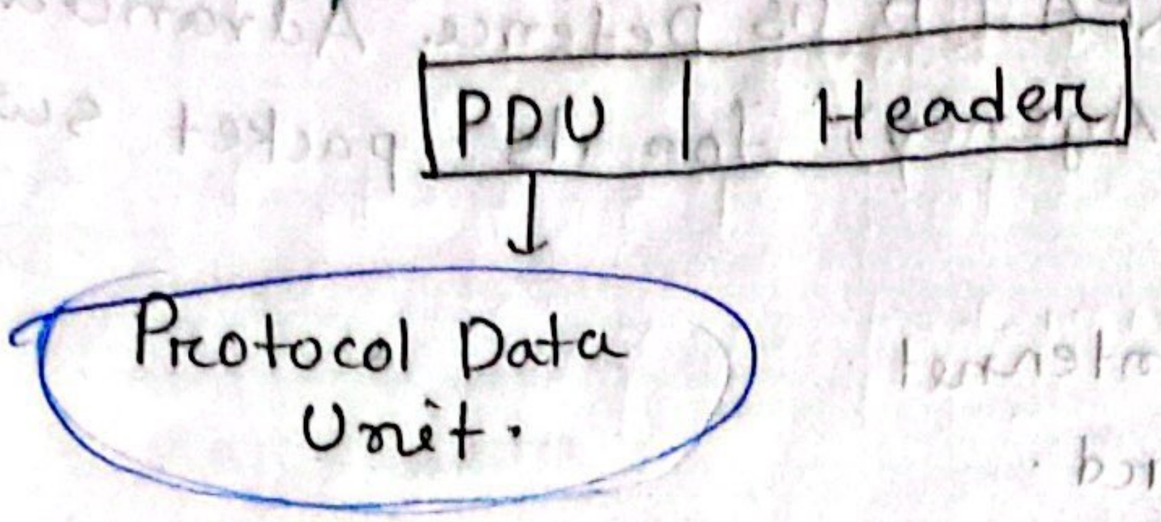
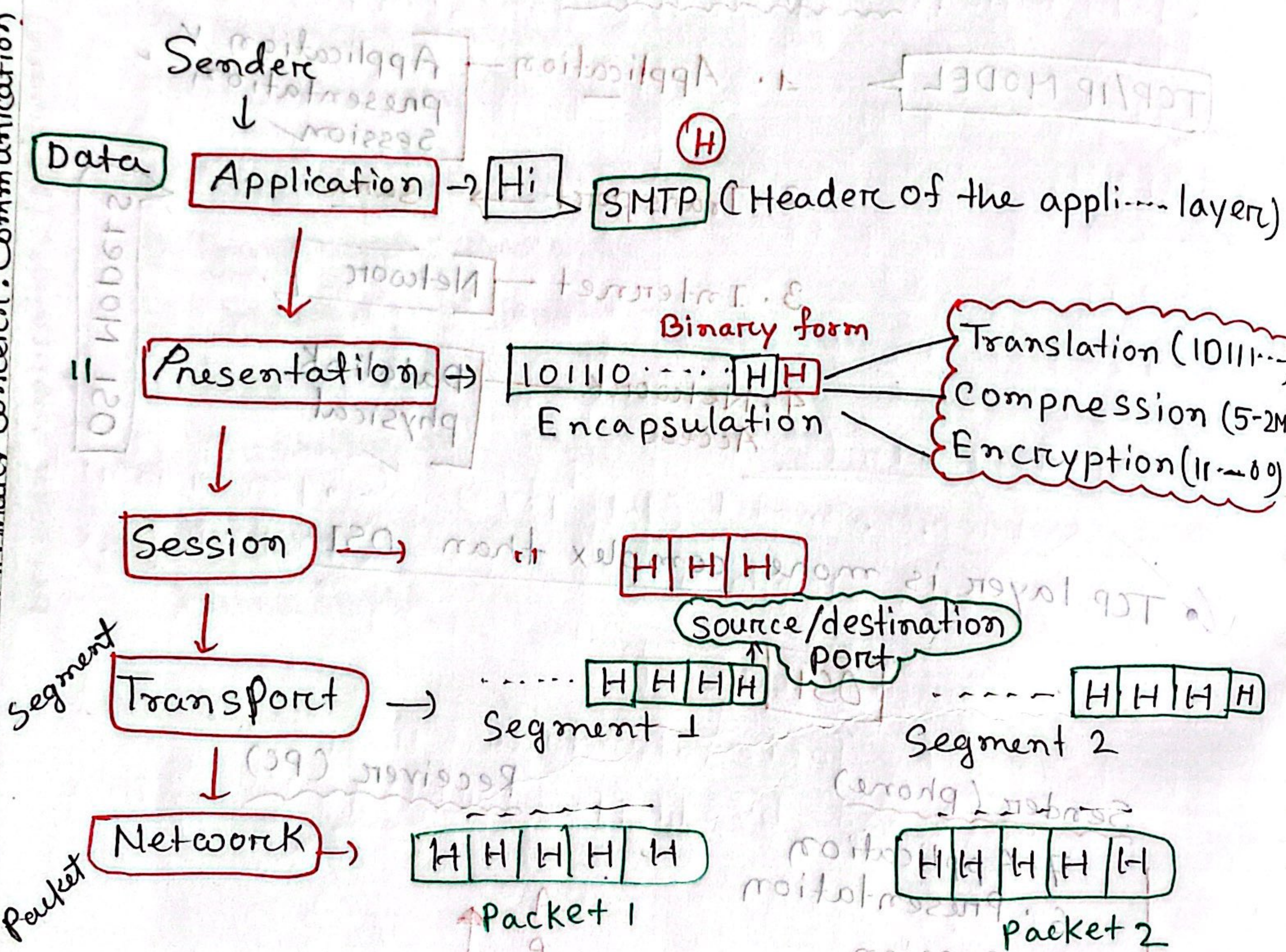
moving raw data

Primary concern: Communication

- Each layer creates data unit.





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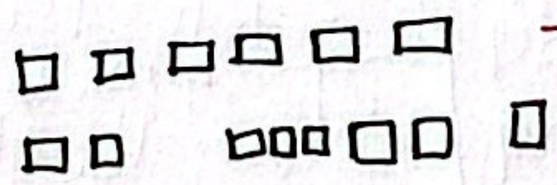
Protocols:

A set of predetermined rules that govern communication.

Syntax: If you create a data then syntax will decide which form it will follow to create it.

Effectiveness of a system depens upon:

1) Delivery (confirms that the data sent to the receiver)
2) Accuracy (ensuring that the data is accurate or not)
3) Timeliness
4) Jitter.
   ↳ (delivering the packets timely.) When there will be a gap between packets then it will be called jitter.



→ perfect stream

→ jitter.

Questions from Chapter 1:

1) simplex and duplex (difference)
2) Elements of data communications with example:
3) Types of connection. (point to point / multipoint) difference
4) How many half duplex / full duplex.
5) How many cables. $(n \cdot (n-1)/2)$
6) How to connect pcs with limited ports.

Bain Haider

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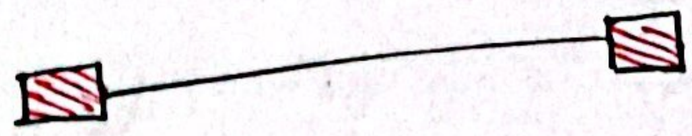
Chapter 1.

Types of connection:

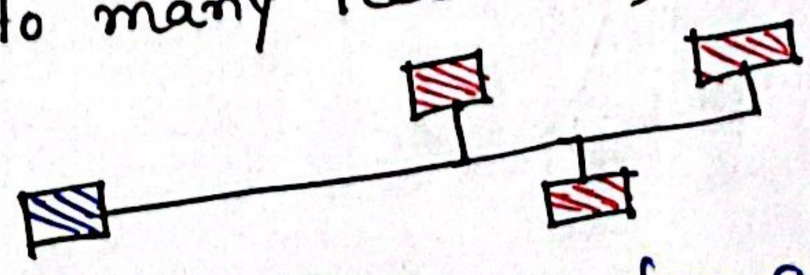
1) **point to point** (no sharing)



(sender and receiver will have only one connection)

2) **Multipoint**: • time share

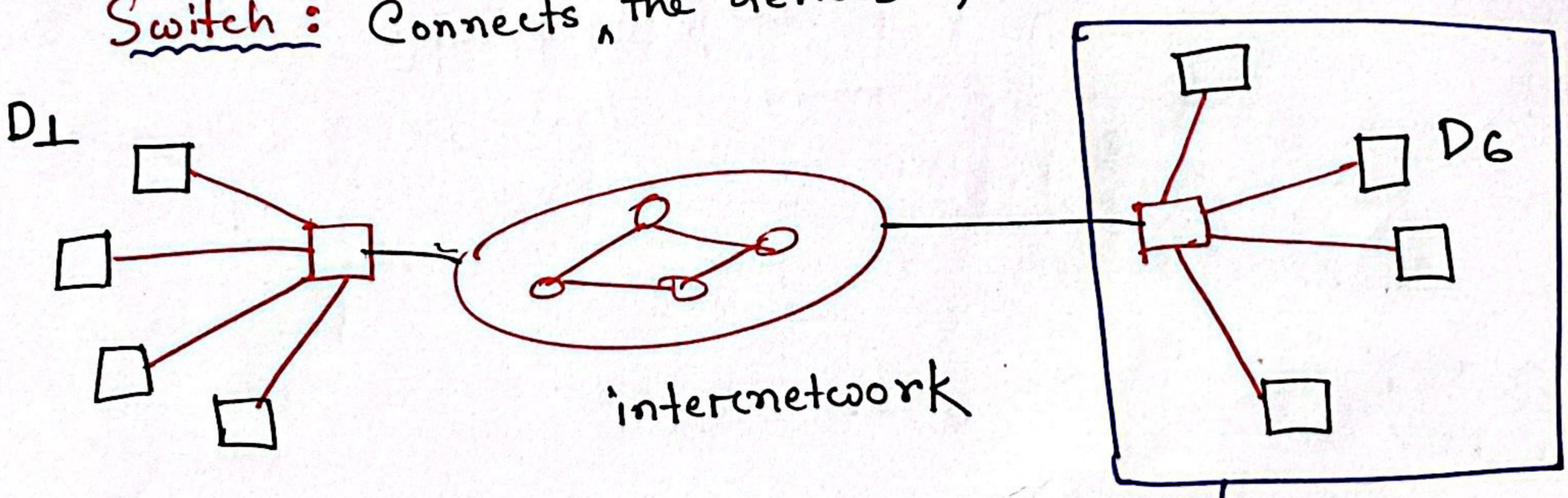
(one sender to many receiver)



[will use for a specific time only)

Router: Connects the devices from different networks (D_1 + D_6)

Switch: Connects all the devices from a network.



→ switch connects all the devices from same network.

Bandwidth:

everyone will use but for a particular portion.

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Week: 3
Analog Signals

Analog Vs Digital :

Bandwidth

One characteristic that measure network performance is bandwidt
2 different contexts.

1. Bandwidth in hertz → range of frequencies that a channe can pass through.
2. Bandwidth in Bits per seconds. (BPS) (speed of bit transmission)

Analog and digital Data :

- Data can be analog or digital.

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Week-3 Analog

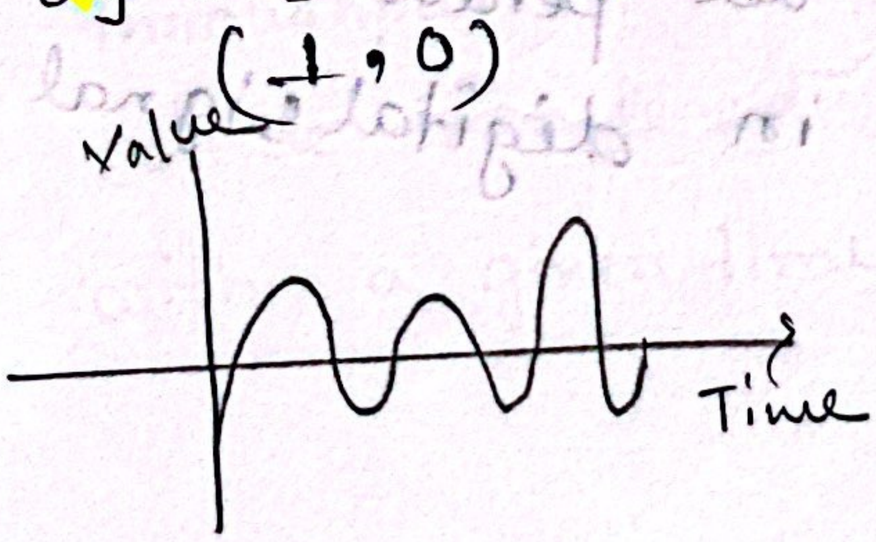
Analog → info this is continuous.
Digital → has discrete / separate stats.

Example Analog: clock.
It has min, hour, sec. (continuous information)
→ movements are continuous.

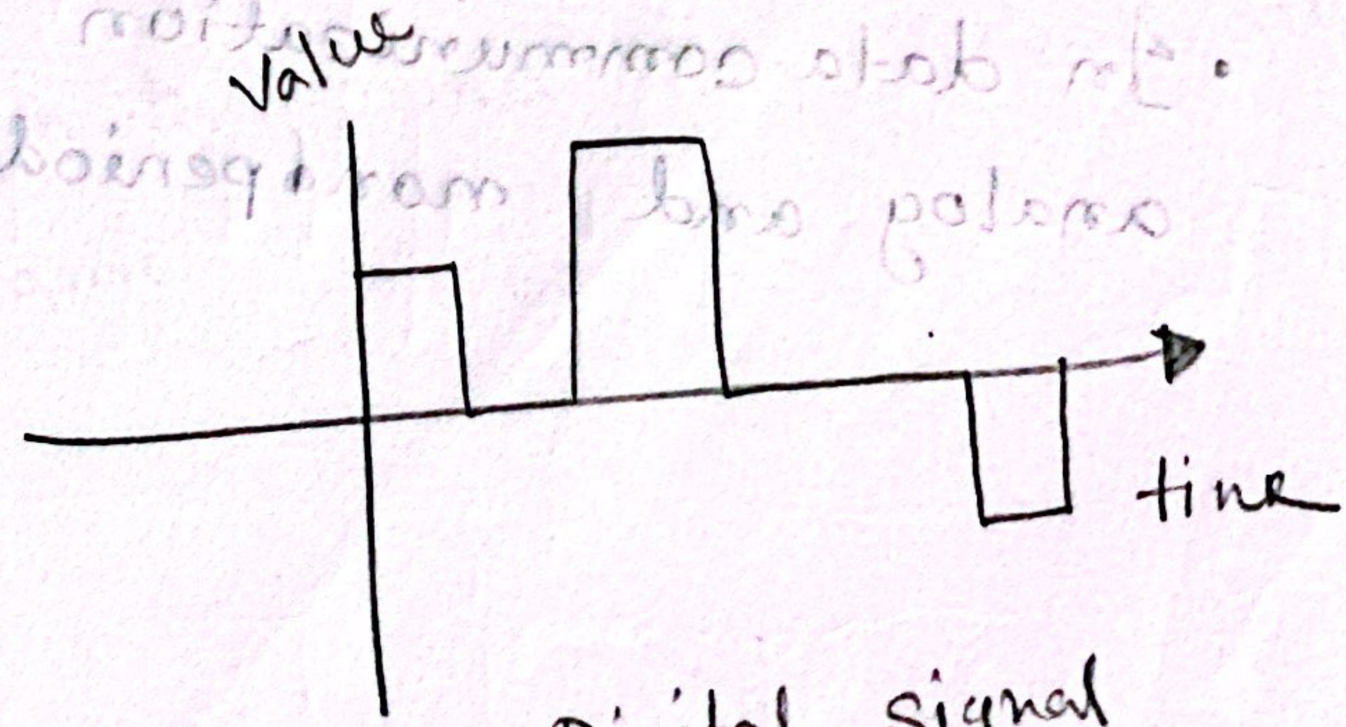
Example digital:
Data in PC memory stored like 0s and 1s only.
Can be changed into ~~digital~~ analog or modulated version.

Digital and analog signals:
→ many levels of intensity over a period of time.

limited number of defined values.
(1, 0)



a. Analog signal



b. Digital signal

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Periodic and Nonperiodic:

Completes any pattern within a measurable time frame is called period and repeats that pattern over sub-sequent identical periods. If it completes a full pattern then it will be a cycle.

changes without exhibiting a pattern or cycle that repeats over time.

- Both analog and digital data can be periodic and nonperiodic.

- In data communication we use periodic in analog and nonperiodic in digital signal.

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Channel bit rate:

We know that data rate refers to the speed of data transfer through a channel. It is generally computed in bits per seconds. (bps). While calculating the channel's bit rate we have to consider 3 factors and these are ~~sampling frequency~~, ~~bit depth~~, ~~number of channels~~.

1) the bandwidth available.
2) The level of the signal we use
3) The quality of the channel.

Bandwidth Vs throughput:

- Bandwidth is the term used for the maximum transfer capacity of a network. On the other hand, throughput is a term used for how much data can be transfered from the source to its destination within a given time frame.

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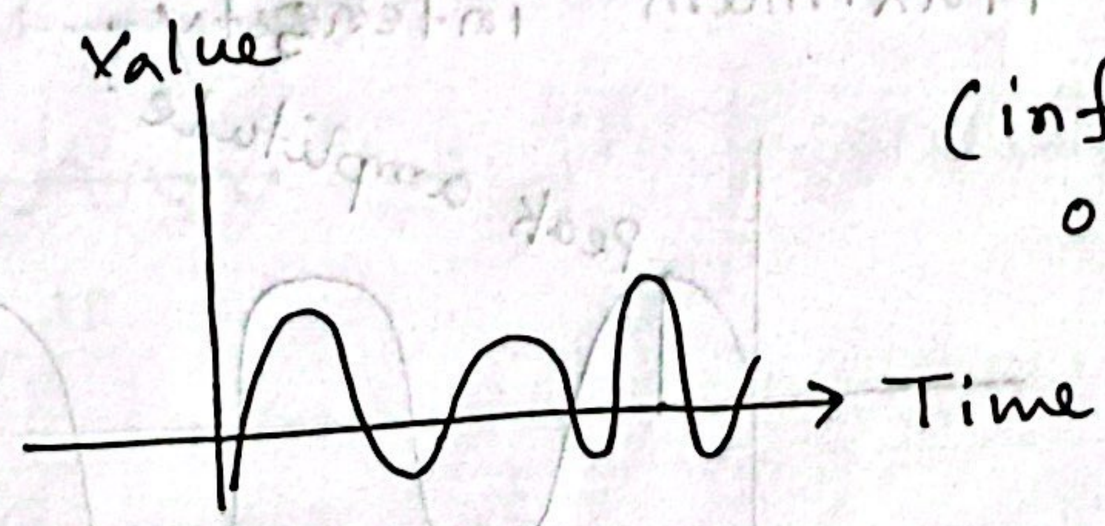
Chapter- 3

Data and Signals

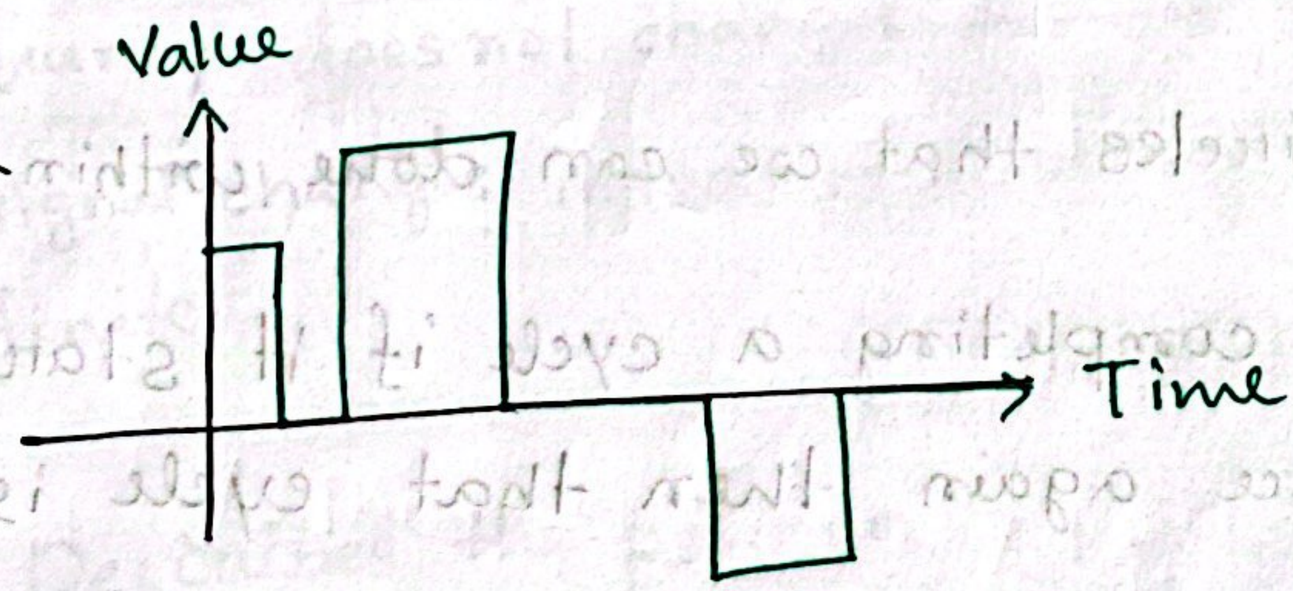
Data → 1) Analog Data → continuous Value.
2) Digital Data → ~~Discrete~~ Discrete Value

Analog Data :



(infinitine number of values)

Digital :



(Digital data have limited number of values)

- In communication we use periodic analog signals and nonperiodic digital signals.

Periodic signal : A specific pattern will repeat after a period of time. This is called periodic signal. Types :

1) simple (can not be devided)
2) composite (composed of multiple sine waves)

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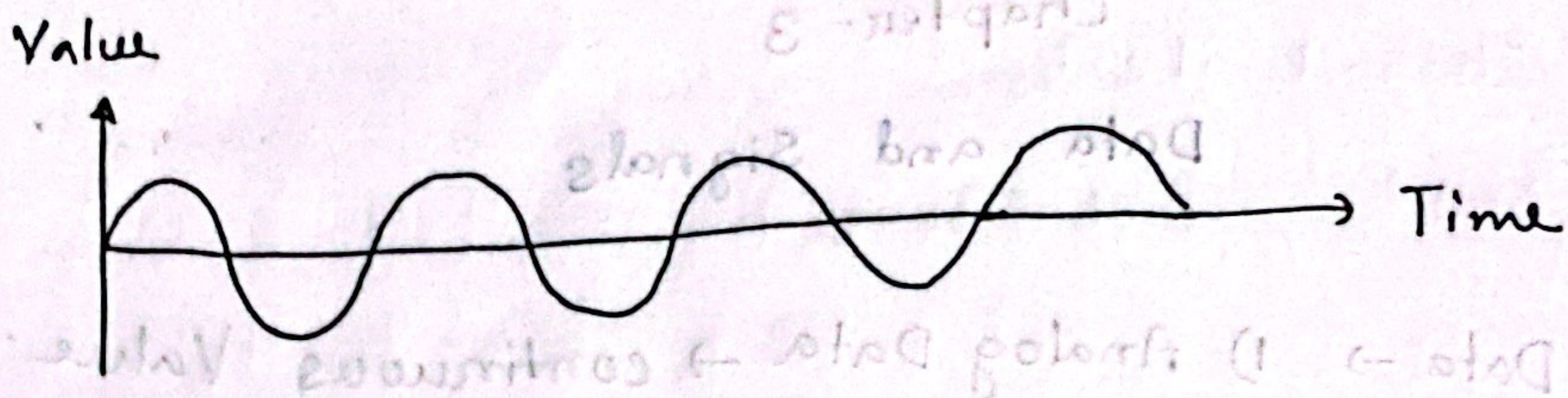
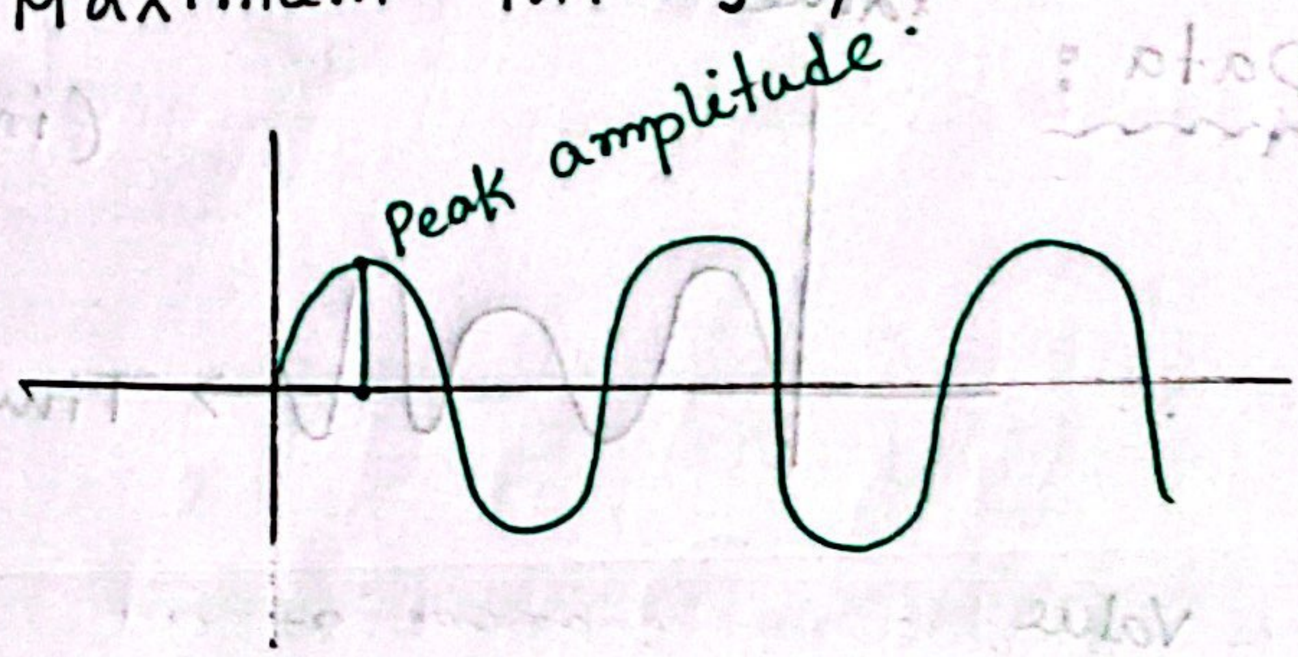


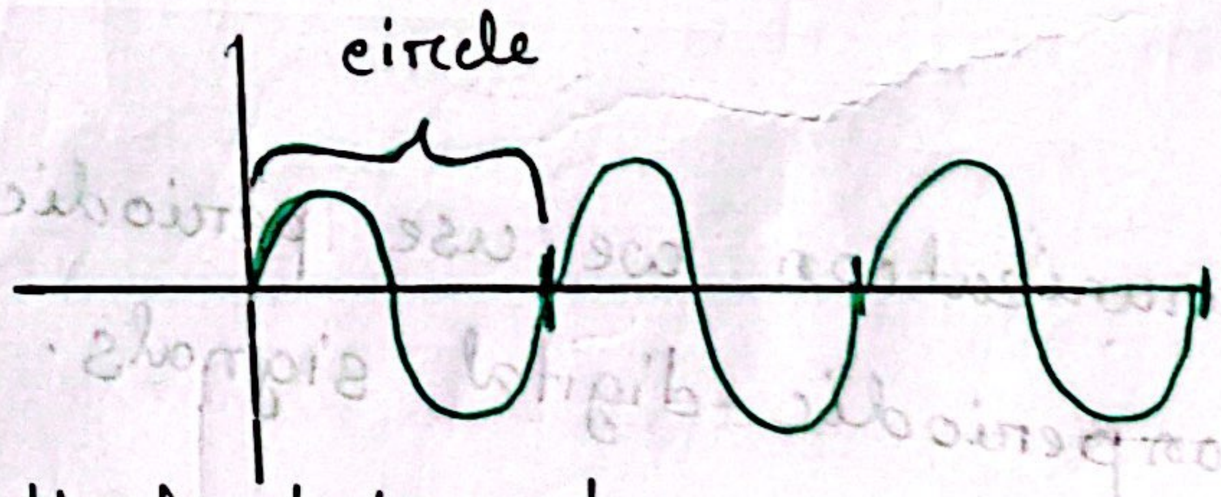
simple sine wave.

Peak Amplitude: Maximum intensity.



Frequency: Circles that we can done within a second.

Circle: Cycle After completing a cycle if it starts from the same place again then that cycle is called circle.



period: Time that takes to complete a cycle.

Frequency and period are the inverse of each other.

$$f = \frac{1}{T} \qquad T = \frac{1}{f}$$

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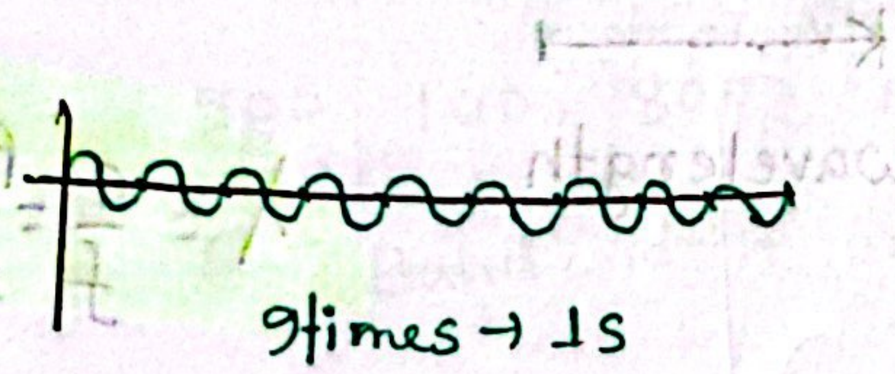
Frequency: is the rate of change with respect to time.

High frequency

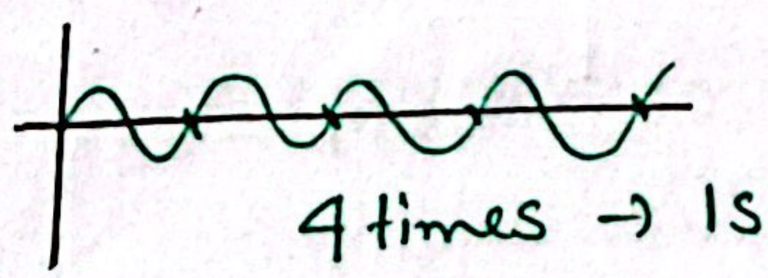
Change in a short span of time



Higher

low frequency

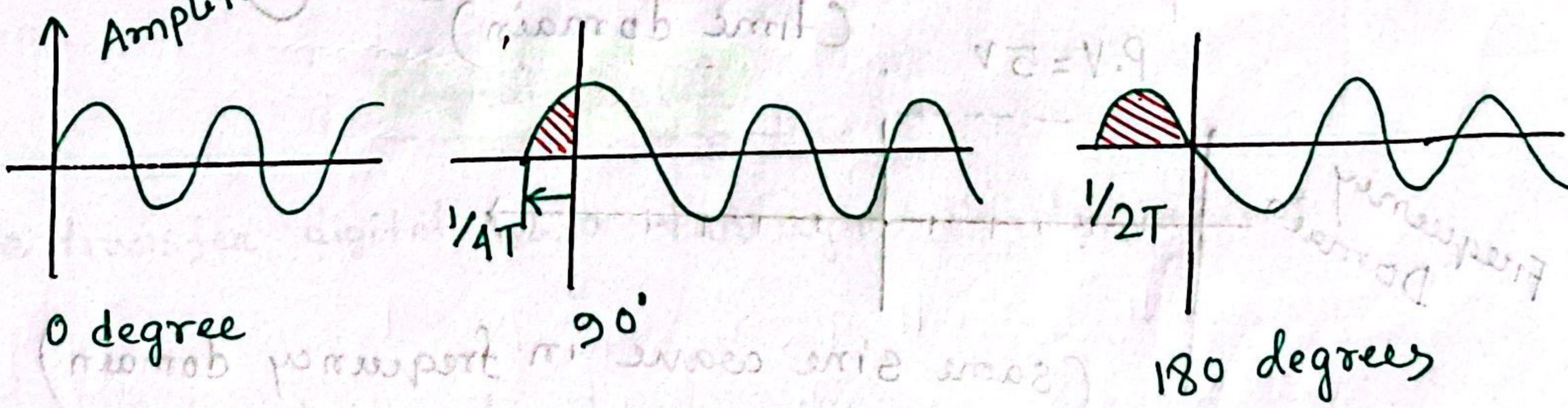
change over a long span of time.



lower.

- If frequency does not changes at all then frequency 0.
- If a signal changes instantaneously, it's frequency is infinite.

Phase: Describes the position of the waveform relative to time 0.



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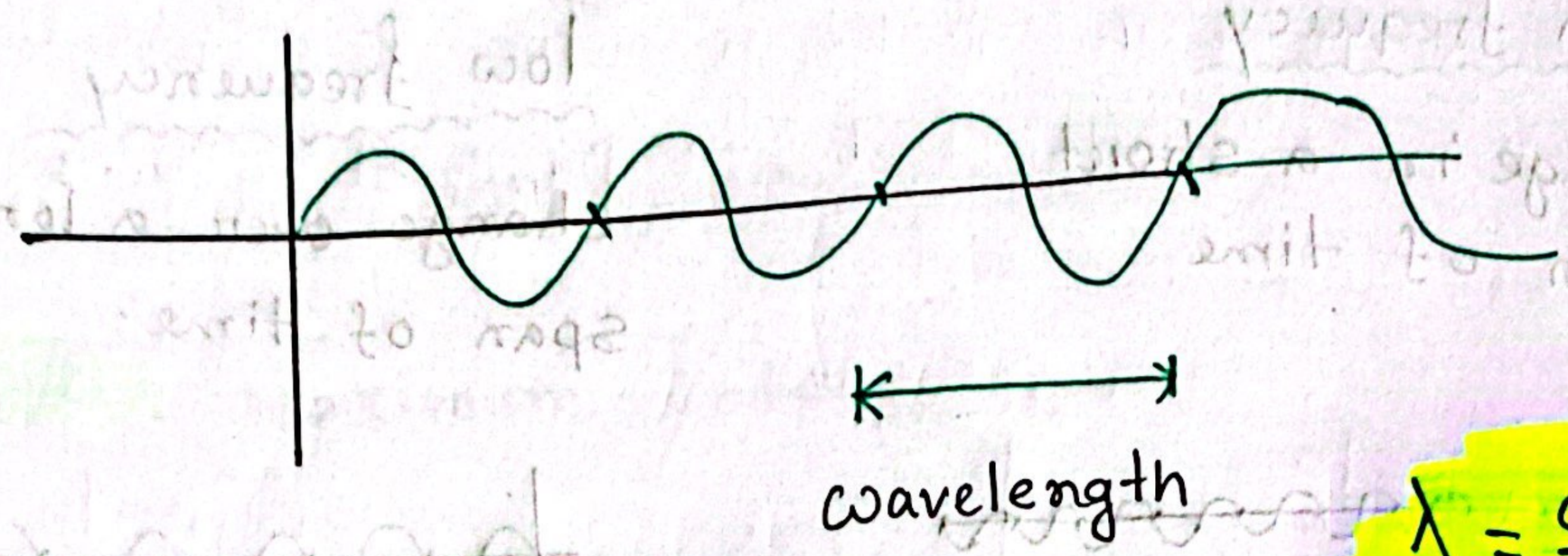
Wavelength

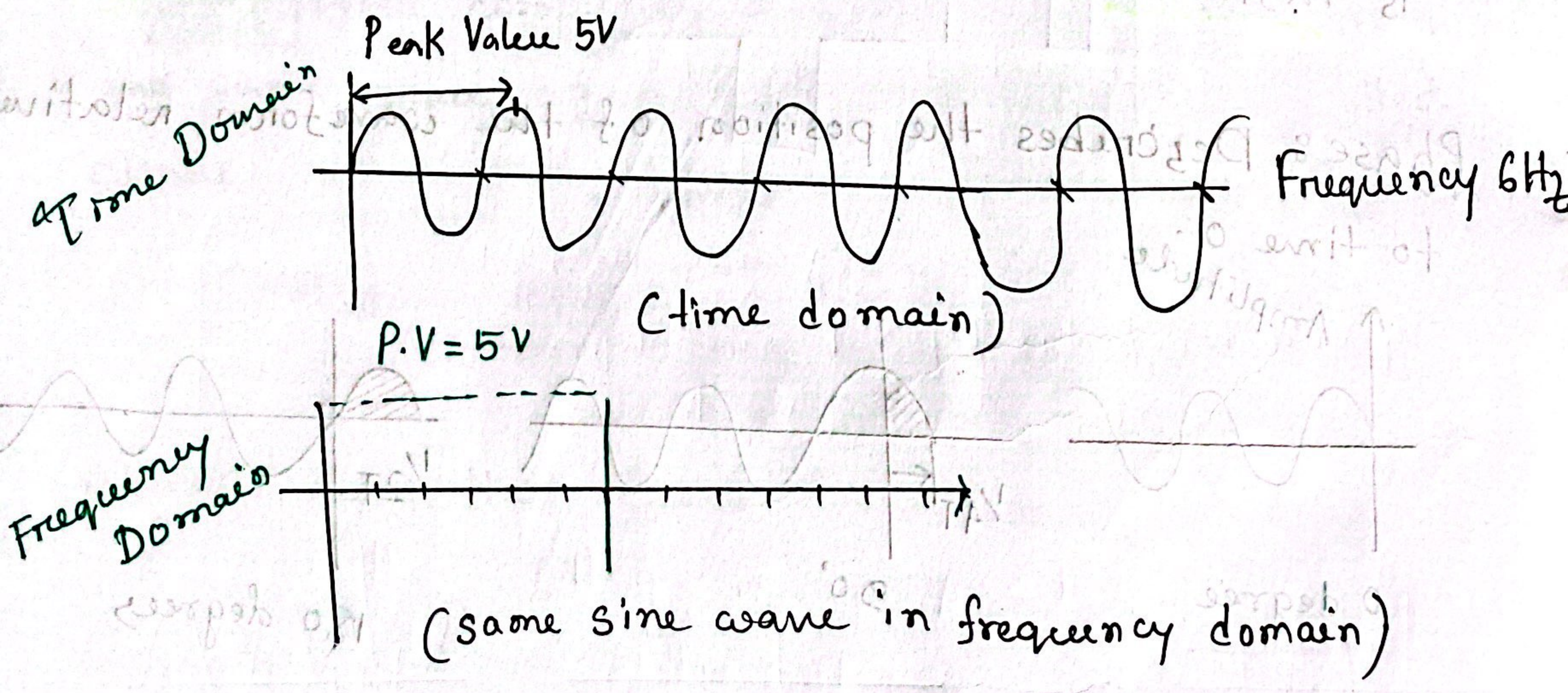
The distance that a cycle crosses at time t.



$$\lambda = \frac{c}{f} = \frac{\text{Speed Progation}}{\text{frequency}}$$

Time domain, Frequency Domain

(when we work with composite cycle) we use time and frequency Domain)



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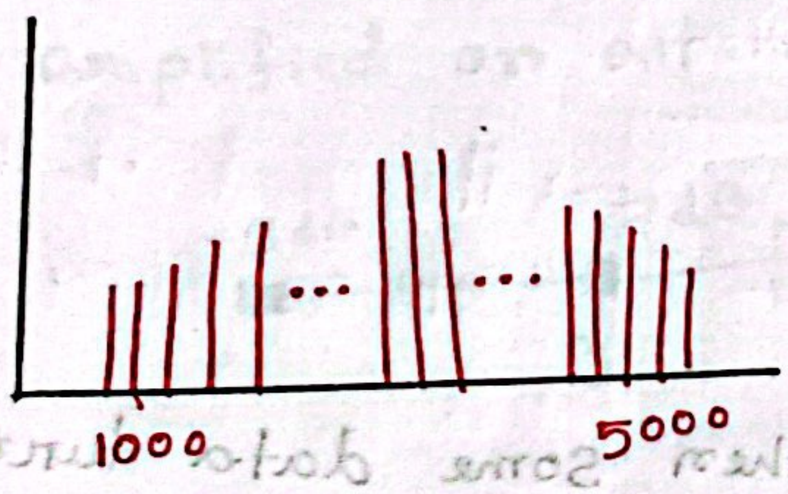
Bandwidth in hertz:

100 Hz bandwidth means → cannot flow more than 100 frequency signals.

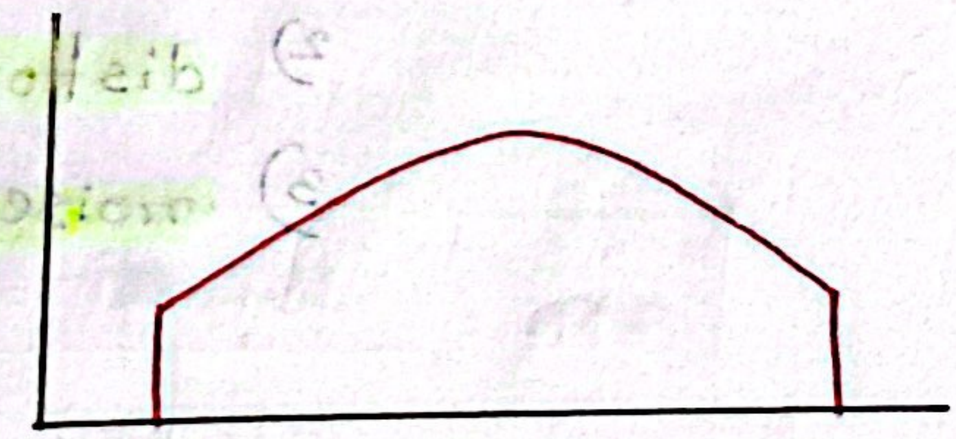
Bandwidth in Hz = Highest frequency − lowest frequency

(In a composite signal there are frequency like 500, 100, 800, 900, 200, 600)

So, Bandwidth in Hz = 900 − 100 = 800 Hz



Bandwidth of periodic signal



Bandwidth of non periodic signal.

Digital Signal

- We transfer digital data through Digital signal.

Bits per level = $\log_2 L$

↳ number of levels.

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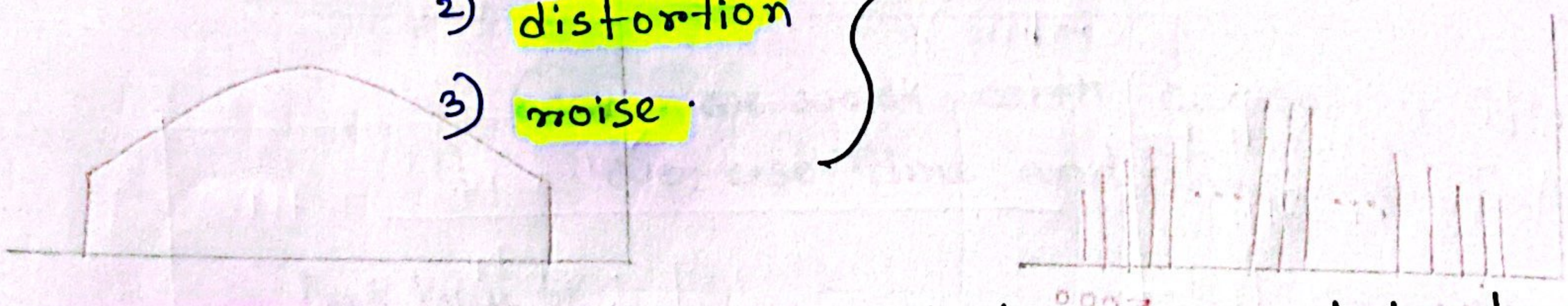
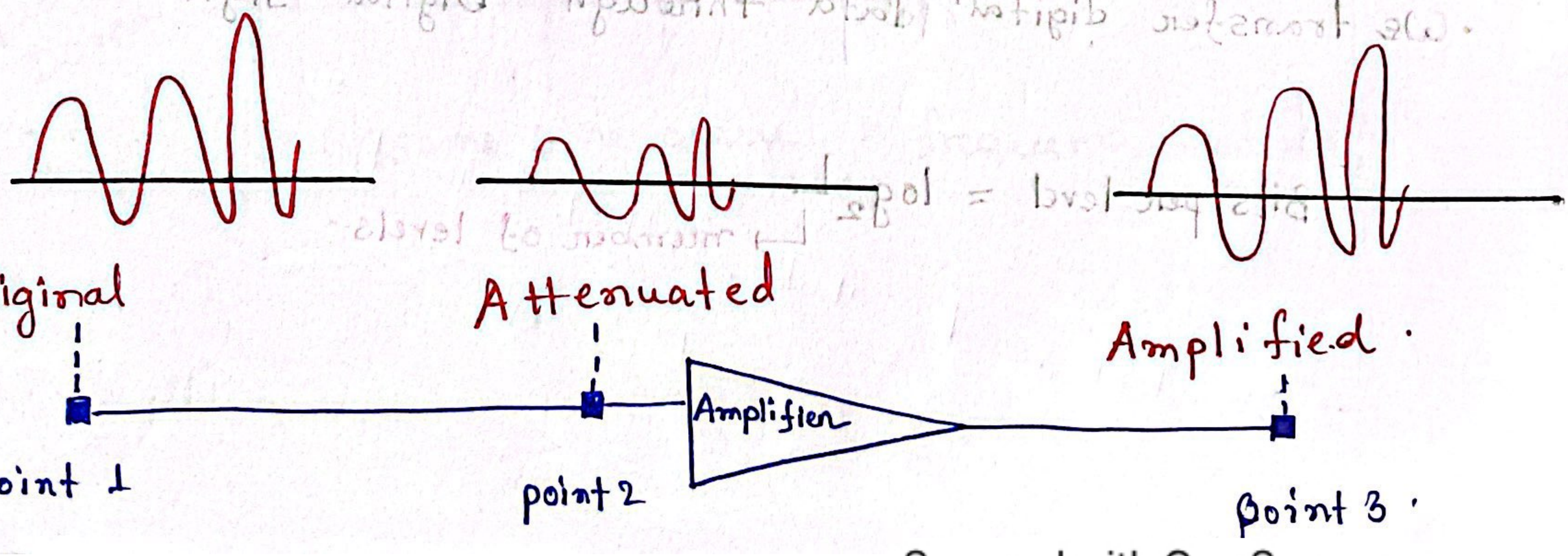
Bit rate: Number of bit that can be transferred within a second. (bps)

Transmission Impairment:
When a signal goes through the transmission medium then it gets affected by many issues.
That means the signal that the sender sent is not as same as the receiver got. (Not same at the end of the medium.)

Three causes:
1) attenuation
2) distortion
3) noise



Attenuation: When a data is sent then some data turn into heat while passing the medium. It is called attenuation. (losing energy)
(we use amplifier to get rid from this problem)
we decide it by comparing two points.



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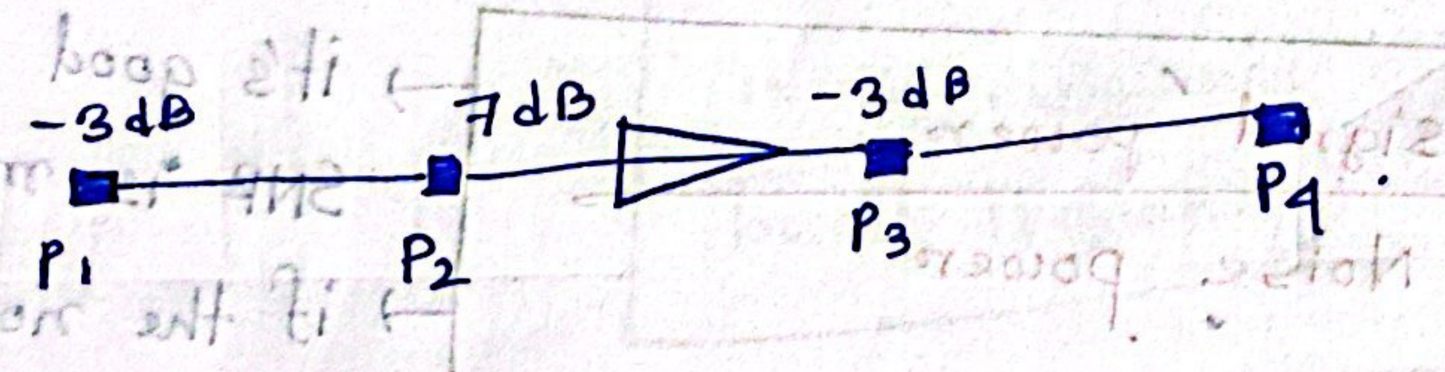
Attenuation: (Close of power)

$$\boxed{10 \log_{10} P_2/P_1} = \text{dB}$$

[if the result is negative (−) then the signal has been attenuated. But if it is positive then the signal is amplified]

dB: if there are more than 2 points then we have to add all the points and then the result will say if it was amplified or attenuated.



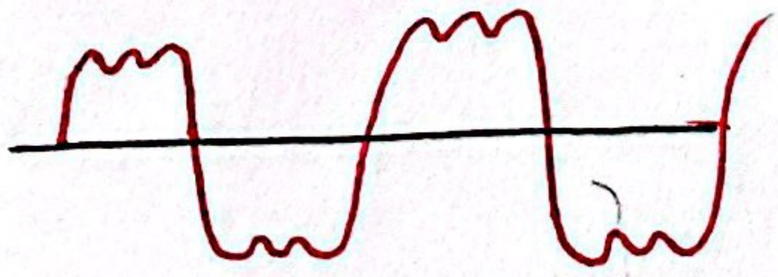
$dB = -3 + 7 - 3$ (P_1 to P_4)

$= 1\ dB$.

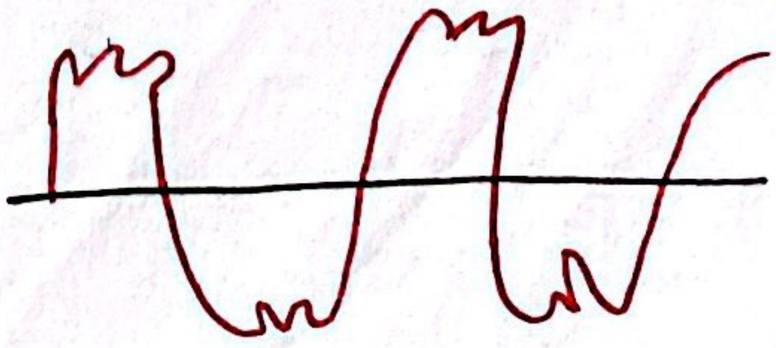
Distortion:

Transmission speed different in signals. (Reason)

Sender



Receiver (disorted/incomplete signal)



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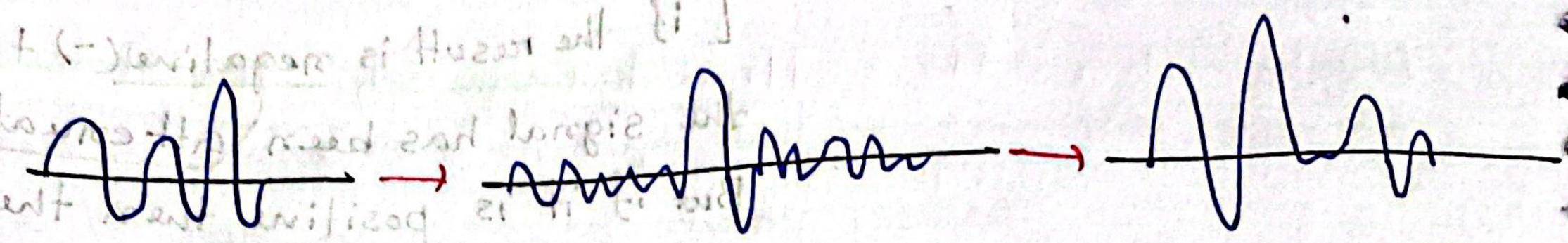
Noise :

if the actual signal is affected because of outer signals then it is called Noise.



Transmitted — Transmission Medium — Received

Noise impact :

Signal to Noise ratio (SNR)

$$SNR = \frac{\text{signal power}}{\text{Noise power}}$$

→ it's good if the SNR is more/big.

→ if the noise power is less then SNR will be big.

$$SNR_{dB} = 10 \log_{10} \times SNR$$

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Data Rate Limits

- Data sending rate in bits per second over a channel.

- Data rate depends on 3 factors:

1. Bandwidth available (Bandwidth ≈ Data Rate)
2. level of the signals we use (signal level ≈ bit rate)
3. Quality of the channel (the level of noise)
   (SNR high = channel best) Noise < SNR hig

1) if the bandwidth is high then the data rate will also high. (Bandwidth is the difference between highest and lowest frequency.) $B = f_n - f_1$.

Level of signal:
if the level is increased then the possibility of error is also increased.

- Increasing the levels of a signal may reduce the reliability of the system.

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Noiseless Channel: Nyquist Bit Rate

(Channel's maximum bit rate)

$$\boxed{C = 2 \times \text{Bandwidth} \times \log_2 L}$$

↳ Data rate in bit per second

Noisy Channel: Shannon capacity (upper limit)

(practical bit rate)

$$\boxed{C = B \times \log_2 (1 + SNR)}$$

Latency (Delay)

✓ Meature the performence of a network.

Throughput

Throughput = actual speed of data rate.

$$= \frac{\text{passing (average)} \times \text{average}}{60}$$

Latency (Delay)

Latency = Propagation time + Transmission Time +

(time that a bit takes to go to sendero to receiver)

(time that takes to send a singnal sender to trans mission media).

⇒ Sendero to media

$$P.T = \frac{\text{Distance}}{\text{Propagation } \cancel{\text{Time}} \text{ speed}}$$

$$T.T = \frac{\text{msg size}}{\text{bandwidth}}$$

Queuing time + Processing Time.

(time when a data waits in quen/box)

(Time that a router takes to process)

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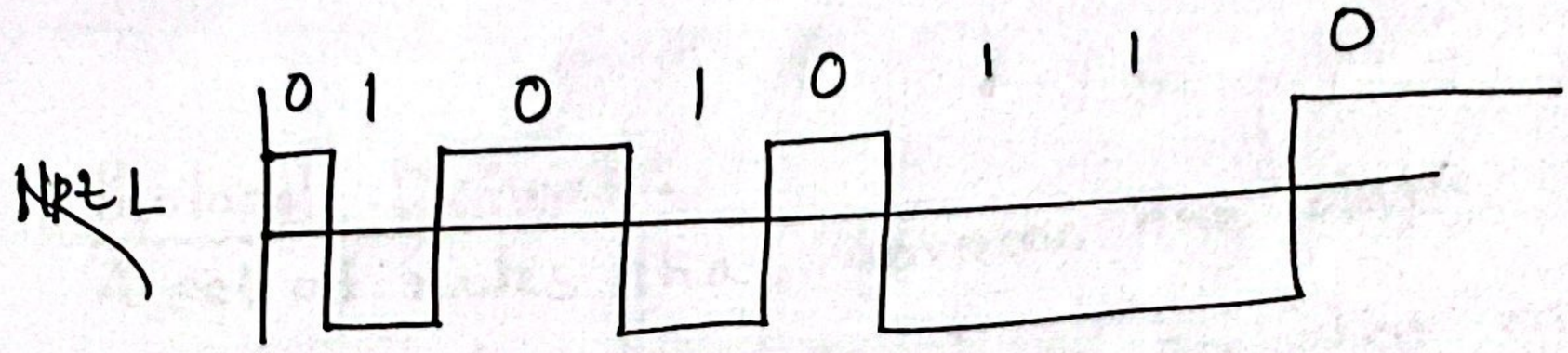
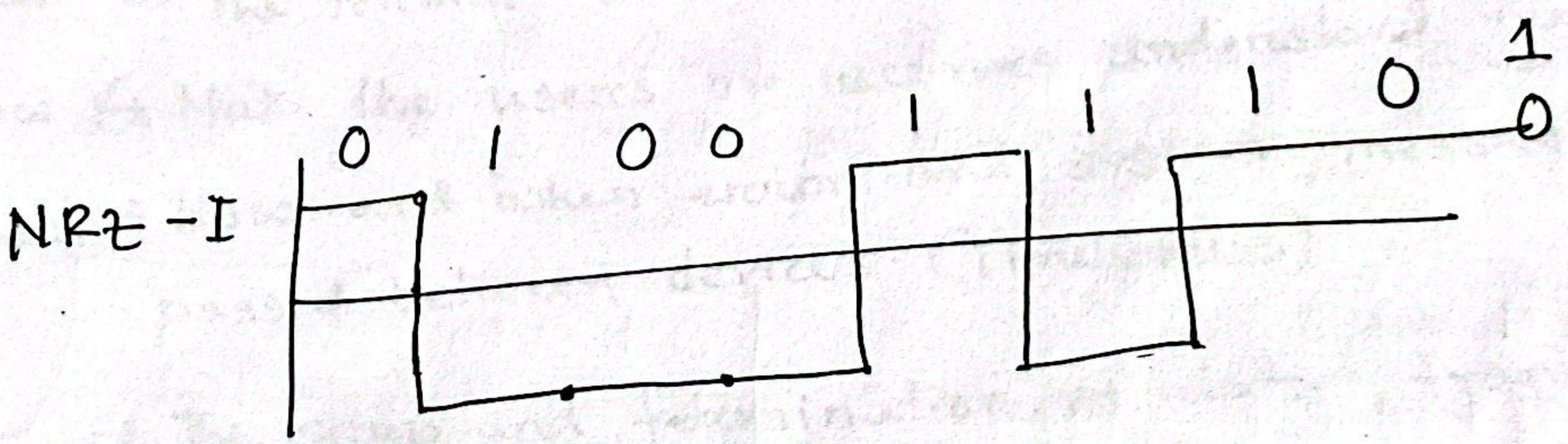
Polar

NRZ-L and NRZ-I . (Non Return to zero NRZ)

↳ 0 means positive (+) or if 0 neg then
→ 1 means negative (−) 1 will be positi





1 inverse
0 → keep it as it is

(1/0)
NRZ → continuous হলে Baseline, DC, self problem

NRZ I → continuous 1 থাকলে problem হবে না।
" 0 " problem হবে।

• pr প্রতি clockpulse এ signal element ২টা হলে Bad.
(Data limit একটি signal ২টি হলে)
Bandwidth বেশী লাগবে।

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Bann Haider

Chapter 2

Layers

Benifits of using layers:

1. To find the faults easily.
2. Changes in one layers do not affect other layers.
3. Have defined info that they act upon.

Protocol Defines:

A set of rules that governs the data.

what → The format or structure of the message. (Syntax)

How → Make the users or receivers understand the message.

when → How and when error and system messages are passed between devices. (Timeliness)

wh. → The setup and termination of data transfer sessions

Standards

→ Features that we want in a thing or things that must be in it.

Standards organizations:

Benefits:

1) create and maintain and open and competitive market.
2) Ensured greater compatibility and interoperability

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Standard categories:

- **De facto**: that have not been approved by any organization.
- **De jure**: approved by organizations.

Protocols and standards:

→ Set of rules that meet the standards turn into protocols later.

- OSI → De Jure standard (approved by organizations)
- TCP/IP protocol → De facto standard.
  Governed by IEIF working groups.

- OSI → 7 layers
- TCP → 4 layers

OSI → Model.
ISO → organization.

Layers

7. Application
6. Presentation
5. Session
4. Transport
3. Network

} Software base

2. Data Link
1. Physical.

} Physical (hardware base)

→ Physical to Application
→ Application → physical

Top down

→ (chrome, firefox are applications and they use some protocols from application layer)

Application layer: http, https, FTP, SMTP, POP3 (protocols)

→ create interface between user and applications.
→ Help to turn user data into data communication format. (protocol depends on what the user wants to do)
→
→ Responsible for providing data services to the user.

- POP3 → Mail load
- SMTP → Mail send
- FTP → image/ movie download.
- HTTP/ https → search

Presentation layer:

→ Translation (binary)
→ compression
→ Encyption

(Adding header in every level is called encyptulation, removing header is called decyptulation)

→ compression: Making data smaller.

1) Lossy (data may lose)
2) Lossless (no chance of data lose)

→ Encyption: SSL protocal
→ turn data into a language so that no one can understand without owner and receiver.

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Session layer:

- Firstly build a session between sender and receiver.
- Authentication
- Authorization
- Session Management
- Session Restoration (Bank does not allow)
- Checkpoint

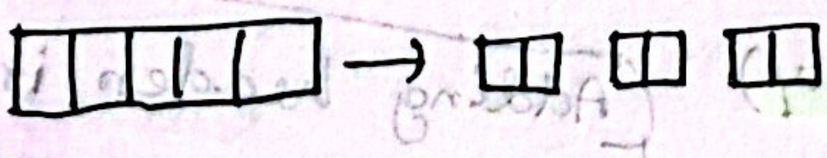
synchronization.

- Dialouge control. (Stablishing session means dialouge control)

Transport layer: Process to process communication.

(sender) (receiver) by using port address.

Responsible for the delivery of a message from one process to another.

-  (segment)

Port address

header + segment → PDU

1. port address
2. Sequence numbers (segment numbers)

16 bits ($2^n=16$) Receiver understands in which port the sender data will work by seeing port address. (process is connected with port)

→ Segmentation and reassembly (Senders' file will be checked by receiver by sequence)

- Connection protocol:
  - TCP → Connection orientation (permission) 3 way hand shaking.
  - UDP → Connection means it will send data (no permiss

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→ asking sender to send slowly to control.

- Flow and Error Control: Sequence → segment missing or not

- Multiplexing:

One to many	many to one
demultiplexing (Receiver)	Multiplexing ~~(receiver)~~

Network layer

→ packet = [H | Data] =

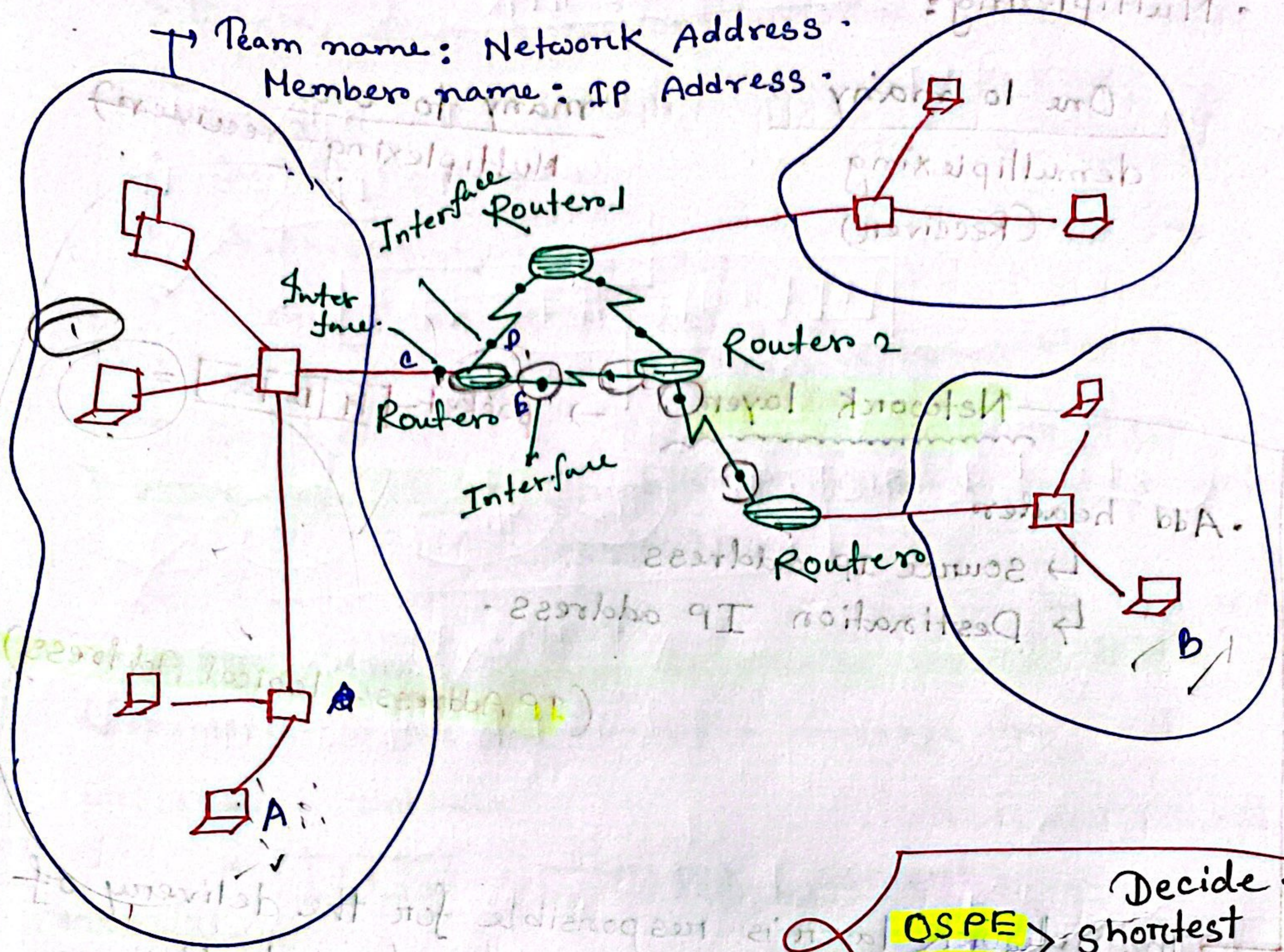
- Add header
  - ↳ source IP address
  - ↳ Destination IP address.

(IP Address → logical Address)

→ The network layer is responsible for the delivery of individual packets from the source host to the destination host.

Barinder

→ Team name : Network Address.
Member name : IP Address.



SM
DM.

OSPF
BGP > Decide shortest path

- Network layer PDU is called packets.
- Common Network layer is called Internet protocol. (IP)

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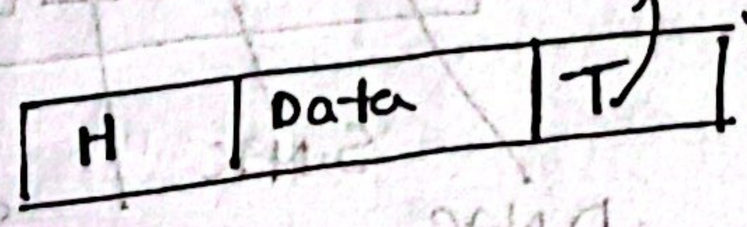
Router → layer 3 device



Tale checks error =0 then if ≠0 then error.

hop to hop change

Datalink layer

- Mac address → physical address (64 bit Hdm)
  - ↳ can't change. 48 bit long
  - → source mac address
  - ↳ destination mac address.

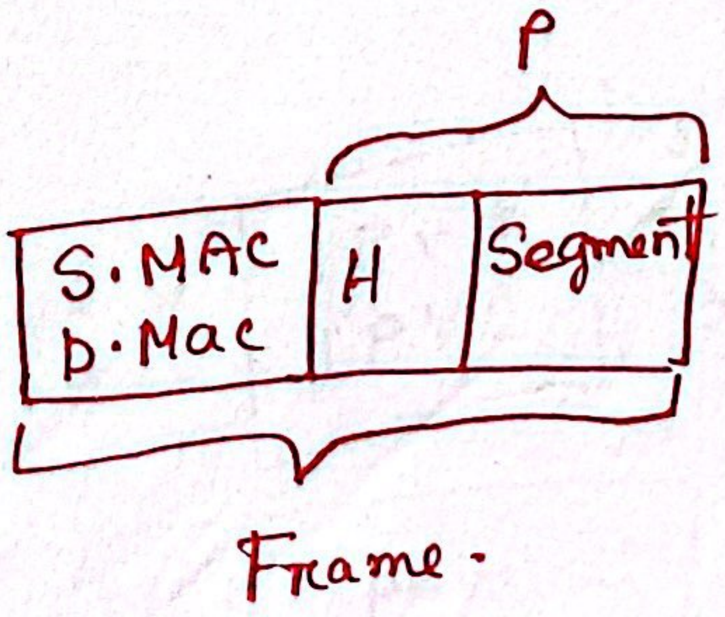
(from last page)

- framing
- Physical Addressing (MAC)
- flow control (speed control)
- Error control.
- Access control. CSMA

A to B → Source Mac A.
Destination Mac C.

- Data link layer is responsible for moving frames from one hop to the next

↳ who will get the media access and who'll not.



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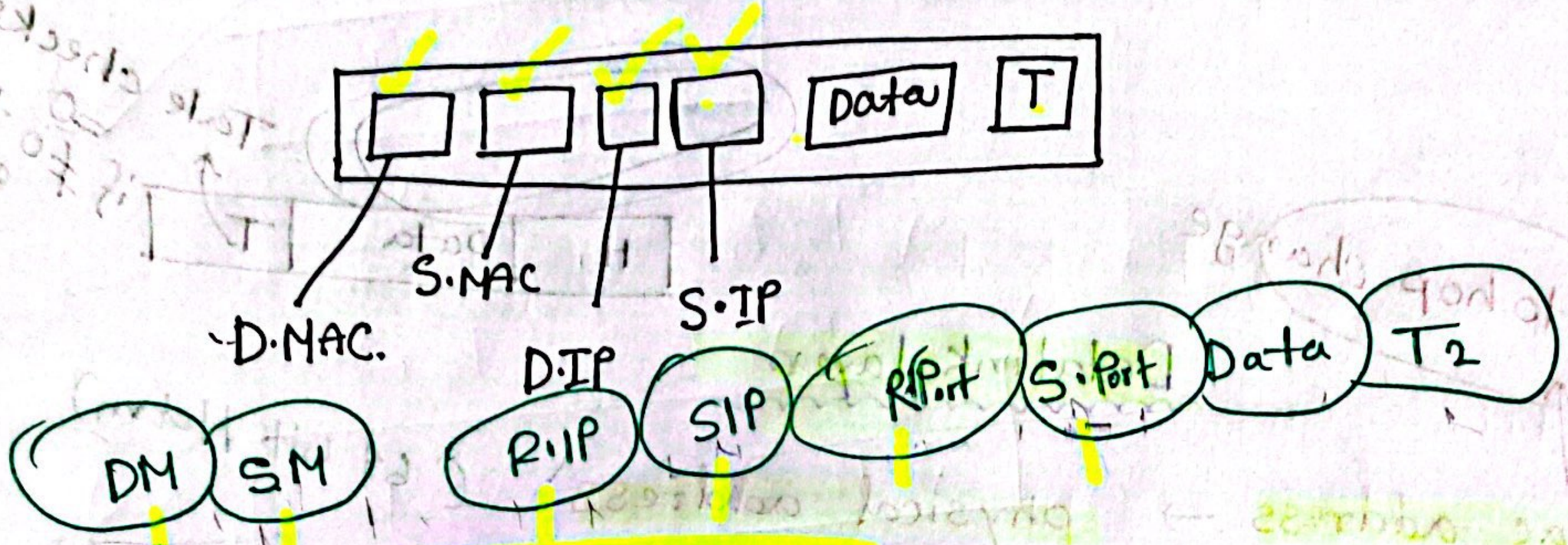
Port → IP → Mac

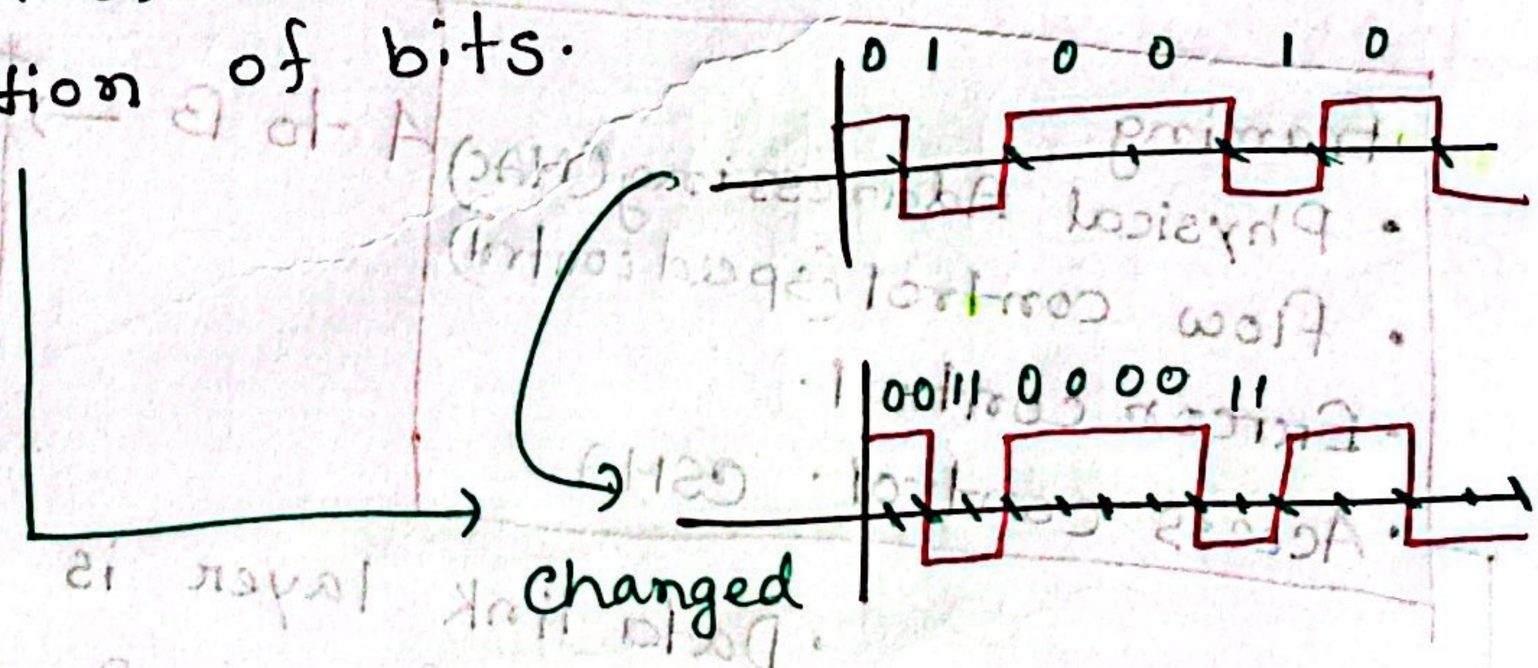
Addressing

- IP → Alphabet - (Capital)
- Mac → Number (Numbers)
- Port Num → Small Alphabet.
-



Physical layer

- Define the data rate.
- Characteristics of interfaces and medium.
- Representation of bits.
- Synchronization of bits.



OSI

A [H + Data]

P → bits, small → encryption [H | H + Data] [H | H | H | Data]

S → Session create → maintain → restore → checkpoint

Port ← T → Segment → header → port, seg number → ptop communication [H | H | H | H | Data]

N → S.IP, RIP → h to h → ~~pack~~ packets [H | H | H | H | H | D]

hop to hop ← D → ~~packet~~ (framing) → S.mac → d.mac → Frames [H | H | H | H | H | H | Data | T]

SMac
D.Mc + H + Data
↳ segments

Ph → signal convert → encrytulation →

Protocols :

A →
P
S } SMTP, FTP, HTTP, DNS, SNMP, TELNET

T → SCTP, TCP, UDP.

N → ICMP, IGMP. IP, RARP, ARP.

P →
Phy → }

IPv4
IPV6 → IP
32 bit
128 bit.

logical.

MAC → physical

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Chapter 2

Question:

1) protocol, standard defination.
   De facto, De Jure

2) **OSI Vs TCP**

3) Layer names.
   ↳ Work of layers
   ↳ define layers by seeing their work.

4) **Port Vs IP Vs MAC**

5) Addressing.

6) Layer port address name.

7)

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Chapter 6

Bandwidth Utilization
Multiplexing and spreading.

- 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 spreding.

Multiplexing

When the bandwidth of a medium linking two devices is greater than the bandwidth needs of devices, the link can be shared.

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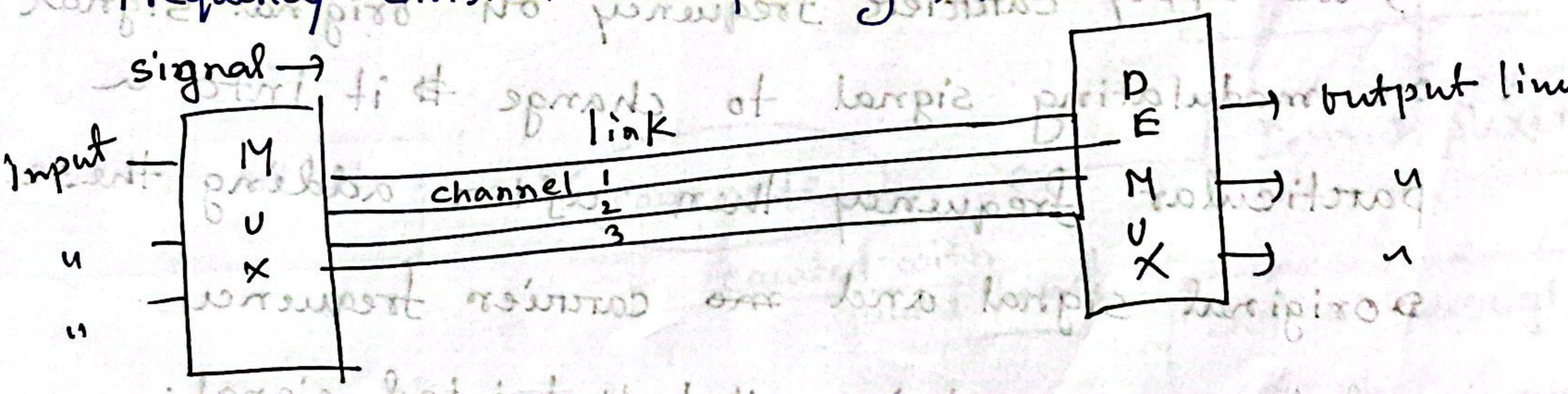
Multiplexing

- Frequency division Multiplexing — Analog — FDM
- Wavelength division multiplexing — Analog — WDM
- Time devision Multiplexing — Digital — ~~Digital~~ TDM

frequency division multiplexing → FDM



→ if bandwidth of the link is more than it's neccesity then we need to do multiplexing.

→

- **Modulating Signal:** Sender to multiplexer → origi data

- **Carrier frequency:** If we apply a particular frequency signal on the original data signal or modulating signal to change the frequency and turn it into a new particular frequency then it is called carrier frequency.

- **Modulated signal:**
if we apply carrier frequency on original signal or modulating signal to change it into a particular frequency then after adding these original signal and carrier frequency whatever we get is called Modulated signal.

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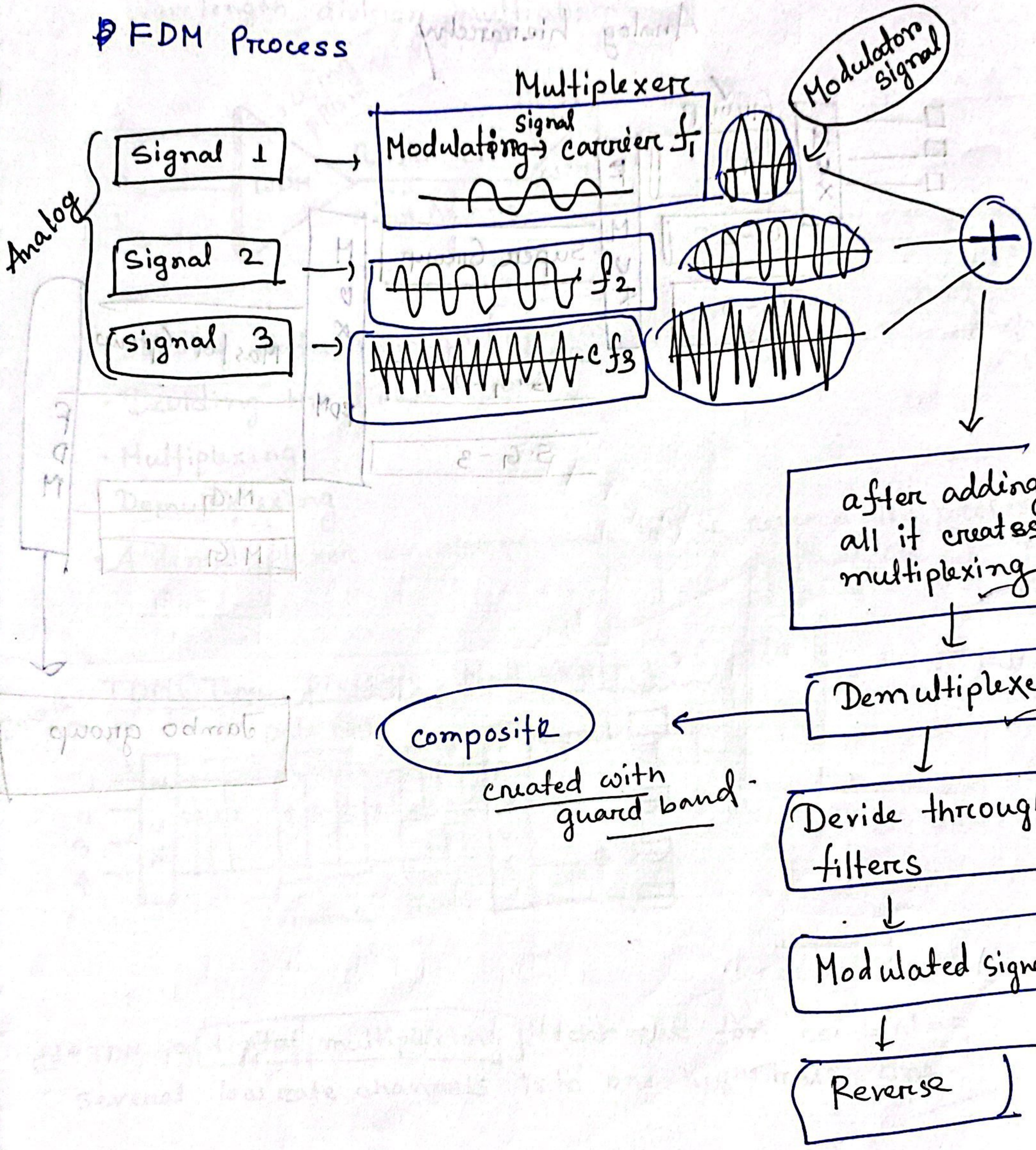
FDM Process



Guard Band : The gap we keep between to signals to avoid over laping is called Guard Band.

$\boxed{20-24}$ $\xrightarrow{GB}$ $\boxed{27-31\,KHz}$

S→1 S-2

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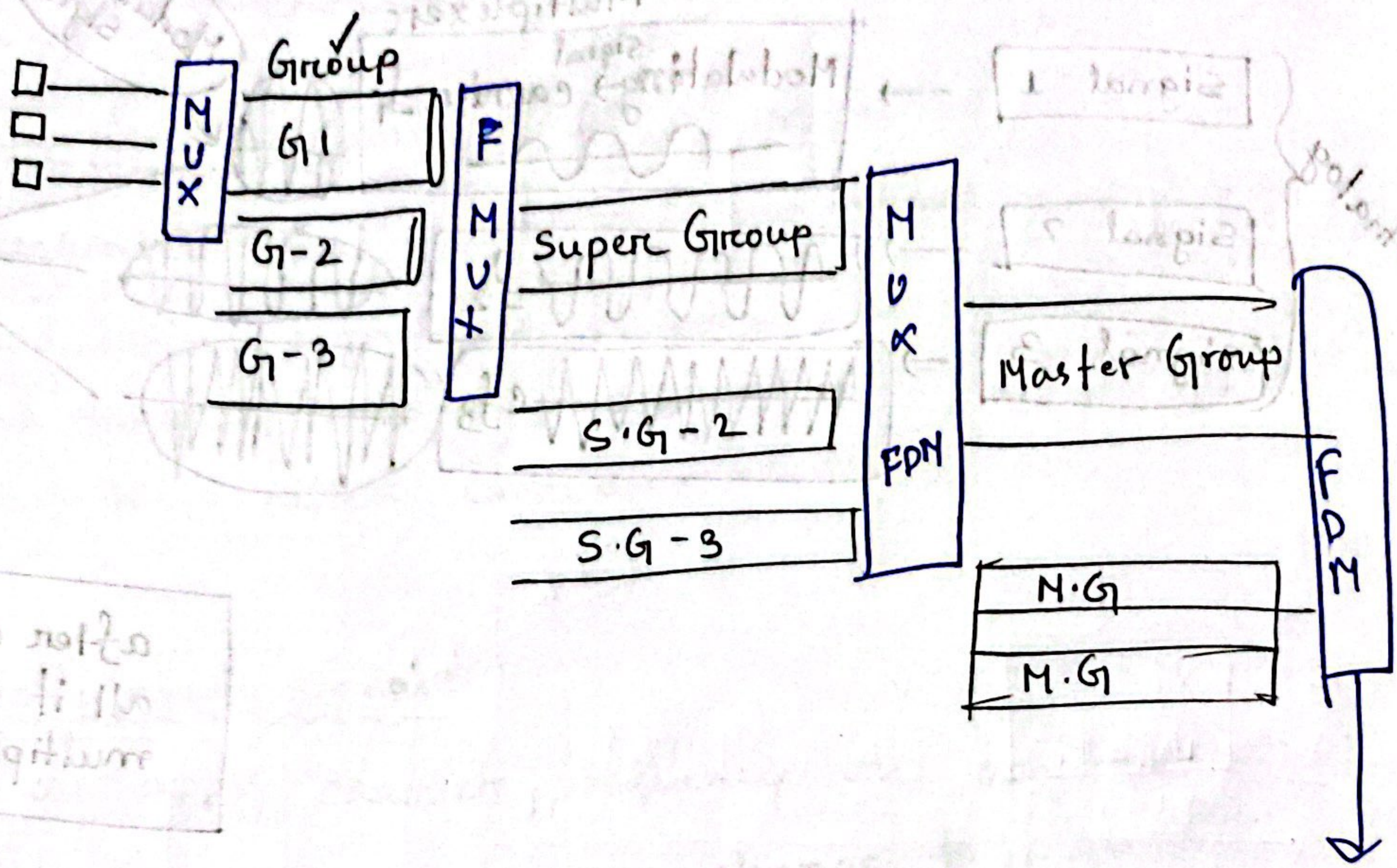
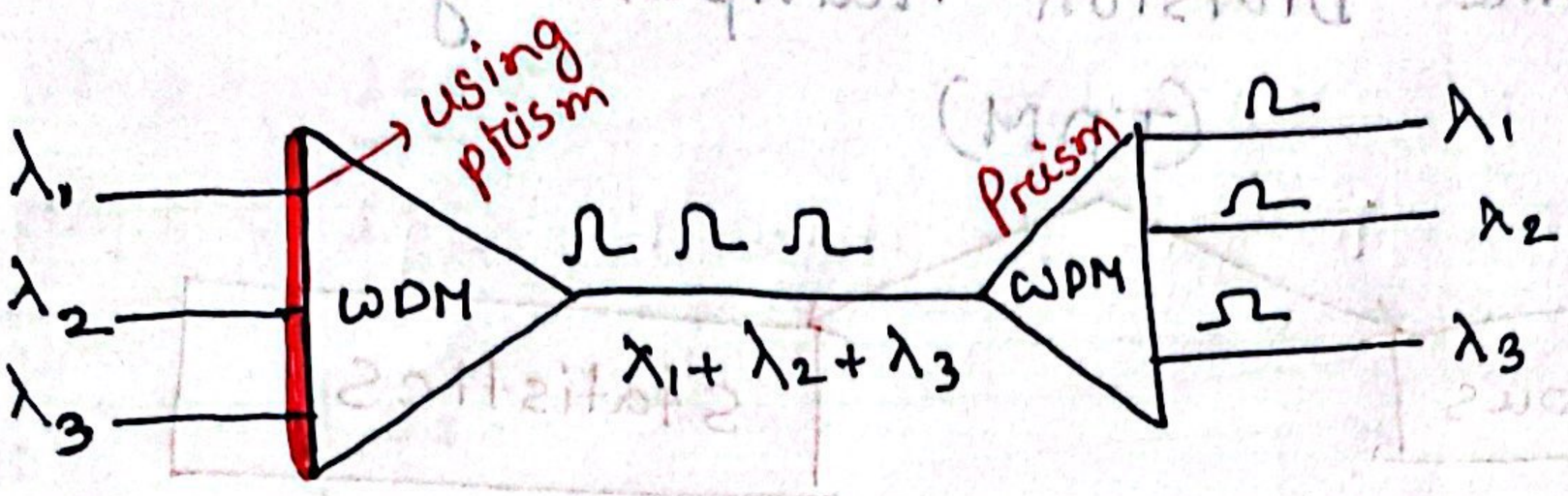
Analog hierarchy



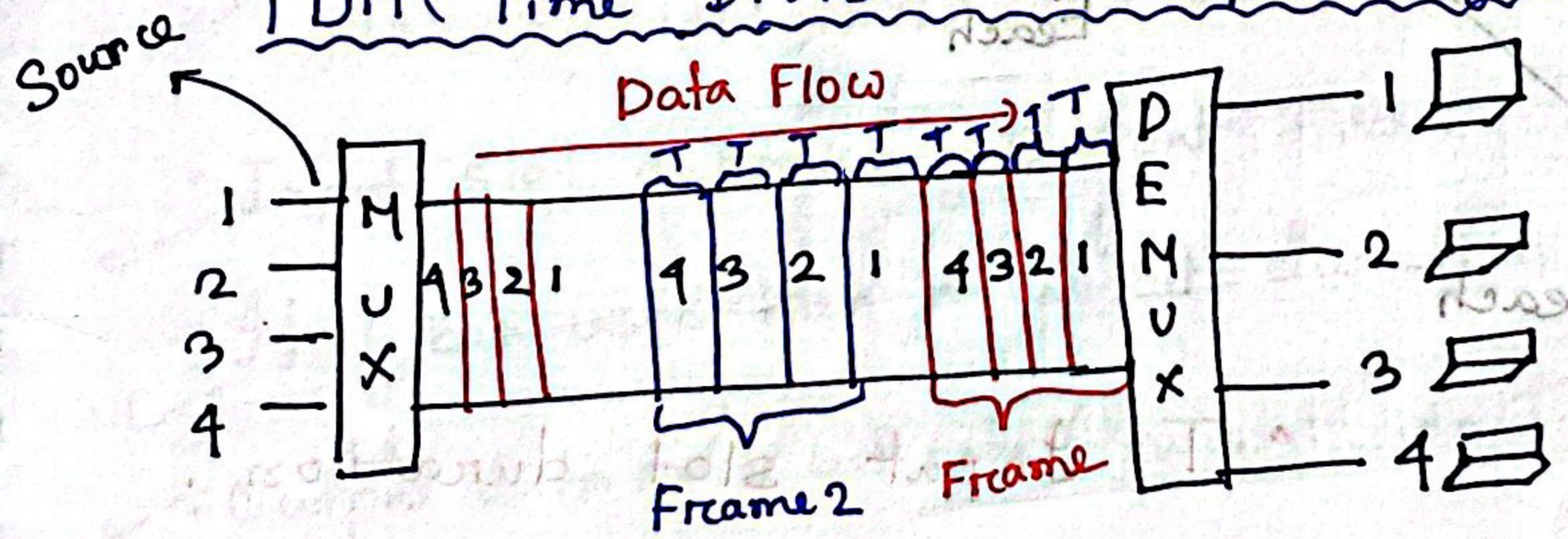
Jambo group

Wavelength division multiplexing



- sending data through $\boxed{\text{optical signal}}$ (light wave)
- Deviding the link.
- Multiplexing
- Demultiplexing
- A demultiplexer can also be made to use reverse the process

TDM (Time Division Multiplexing)

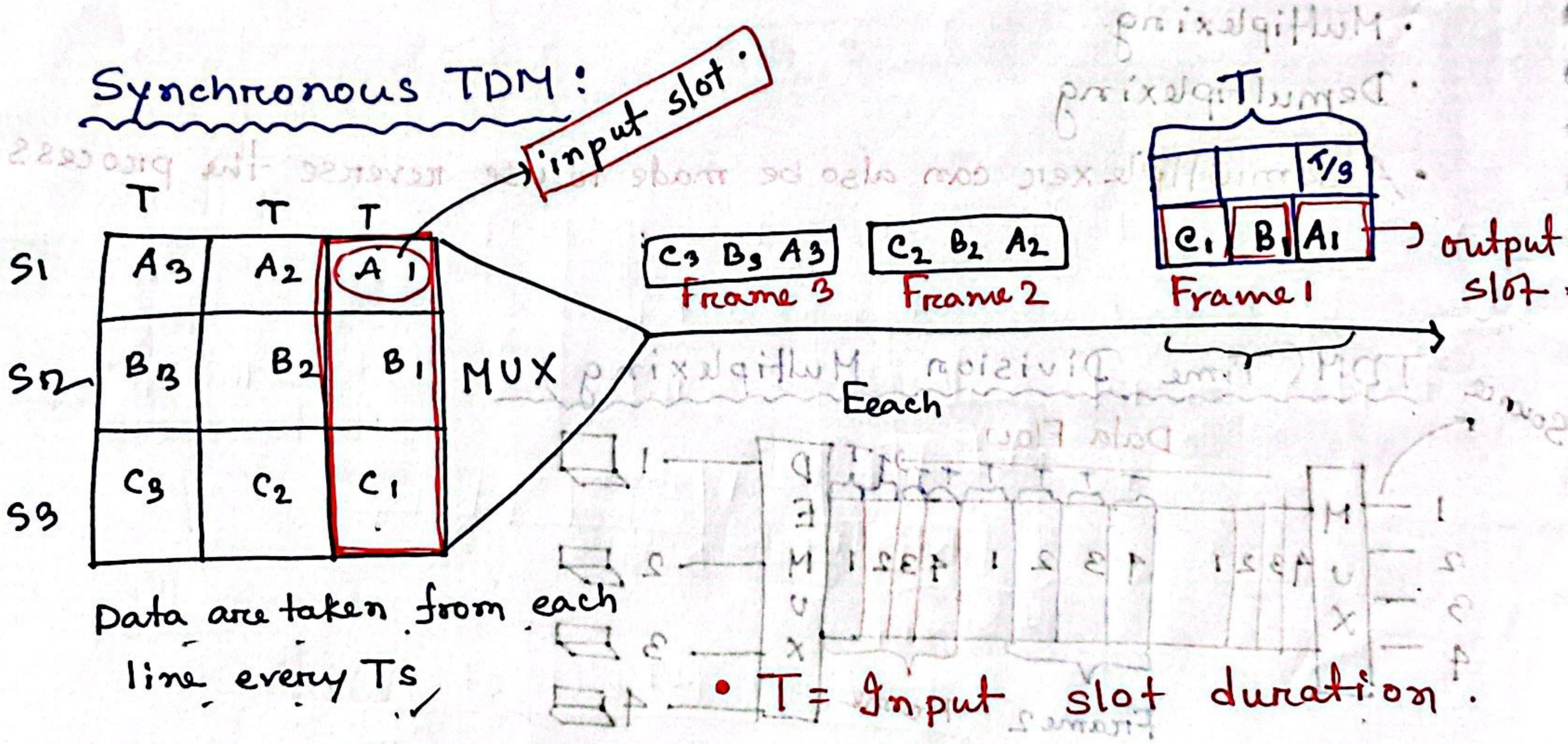


- TDM is $\boxed{\text{digital multiplexing}}$ technique for combining several low rate channels into one high rate one.

Time Division Multiplexing (TDM)

- Synchronous
- Statistics

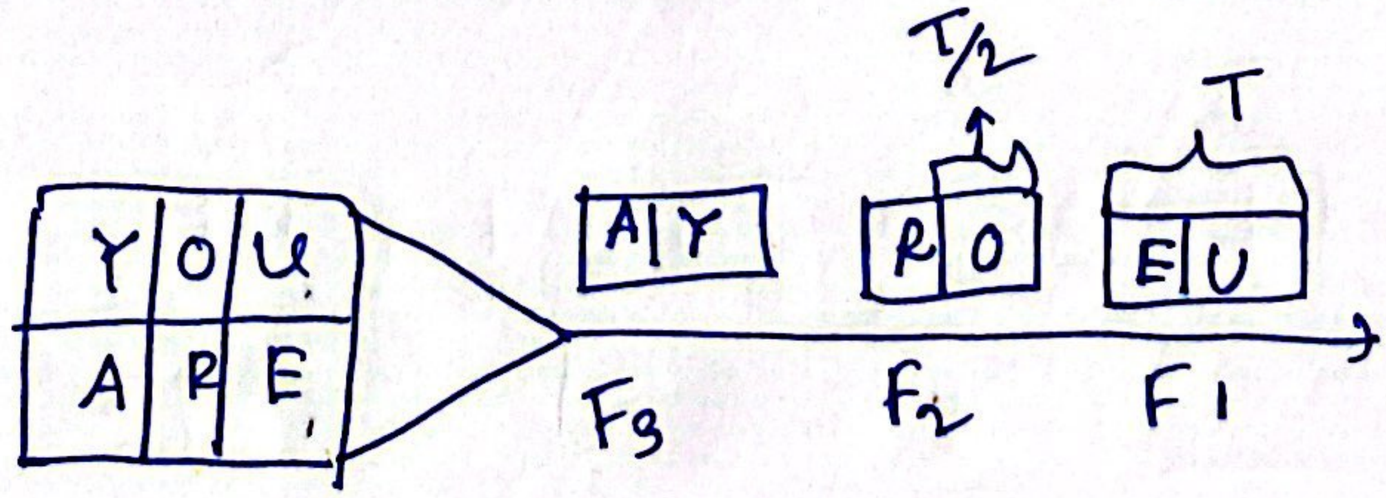
Synchronous TDM:



Data are taken from each line every Ts

- T = Input slot duration.
- Input slot duration = Frame duration
- output slot duration $= \frac{T}{N}$ (No of input channel)

Example:



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Rules

Kbps = $\underline{1000}$

Mbps = 10^6

$\frac{1}{10^6} = 1\mu s$.

- Output slot duration = $\frac{T}{N}$.
- Output frame bitrate = $T^{-1} = \frac{1}{T}$.
- Output bit duration = $\frac{T}{\text{Total bit}}$. (output bit duration = $\frac{2}{\text{Data Rate}}$)
- If 2 bit then input slot duration = $\frac{1}{\text{Frame Rate}} = \frac{1}{1/T} = T$
- Output Frame Duration = $\frac{1}{\text{Frame Rate}}$.
- Input slot duration = Output Frame duration.
- If 1 bit used then input bit duration = Input slot duration.
- Output data rate/bit rate/transmission rate = output Frame rate × Size (F + sync bit)

$= \frac{1}{T} \times (F + \text{bits})$

$= \frac{1}{\text{Output bit Duration}}$.

→ data rate of the link is 'n' times faster and unit duration is n times shorter.

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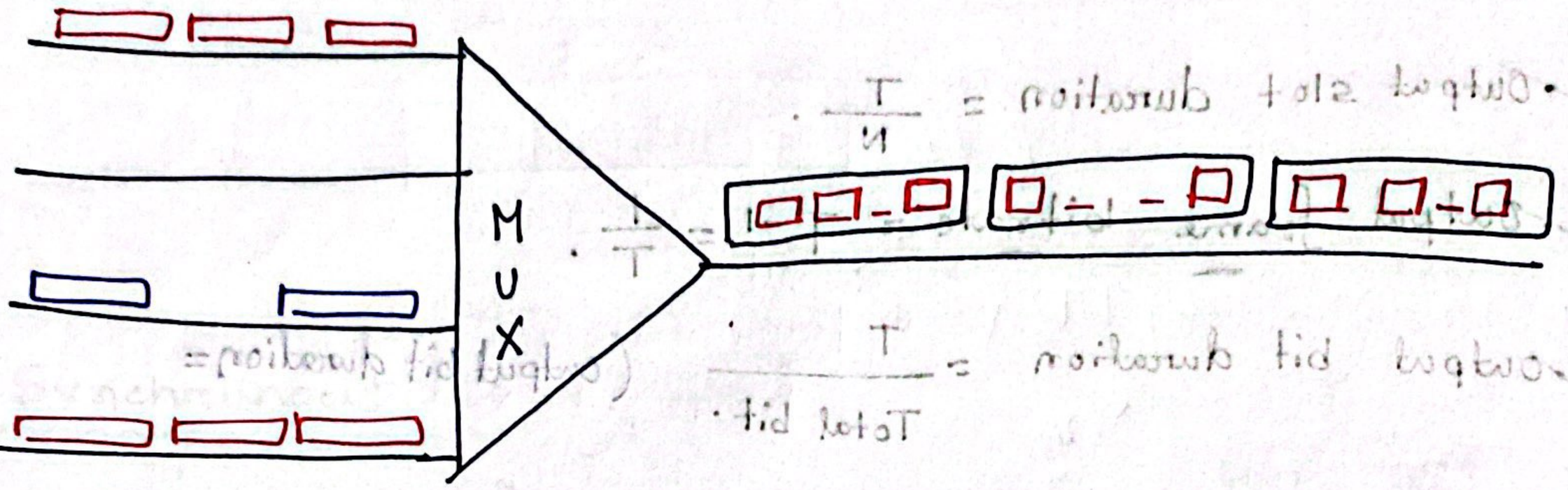
Interleaving.

Empty Slot



Synchronous TDM → doesn't matter if there is any slot in input or not but there will be specific slot in output for empty slot.

Problem
(So it will waste time)

Data Rate Management

3 Strategies

→ Mutilevel Multiplexing.

→ Multiple slot Allocation.

→ Pulse Stuffing.

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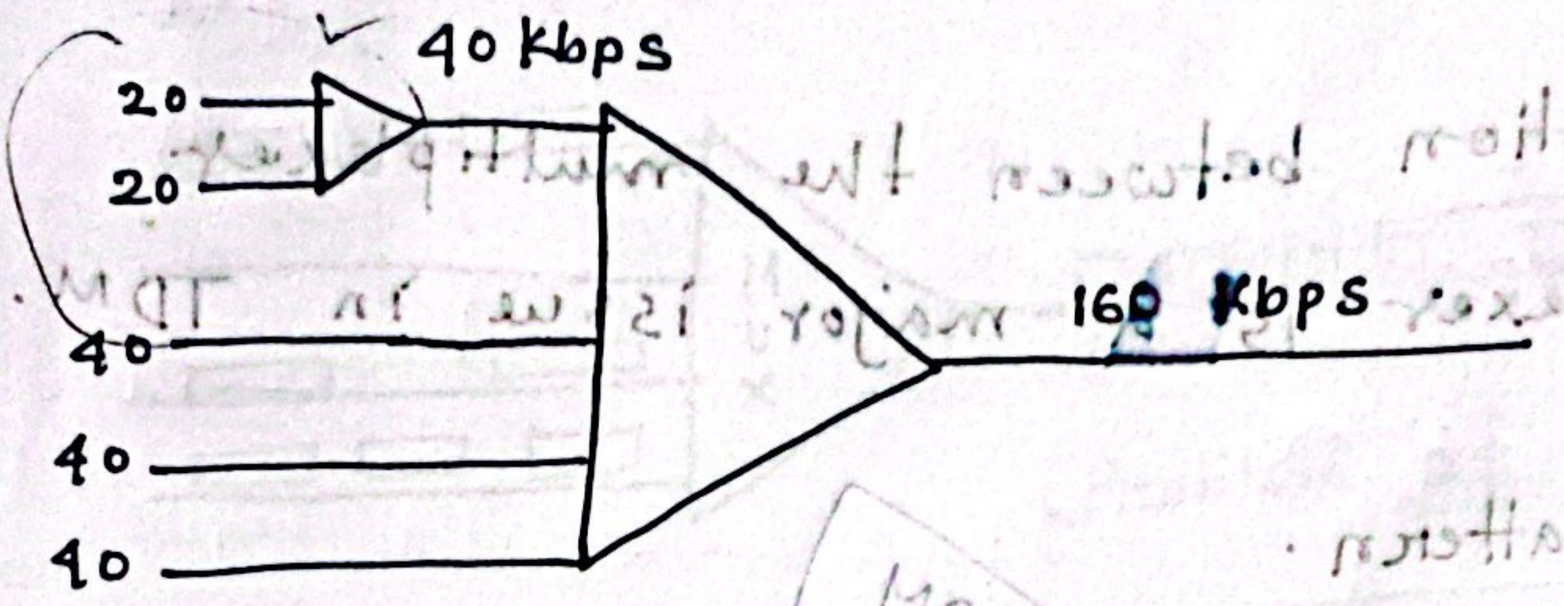
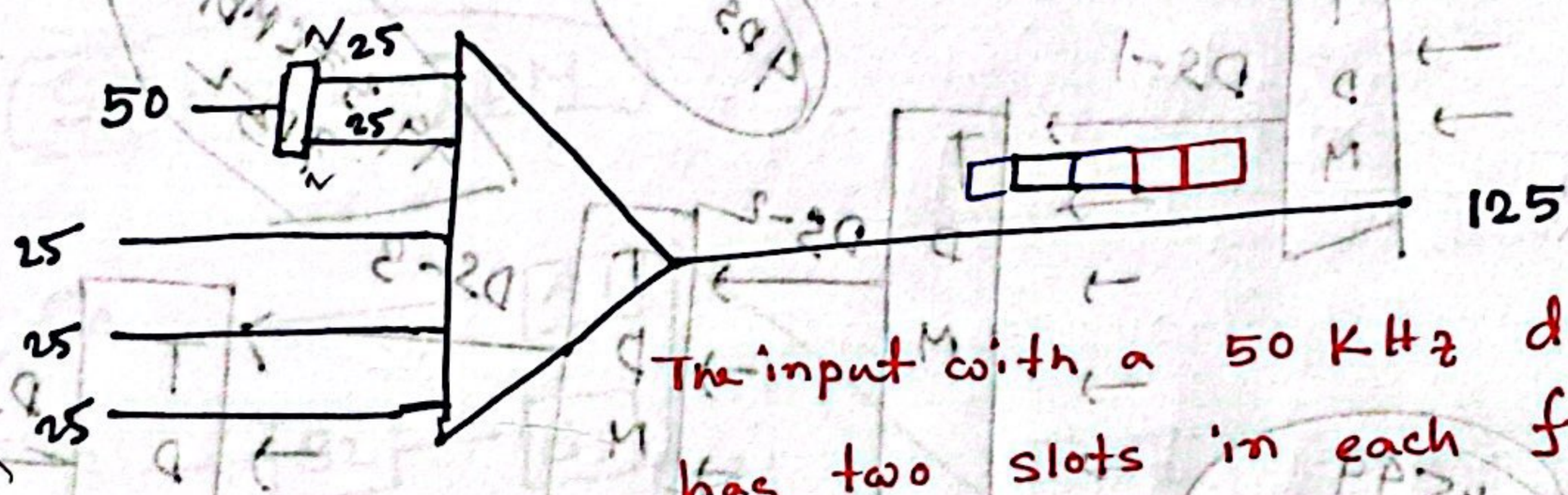
Multilevel Multiplexing

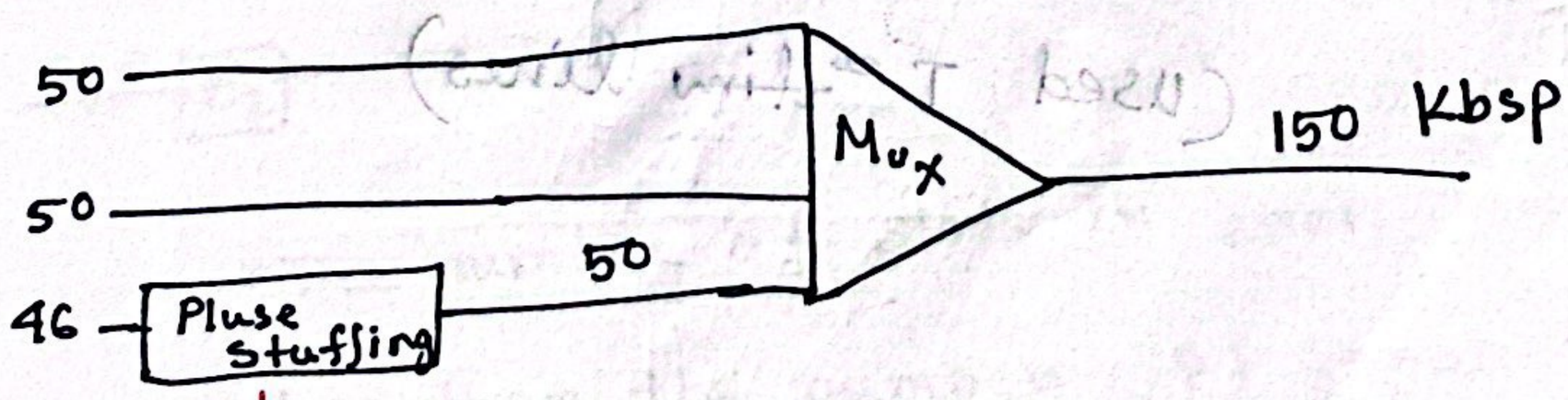


Multiple Slot Multiplexing



The input with a 50 KHz data rate has two slots in each frame.

Pulse Stuffing



Adding extra bits.

- pulse stuffing.
- bit stuffing
- padding.

(we will target the highest number of bits)

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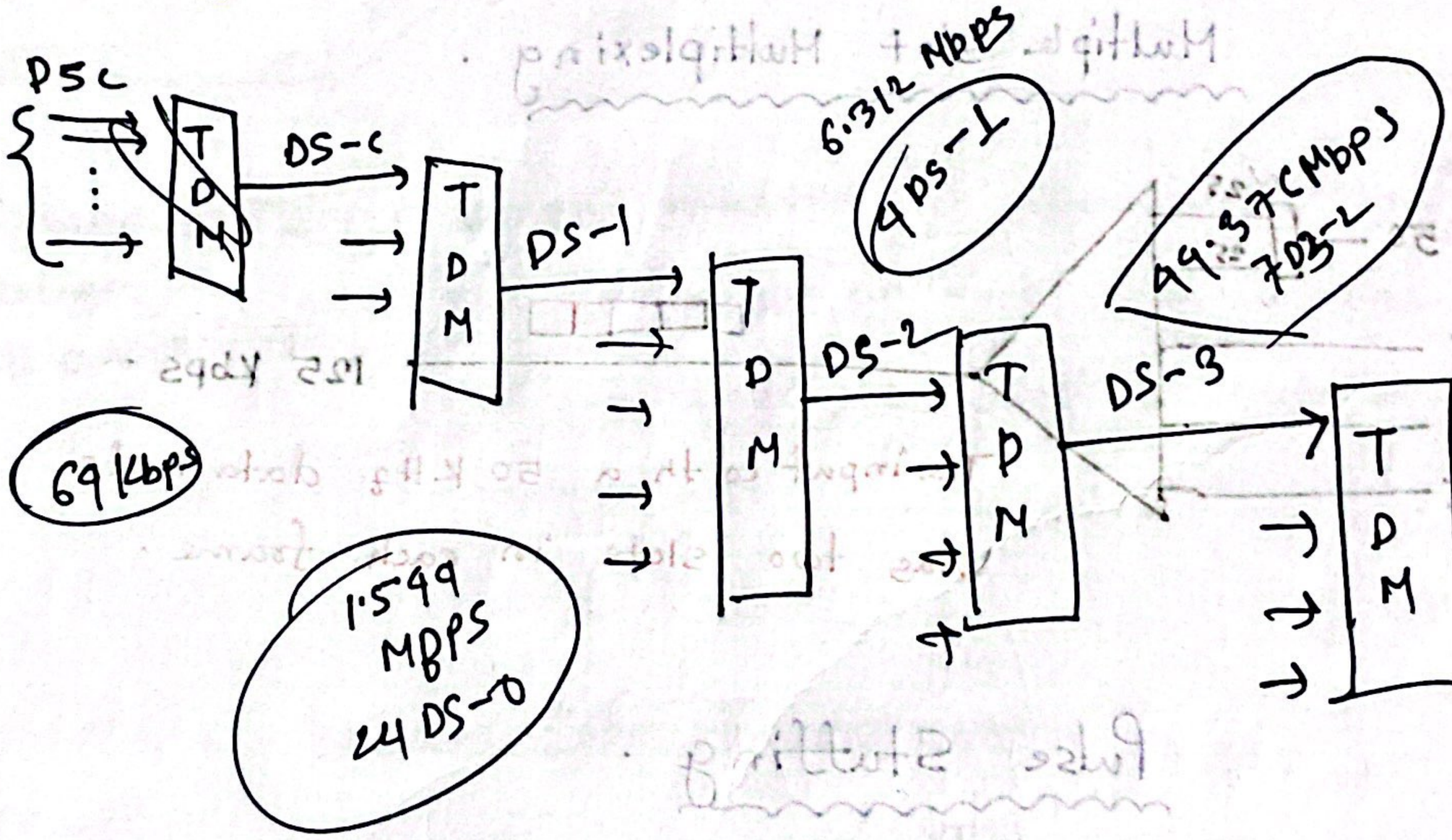
Frame sychronization

→ synchronization between the multiplexer and demultiplexer is a major issue in TDM.

→ Follows a pattern.

FDM

Digital Signal Service : (used by telephone company)



(used T ~~dim~~ lines)

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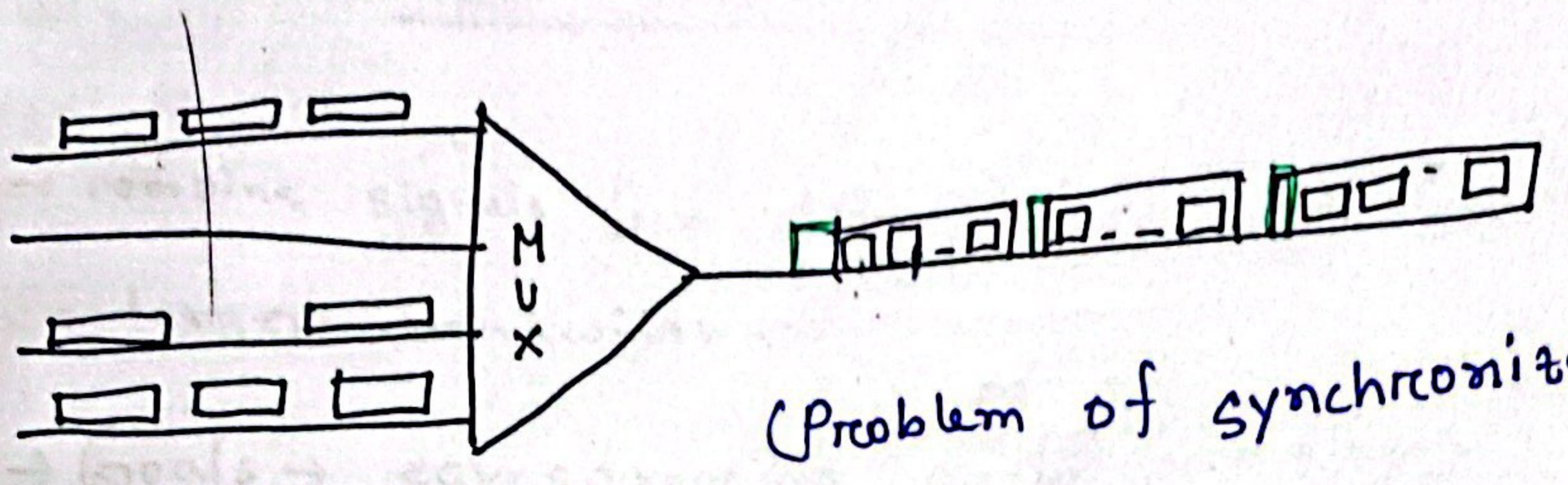
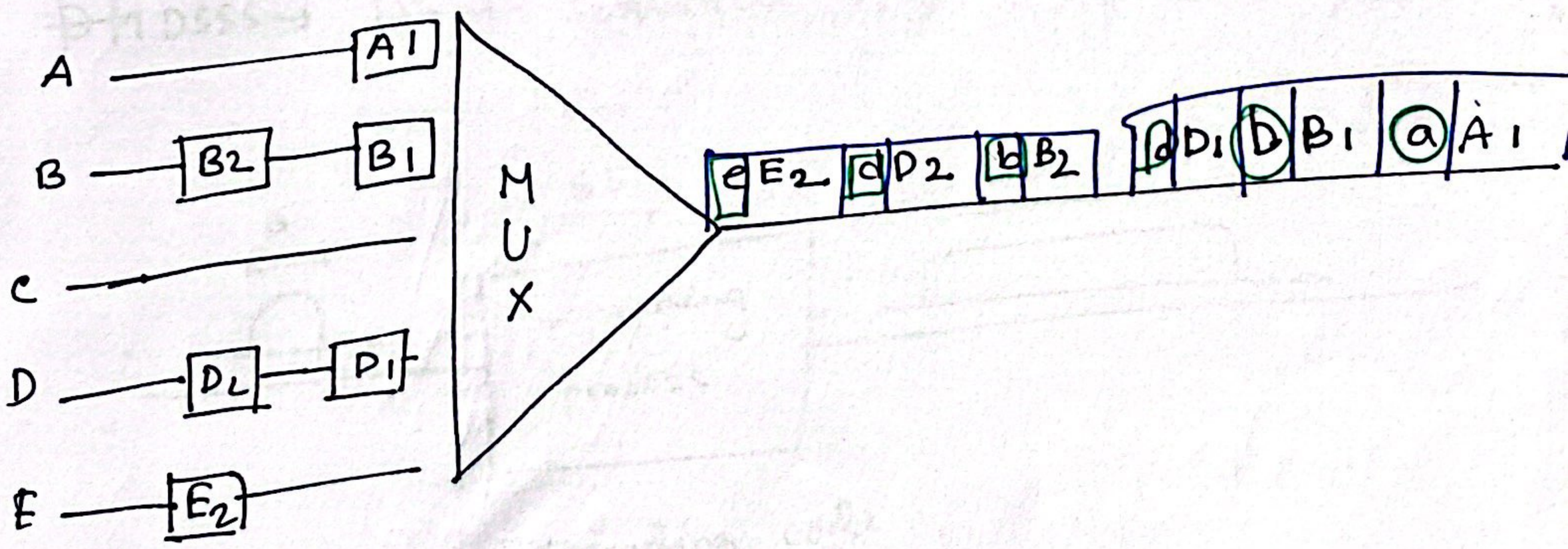
Empty slots



(Problem of synchronize TDM)

There will be no empty slot in statistical TDM.

Statistic TDM



- The number of slots in each frame is less than the number of input lines.
- Need addressing. ✓
-

Need of Balance between these two ✓

- Block of data many bytes.
- Address few bytes

Spread Spectrum.

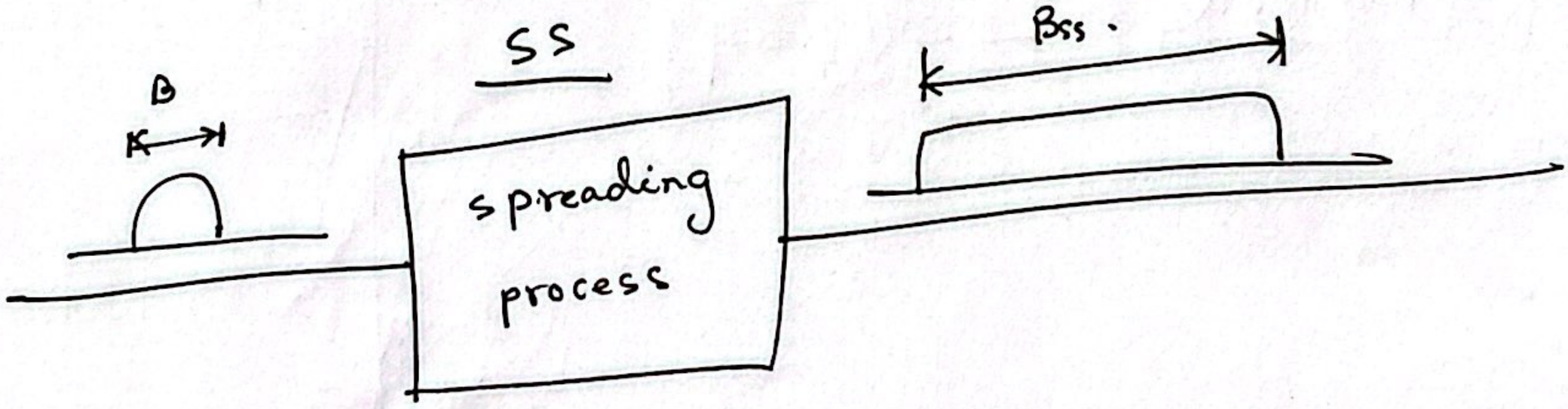
→ combine signals from diff. sources to fit into a largero bandwidth.

→ Goals → eavesdropping and Jamming.

↳ to achieve these goals SS technique add redundancy.

FHSS → Frequency hopping SS.

~~DH~~ DSSS → Direct sequence spread Spectrum Synchronous



spreading code.

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Chapter - 7

Transmission Media → through which the signal passes.
Also known as physical medium. (wired and nonwired)

Transmission Media

- Guided Media
  ↓
  (physical/wire type)
- Unguided media
  ↓
  (radio → wave type)
  (wireless)

↳ Twisted pair cable: (why twisted pair cable is twisted)

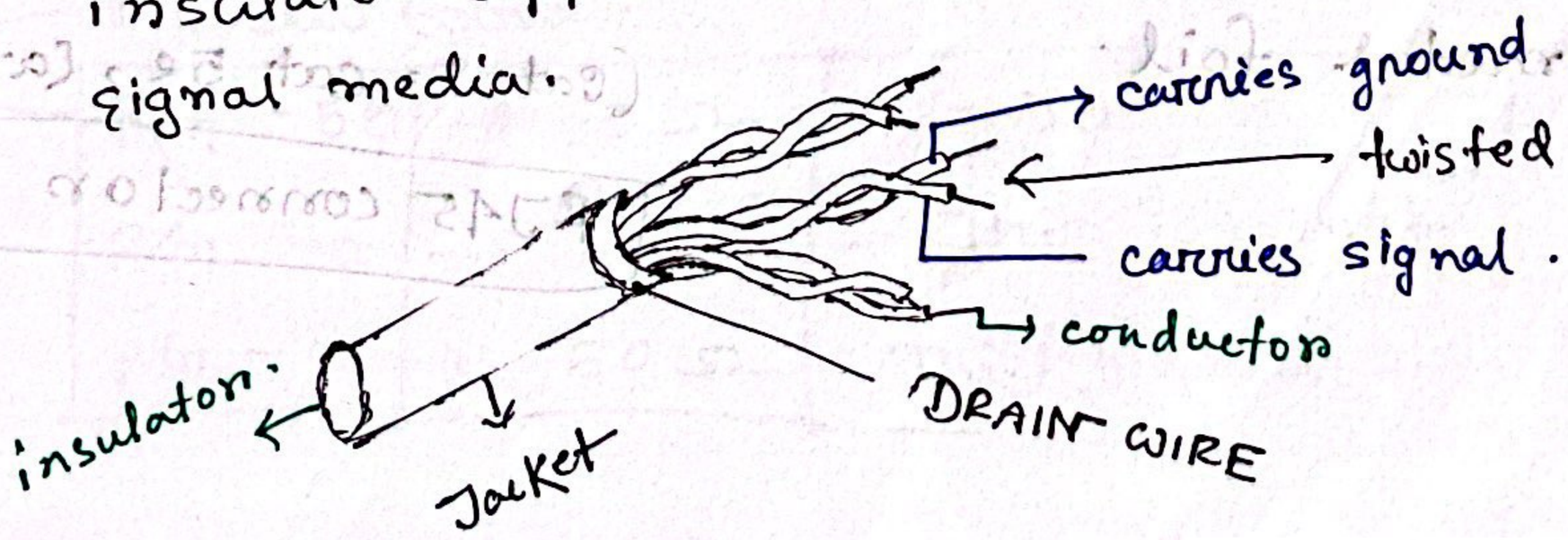
Question

↓

(Because by twisting the pair we just control the noise affect. Because if it was not twisted then the noise level would be diff. But we need a balance

↳ (

- Twisted pair cable is made of two plastic insulated copper wires twisted together to form a signal media.



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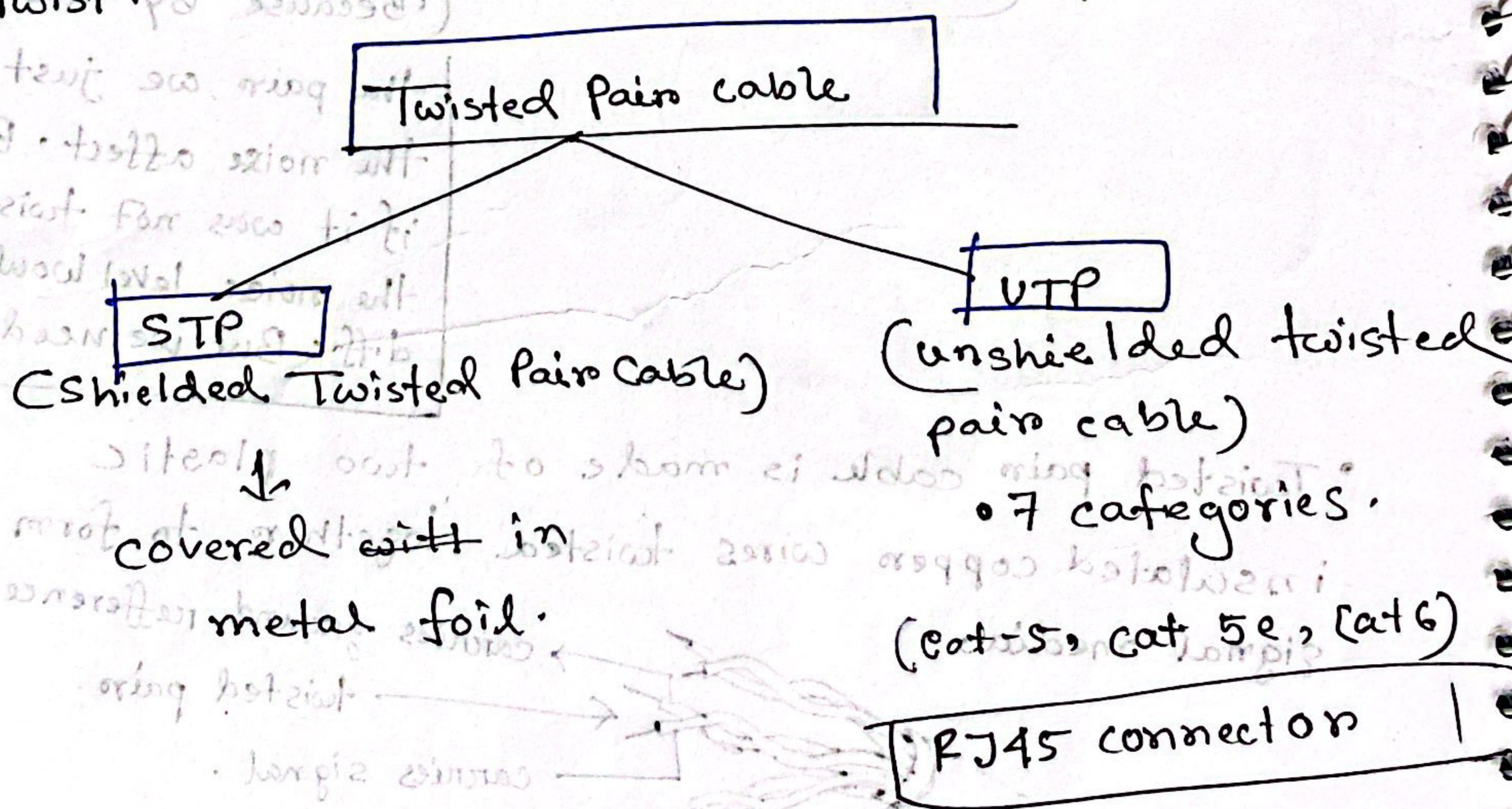
• Twist between wires are helpful in reducing noise (electro magnetic intereference) and crosstalk

Reason Behind twisting:

→ to eleminate ~~or~~ noise and cross talk, or to avoid minimize.

→ we know when there is electron flow through a wire, it creats magnetic field around it. And while the two cables are twisted, ~~the~~ their direction will be diffenent and the possibility of losing noise will be increase. That's why these cables are twisted.

→ The external waves cancel out due to the diffent twist.



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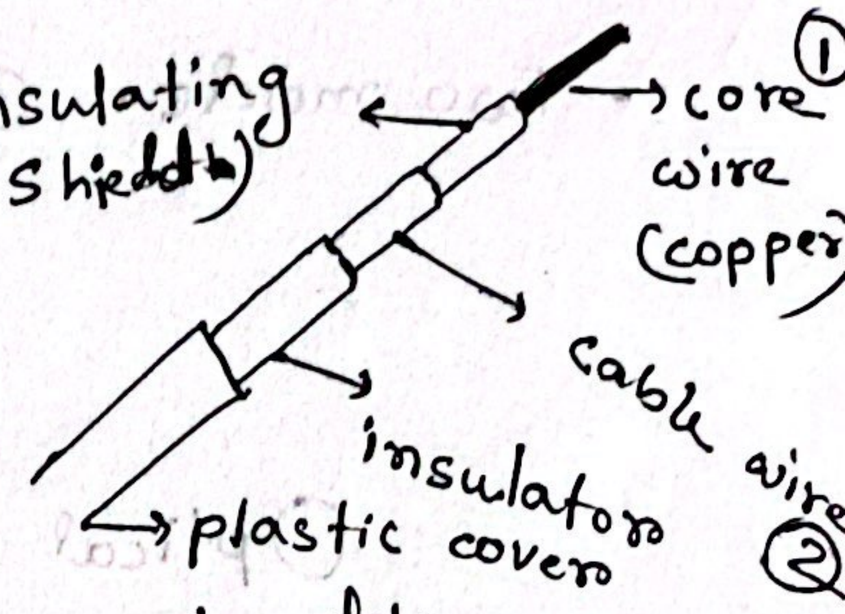
Useage

1) in telephone lines.
2) In DSL (Digital subscriber line)
3) In lans (LAN)

Chapter 7 Part 2

Coaxial Cable



→ two wires of copper.
→ core wire lies in the center
Made of solid conductor.
→ core is enclosed in a insulating sheath.

Coaxial Cable - 2

→ Because of its structure it can carry high frequency signals → twisted pair cable.

→ it structure provides a good shield against noise and cross talk.

→ high bandwidth → up to 450 mbps.

→ cables are connected using BNC/ BNC-T connector.

→ Radio Gord.

RG - 59	→ 75 Ω	→ cable TV
RG - 58	→ 50 Ω	– Thin Ethernet
RG - 11	→ 50 Ω	– Thick Ethernet

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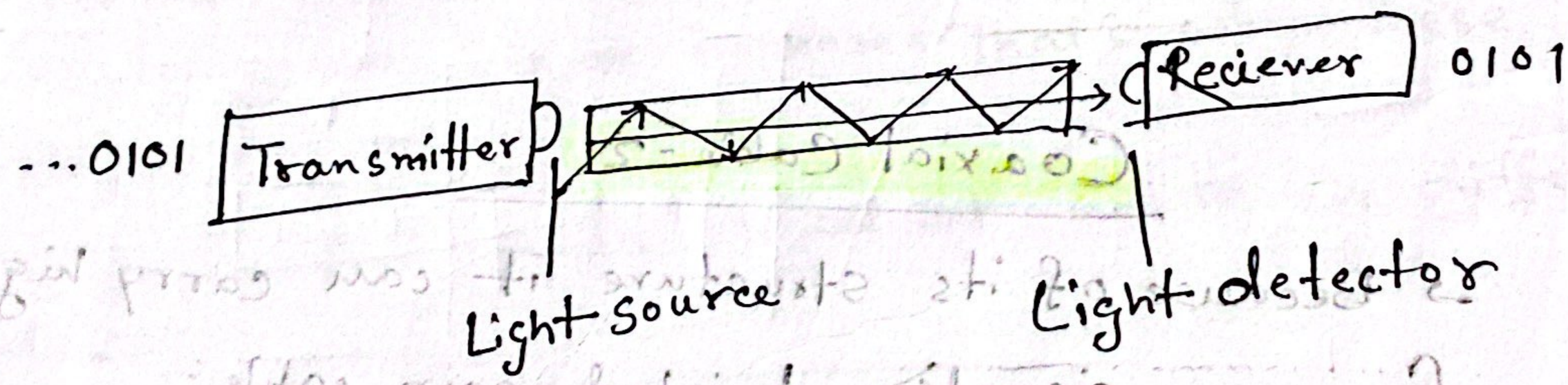
Fiber optics

- Refracts at 90 degree (on critical angle)
- Made of (core) high quality glass or plastic.
- Highest mode of speed > coaxial > twisted pair.
- Two mode. Single and multimode.

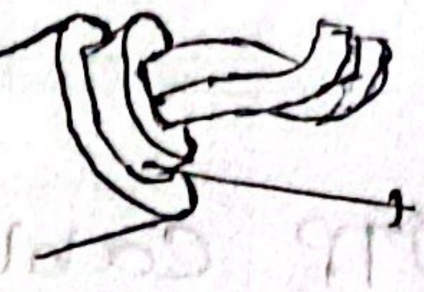
Optical Fiber Basic Working procedure



Part - 1

STP - use metal which improves the signal Quality.

- STP more expensive than UTP cables.



→ Metal Shield.

UTP 7 categories

1)	<0.1 →	unshielded twisted pairs in telephone.
2)	2 →	" " " → T-lines.
3)	10 →	Improved Cat 2 → LANS.
4)	20 →	" " Token Ring Networks → LANS
5)	100 →	24 AWG Jacket and outside shield → LANS.
(5E) 6)	125 →	Extra feature to minimize the crosstalk and electromagnetic interference. → LANS
6 6)	~~60~~ 200 →	match components coming from same manufacturers. → LANS
7)	600 →	SSTP (Known as) Each pair is wrapped in helical metalic foil. (crosstalk decrease, data rate increa

Scanned with CamScanner

- Most common UTP connector RJ-45.
- Also known as Key connector.

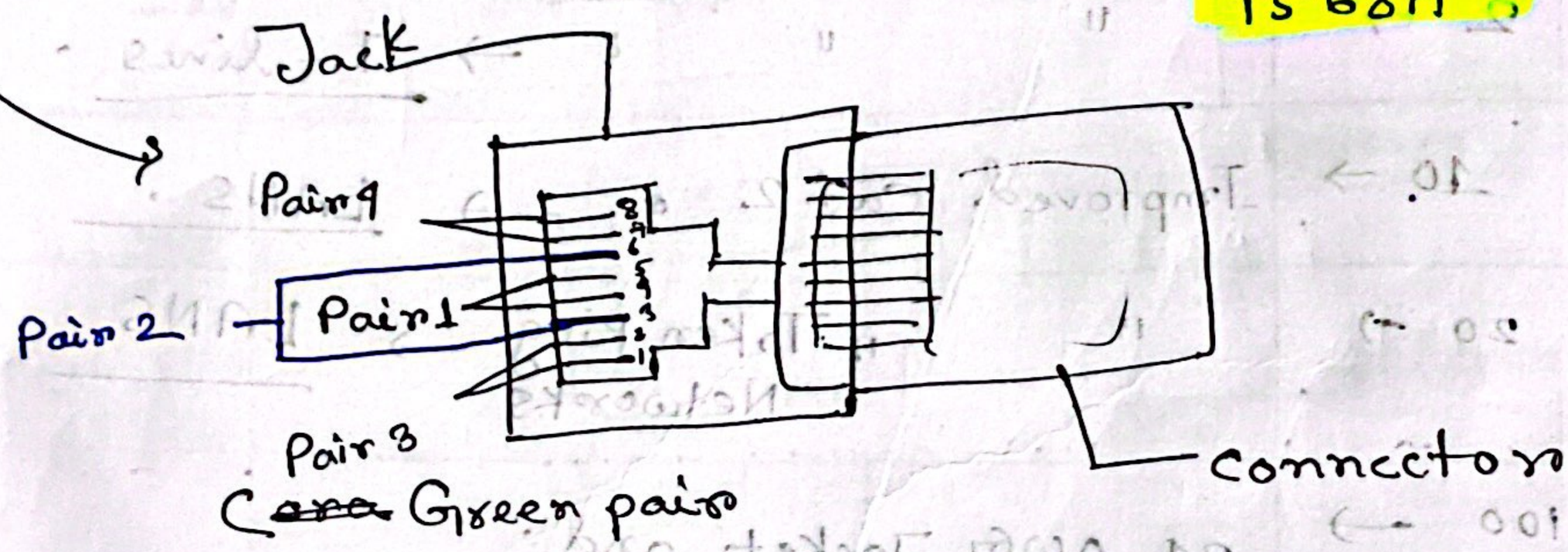
UTP Cable.

wiring pattern

① T5 68A → Green pairs together.

② T5 68B → ~~orage~~ Orange pairs together.

T5 68A



T568B

Here, when the (1,2) pair 3 will be in orange color then it will be T568 B.

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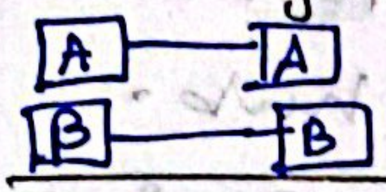
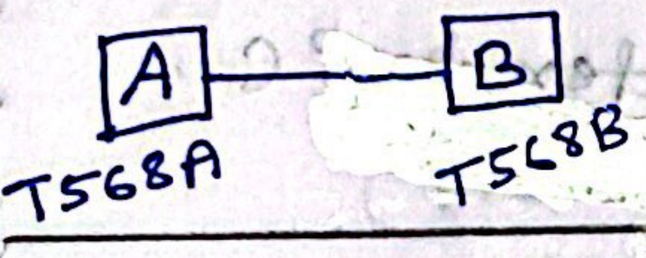
UTP cable Types -

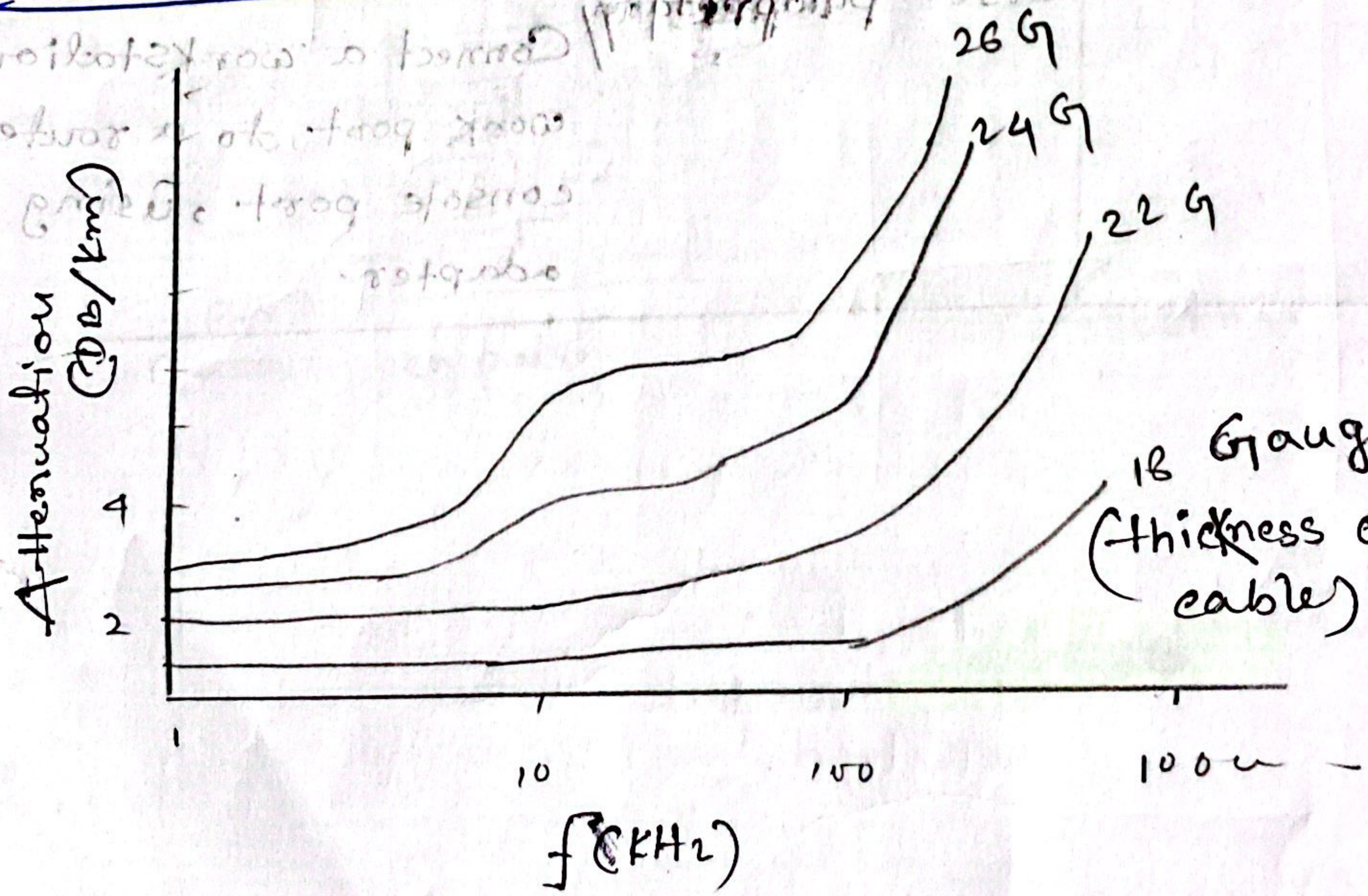
Cable Type	Standard	Application.
Ethernet Straight through 	Both end T568A or Both end T568B	Connecting network 1 host with 1 device (switch/hub)
Ethernet cross over 	One end T568A and other end T568B	2 Host connecting / 2 device connecting (switch to switch, router to router)
Rollover	Cisco proprietary	Connect a workstation network port to a router console port, using an adapter.

Interconnecting Devices using crossover cable:

Use:

Straight Through	Crossover cables
• Switch to router.	• Switch to Switch
• Switch to PC/server.	• Switch to hub
• Hub to PC or servers	• Hub to hub.
	• Router to Router
	• PC to PC
	• Router to PC.

UTP Performence



Attenuation increases means frequency increasing.

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Twisted Pair

Applications:	Pros	Cons.
• Most common. • Telephone Network (house x local exchange) • Within a Buildings: – PBX (Private Brach exchang) • For Local Area Networks • 10/100 Mbps/1 Gbps	Cheap and easy to work with.	Low data rate and short range.

part 2.2

Coaxial Cable – 2

BNC Connectors

BNC → TV.

BNC T → Ethernet.

BNC Terminator →

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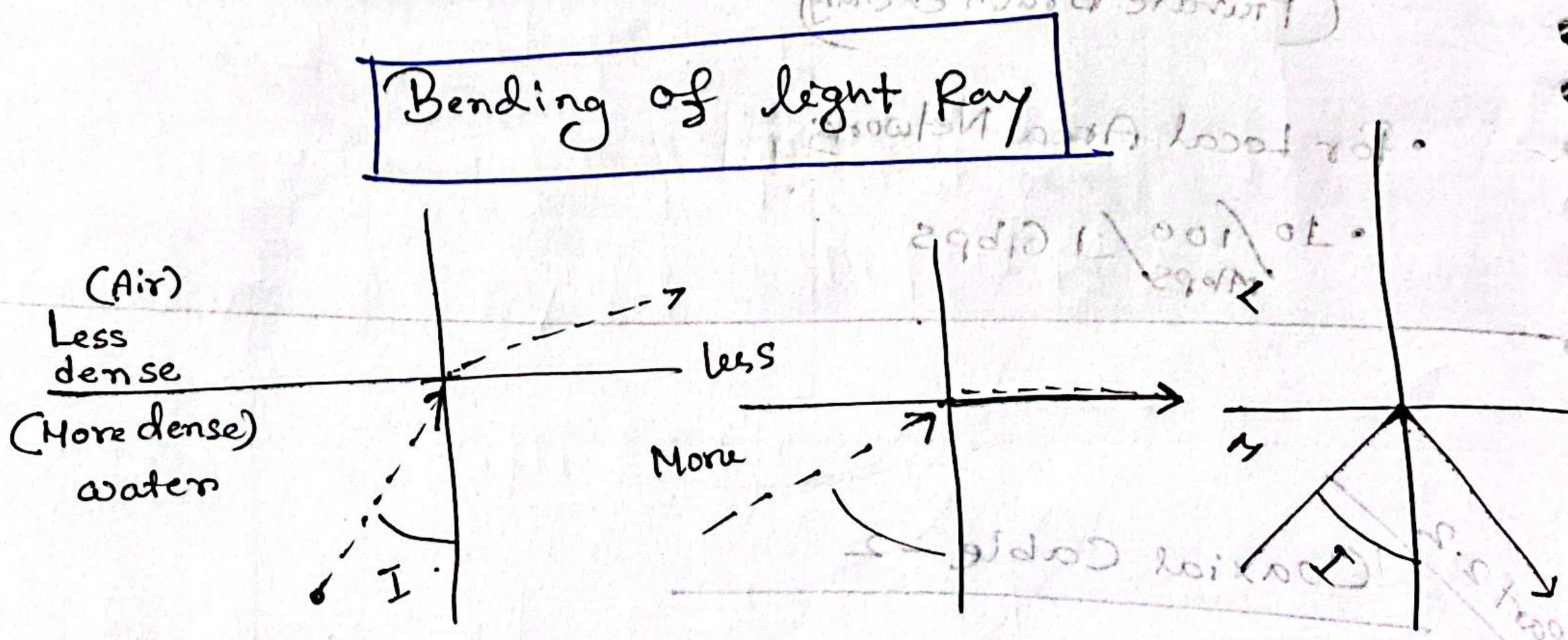
Part 3. Chapter 7

Fiber Optic

- Made of glass / plastic / transmit signal in form of light.
- Carried → photon pulse through thin glass strands.
- (LED) OR (ILD → laser diode) System to produce light wave.

Bending of light Ray



I < critical angle refraction.

I = critical angle refraction

I > CAR

Optical Fiber Benifits

- Greater capacity
- Small in size / weight.
- Lower attenuation.
- Electromagnetic Isolation.
- Greater repeater spacing.
- Immunity to corrosive materials.
- More immune to tapping

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Fiber optical Cons.

- More expensive
- Difficult skills and equipment required.
- More hard/carefull handling.

Applications

- Long haul trunks.
  - ↳ length 1500 km + 20,000 - 60K voice channels.
  - → undersea optical fiber.
- Metropolitan trunks.
  - → 12 km length, 10K voice channel.
  - → underground conduits joining telephone exchanges
- Rural Exchange trunks.
  - 40 – 160 km, in length + less than 5000 voice channels.
- Subscribers loops
  - handling voice, data, image, video.
- LANs
  - 100 Mbps → 1Gb.

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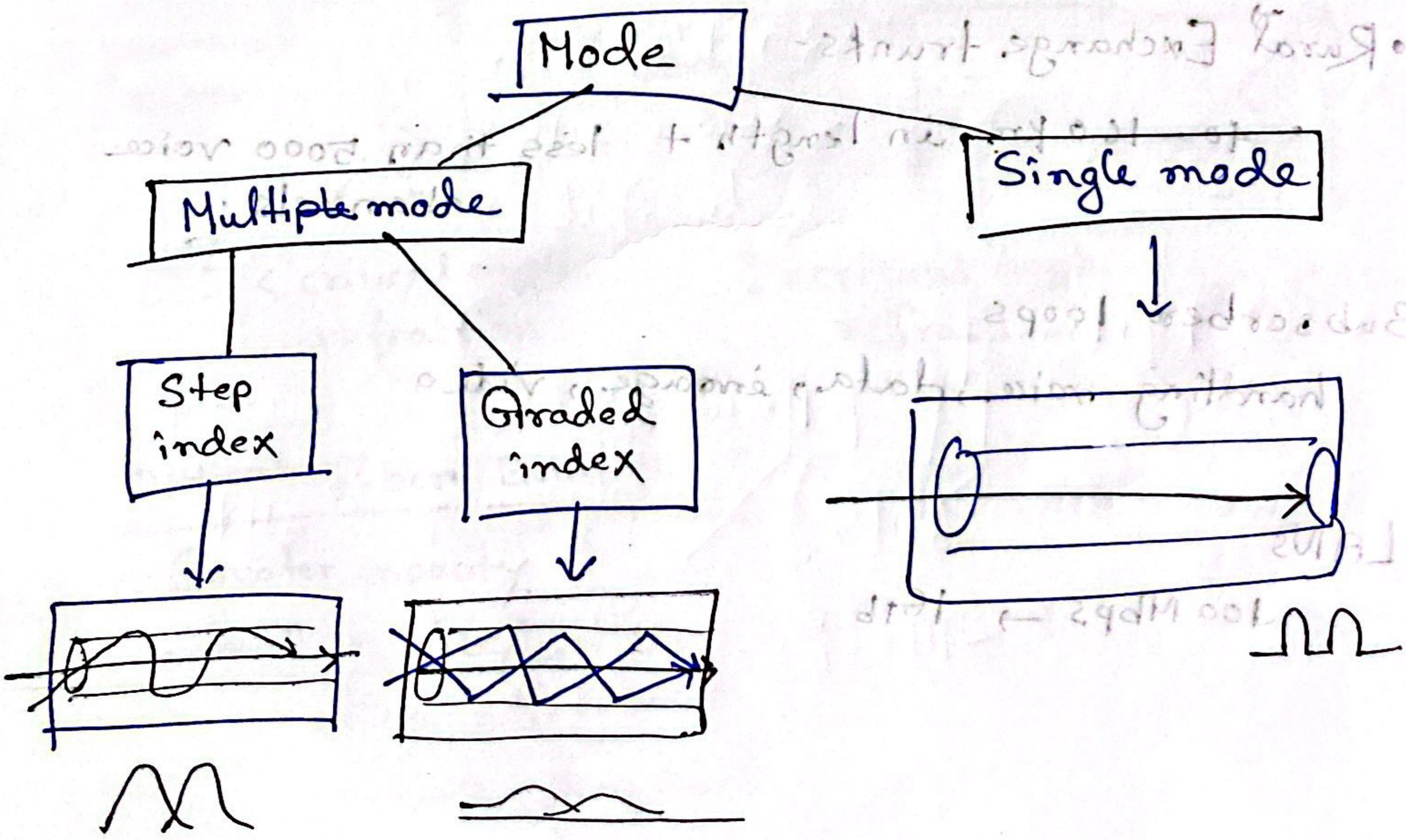
Optical Fiber

Transmission Characteristics.

- Light Emitting Diode (LED)
  - → cheaper
  - → wider operating temp range.
  - → Last longer.

- ILD (Injection Lase Diode)
  - → More efficient.
  - → Greater data rate.

Usage
- Wavelength division Multiplexing.



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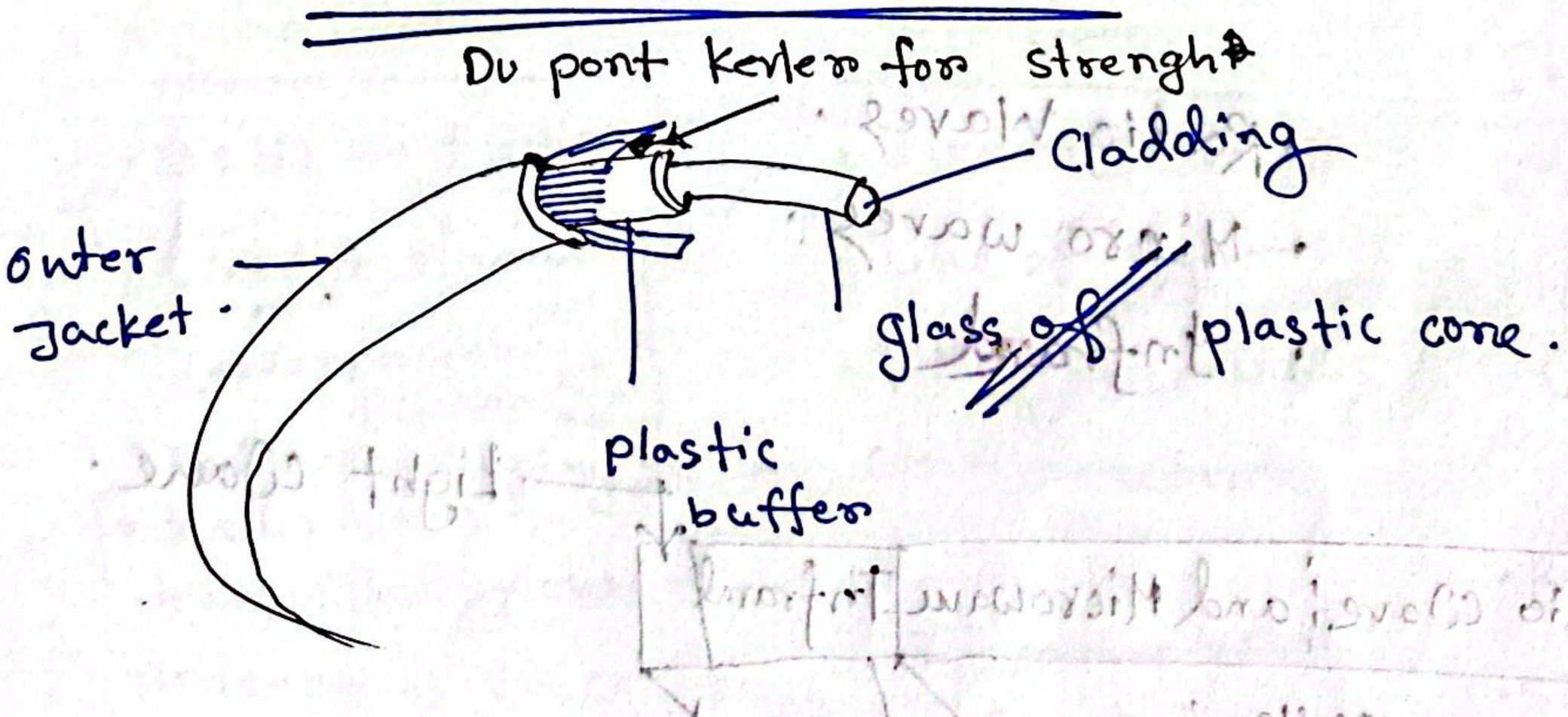
Single Mode	Vs	Multimode
① Small core.		① Big core.
② less despresion.		② Allows greater dipersion loss of signals.
③ long distance (100km, 62,14 ml)		③ Uses for long distance but smaller than Single Mode.
④ Usage leaser as light source. (thousand meters distance)		④ LED use → light source (100 meters distance)

Fiber Construction



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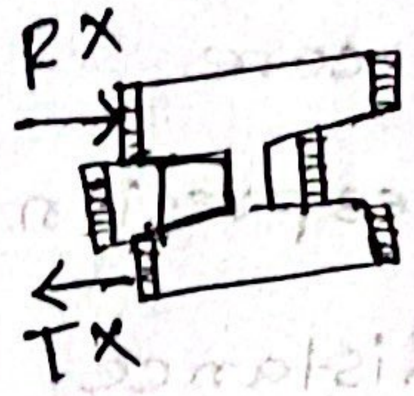
Fiber optic connectors

1. St connector (networking device)
2. MT RT connector.

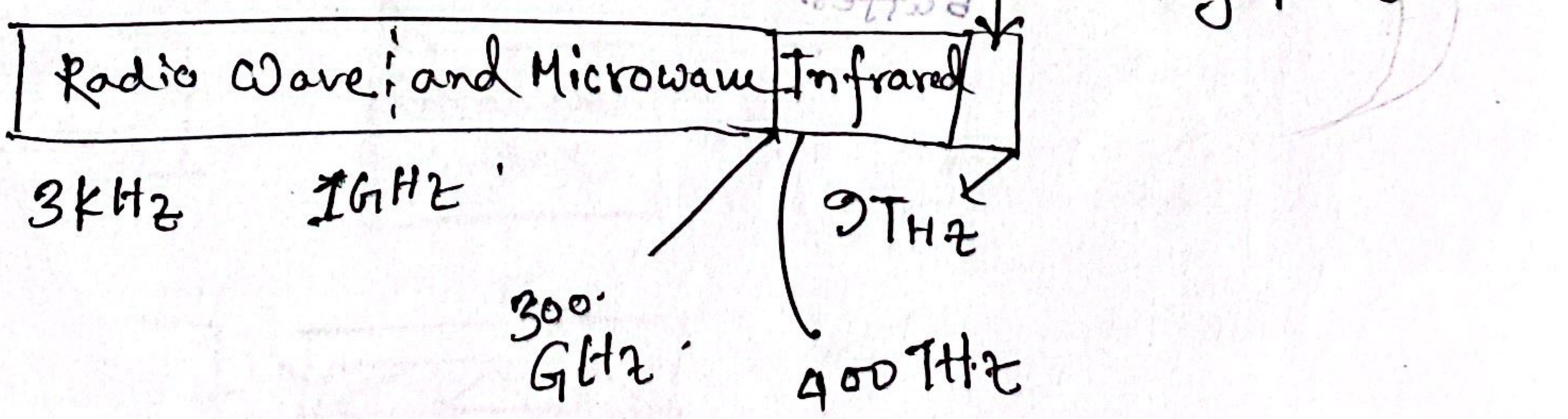


Under Guided Media

Wireless

Unguided media transport electromagnetic waves, without using physical conductor. Known as wireless.

- Radio Waves.
- Micro waves.
- Infrared



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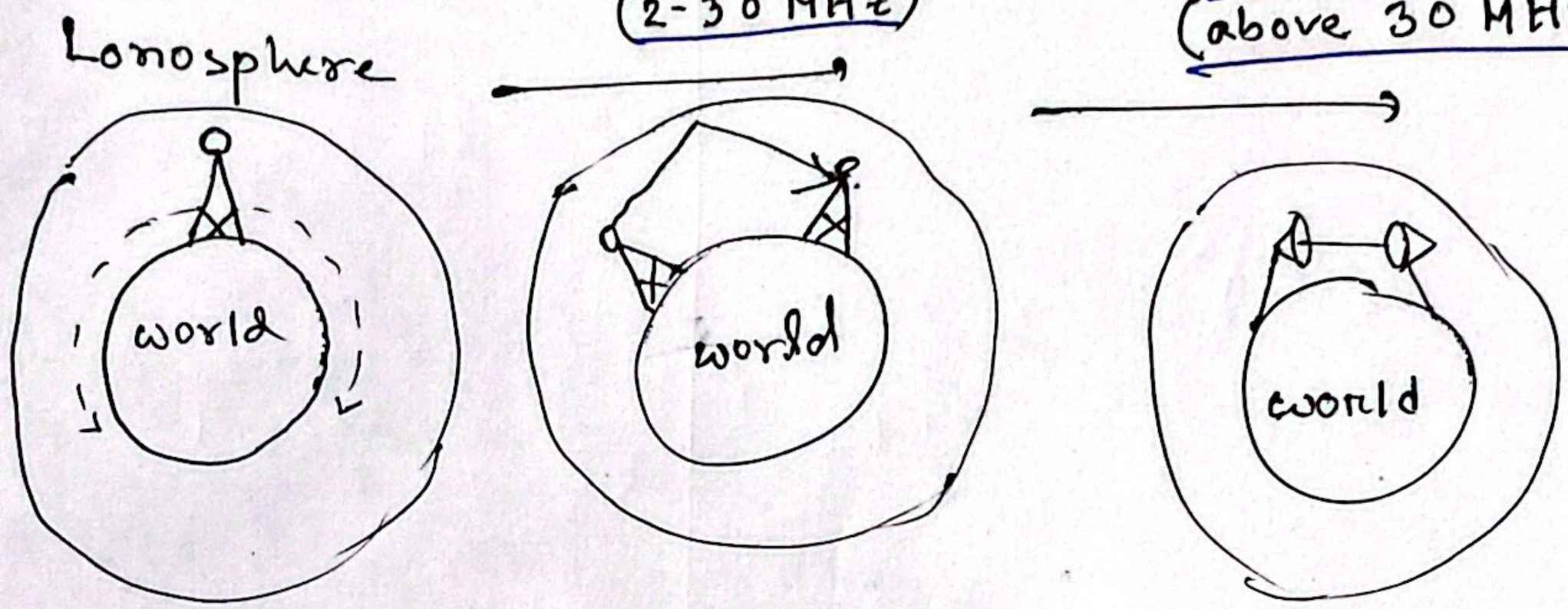
Propagation methods.

① Ground propagation (below 2MHz)

② Sky propa... (2-30 MHz)

③ Line of sight propa.. (above 30 MHz)

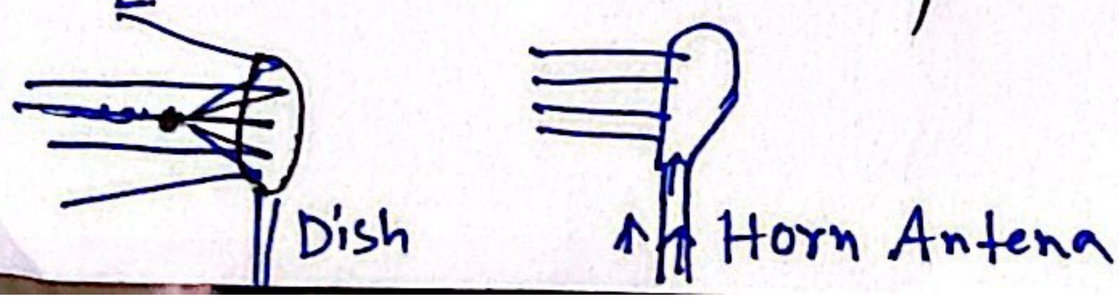


Band → 8

Radio Waves

- 3 KHz → 1 GHz
- Omnidirectional. (every possible direction)
- Radio, TV, paging system
- Radio Waves transmitted by one antenna is susceptible to interference by another antenna that may send signals using the same frequency.

Disadvantage



MicroWaves

- 1 GH → 300 GHz.
- Line of sight
- VHF microwaves can't penetrate walls.
- Microwave band is relatively wide.
- Telephone, (cellular), satellite wireless LANs

Infrared

- 300 GHz - 400T
- HF
- Cannot penetra walls.
- Remote control.
- Short range.

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