

## chapter 1

### Data communication and components

- \* OSI is important to transmit the packets (60) data
- \* OSI stands for open system Inter connection
- \* OSI stands for open system Inter connection it has 7 layers and it is located at NIC interface
- \* TCP/IP stands for Transmission control protocol / Internet protocol it has 5 layers giving the structure to the TCP/IP

### TCP/IP:-

- ⇒ Transmission control protocol / Internet protocol . It has 5 layers they are :-
  - ⇒ physical layer
  - ⇒ Data link layer (DL)
  - ⇒ Network layer
  - ⇒ Transport layer
  - ⇒ Application layer

### Data communication:-

Exchange of data between two devices through transmission medium is called data communication

There are different types of data communication

1. Text

2. Numbers, mathematical objects to transfer

3. Images

4. audio and video etc;

- \* Devices may be computer, work station, Network device, video camera etc.

## Different types of transmission Mediums:-

- 1. Wired → with connection oriented
- 2. Unwired / noise less → connection less
- 1. Wired: Twisted pair (or) wire, coaxial cables  
optical fiber → ex: lan wire
- 2. Wireless: Radio waves & Microwaves, infrared waves

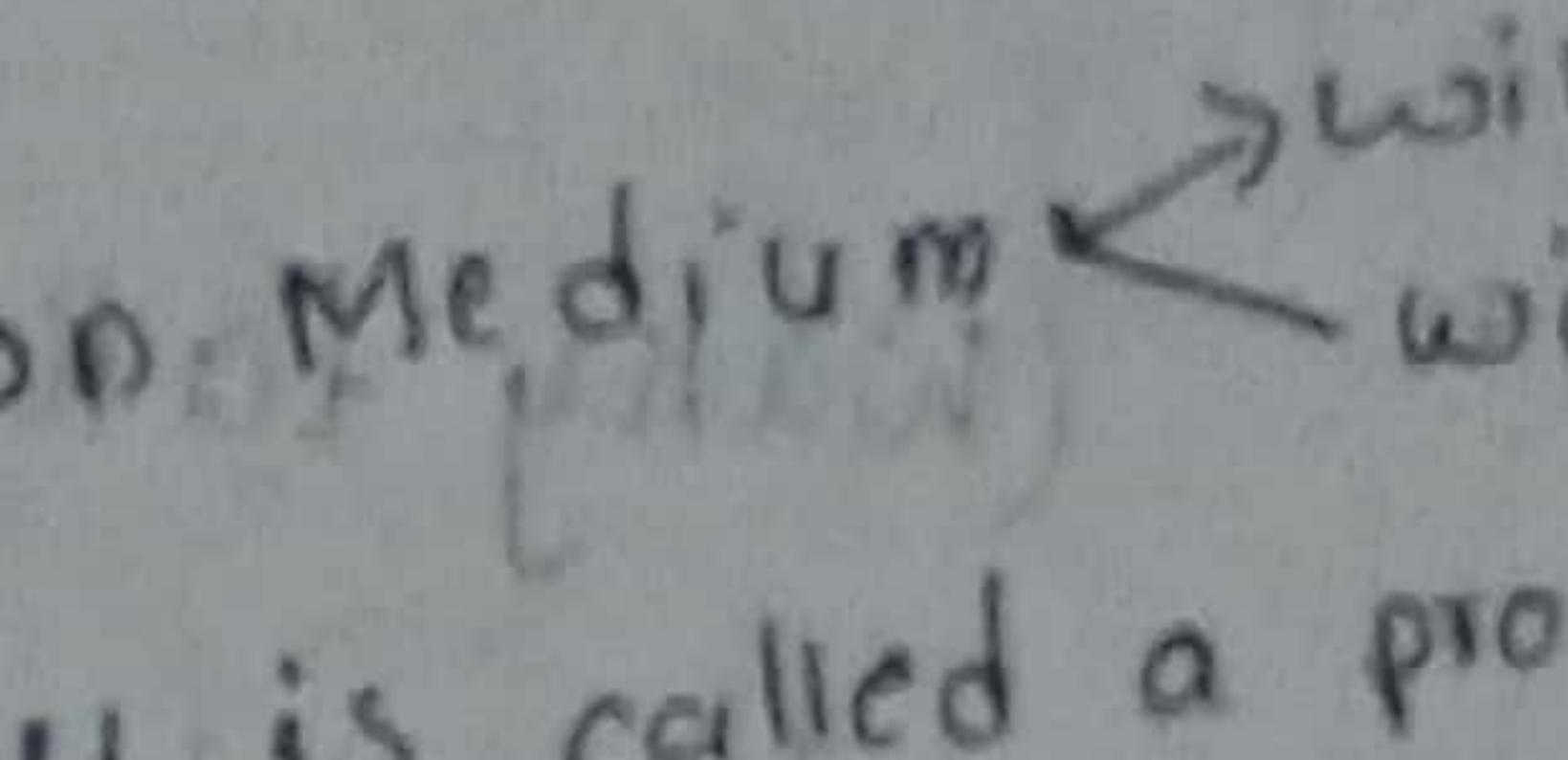
The effectiveness of data communication can be defined by four characteristics:

1. Delivery: The system must deliver the data to the correct destination
2. Accuracy: System must send data within time accurately
3. Timelines → system must send data within time
4. Jitter → The difference in the arrival time of a packet is called jitter. That is data packet must send within a fixed time

For ex:- If the 1<sup>st</sup>. packet of video data is received to 20ms & 2<sup>nd</sup> one is received in the interval of 30ms, it leads to "Low Video Quality".

## Components of a Data communication systems:-

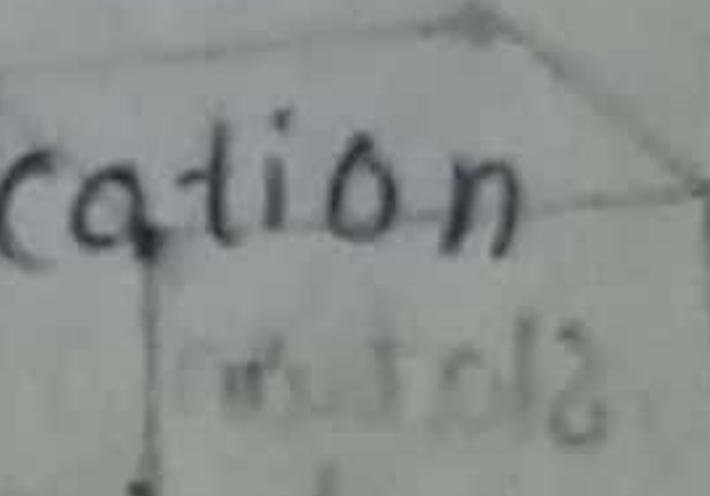
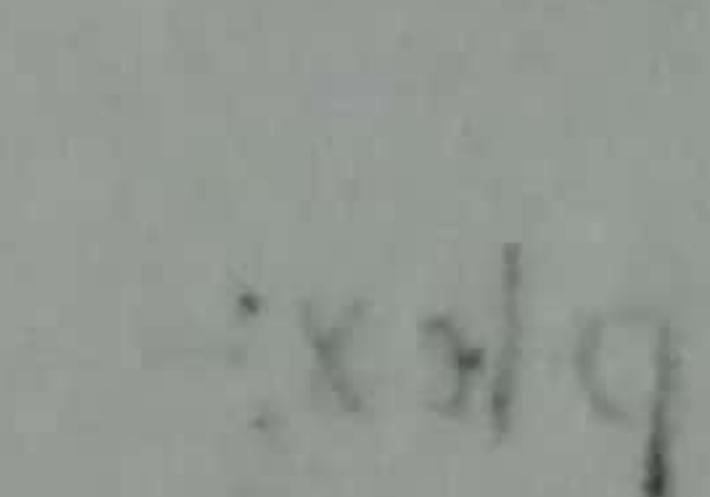
There are 5 entities in a data communication system:

1. Message → Data, which want to send to the user.
2. Sender → Who always sends a message.
3. Receiver → Is a device, who always receive a message.
4. Medium → Transmission medium  wired
5. protocol → set of rules, is called a protocol. A protocol governs entire data communication. protocol is an agreement b/w 2 devices to exchange the data.

→ GI has two software they are:

1. OSI :- open system interconnection.
2. TCP/IP :- transmission control protocol / internet protocol.

Data-flow: There are 3 methods for the data flow in data communication

1. simplex (Keyboard) 
2. Half-duplex 
3. Full-duplex 

\* Simplex Mode: is unidirectional data transmission method.

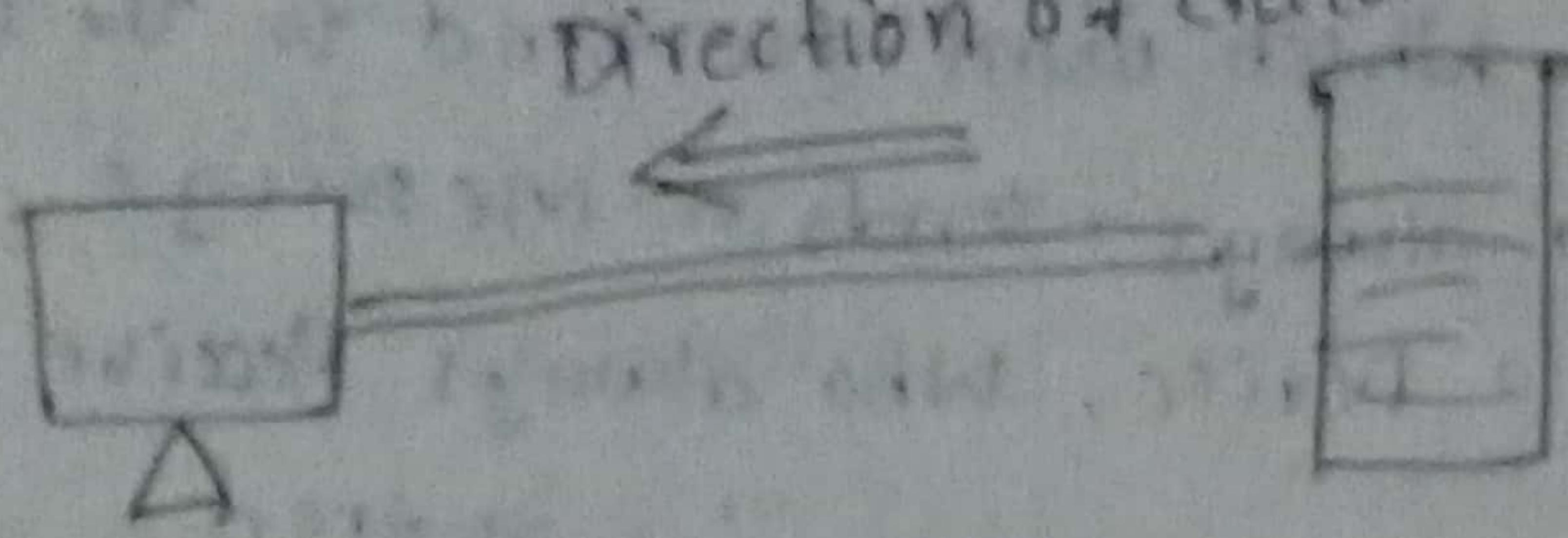
In this mode one system can send the data.

→ Sender always sends data.

→ Receiver always receives the data.

→ Here, the entire channel is utilized by center that means entire channel is used for sending data to the user.

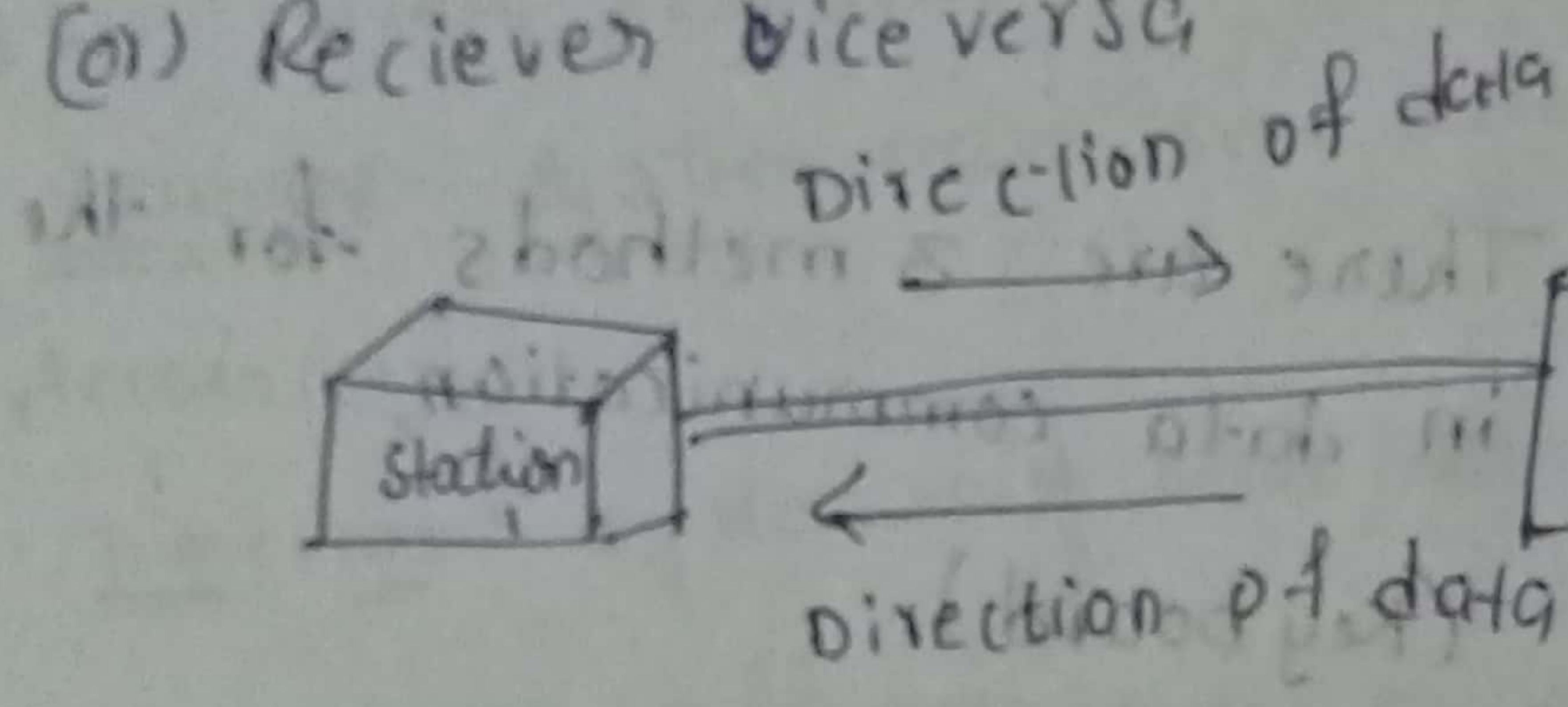
Sending data to the user.



Half duplex:- (Waky Taky)

In this mode, the data transmission is in two direction. But not same time. one station sends the data and thus, simply receives data and vice versa.   
 ⇒ Here entire channel utilized, by sender.

(a) Receiver vice versa



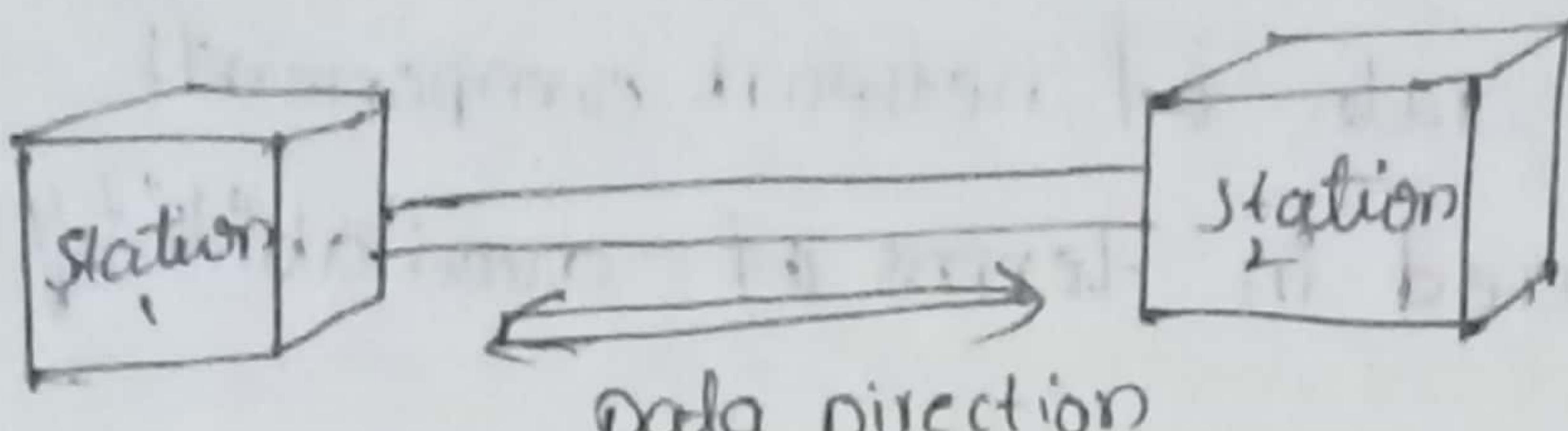
Full duplex:-

full duplex mode is bi-directional data transmissions at same time.

⇒ In this mode at a particular time a station can send & receive the message.

In this mode the entire channel is divided into 2 parts, the 1st half is utilized by station send & receive and half is utilized by

station 2 to send & receive.



Ex:- Telephone

Network:-

A Network is a set of devices connected by communication links.

⇒ A Node can be a computer, printer, or any other device capable of sending and receiving data generated by other Nodes on the network. A link can be a cable, air, optical fiber. (or) any medium which can transport a signal carrying information

Network Criteria:-

- ⇒ performance
  - ⇒ Reliability
  - ⇒ Security.
- Depends on Network element  
↳ measured in terms of Delay & Throughput

Performance:- performance of Network measured in terms of Delay & Throughput

The good computer network having the less delay and high throughput.

## Reliability:-

- Failure rate of network components
- Measured in terms of availability / robustness

Security: formula =  $\frac{\text{No. of failures}}{\text{No. of failures} + (\text{No. of failures})^2}$

\* Data protection against corruption / loss of data due to

\* Error

\* Malicious users

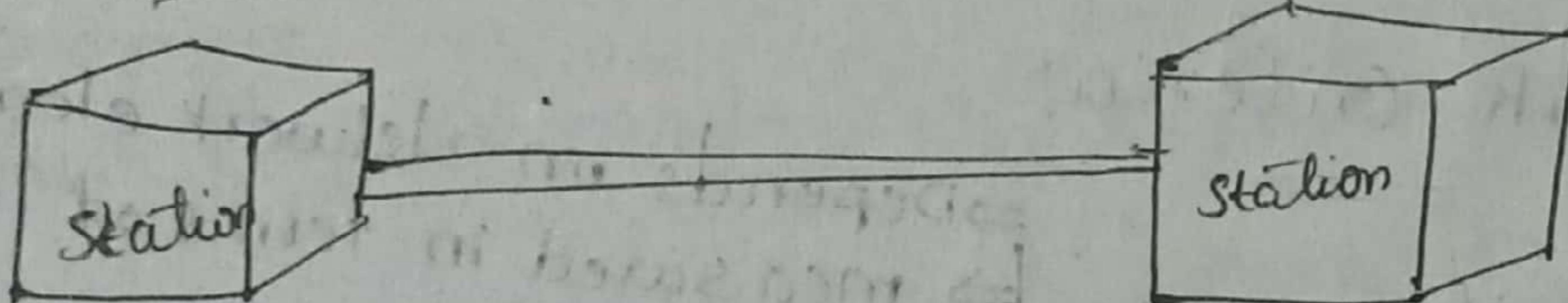
## Physical structures

⇒ Types of connection

1. Point to point

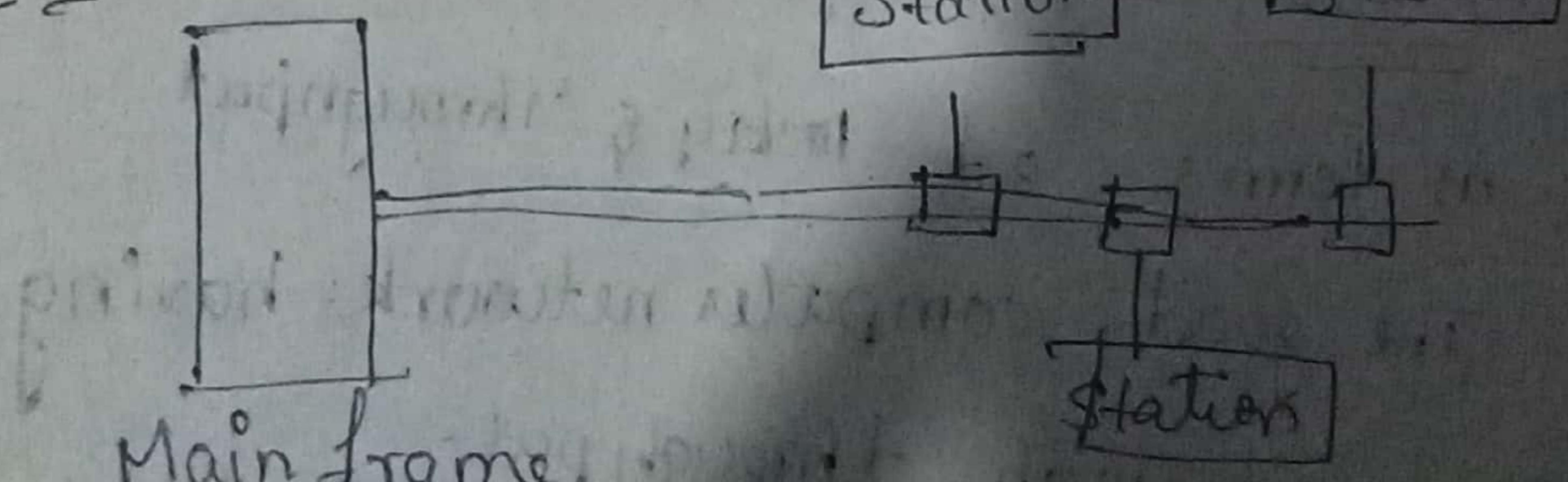
2. Multi-point

## Point to point:-



There is a dedicated link to point to point connection between two devices only

## Multi point:-



Sharing a single link between more than two devices.

## ⇒ Physical Topology:-

\* Connection of devices

Physical topology describes the layout of physical connections between different devices and links

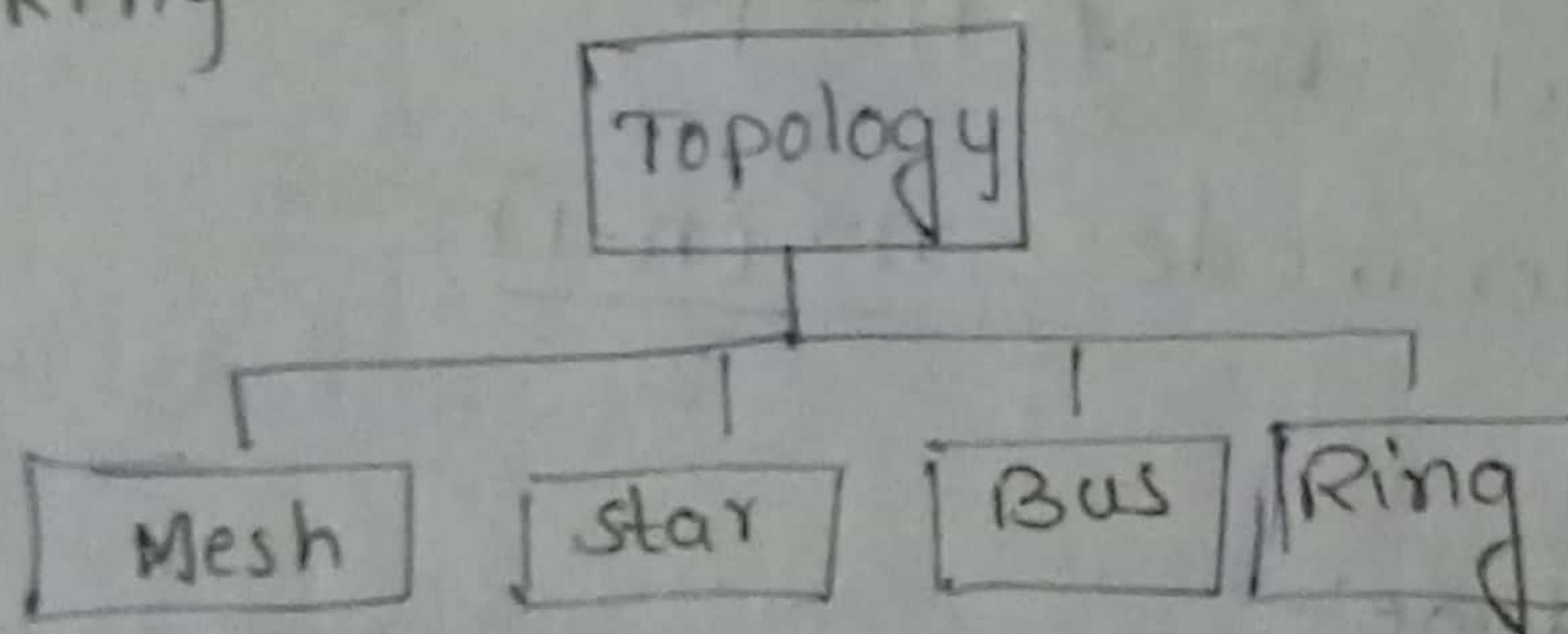
There are 4 types of physical topologies

\* Mesh

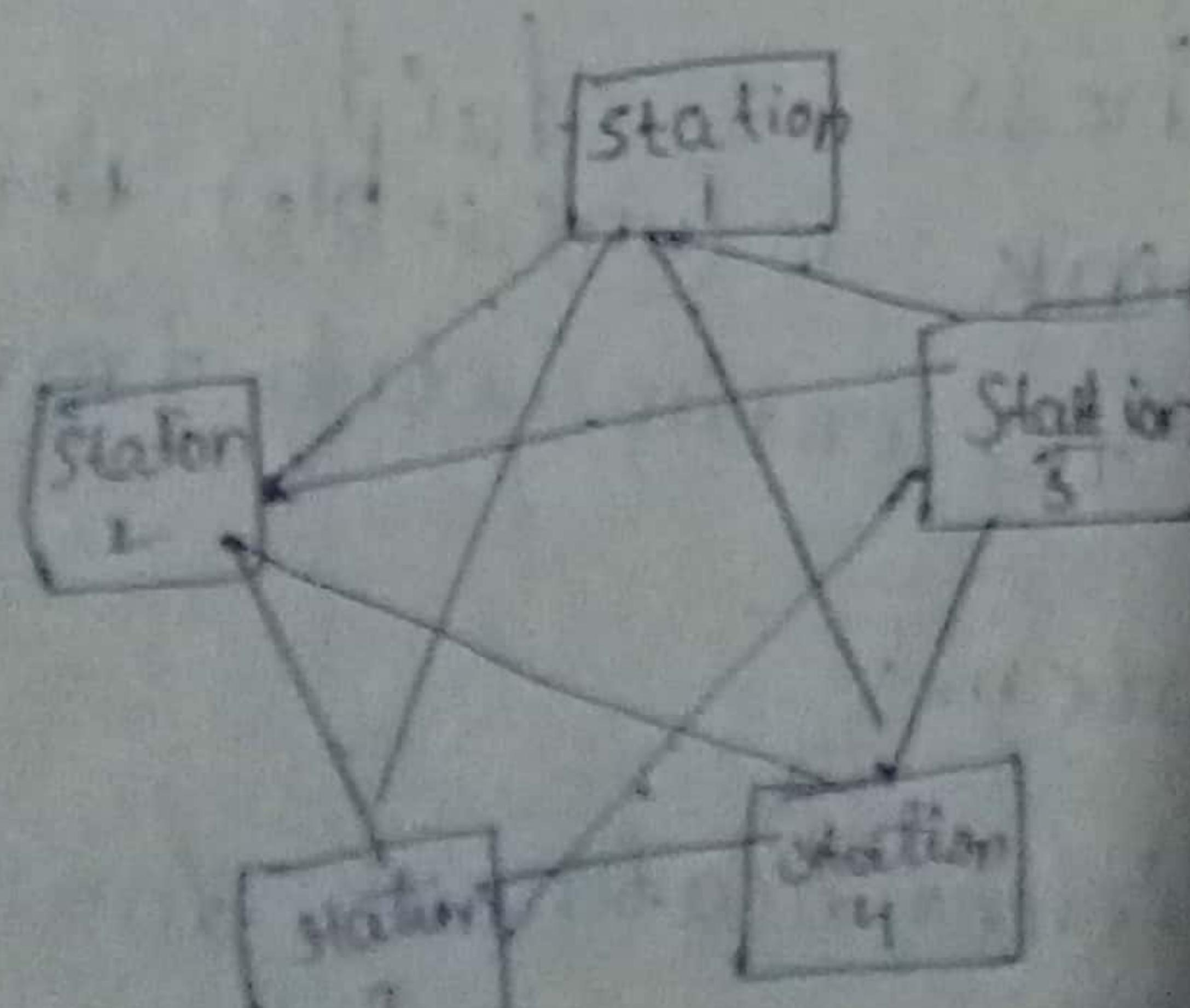
\* Star

\* Bus

\* Ring



Mesh: A Mesh topology, there is a point-to-point dedicated link between each device



If there are  $n$  number of devices in mesh topology number of connections at each devices is  $n-1$

\* Total number of connections in entire topology is  $n*(n-1)$  connections

\* Total no. of physical links in duplex mode (data is Bi-directional)  $\frac{n*(n-1)}{2}$

\* No. of I/O ports at each device  $(n-1)$

\* Total no. of I/O ports in entire topology is  $n*(n-1)$

\* Total no. of I/O ports in physical links in duplex mode  $\frac{n*(n-1)}{2}$

### Advantages:-

\* Less traffic

\* Data guarantee

\* Robustness

\* if one link is (useless) then it will not effect the entire data transmission in the system

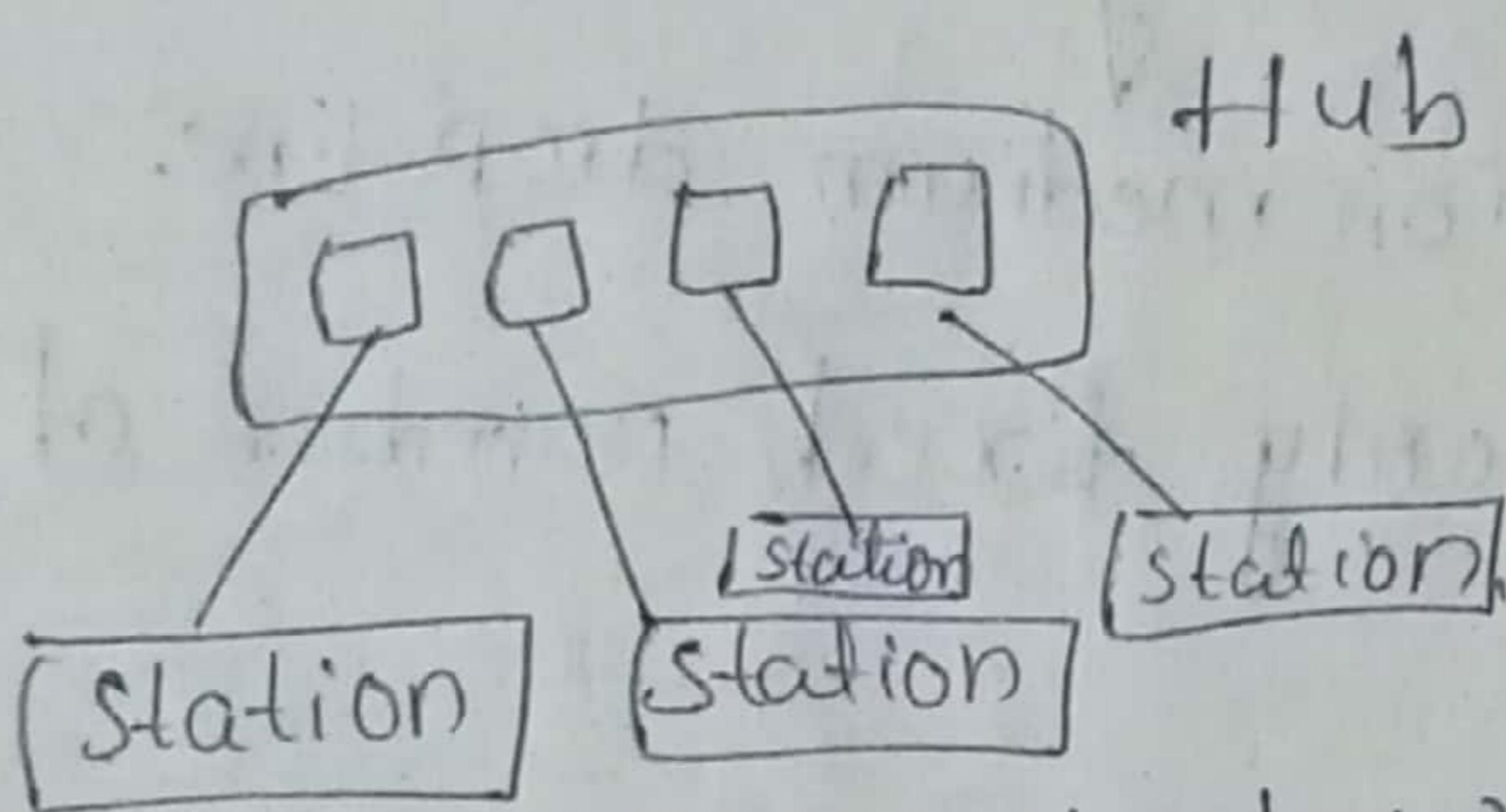
\* fault identification & fault isolation is easy

## \* Disadvantages:-

- \* Require more no. of cables
- \* Require more no. of connection ports
- \* cost increases.
- \* Mesh topology is generally implemented at regional telephone office where regional office offices are connected with other regional office offices.

## \* Star topology:-

In star topology every dedicated point with hub connected with hub of link.



- \* Every station connected with the hub
- \* In star topology there is no direct connection

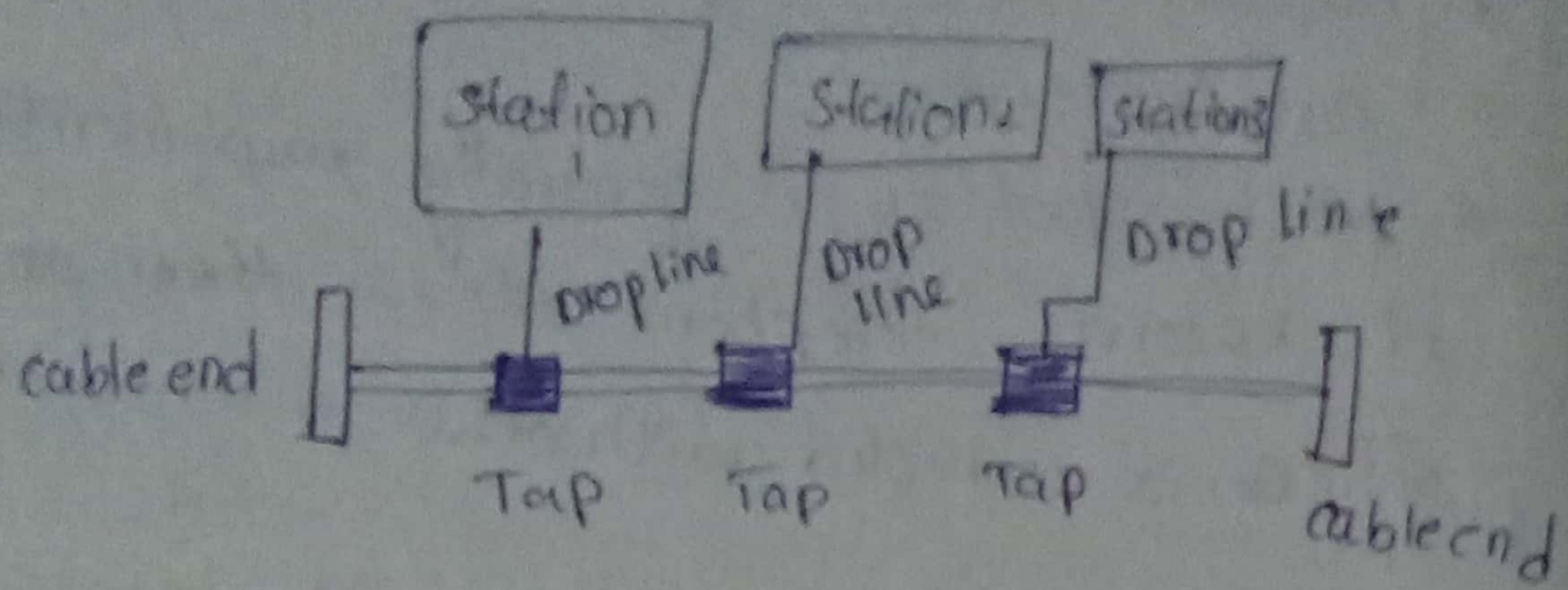
## Advantage:-

- \* less traffic
- \* less cabling
- \* Data guarantee
- \* fault identification and isolation is easy

## Disadvantage:-

- \* less Robustness
- \* if central controller fails entire systems (hub) are collapsed.

## Bus-topology connecting three stations



- ⇒ In Bus topology a transmission medium connects multiple devices by using multiple points.
- ⇒ Each and every station connects with the a transmission medium drop line.
- ⇒ They are only fixed number of devices in a bus.

⇒ only the desired station will receive the message from the transmission medium

⇒

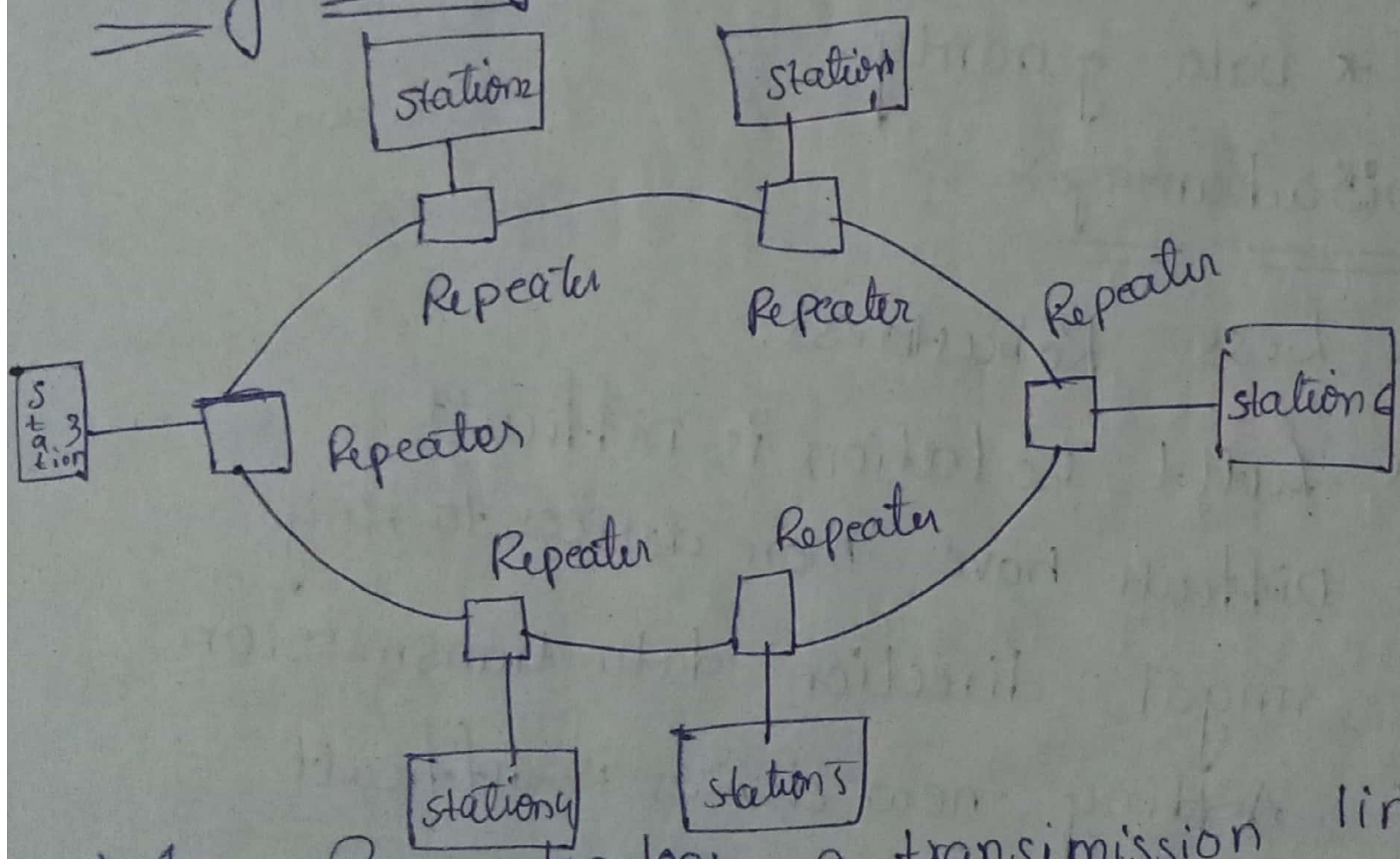
## Advantages:-

- ⇒ Less cabling
- ⇒ Requires less no. of i/o ports
- ⇒ easy installation

## Disadvantages:-

- ⇒ More traffic
- ⇒ Less Data guarantee
- ⇒ Less Robustness  
(if transmission fails we cannot pass data)
- ⇒ Difficulty of Reconnection
- ⇒ Adding new devices are difficult.
- ⇒ Bus length this long the strength is decrease.  
Because of taps (The tap observes signals and weaken the signals)

## Ring topology:-



⇒ In Ring topology a transmission line consists of only two systems on each side

⇒ Every device have a desired point-to-point

dedicated connection to its neighbors.

⇒ In Ring topology the data always travels in one direction (unidirectional).

Ex:- if we have send data from 1 to 6  
The direction of data transmission is left to station 1

⇒ then the data path is 1-2-3-4-5-

There is no direct transmission of data 1 to 6  
is not possible

Advantages:-

\* less traffic Because of repeater.

\* easy installation

\* signal strength is always same

\* Data guranty.

Disadvantage:-

\* less Robustness

\* fault isolation is difficult

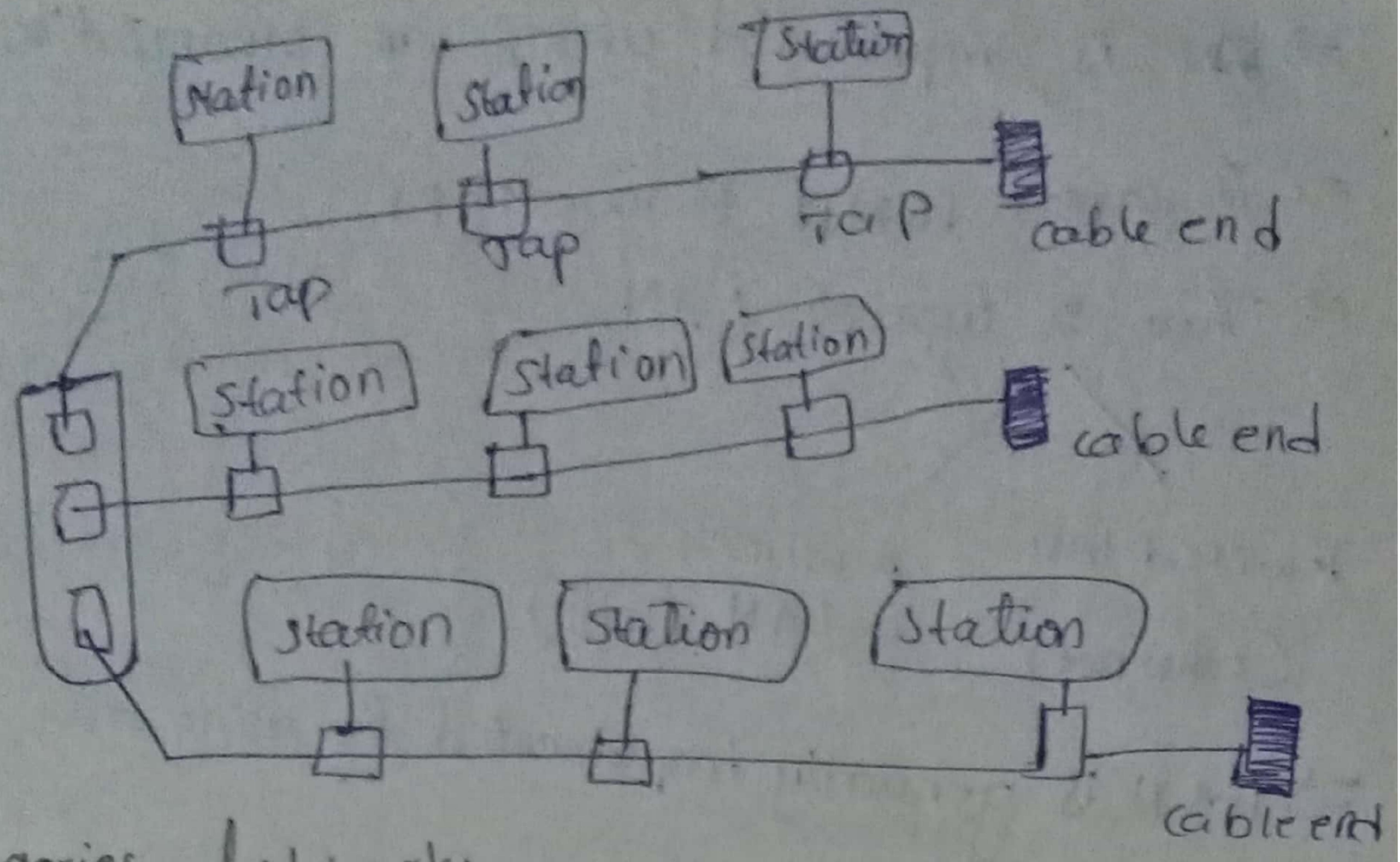
\* difficult have more devices to rent

\* singal direction data transmission

\* Adding new devices is difficult

Hybrid topology:-

\* it is a combination of star and Bus topology.



## Categories of Networks:

⇒ There are 3 types. They are

1. LAN
2. WAN
3. MAN

LAN (Local Area Network) → Ethernet

⇒ The Network within the Building (o)

campus

⇒ It provides a file sharing in the internet

through LAN

⇒ Designed to provide local interconnectivity

⇒ A Network which covers a small area Network

like network within a building (o) a campus

is called Local Area Network.

⇒ LAN covers few kilometers

⇒ LAN's are used to share files & printers

files / documents Resource

⇒ LAN is implemented within an organization

⇒ it covers 16 Mbps to 1000 Mbps

⇒ There are 2 types of LAN

1. wired LAN  
(cathedral)

2. wireless  
LAN (wi-fi)

⇒ LAN is generally implemented by using star.

& Bus & Ring Topology

2. MAN (Metropolitan Area Network):-

⇒ A Network which covers within a city or few cities is called MAN

⇒ city cable Network is an example

⇒ Telephone Network is an example

⇒ It covers 10-50 km.s

⇒ Speed 16gbps to 1000gbps

3. WAN (Wide Area Network):-

⇒ A Network which covers entire country and different continents and world

⇒ WAN is a combination of 'n' number of LAN's & MAN's

⇒ it is 2 type:- 1. point to point WAN  
2. switched WAN

## Network models

OSI and TCP/IP are the layered Network model

1. Open system interconnection(OSI)
2. Transmission control protocol / Internet protocol

Every part & every individual layer has the responsibility to send data from one step to another

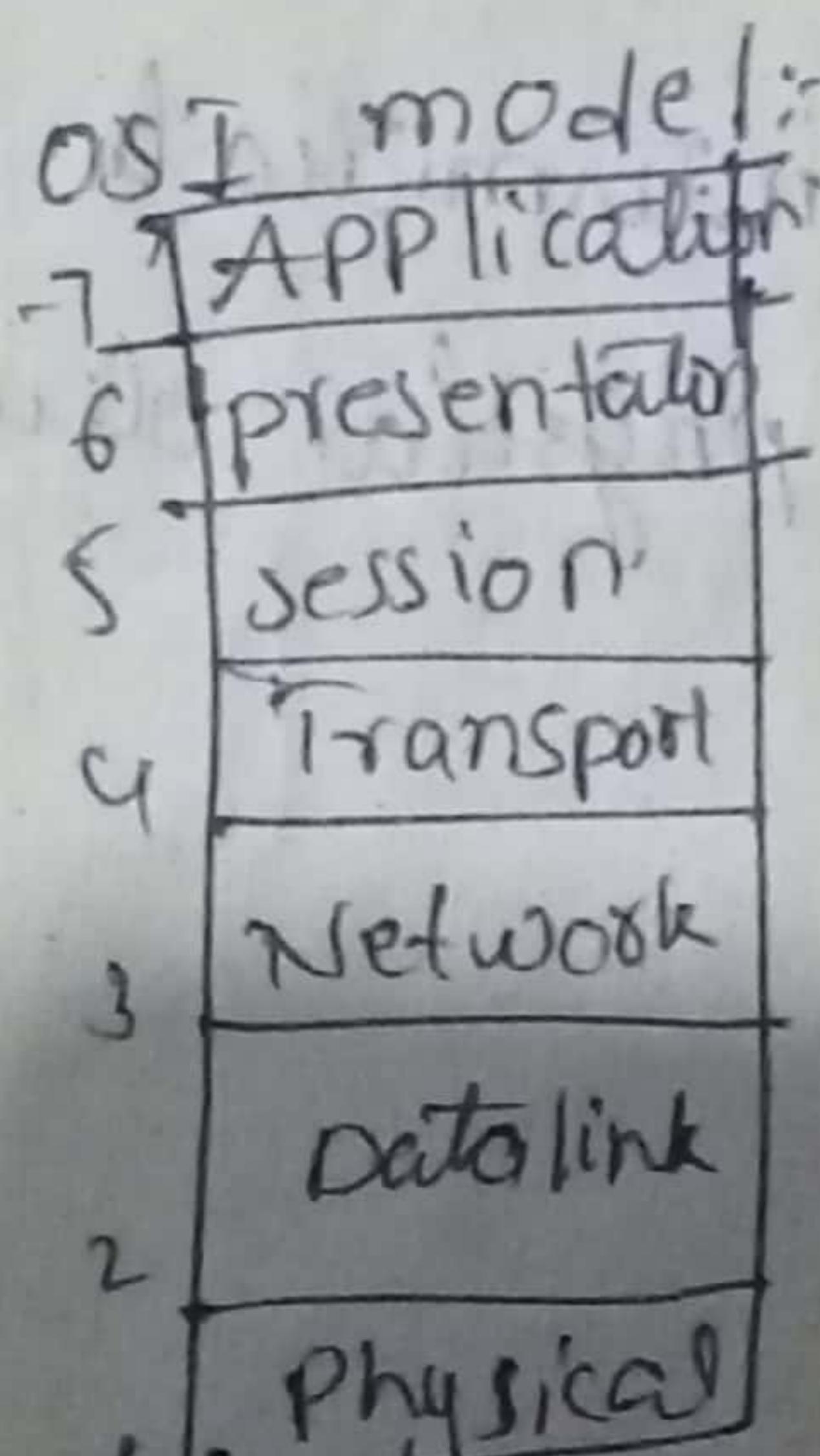
⇒ entire process is not done by single layer  
it is the combination of layers

⇒ OSI (Open systems Interconnection):

any system want to connect with the network is called open system Interconnection

There are seven layers in the OSI model:-

- \* Physical layer
- \* Data link layer
- \* Network layer
- \* Transport layer
- \* Session layer
- \* presentation layer
- \* Application layer.



~~PS~~ Applications

Presentation:-

Session:-

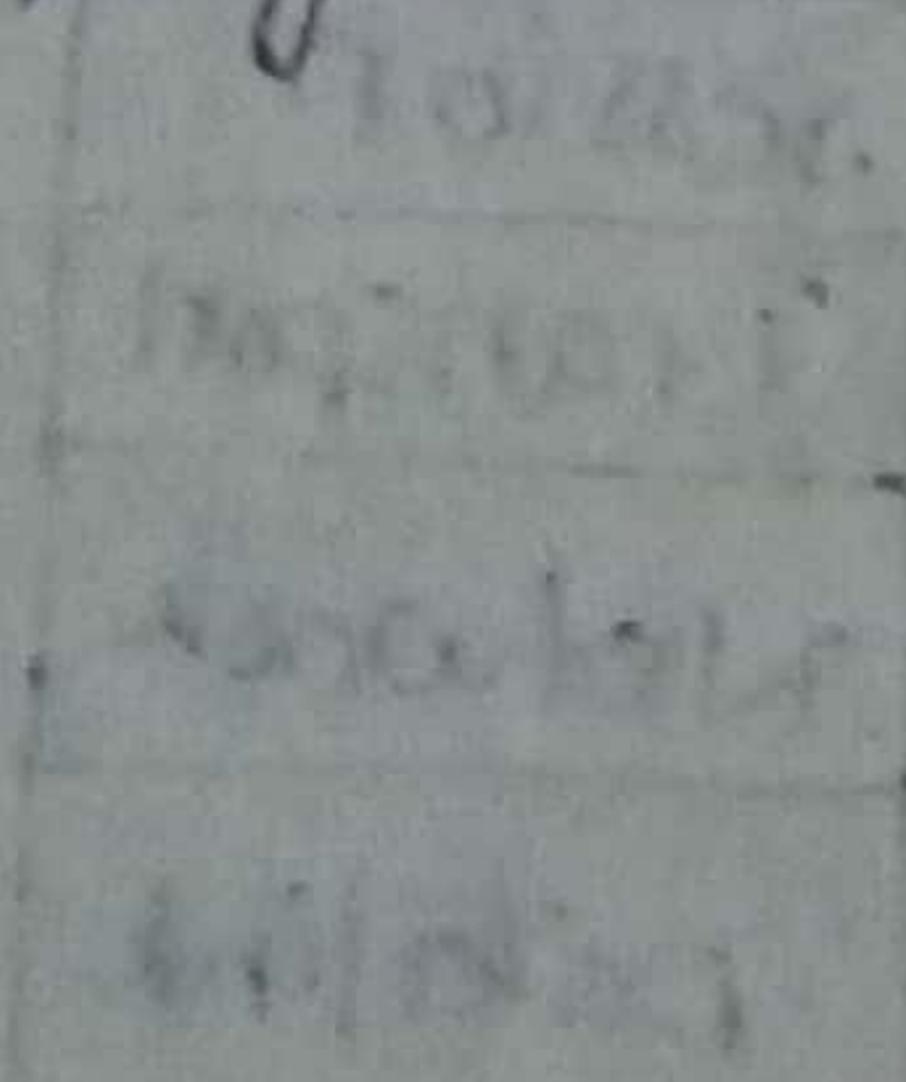
Transport:-

Network layer: Network layer deals (or) identify different type routers.

Data link layer: Data is transformed from one layer to another to trailer error checking device.

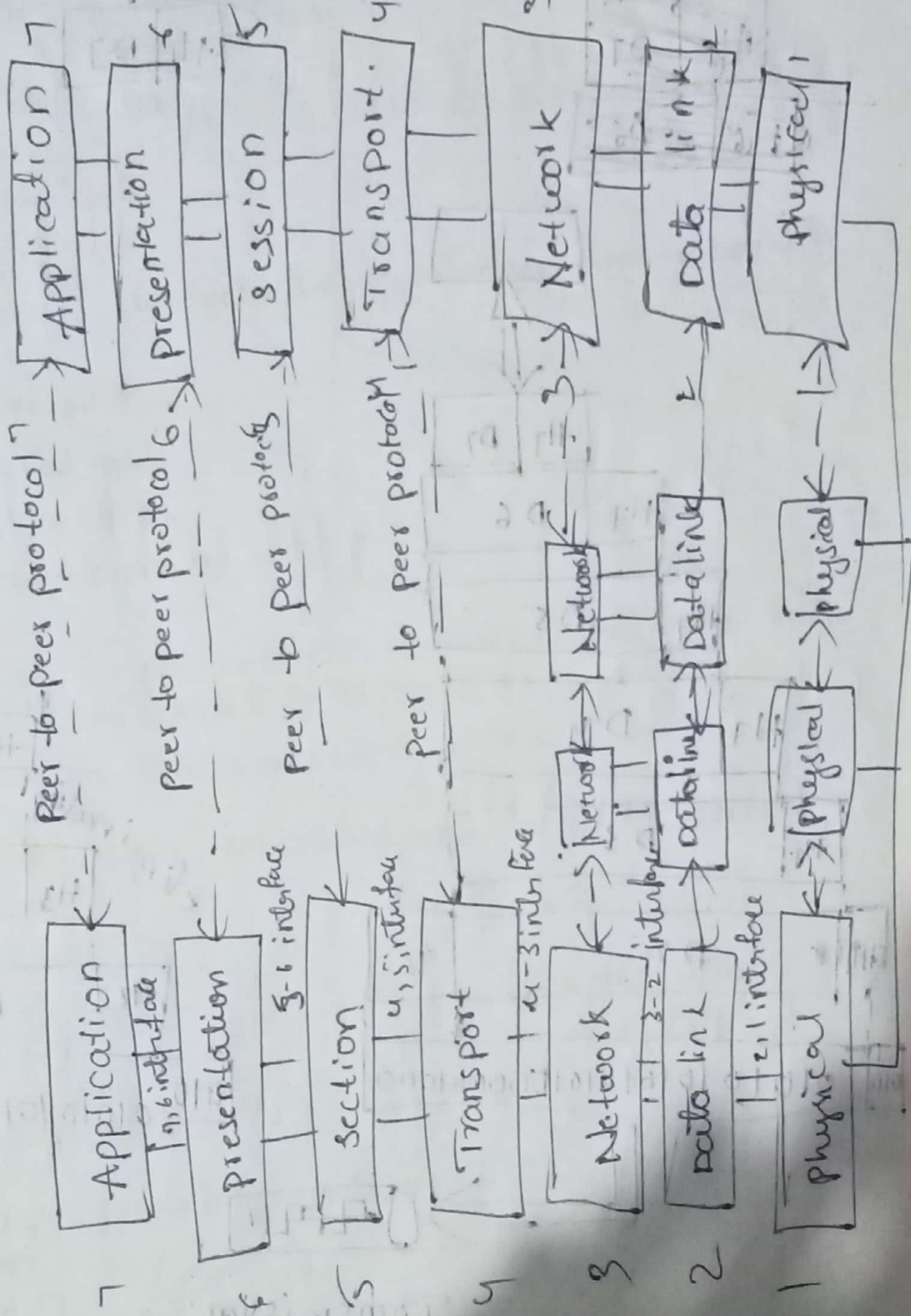
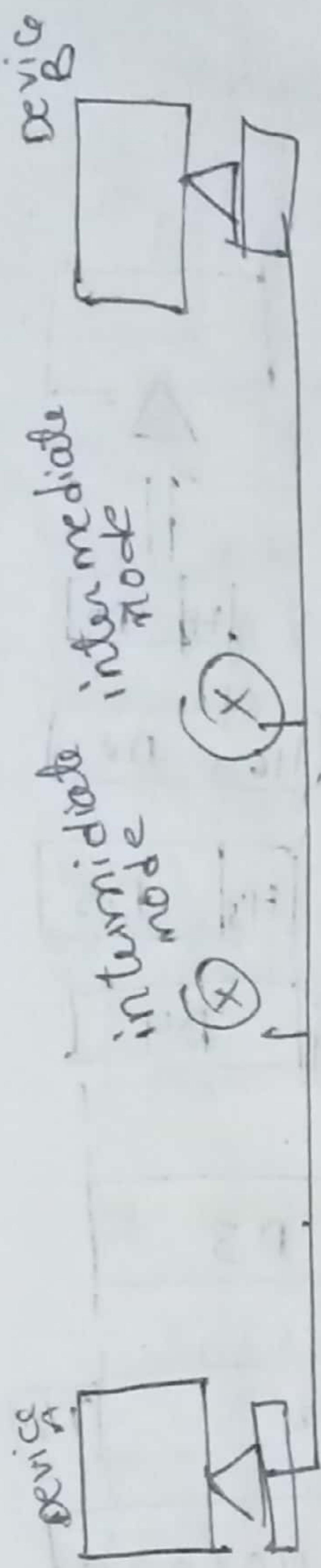
Physical layer:

Network, Datalink, Physical layers are intermediate layers, it connects intermediate physical devices.

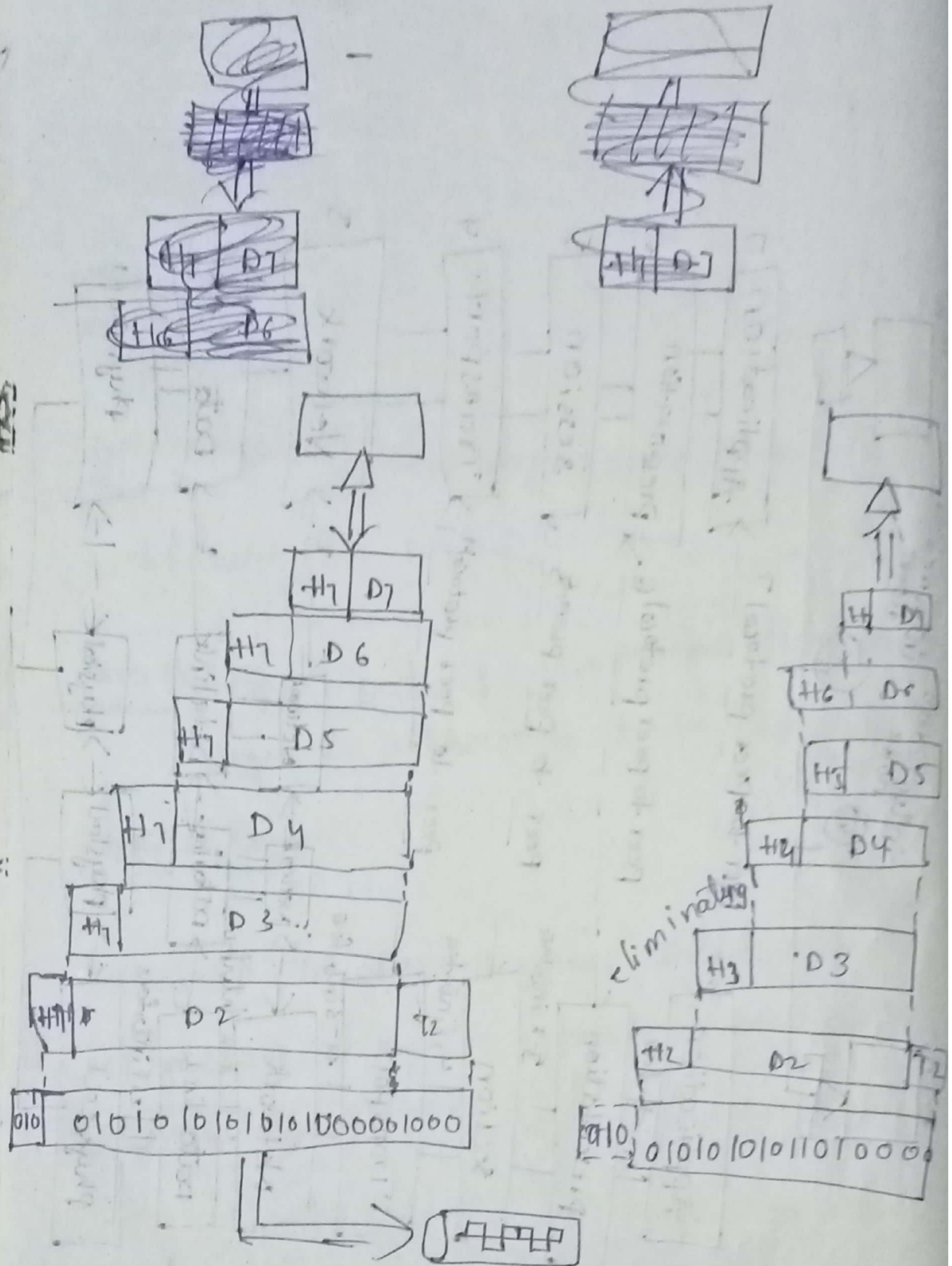


# The interaction

b/w layers in osi Model



# An exchange using the OSI model



Transmission  
medium

Physical layer:- Physical layer is responsible for moments of bits from one half (Node) to another next part. Physical layer deals with electrical & mechanical specification of transmission medium.

Physical layer is also deals with many other things.

1. physical characteristic of interface and medium

- \* wired pair

- \* coaxial cable

- \* optical fiber

2. Representation of bits { 0, 1 }

Physical layer converts entire data into bits & Bits are converted into signals

3. Data rate or transmission rate:-

Physical layer concern speed of a bit and

duration of Bit

4. Synchronization of Bits:- It controls the flow of the sender and receiver.

5. Line configuration:- Physical layer is concerned with connection of network.

- \* point-to-point

- \* multi point

6. Physical topology: -

- Mesh
- Star
- Bus
- Ring

7. Transmission mode:-

\* Simplex

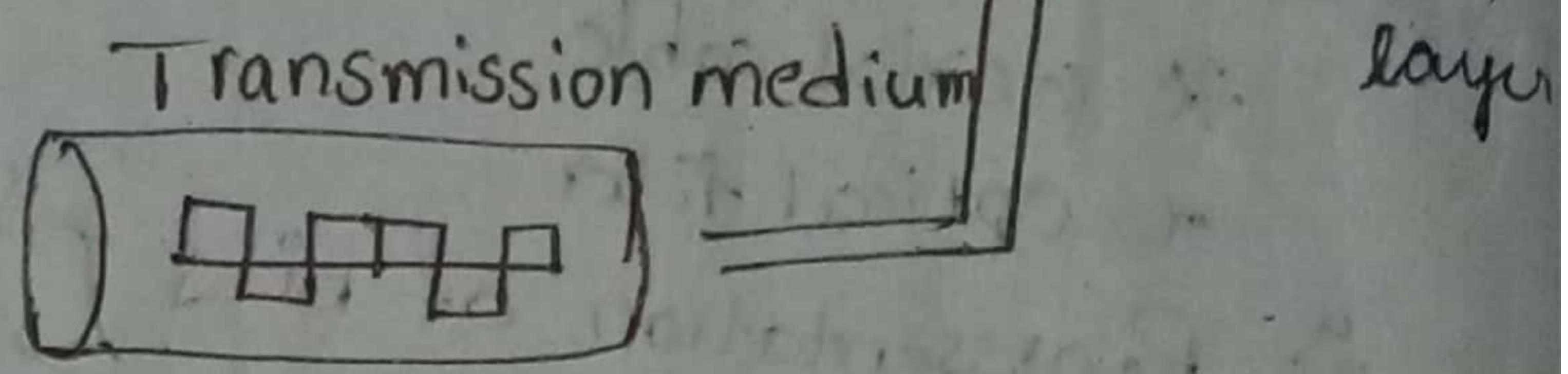
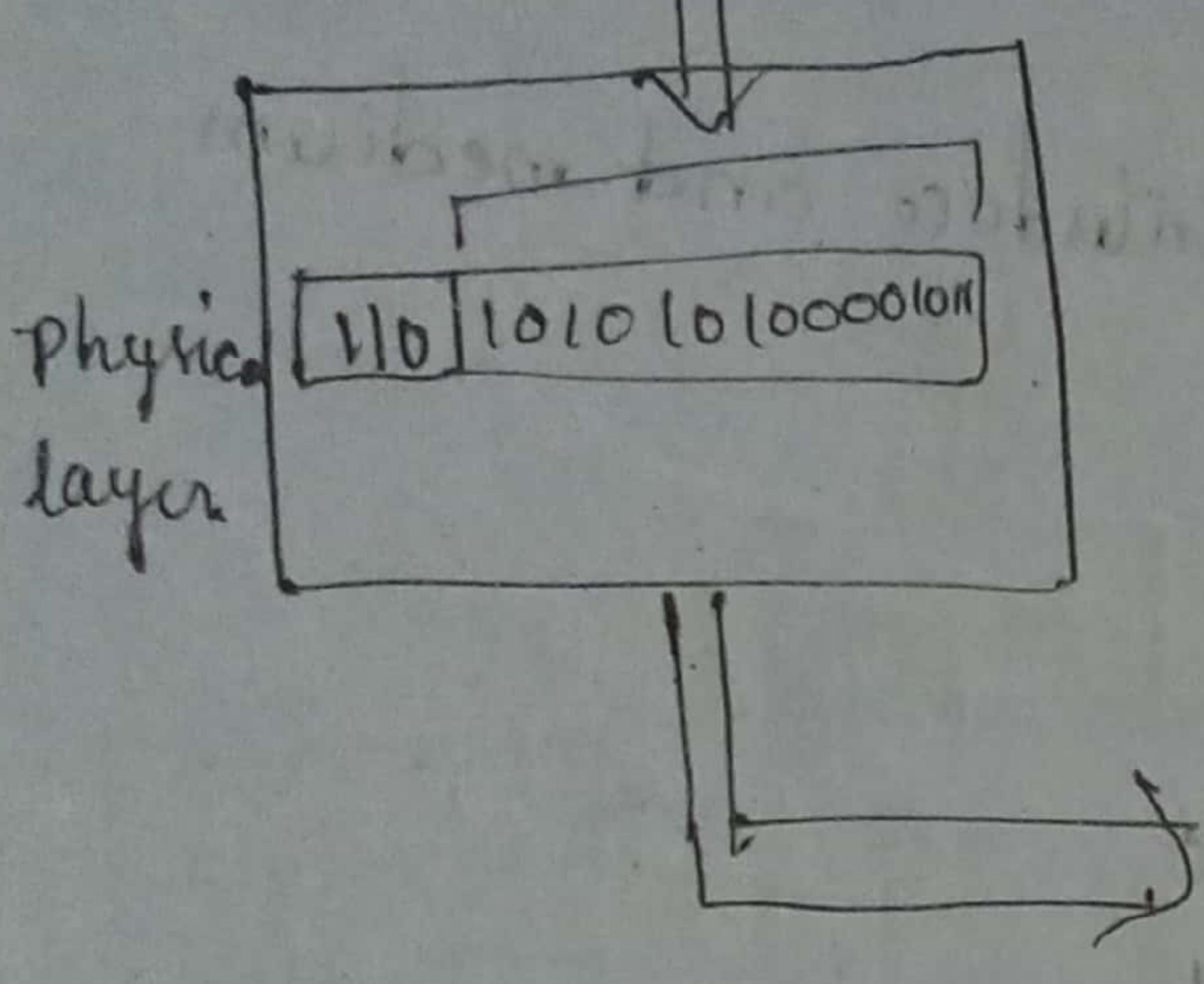
\* Half duplex

\* Full duplex

Diagram for physical layer:-

From data link layer

to data link layer



Data link layer:

Data link layer is responsible for moment of "frames" from one hop to the next

of "frames" from one hop to the next

⇒ In Data link layer extra data is added as

"trailer" ⇒ it is a error checking software  
or error control software.

⇒ Data link layer receives data from network layer converts data into frame. By adding trailers → error control mechanism

## Datalink layers

⇒ it is also responsible for following characteristics

1. framing :- converts data <sup>as</sup> ~~data~~ frames

2. physical addressing :- physical address are MAC address (medium access address) - 48 bits (octet)

9F:1C:3B:5C:4A:2B

{ 8 bits

⇒ Data link layer maintains the physical address of sender as receiver as well as intermediate nodes.

3. Flow control :-

Data <sup>link</sup> layer is flow control at

sender, receiver, intermediate nodes.

4. Error control :-

\* Bit checking each and every bits

\* Hamming distance

↳ Error detection → CRC

↳ Error checking → CRC

5. Accesses control :- Data link layer decides

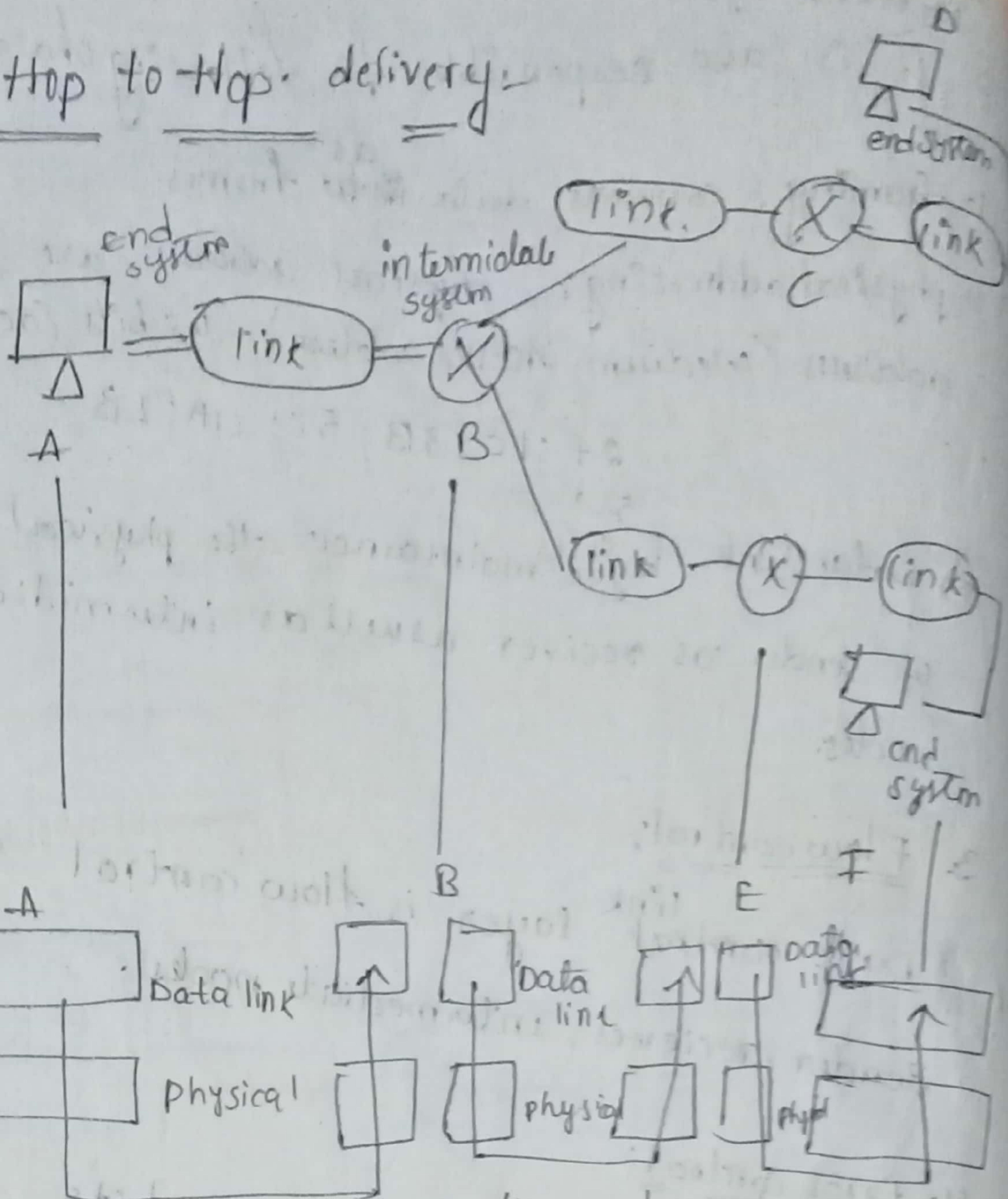
which device has a complete control on a link when multiple devices connecting to same unit.

⇒ ALOHA → pure ALOHA

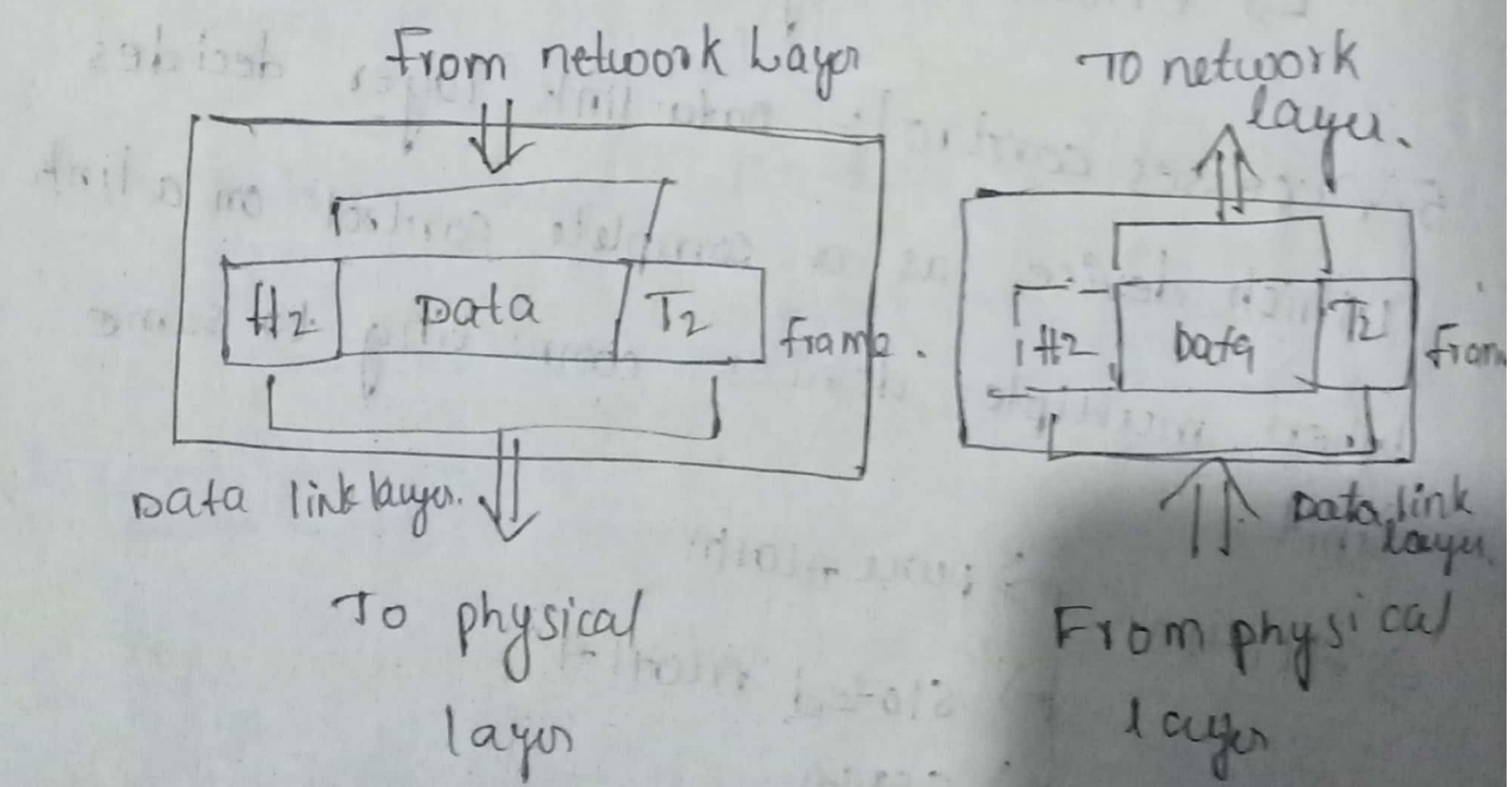
→ slotted ALOHA

CSMA } CSMA/CD  
CSMA/CA carries and multiple access.

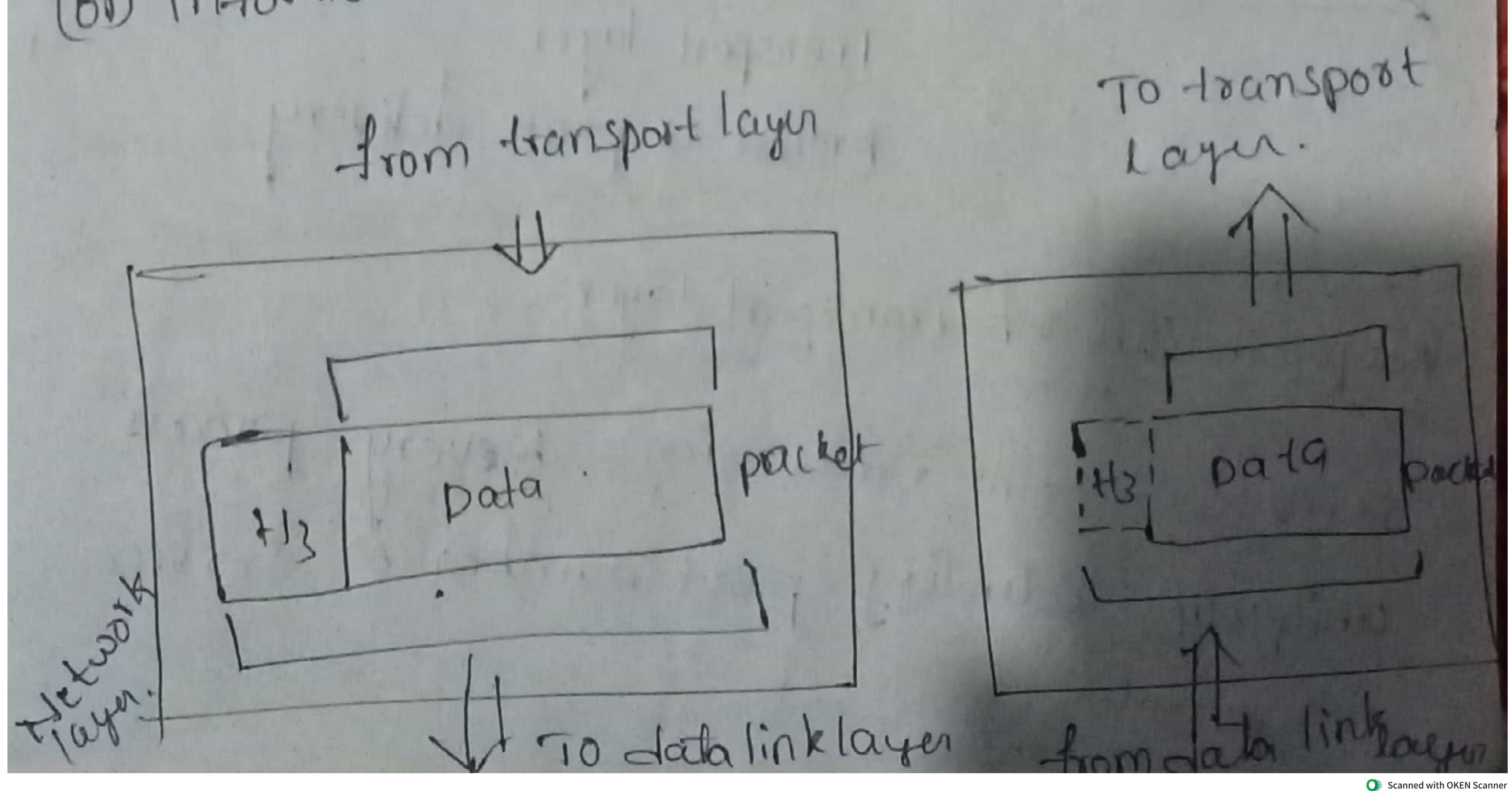
## Hop to Hop delivery



## Data link Layer:



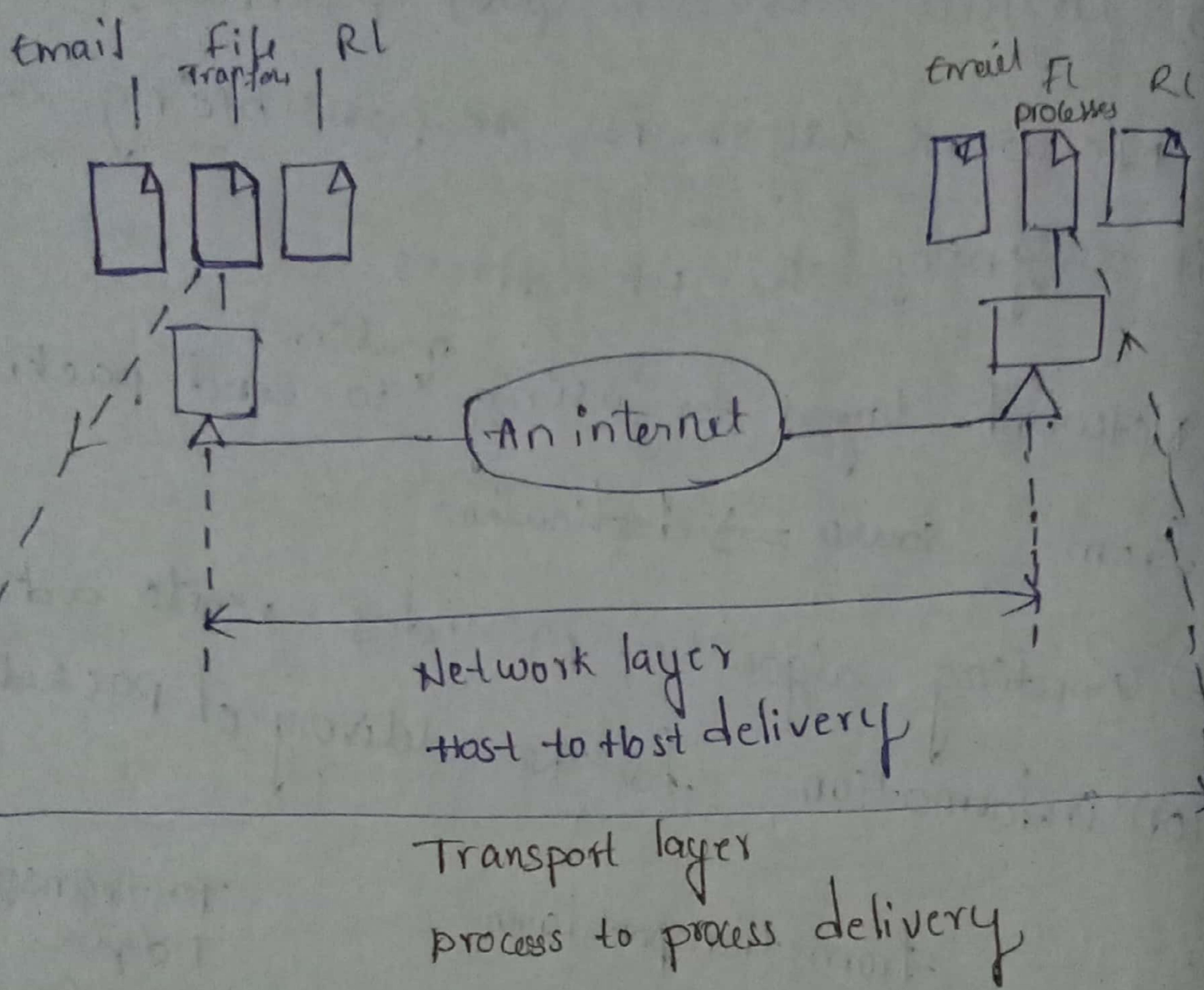
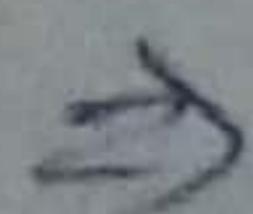
Network layer: Network layer is responsible for sending (i) delivery packages from source to destination other responsibilities:-  
⇒ it is responsible for logical addressing & routing.  
⇒ logical addressing (ip address).-  
Network layer is responsible for assigning ip address to send packet from source to destination  
⇒ Routing algorithm provides routing information for the delivery of packet.



## Transport layer:-

Transport layer is responsible for the delivery of the msg from one process to another.

⇒ Data unit in transport layer is TCP Segment, and UDP Datagram.



## Responsibilities of Transport layer:-

• Source - Point Addressing: Every process uniquely identify port number or service port.

Transport layer responsible for sending msg from source to destination by using ports.

### Segmentation & reassembly:-

Transport layer divides chunks in the larger data in to smaller data units it is called segment.

\* Every segment has a sequence number to correctly identify receiver.

### connection control:-

{ connection oriented done by TCP  
connection less done by UDP

↑ three way hand shaking method used  
Before data transfer path is established b/w sender & receiver  
↓ data is transported independently

→ Data is guaranteed in connection communication

### Flow control:-

⇒ Transport layer is also responsible for n to n

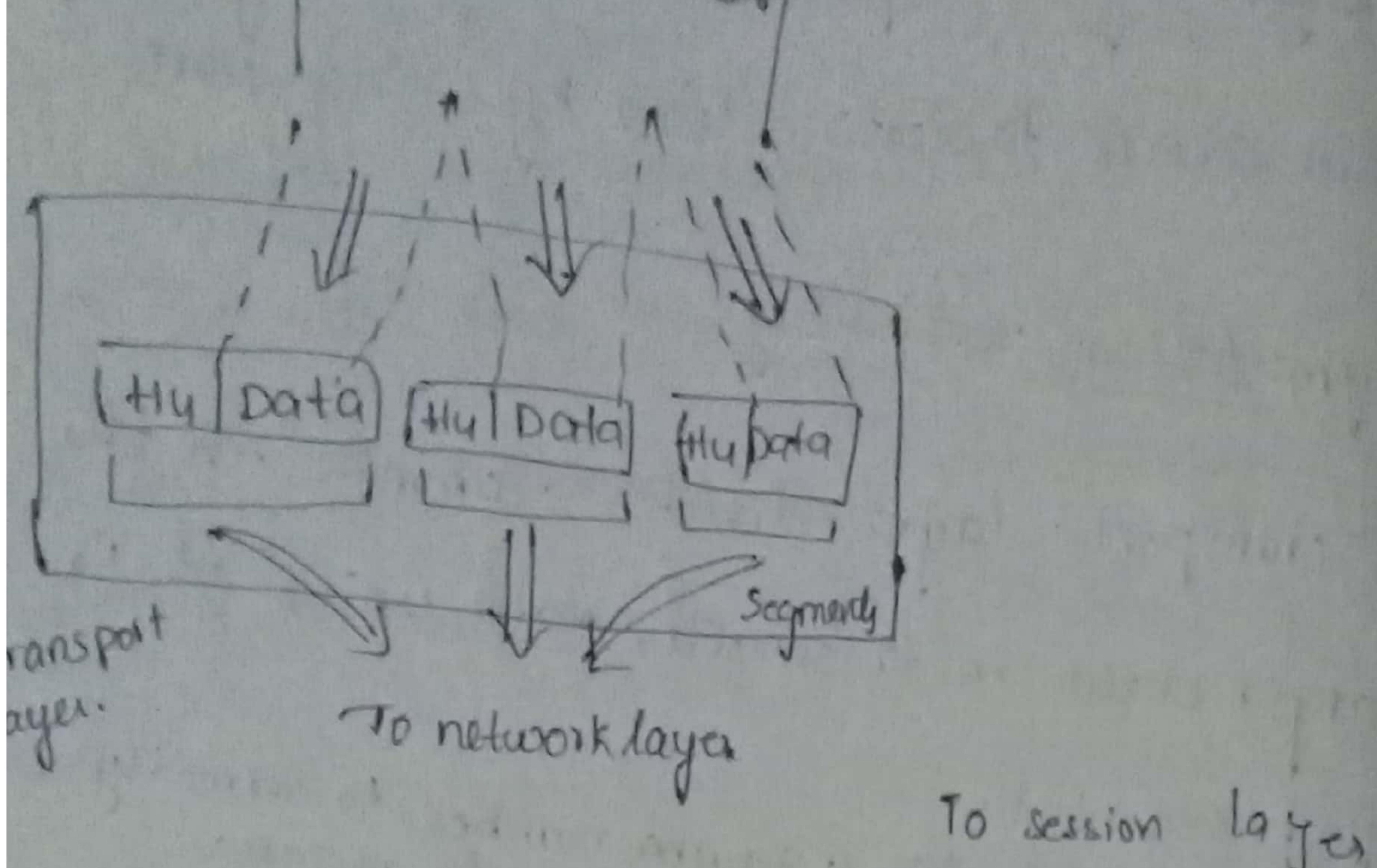
(n) hope to hope

### transport Error control:-

Transport layer retransmits damage data packets

to control errors in the data package

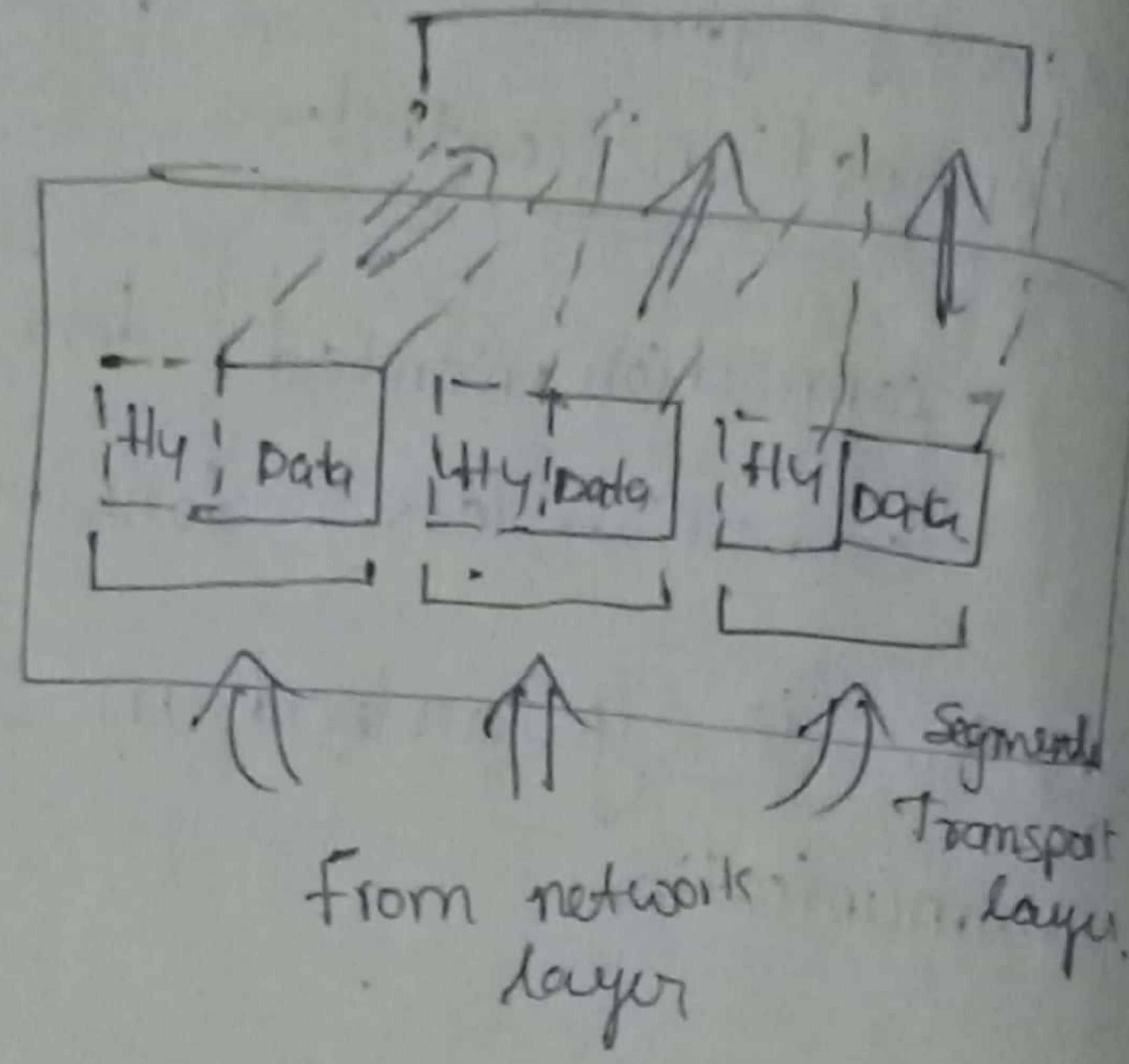
From session layer.



transport  
layer.

To network layer

To session layer



From network layer

Segmented  
Transport  
layer.

## Session layer:

Session layer is responsible for

- \* Dialog control
- \* Synchronization

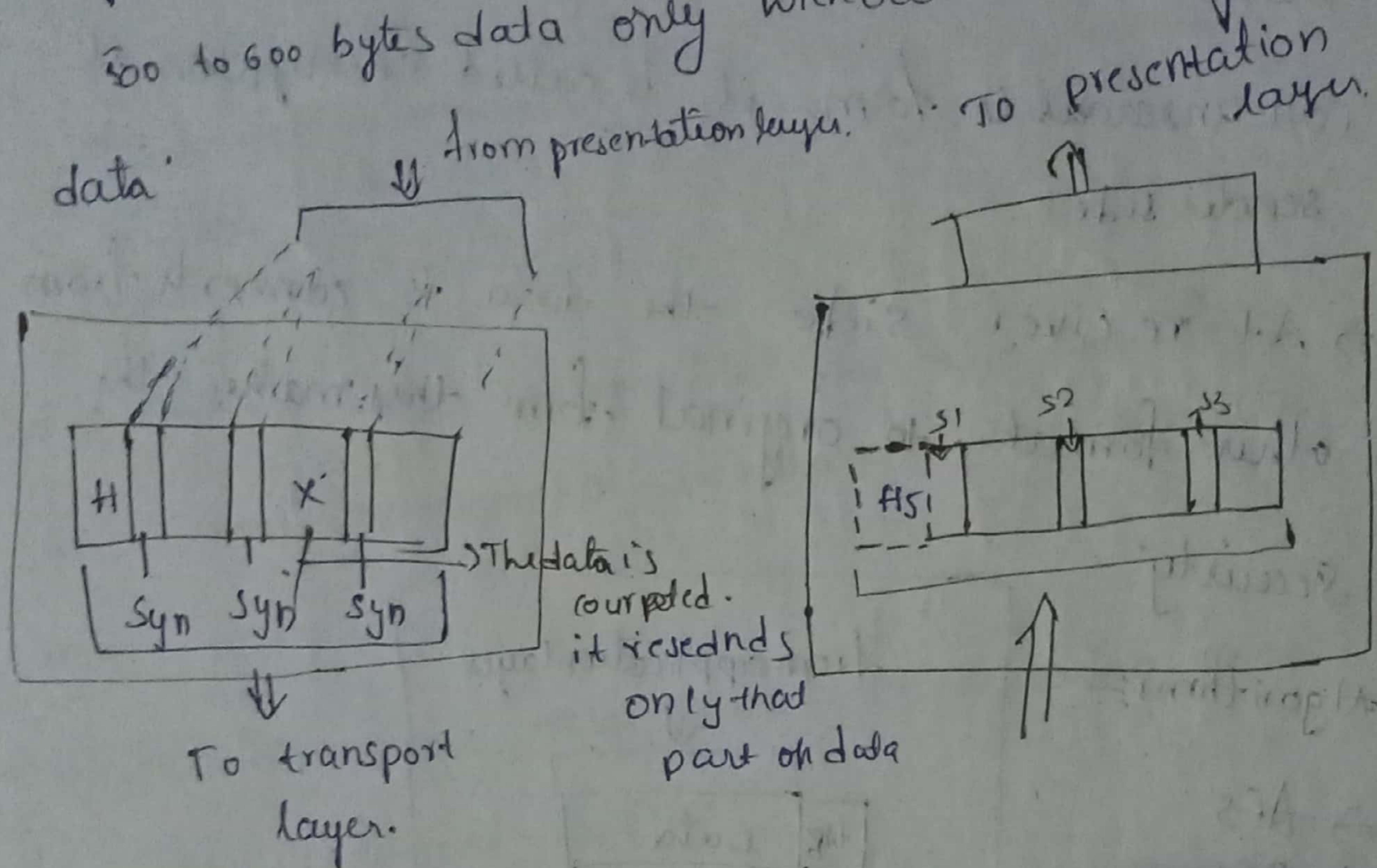
⇒ Session layer is responsible for initiating the communication between sender & receiver either in half duplex or full duplex mode this is called dialog control.

synchronization: session layer is responsible for synchronization.

allowing data by keeping check points (or) syn points.

⇒ if we need 1000 bytes of data, syn points for every 100 bytes.

⇒ if the data is damaged in between 500 to 600 bytes. Session layer resending corrupted data 500 to 600 bytes data only without resending entire data.



Presentation layer: it concerns syntax & semantic.

data which is transmit sender and receiver.

⇒ presentation layer is responsible for translation, encryption, compression.

⇒ During data transmission the entire data can be converted into bits (0,1) and then it is converted into signal +5V +12V -12V -5V.

it has three levels.

\* Translation (encoding)

\* Encryption

\* compression

NRZ-L

NRZ-I

Bi-phase Encoding

Monchester Encoding

Bi-phase Monchester Encoding

Encryption:- presentation layer converts original

data into other form un understandable form,

(a) unreadable form; it is called encryption at sender side

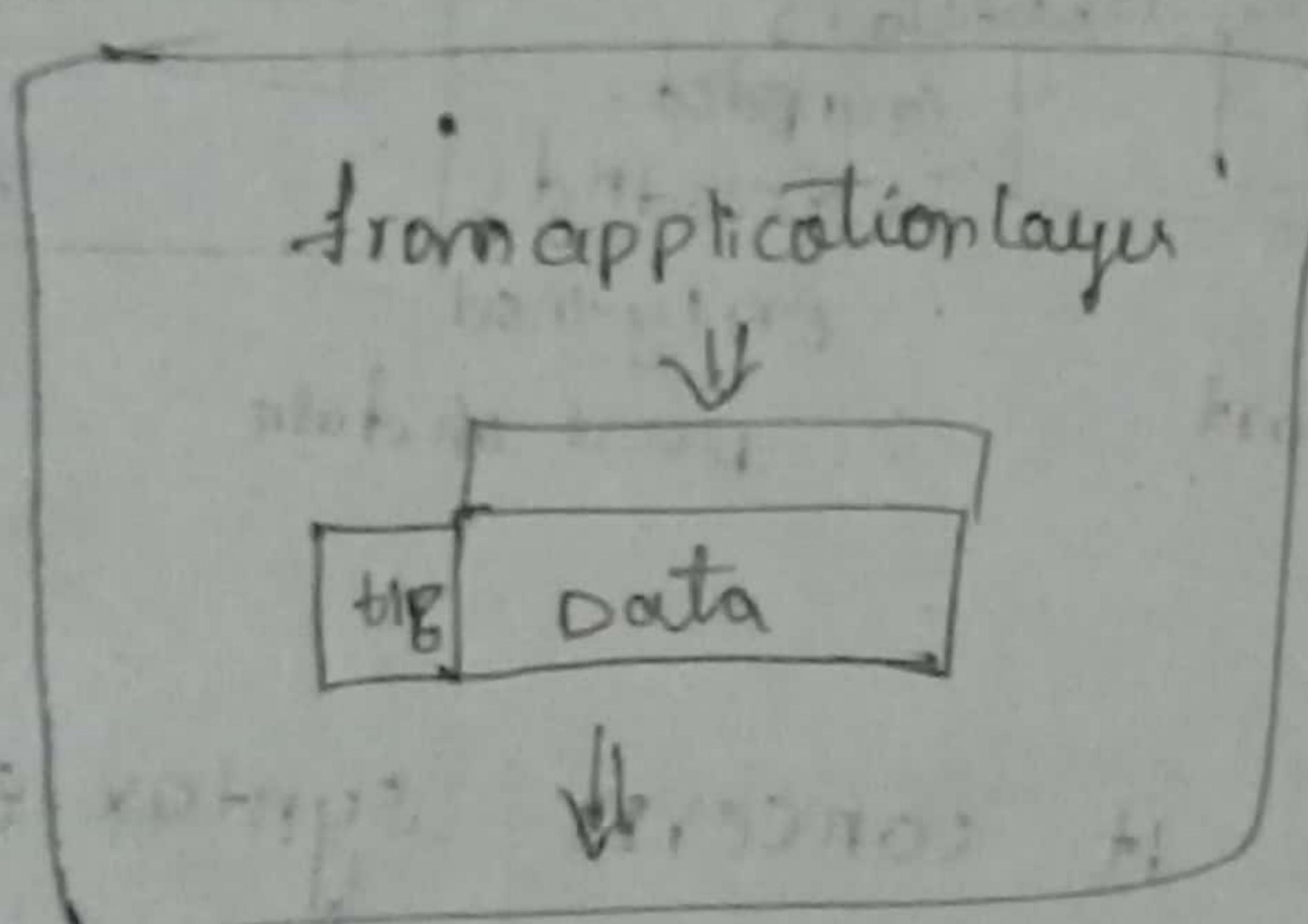
At receiver side the data is converted from other form to original form this makes the security

Algorithms:-

→ AES

→ DES

→ RSA



⇒ Blowfish

To session Layer.

⇒ Message Digest

for data compression

⇒ compression reduces number of bits in the data  
so, it reduces the data transmission

compression:- session presentation layer is responsible

- \* Huffman coding
- \* lossy compression
- \* lossless compression

Application layer: Application layer responsible for providing different services to the user.

- \* Network services, virtual terminal (Remote login)
- \* file access, manages
- \* Mail services
- \* Directory management

~~to remote~~  
Login to the L.

Application layer responsible for file transfer, access and management in between local computer

and

Application layer responsible for sending mail

between different hosts

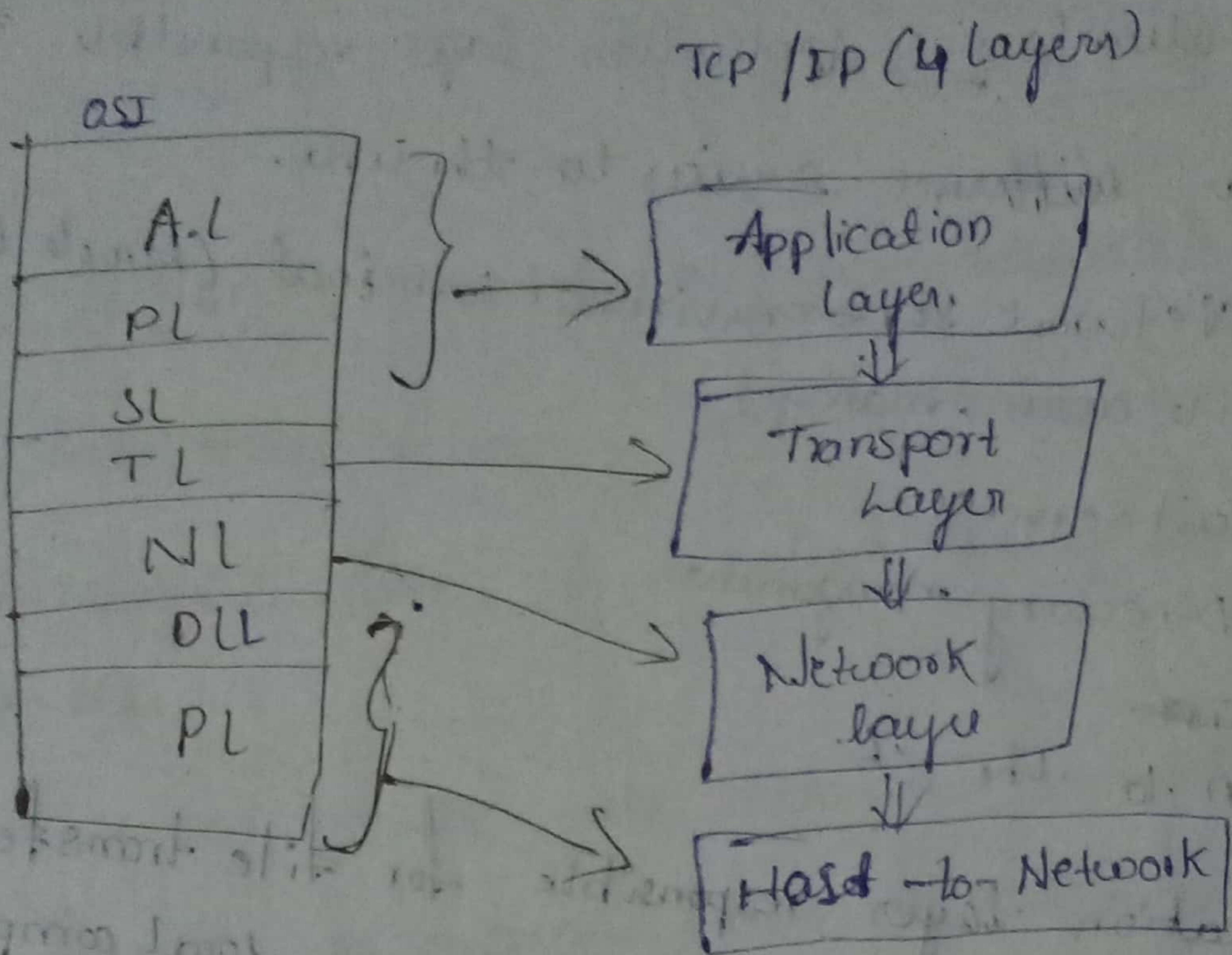
Application layer responsible  
and database management

for distributed file.



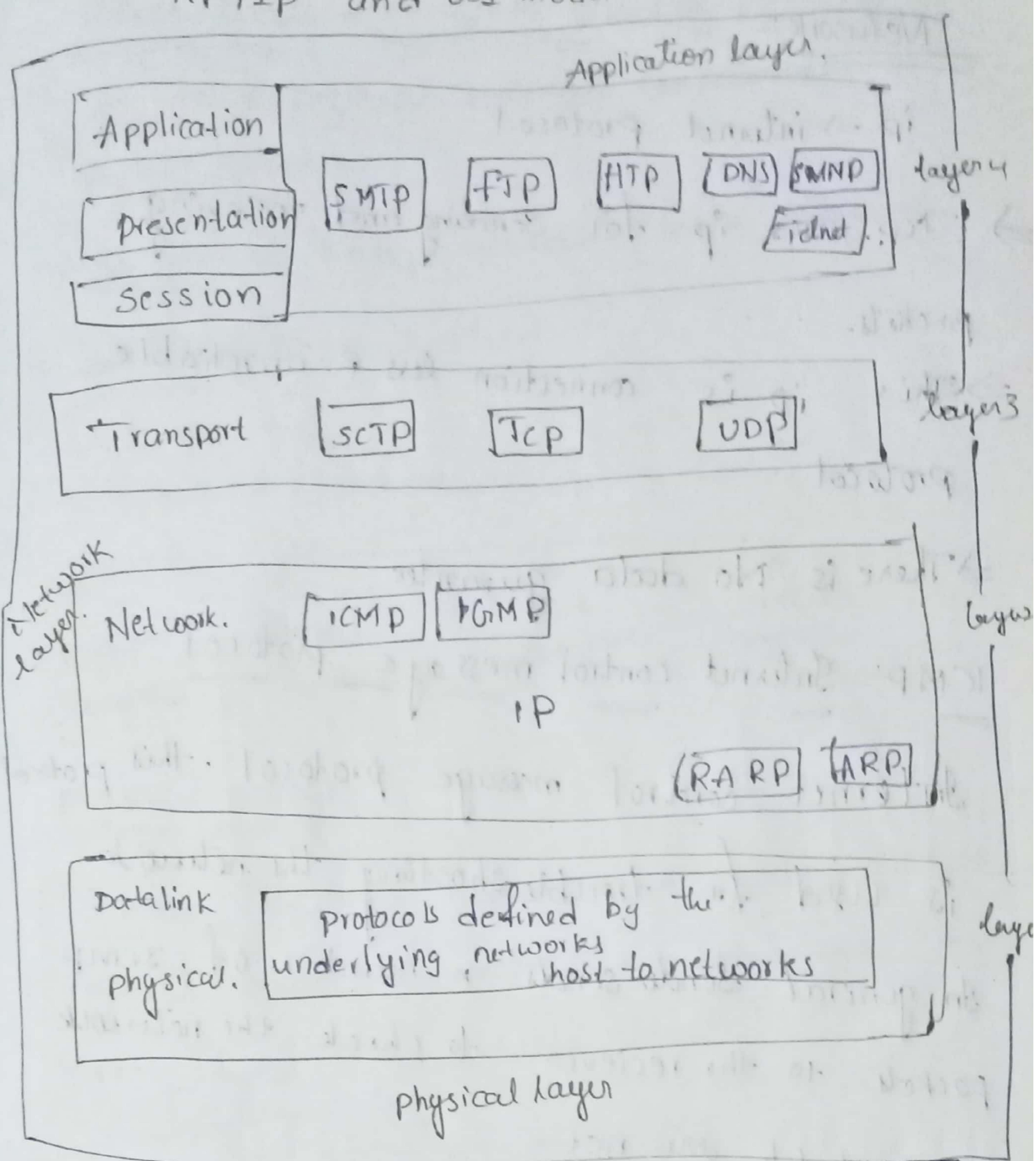
TCP / IP: Transmission control protocol / Internet protocol

Internet protocol



When TCP / IP compared with OSI reference model  
we can say that TCP / IP have 4 layers

# TCP / IP and OSI model



## Physical & Datalink

Physical layer responsible for movement of bits  
There are no different protocols in physical and datalink layer. But this layer to exactly  
But how physical & Datalink layer

## Network :-

ip → internal protocol

⇒ TCP uses ip for sending and receiving packets.

⇒ This ip is connection less & unreliable protocol.

⇒ There is No data guarantee

ICMP: Internet control message protocol

Internet control message protocol . this protocol

is used for troubleshooting the network.

In general sender sends n number of ICMP packets to the receiver to check the network

is available or not

IGMP: Internet group management protocol

IGMP responsible for group mail

ARP-Address Resolution protocol.

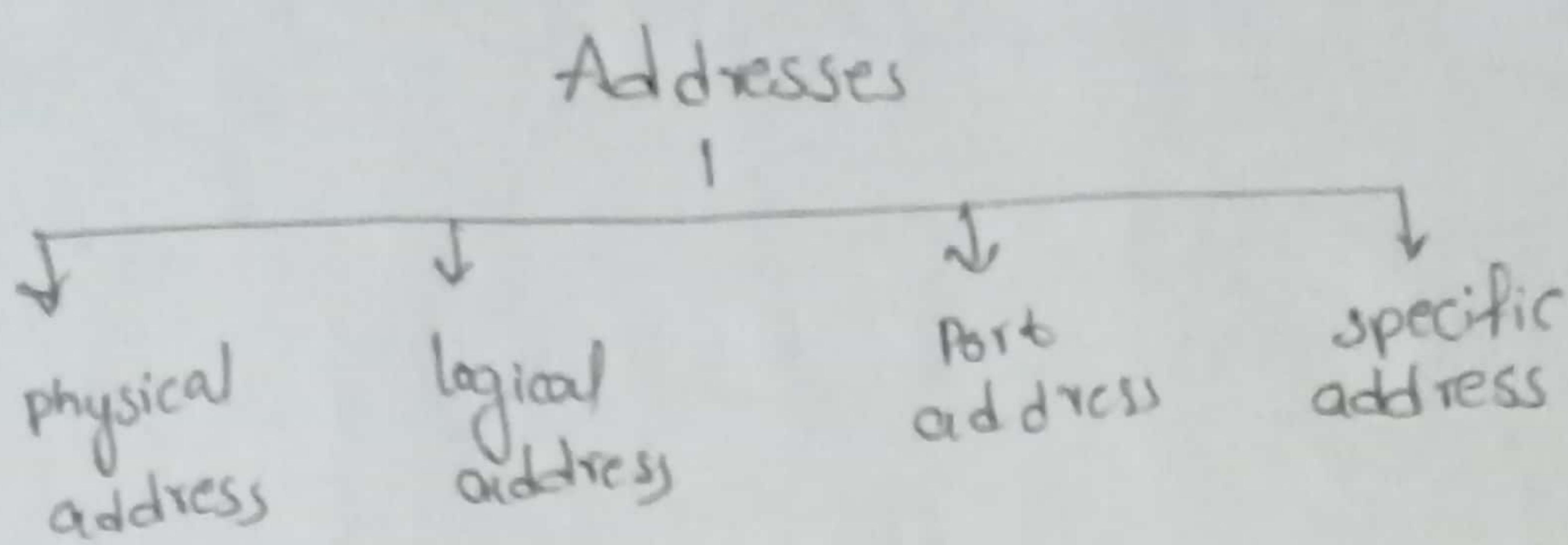
This protocol maps logical address to physical address

Logical → physical  
Address Address

## Reverse address Resolution protocol: RARP.

It maps physical address resolution to logical address

⇒ In general RARP activated when internet is connected to the system



### Physical address:

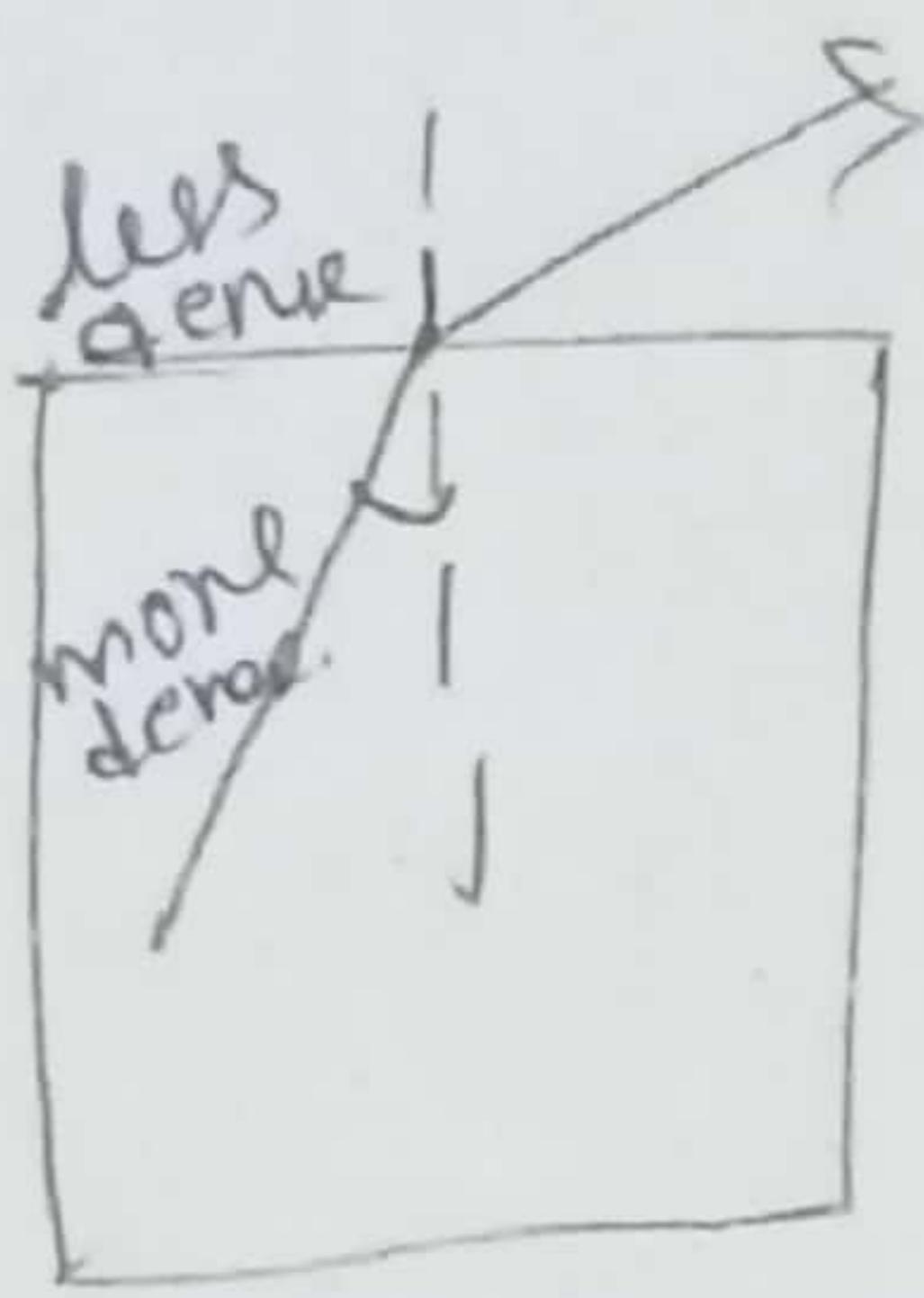
⇒ Most Local-area network use a 48-bit(6 byte) physical address written as 12 hexadecimal digits, every byte 2 hexadecimal digit

07:01:02:01:2C:4B

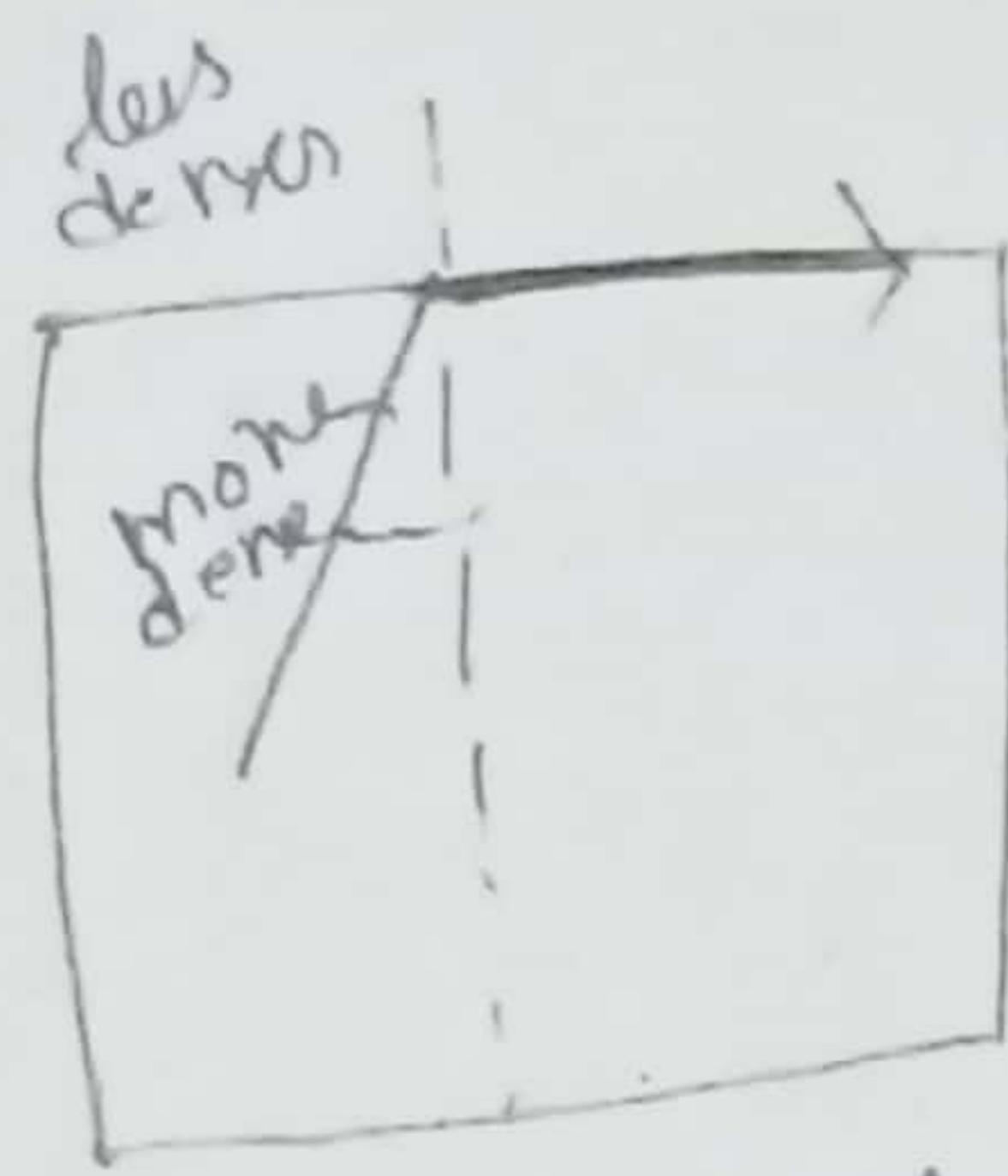
A - 6 bytes (12 hexadecimal digits) physical address

## Fiber optic cable:

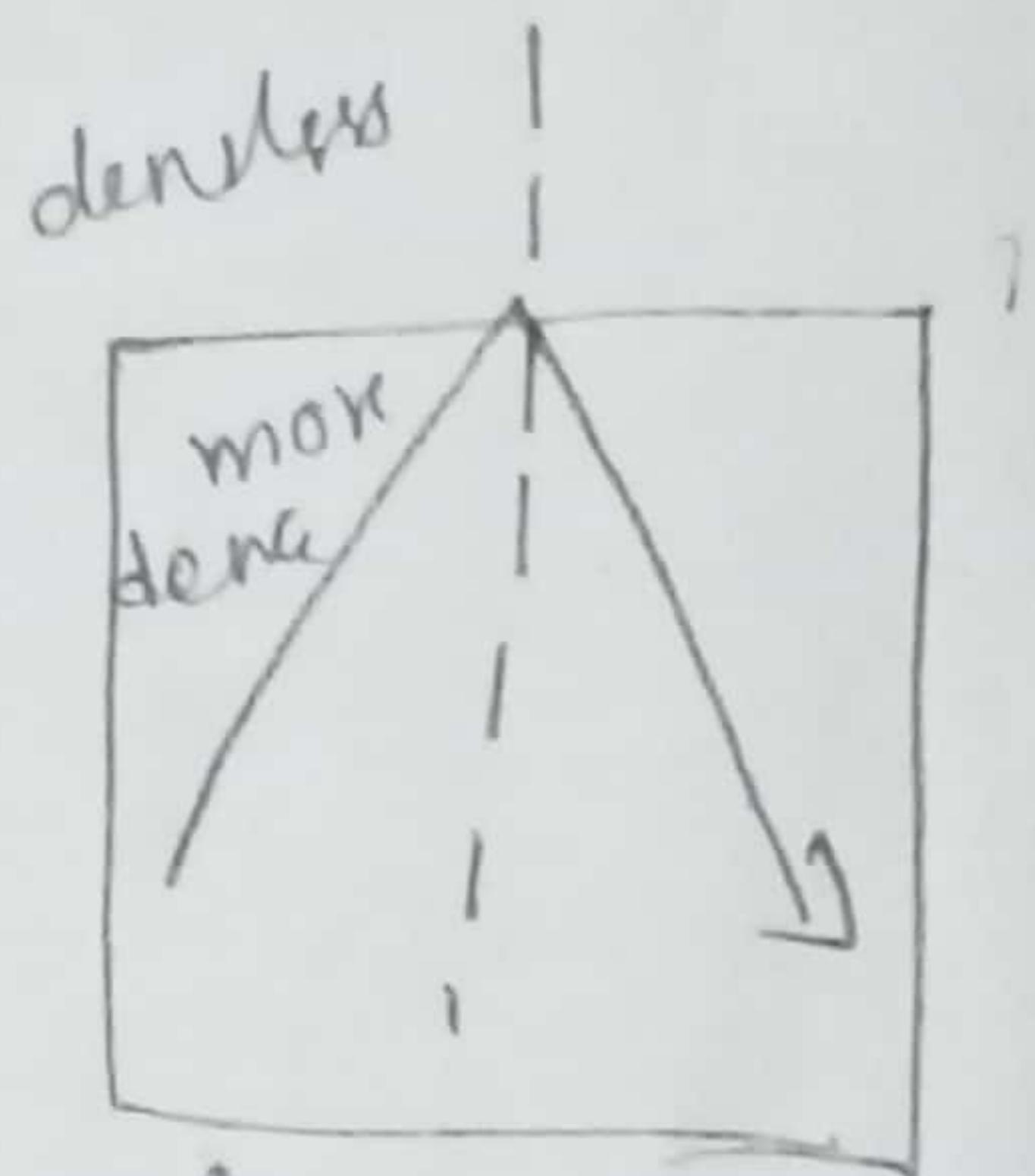
- ⇒ fiber optic made of glass or plastic transmits signals
- ⇒ light travels from one medium to another medium with some angle is called angle of incidence
- ⇒ The angle of incidence which makes  $90^\circ$  to the normal to the surface of separation of two media is called critical angle.



$i < C.A$   
Refraction



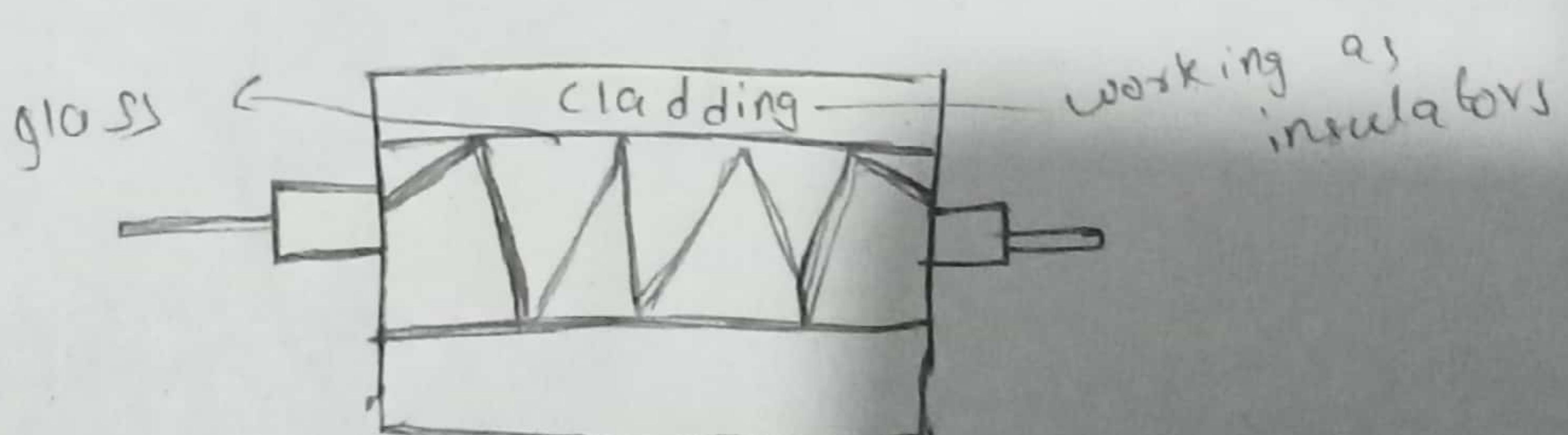
$i = C.A$ , Refraction



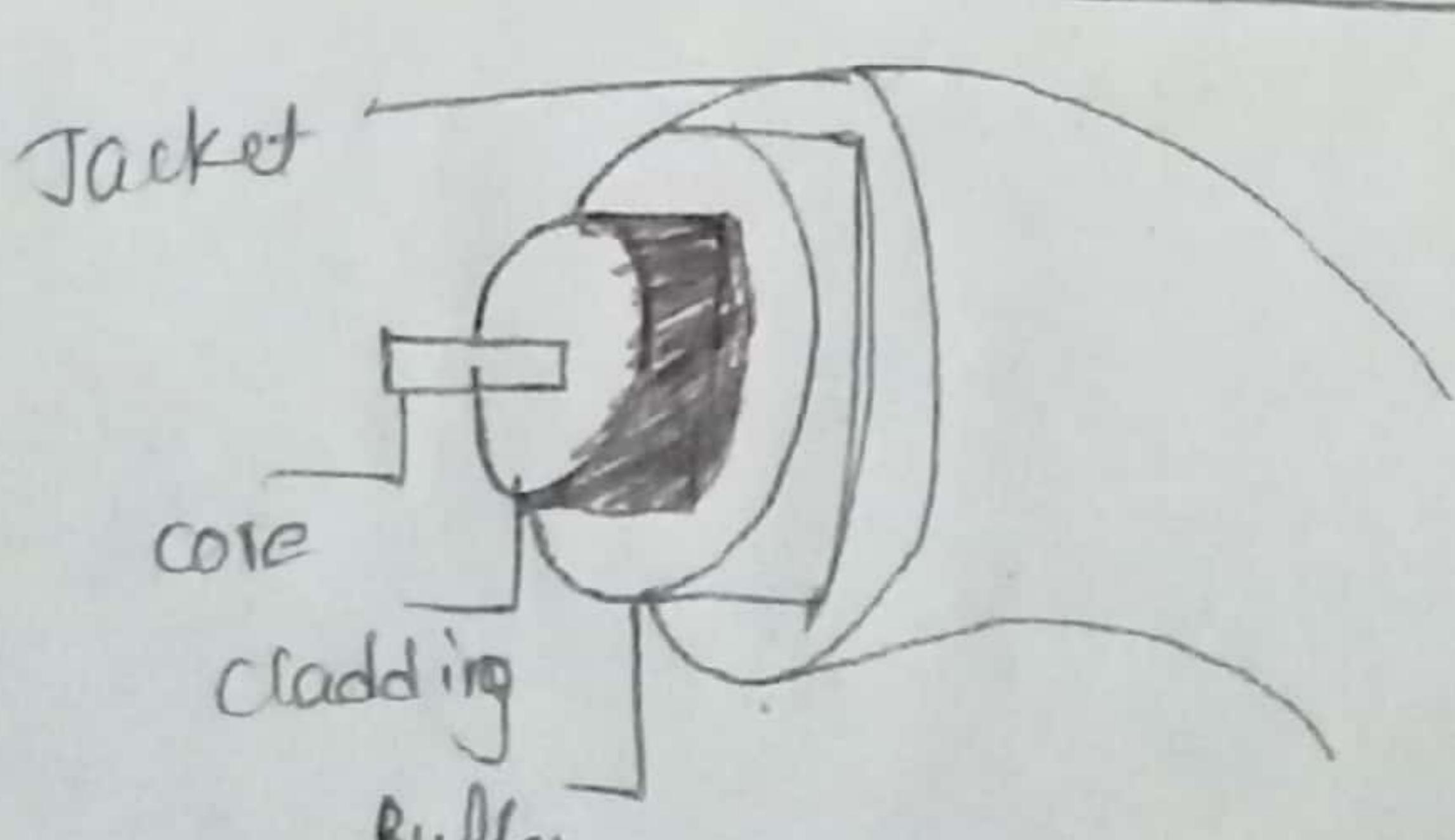
$i > C.A$ , Refraction

## optical fiber:

i)



ii)



## Areas of Applications:

1. Telecommunication
2. Local Area Networks
3. cable TV.
4. CCTV
5. Medical Education.

## Advantages of optical fiber:-

1. Greater capacity .: High speed & long distance
2. Smaller size & light weight
3. Lower attenuation
4. Electromagnetic isolation
5. More resistance to corrosive materials
6. Greater repeater spacing facility.

## Disadvantages:-

- \* Installation and maintenance is difficult.
- \* only unidirectional light propagation.
- \* much more expensive.

