Course Code	18CSS202J	Course Name	COMPUTER COMMUNICATIONS	Course Category	S	Engineering Sciences	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Understand the basic services and concepts related to Internetwork
CLR-2 :	Understand the layered network architecture
CLR-3 :	Acquire knowledge in IP addressing
CLR-4 :	Exploring the services and techniques in physical layer
CLR-5 :	Understand the functions of Data Link layer
CLR-6 :	Implement and analyze the different Routing Protocols

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Learning Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	PLO 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		1	2	3	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Apply the knowledge of communication	2	80	70	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Identify and design the network topologies	3	85	75	H	-	H	-	-	-	-	-	-	-	-	-	M	-	-
CLO-3 :	Design the network using addressing schemes	3	75	70	H	H	-	-	-	-	-	-	-	-	-	-	M	-	M
CLO-4 :	Identify and correct the errors in transmission	1	85	80	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Identify the guided and unguided transmission media	1	85	75	H	-	-	H	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Design and implement the various Routing Protocols	3	80	70	H	H	H	H	H	-	-	-	-	-	-	-	M	-	M

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Evolution of Computer Networks, Network categories	IPv4 Addressing, Address space	Line coding: Unipolar scheme	Framing, Flow Control Mechanisms	Forward Techniques, Forwarding Process
	SLO-2	Data Transmission Modes, Network topologies	Dotted Decimal Notation. Classful Addressing	Polar schemes, Bipolar schemes	Sender side Stop and Wait Protocol, Receiver side Stop and Wait Protocol	Routing Table
S-2	SLO-1	Circuit Switching and Packet Switching	Subnet Mask	Amplitude shift keying, Frequency shift keying	Goback N ARQ, Selective Reject ARQ	Intradomain Routing and Interdomain Routing
	SLO-2	Protocols and standards	Subnetting	Phase shift keying, Pulse code Modulation, Delta Modulation	CRC, Checksum	Static Routing and Dynamic Routing
S 3-4	SLO-1 / SLO-2	Lab 1: **IP Addressing**	Lab 4: **Router Configuration (Creating Passwords, Configuring Interfaces)**	Lab 7: RIP v1	Lab 10: **EIGRP Authentication and Timers**	Lab 13: **Examining Network Address Translation (NAT)**
S-5	SLO-1	Layers in the OSI model, Functions of Physical layer, data link layer	Special Addresses	Multiplexing: FDM	Types of Errors	Distance Vector Routing, Problem Solving
	SLO-2	Functions of Network layer, Transport layer	Special Addresses	Multiplexing: FDM	Types of Errors	Link state Routing
S-6	SLO-1	Functions of Session, Presentation layer and Application layer	Classless Addressing	TDM	Forward Error correction	Problem solving
	SLO-2	TCP/IP protocol suite , Link layer protocols	Problem Solving	WDM	CSMA, CSMA/CD	Path vector Routing
S 7-8	SLO-1 / SLO-2	Lab 2: Subnetting (VLSM)	Lab 5: Basic Switch Configuration: Vlan	Lab 8: RIP v2	Lab 11: Single-Area OSPF Link Costs and Interface	Lab 14: BGP Configuration
S-9	SLO-1	Network layer protocols	Private Address, NAT, Supernetting	Guided Media: Twisted Pair, Coaxial Cable Fiber optic cable	Hamming Distance	RIP v1,RIP v2
	SLO-2	Transport layer protocols	Hub, Repeaters, Switch	Unguided media: Radio waves	Correction Vs Detection	OSPF
S-10	SLO-1	Serial and Parallel Transmissions	Bridge	Microwaves	HDLC	EIGRP
	SLO-2	Addressing	Structure of Router	Infrared	PPP	BGP
S 11-12	SLO-1 / SLO-2	Lab 3: LAN Configuration using straight through and cross over cables	Lab 6: Static and Default Routing	Lab 9: EIGRP Configuration, Bandwidth, and Adjacencies	Lab 12: Multi-Area OSPF with Stub Areas and Authentication	Lab 15: Configuring Static and Default Routes

UNIT - 1

EVOLUTION OF NETWORKS :-

- Need of a Network :-

* It enables associated PCs to share documents and information and also equipment assets (ie) scanner, projectors, storage Devices etc.

(i) ARPANET (Advanced Research Agency Network)

- It became the basis of the Internet
- established in 1969
- Here various PCs were associated at various colleges and US DoD for sharing of information and messages and playing along seperation diversions and associating with individuals to share their prespectives.

(ii) NSFNET (National Science Federation Network)

- It was created by National Science federation Network which was more capable than ARPANET
- It became the backbone infrastructure for commercial public Internet.
- main aim was to use network only for academic research

(iii) INTERNET

- It is a network of networks
- It is a globally evolved + connected network system that utilies TCP/IP to transmit information.

(iv) INTERSPACE

- It is a software that allows multiple users in a client-server environment to communicate with each other to send and receive data of various types such as data files, video, audio and textual data.

TYPES OF NETWORK :-

(i) LOCAL AREA NETWORK (LAN)

- It is a network that is confined to a relatively small area eg: labs, school, colleges etc.
- In this one computer is designated as the file server. It stores all of the software that controls the network as well as the software that can be shared by the computers attached to it.

- Computers connected to file server are called workstation

- Speed varies from 10Mbps to 10Gbps

(ii) WIDE AREA NETWORK :-

- It covers a large geographic area such as a County, continent etc.

- It is two or more LANs connected together. Connected LANs can be seperated miles apart.

- To cover great distances, WAN may transmit data over leased high-speed phone lines (or) wireless link such as satellites.

- eg: Internet

(iii) METROPOLITAN AREA NETWORK (MAN)

- It is a large computer network that usually spans a city (or) a large campus

- It has more Geographic area than lan ranging from several blocks of buildings to entire city

- It might be organized and operated by a single organization but used by many individuals.

- It covers 5 to 50km

- Eg: Telephone Company that provides a high speed DSL to customers and Cable TV Network.

DATA TRANSMISSION MODES :-

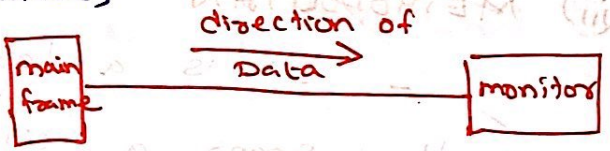
Communication between devices can be Simplex, half-duplex and fully duplex

(i) Simplex

In this mode the communication is unidirectional

only one of the two devices on a link can transmit and other will act as a receiver.

eg: keyboards, monitors, mouse etc.



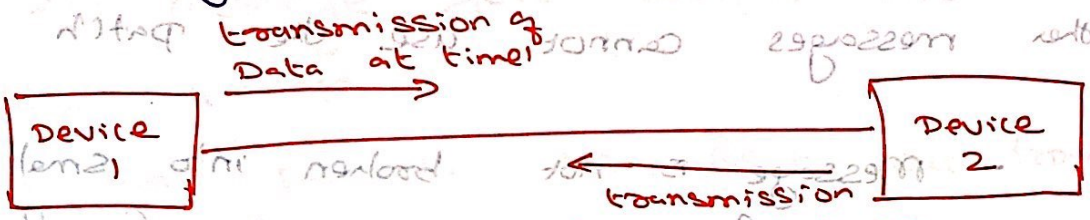
(ii) Duplex

- half-duplex.

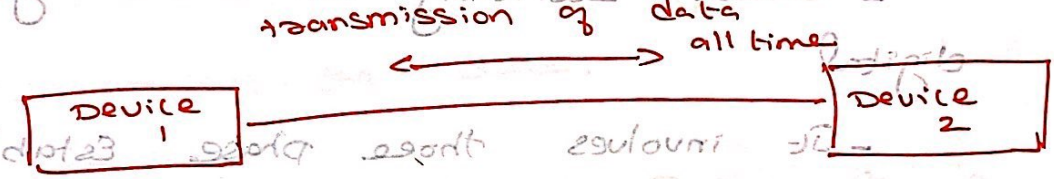
Both devices in a link can both transmit & receive data but not at the same time

- (or) when one device is sending the other will be receiving & vice-versa
- This is used in cases where there is no need for communication in both direction at the same time so the entire channel is used for single direction either transmisson or receiving

eg: walkie-talkies, citizens Band radio etc.



- Full Duplex



- Both Devices can transmit & receive signal at the same time
- The link must have two physically seperate channels one for sending & other for receiving (or) the capacity of the channel is divided between signals travelling in both directions

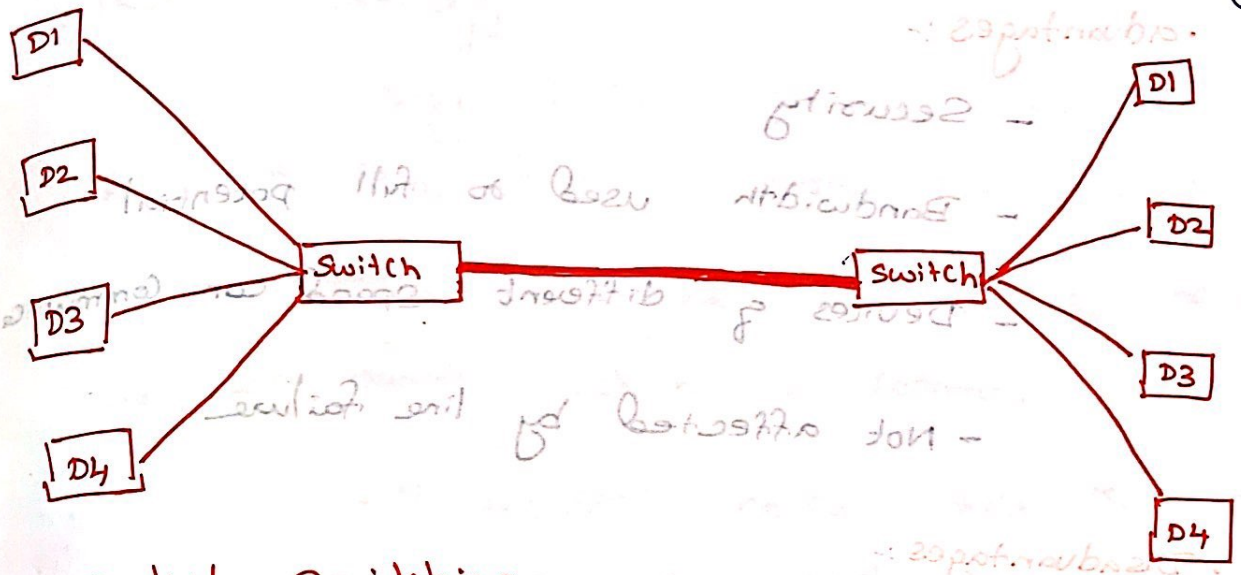
eg: telephone line, etc.

CIRCUIT SWITCHING AND PACKET SWITCHING

- Circuit Switching
  - There is a dedicated connection is always available between two end systems Switch can only make it active or inactive
  - A message is sent through a channel via the switches at the same time other messages cannot use the patch
  - Message is not broken into small pieces orginal message is transfered
  - Circuit Switching can be analog or digital
  - It involves three phase Establish, Transfer Disconnect

- Advantages
  - No interference, no sharing
  - Guranteed full bandwidth for the duration of the call
  - Quality of Sevice

- Disadvantages
  - Inefficient because only few can be transmitted at a time
  - long time to set up the circuit
  - During Crisis network become unstable



- Packet Switching

- A message gets broken into small data packets

- These packets are sent out from the computer and they travel around the network and find the efficient path for transmitting the data.

- Each packet are sent with a header address so it tells where to go and also how many sequence for re assembly at the destination to get the correct message

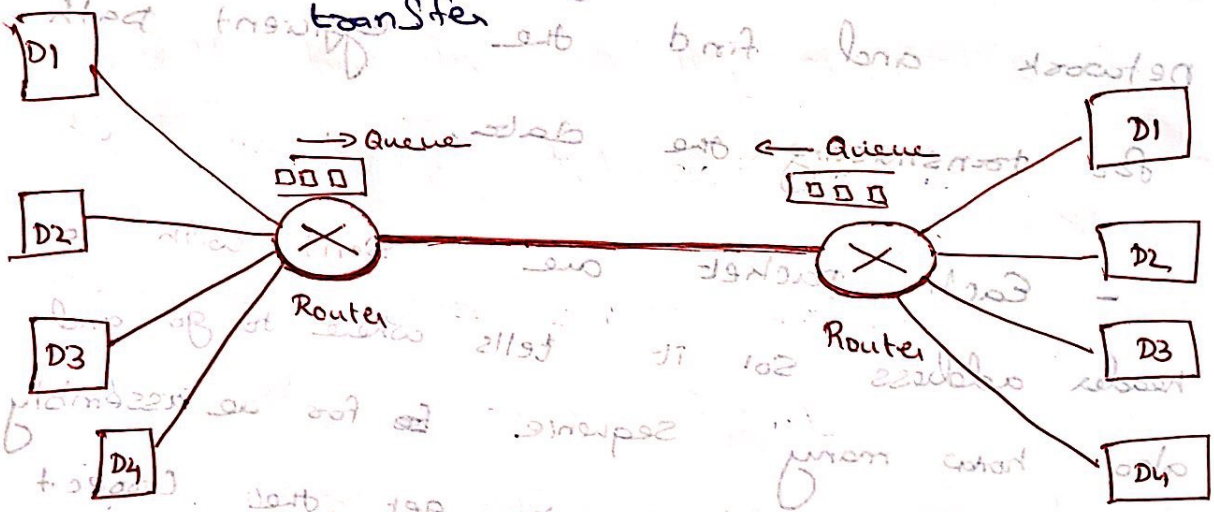
- If one packet fails to arrive the recipient computer sends a message back to the computer which orginally sent the data, asking for the missing packet to be resent.

• advantages :-

- Security
- Bandwidth used to full potential
- Devices of different speed can communicate
- Not affected by line failure

• Disadvantages :-

- Heavy use these can be delay
- Data packets can get lost or become corrupted
- Protocols are needed for a reliable transfer



NETWORK TOPOLOGY :-

- It refers to a way in which a network is laid physically.
- Two or more links together is called a Topology.

(i) Mesh Topology :-

- Every devile has a dedicated point to Point link to every other device

- There will be traffic only between the two device which it connects

- N - represents nodes which is the number of devices connected

- Each devices must has (N-1) links coming out of it

- Total links in a Mesh Network is $\frac{N(N-1)}{2}$

- Advantage

(i) No traffic problem between two devices

(ii) If one link is unstable it will not affect the entire network

(iii) fault identification & analysis is easy

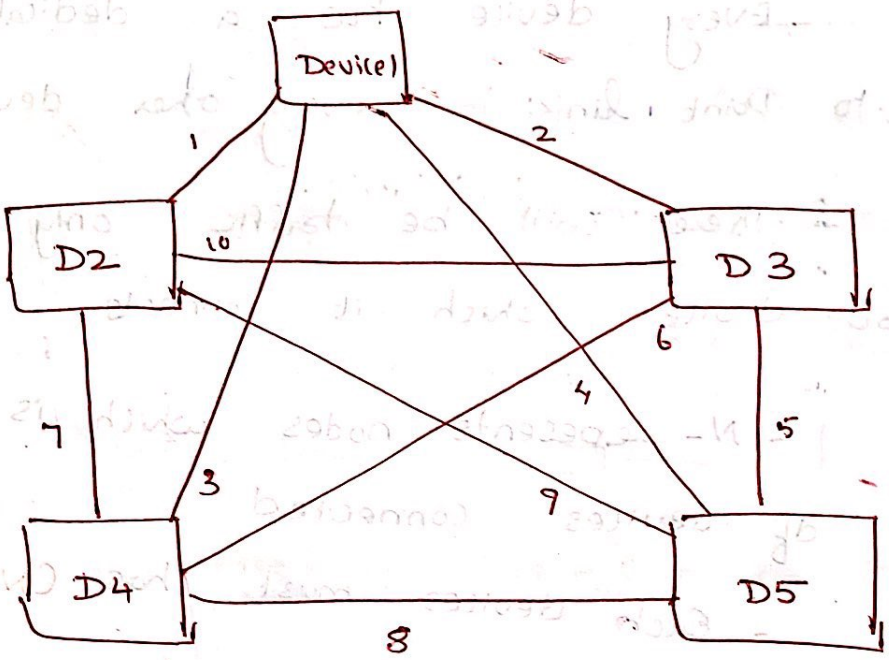
- Disadvantage

(i) it requires more amount of cabling

(ii) Installation & reconnection are difficult

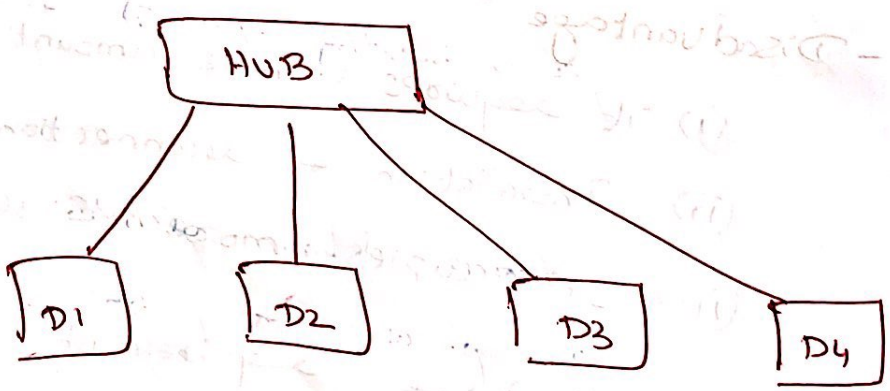
(iii) It occupies more space

(iv) Hardware requirement is high & expensive



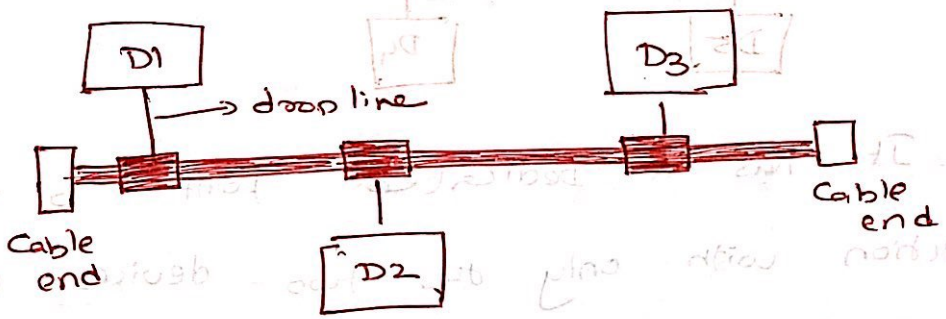
(ii) STAR TOPOLOGY

- Each device is connected to a central controller usually called hub
- Controller act as an exchange
- If one device wants to send data to another it sends the data to controller which sent it to the required device



- Advantage
  - If one link fails only that link fails it will not affect the entire network
  - Easy fault identification
  - Less cable + I/O ports
- Disadvantage
  - whole network depends on a single point

(iii) Bus Topology

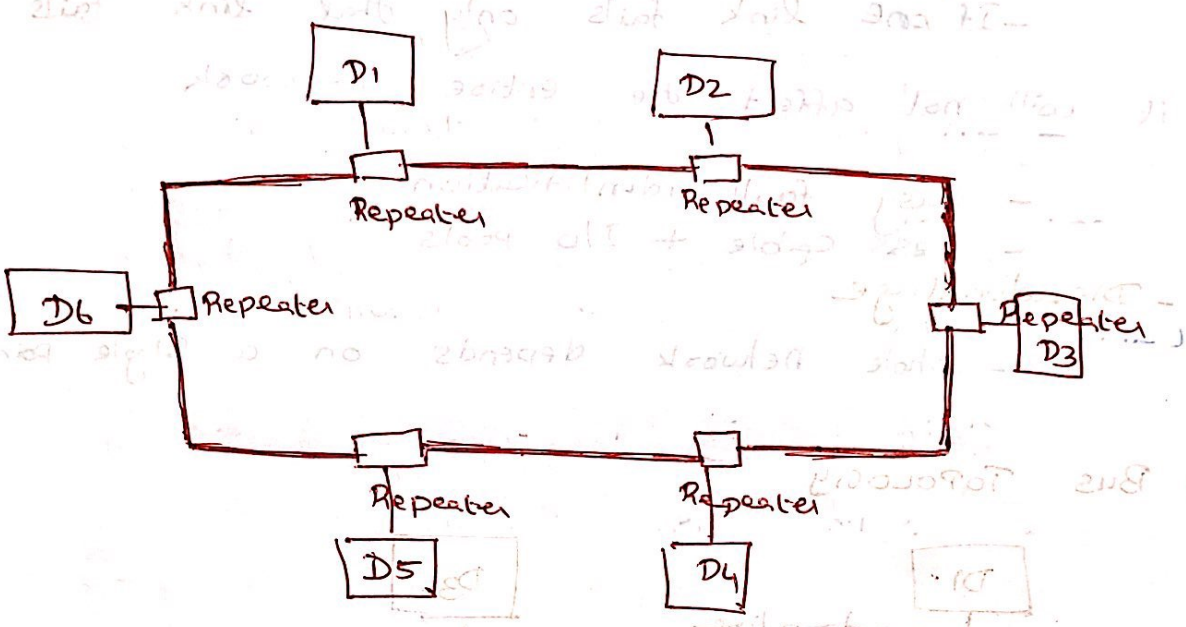


- one cable connects to all the devices for sharing data with the help of taps + Drop line
- As signals transmitted through cables it generates heat which may affect the taps ∴ there is a limit for how many devices can be connected

- Advantage
  - Ease of installation
  - Less cabling than star + mesh topology

- Disadvantage
  - Difficult fault identification
  - Difficult to add new devices
  - fault or break in the main line affects the entire System

(IV) RING TOPOLOGY



- It has a Dedicated point to point connection with only the two devices on either side of it.
- A Signal is sent in one direction from device to device until it reaches the destination
- Repeater regenerates the bits and passes them along.

- advantage
  - Easy to install and reconfigure
  - fault identification is simplified
- disadvantage
  - unidirectional signal
  - Adding or deleting a device is tough

#STANDARDS AND PROTOCOLS

_PROTOCOLS:-

- In computer networks, two entities cannot simply send bit stream to each other, they must agree on a protocol
- Protocol is a set of rules that govern data communications

(i) Syntax
- format of data (ie) order in which they are presented

(ii) Semantics
- meaning of each section of bits
eg: whether address - identify route to be taken or final dus of message

(iii) Timing
- Refers to two characteristics
- when data should be sent
how fast it has to be sent

- STANDARDS

- essential in creating + maintaining open and competitive market for equipment manufacturers + in guaranteeing national and international operability of data

- It provides guidelines to manufacture Vendors, govt agencies + other services provides to ensure interconnectivity

Data Communication falls in two catogories

(i) De facto (by fact (or) by convention)

* Standards not been approved by organized body but adopted as standards through widspread use

* established by manufacturers, who seek to define functionality of new product & technology.

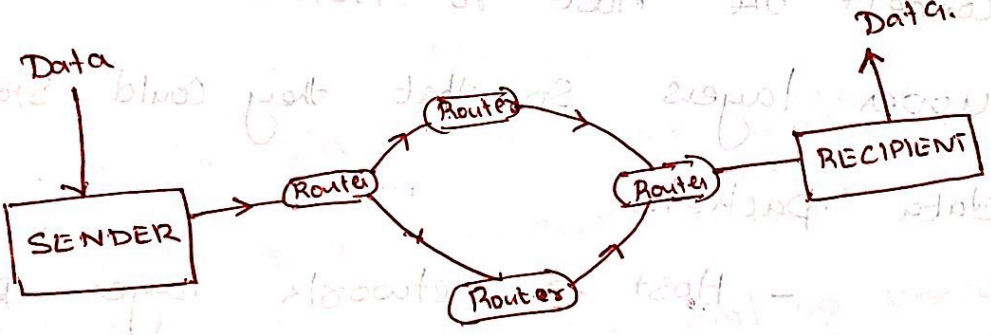
(ii) De Jure (By law (or) by regulation)

* registered by officially recognized body.

THE TCP/IP PROTOCOL SUITE :-

- The Transmission Control / Internet protocol Suite of protocol form the basis of the Internet.
- It creates a virtual network when multiple computer networks are connected together.

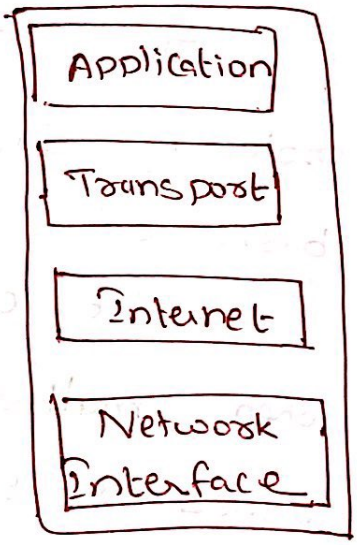
- Internet protocol address is a numerical label assigned to each device (eg: computer, printer) participating in a computer network that uses the Internet protocol for communication



* The TCP protocol breaks data into packets
* Packets send from Router to Router over the Internet via Internet protocol
* In receiving end TCP reassemble the packets to whole message.

It consist of four important layer

(i) Application
(ii) Transport
(iii) Internet
(iv) Network Interface



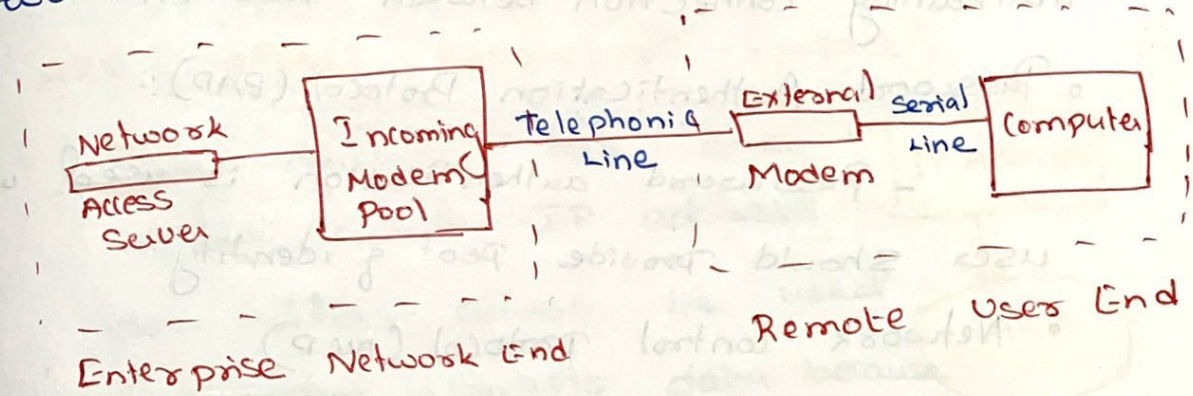
(i) Network Interface Layer

- It is the bottom layer of TCP/IP model lies below the Internet Layer
- It connects Host to Network Layer
- main function of this layer is to connect the host to Network & Inform th upper layers so that they could start sendin data packets
- Host to network layer protocols are of two types SLIP (Serial Line IP), PPP (Point to Point Protocol)

(a) SERIAL LINE INTERNET PROTOCOL

- It is very simple and used to connect the workstation to internet over dial up line using a modem.

- It begins transmission only when there is a proper connection between two modem



drawbacks

(i) It is not an approved internet Standard

(ii) It doesnot provide any authentication

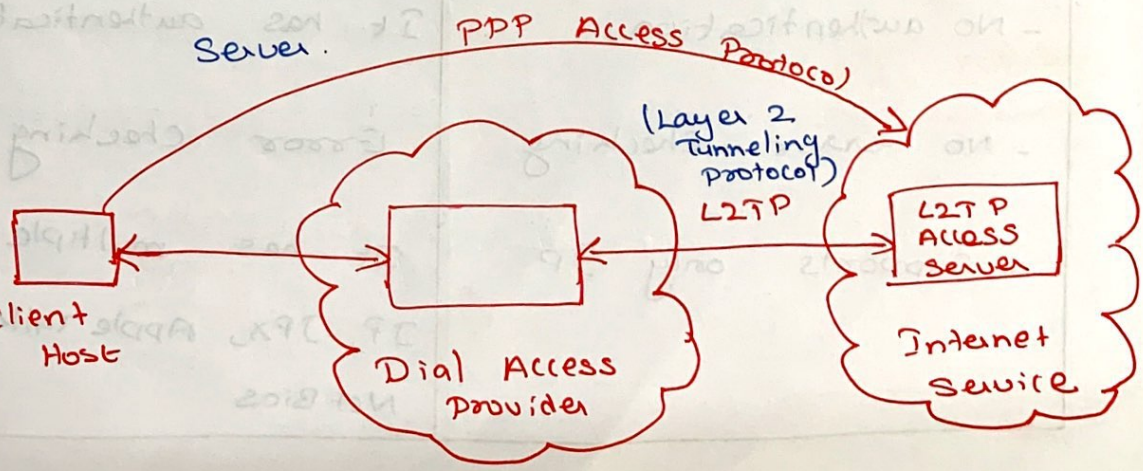
(iii) They donot provide way of detecting (or) correcting errors in transmission

(b) Point to Point Protocol

- It is a data link layer protocol

- It is a standard protocol for remote access, using dial-up connection

- It passes the packet in the form of frame between a client & Server.



It has the following protocol

- Line Control Protocol (LCP):-
  - It is responsible for establishing, maintaining connection between two end
- Password Authentication Protocol (PAP):-
  - Password authentication is used where user should provide proof of identity
- Network Control protocol (NCP)
  - once autentication is done, it Send NCP packet. This packet tells ISP Server what kind of traffic is to be passed
- IP Control Protocol (IPCP)

  In this the IP packets are exchanged

SERIAL LINE IP	POINT TO POINT PROTOCOL
- Older Protocol	New protocol
- Require no addressing	Supports dynamic IP address
- No authentication	It has authentication
- No error checking	Error checking
- Supports only IP	It has multiple protocols IP, IPX, Apple Talk, Net Bios

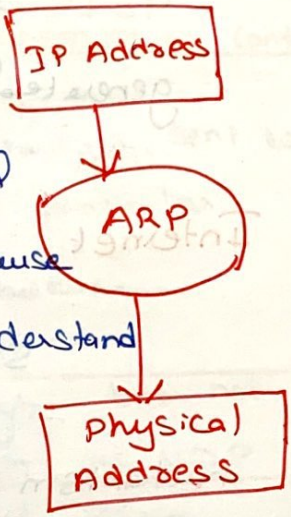
iii) Internet Layer

It has five network layer protocol

- ARP - RARP - IP - ICMP - IGMP

ARP (Address Resolution Protocol)

- Every machine has one address called IP address this address cannot be used for sending packets data because data link layer doesnot understand the internet address

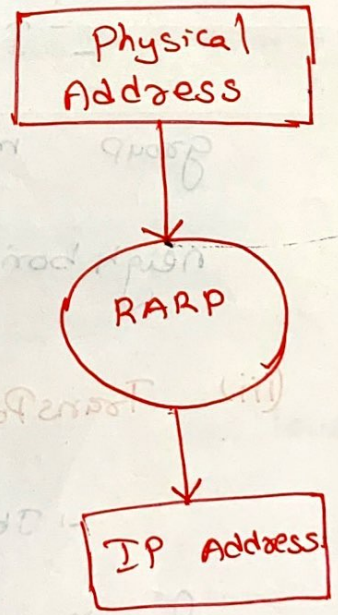


- This provides essential sevices when TCP/IP is running in LAN

RARP (Reverse Address Resolution Protocol)

- It is used to obtain the IP address as a Host based on its physical address

- It works on the opposite direction of ARP



INTERNET PROTOCOL

It is a very important protocol of the network layer

- It is responsible for carrying data generated by all TCP/IP protocol

Internet Control message Protocol (ICMP)

Since IP doesnot have a built in mechanism for sending error and control messages This provides an error control

Internet Group Management Protocol (IGMP)

- It used to report their multicast group memberships to any immediately neighboring multicast routind devices

(iii) Transport Layer (TCP and UDP)

- It runs on top of Internet layer and is mainly concerned with transport of packets from Source to destination

- main function is to deliver packets between the end points

- It uses two protocols TCP + UDP

Parameter	UDP USER Datagram Protocol	TCP Transmission Control
(i) Data transfer	Data is sent in Discrete packages by the application	Data is sent with no particular Structure
(ii) Transmission Speed	Very High	High but not as high as UDP
(v) feedback.	No Handshake	hand Skame
(iii) Protocol Connection set up	Connectionless	Connection oriented
(v.)	No Error + flow control	Provides Error + flow control
(iv) used	UDP is useful when speed in considered	TCP is used to transmit data without error

(iv) APPLICATION LAYER

- This doesnot have session for Presentation layer on top of transport layer

- Application layer has all higher level protocol

- Protocol used in the application layer are as follows.

(a) DHCP (Dynamic Host Configuration Protocol)

- It assigns IP address

(b) DNS (Domain Name System)

- translates website names to IP address

(c) HTTP (Hypertext Transfer Protocol)

- used to transfer web pages (ie) fetching pages

(d) TELNET (teleCommunication Networ)

- Bidirectional text Communication via a terminal application (virtual protocol to work from remo

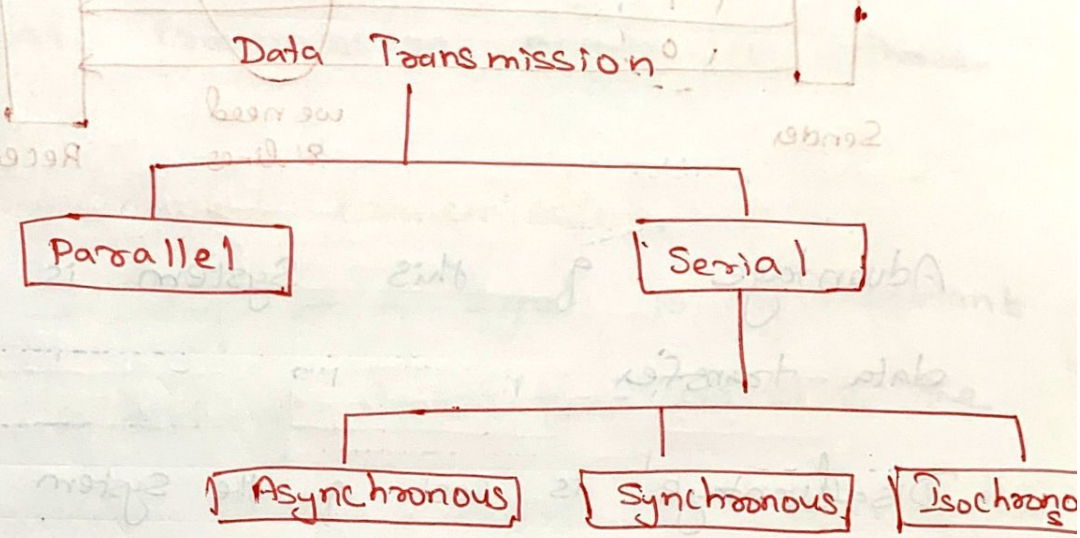
(e) SMTP (Simple Mail Transfer Protocol)

- It sends email messages

OSI	TCP/IP
- It has sevel layer	It has 4 layer
- It Supports both Connection oriented and Connection less Communication	It Supports only Connection less
- Transport layer guarantees delivery of Packets	Transport layer doesnot guarantee delivery of Packets

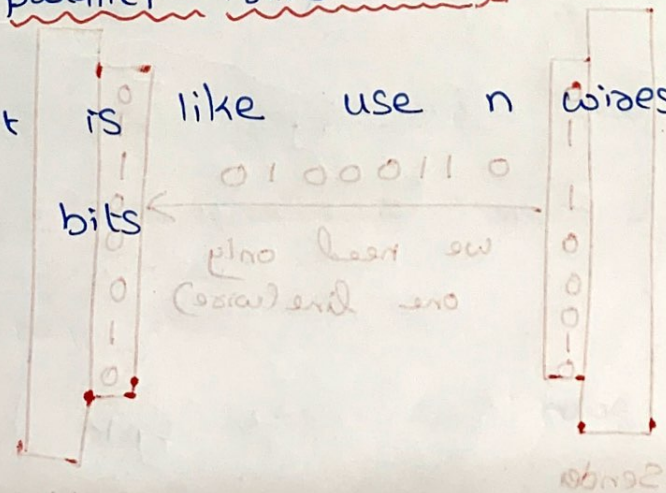
Transmission Modes

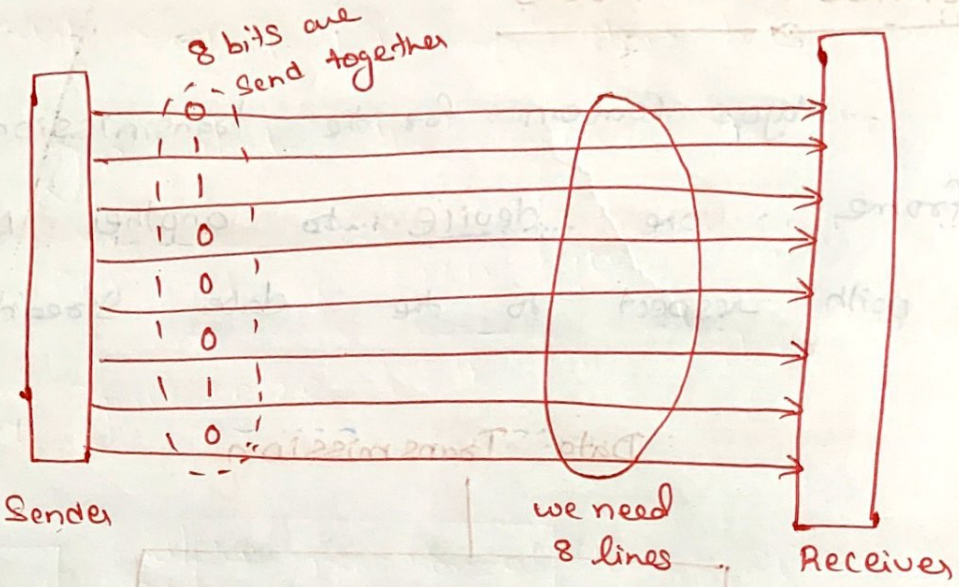
Major concern for the transmission of data from one device to another is wiring with respect to the data stream



* PARALLEL TRANSMISSION

- Binary data consisting of 1s & 0s may be organized into groups of n bits each
- By grouping, we can send data n bits at a time instead of 1. This is called parallel transmission.
- It is like use n wires to send n bits



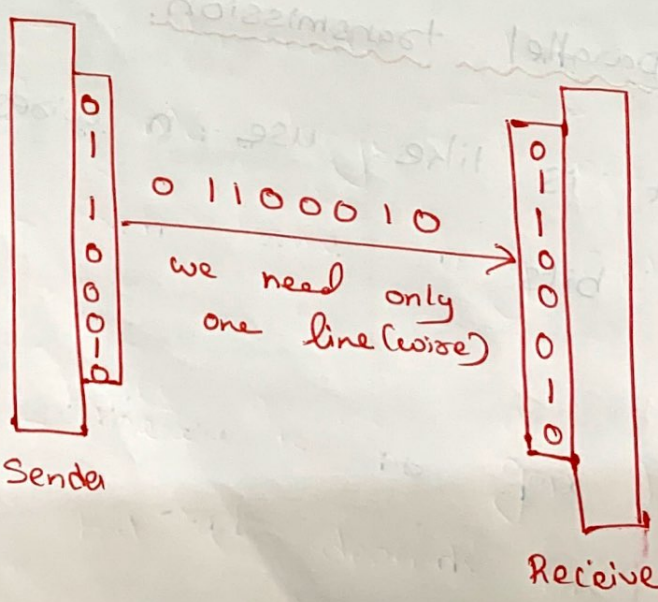


Advantage of this System is Speed of data transfer

Disadvantage is Cost of the System is high as it requires n bits

* SERIAL TRANSMISSION:-

In this type of transmission on bit follows the another so we need only one Communication line

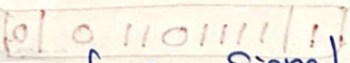


advantage of this mode is it reduce the cost of transmission

conversion is needed from serial to parallel & parallel to serial

Serial Transmission occur in three ways

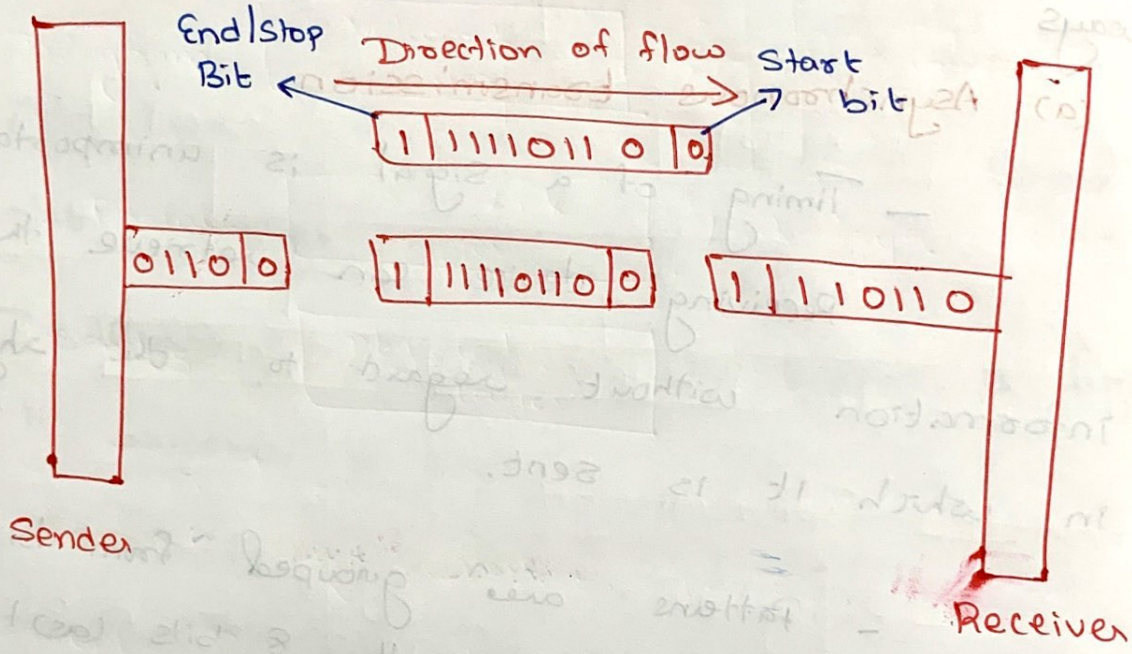
(a) Asynchronous transmission



- Timing of a signal is unimportant
- Receiving device can retrieve the information without regard to the rhythm in which it is sent.

- Patterns are grouped from bit stream to bytes. usually 8 bits (as) 1 byte
- without synchronization receiver cannot use timing to predict when the next group will arrive.
- Each byte will have a start bit which is usually '0' and an end bit '1' called stop bits.
- Each byte will have a ~~bigger~~ gap of different duration

- The Start bit and Stop bits and the gap alert the receiver to the beginning and end of each byte and allow it to synchronize with the data Stream



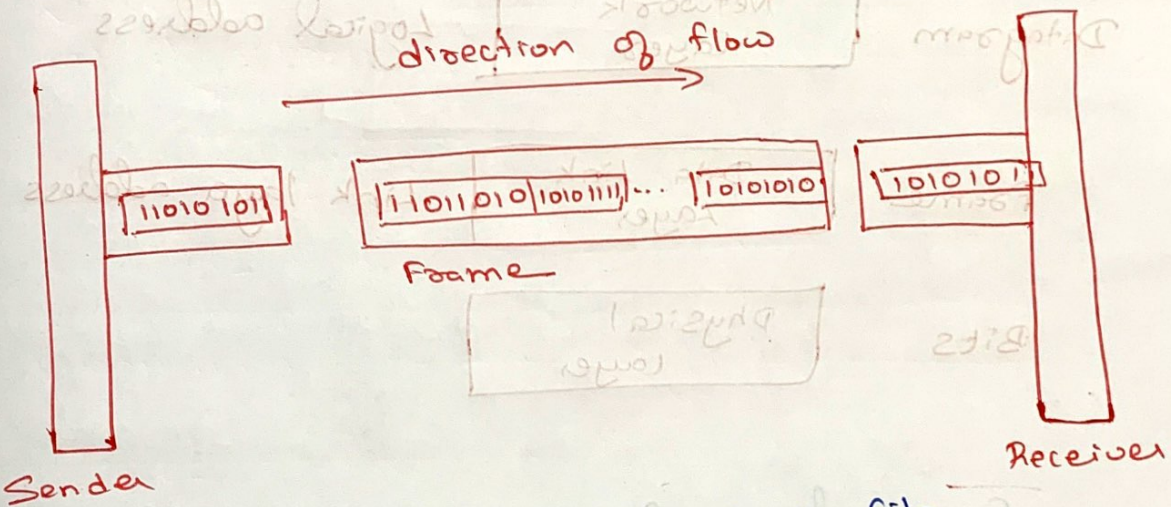
It is suitable for slow speed communication (ie) keyboard to a computer

(b) Synchronous Transmission

- In this mode bit Stream is combined into longer frames
- Each frame may contain multiple bytes
- There is no gap between each frame but it depends on the user to

Seperate each bits for decoding.

- Although there is no gap between characters in synchronous serial transmission there may be uneven gaps between frames



eg: Sending a large text file

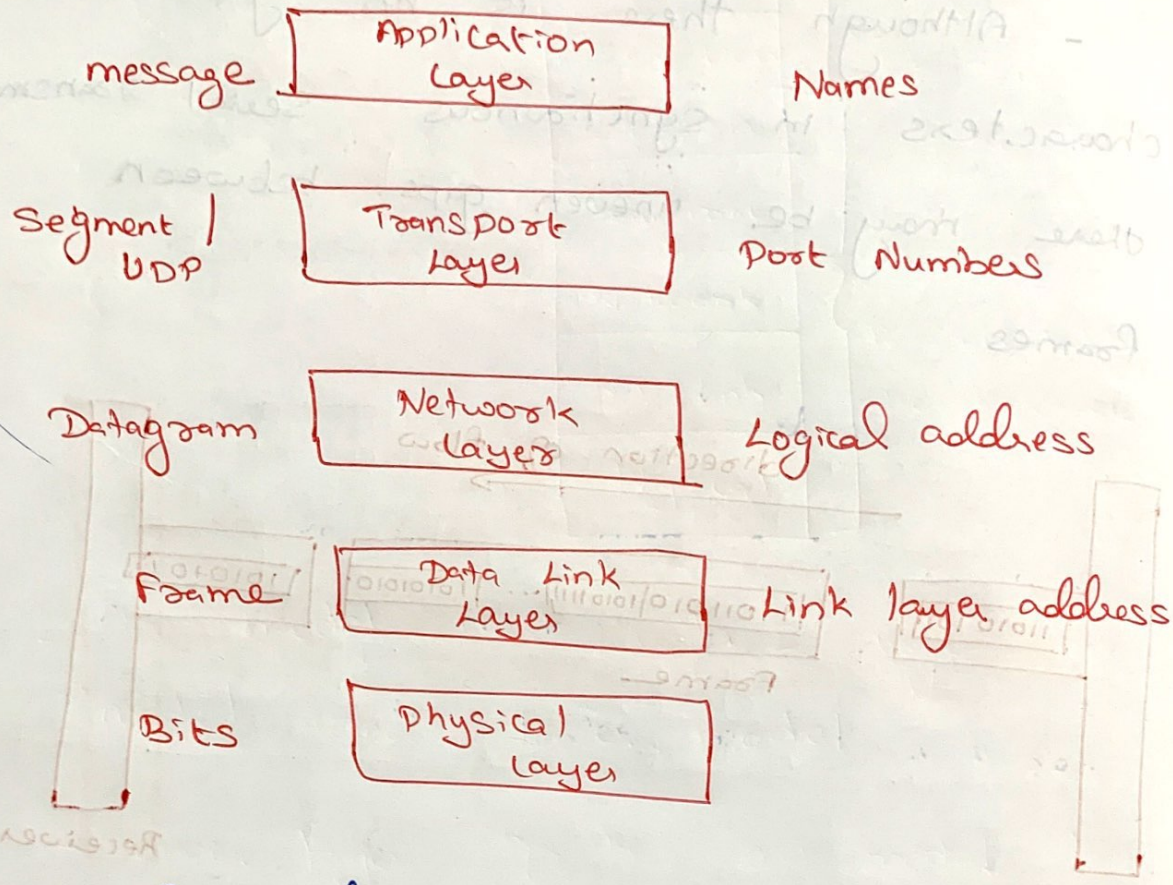
(c) Isochronous Transmission

- In real time, audio and video uneven delays between frames are not acceptable In this cases synchronous transmission fails.

- for eg: when viewing an video it describes 60 fps (ie) there should be no delay between frames So for this type just sync of characters are not sufficient entire frame has to be synched.

- Isochronous guarantees the data arrive at a fixed rate.

ADDRESSING:-



Each layer have seperate address except physical layer where there is no address but it has only Bits

- At application layer we use names to define the site that provides sevices

eg: someorg.com

- At Transport layer, addresses are called ports number these defines application layer program at soure and destination

- At network layer, the address are global while the whole internet is a scope.

- Data link layer address is call MAC (media Access control Address)

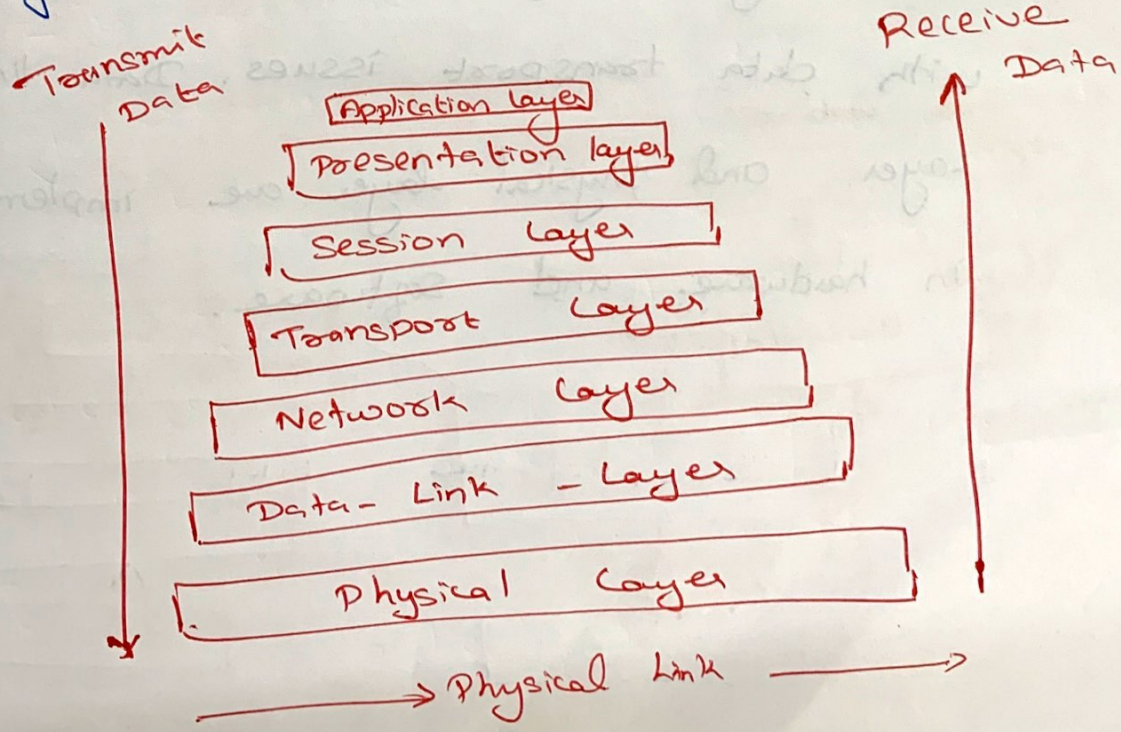
OSI MODEL

- It stands for open System Interconnection

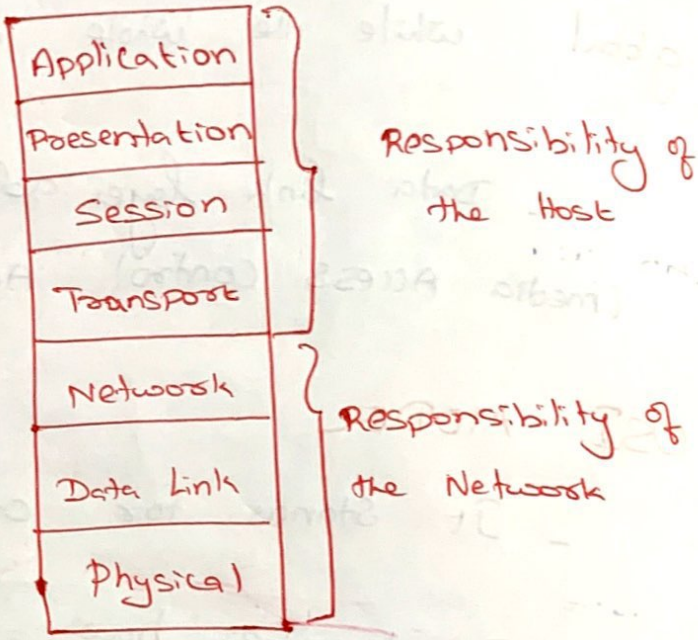
- It describes how information from a software in one computer moves through a physical medium to Sofware application in another computer

- It consist of seven layers

- Each layer will be assigned + peyormed independently



CHARACTERISTICS OF OSI LAYER



- OSI model deals with 2 layer an upper model and lower model
- upper layer of the osi model deals with application related issues and they are implemented only in the Software.
- Lower layers of the OSI model deals with data transport issues. Data link Layer and physical layer are implemented in hardware and Software.

Functions of the OSI Layers

Application → Provide the Sewices to the user

Presentation ← translation, compression + encryption

Session → establish manage ← terminate sessions

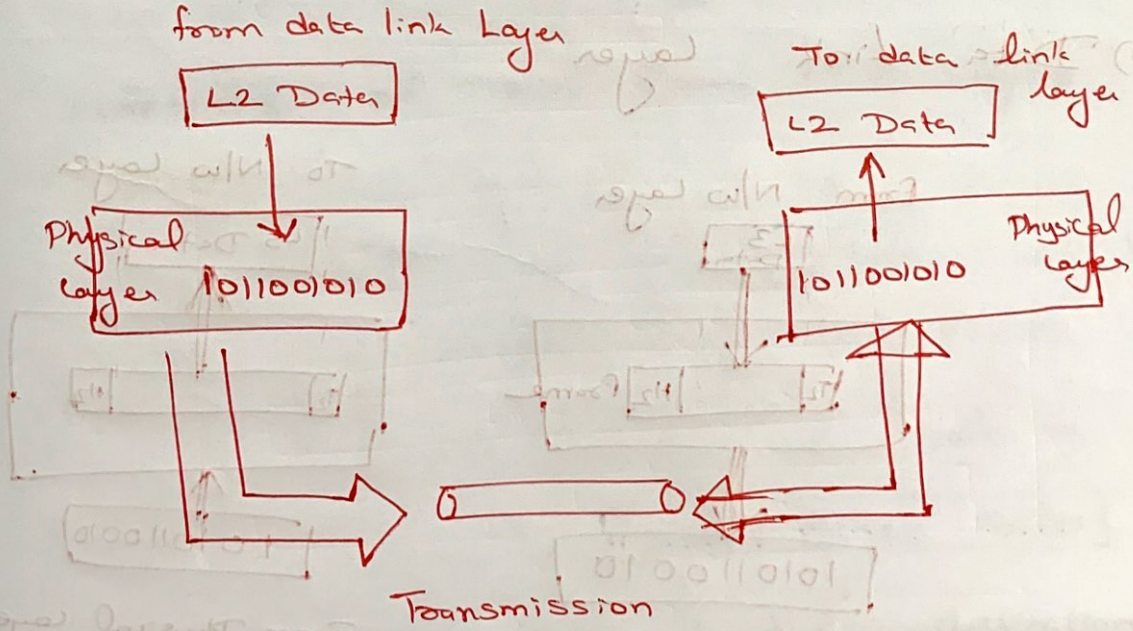
Transport ← reliable message delivery from process to process

Network → Packets from Source to Destination

Data Link ← error free transfer of Data frames

Physical → physical medium through which bits are transmitted.

(i) Physical Layer



- Transmit individual bits from one node to another node

- establish maintain and deactivate the Physical Connection

Functions of a physical Layer:

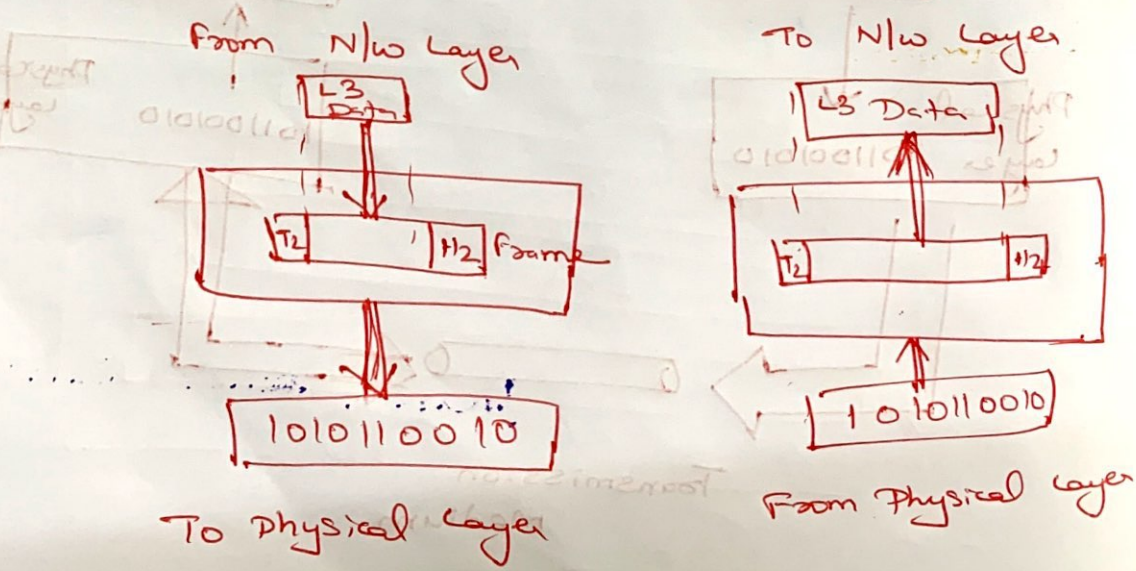
* Line Configuration :-
  defines how two or more devices can be connected physically

• Data Transmission :-
  defines the transmission modes whether it is simplex, half or full duplex

• Topology :-
  - how network devices are arranged

• Signals :-
  - determines the type of signal used for transmitting information

(ii) Data - Link Layer



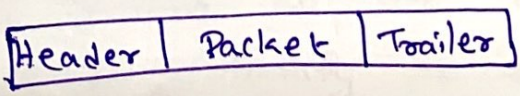
- Responsible for error free transfer of data frames
- defines the format of data on the network
- Mainly responsible for unique identification
- It consist of two sub layers

* Logical Link Control Layer:-
  - It is responsible for transferring the packets to the Network layer of the receiver that is receiving
  - Identifies the address of the network layer protocol from the header
  - Provides flow control

* Media Access Control Layer
  - MAC is the link between Logical link control layer and networks physical layer.
  - used for transferring the packets over the network

Functions of the Data Link Layer

- Framing:-
  It translates the physical's raw bit stream into packets known as Frames
  It adds header and trailer to the frame



Header contain hardware destination + Sowre address

- Flow Control

  - It is the main function of Data link layer

  - It is the technique by which constant data rate is maintained at both sides so no data is corrupted

- Error Control

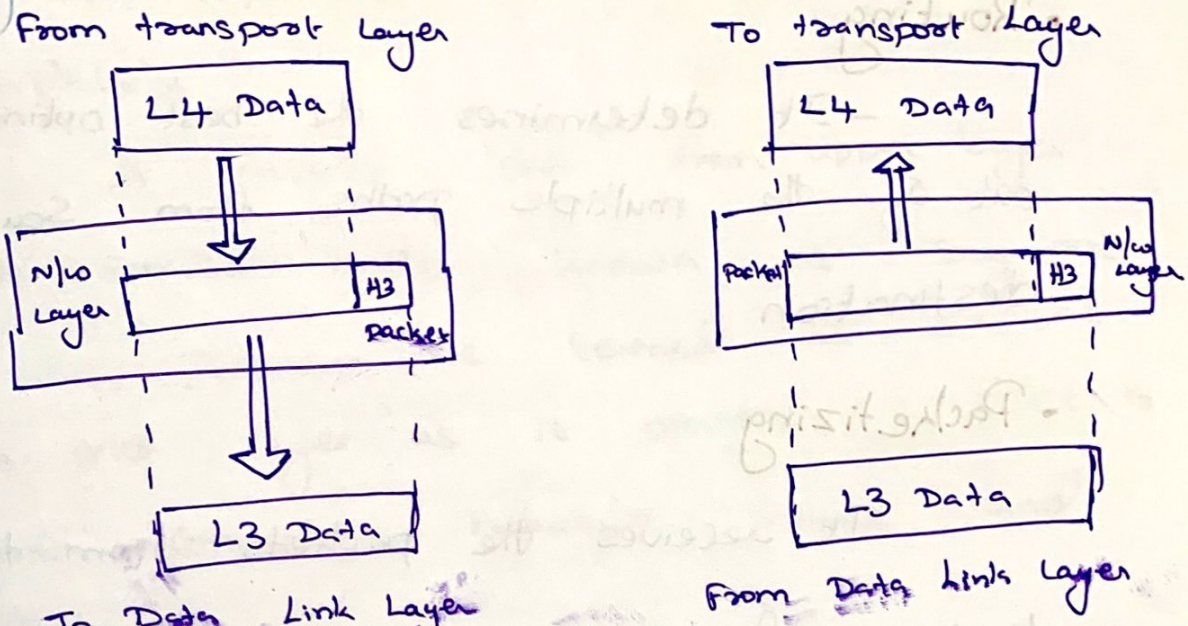
  - It is acheived by adding a calculated value (RC (Cyclic Redundancy Check) that is placed to the trailer

  - This helps in finding the error which was sent to the receiver

- Access Control

  - when two or more devices are connected to the same communication channel, data link layer protocol are used to determine which device has control over the link at a given time.

(iii) NETWORK LAYER



- It manages device addressing and tracks the location of devices on the network
- It determines which path to choose the data from source to destination depending on traffic, Priority etc
- Routers are layer 3 devices

Functions of Network Layer

- **Internetworking**
  - It is the main responsibility of the network layer, provides logical connection between different devices
- **Addressing**
  - It adds source & destination address to the header of the frame. addressing is used to identify the device on the internet.

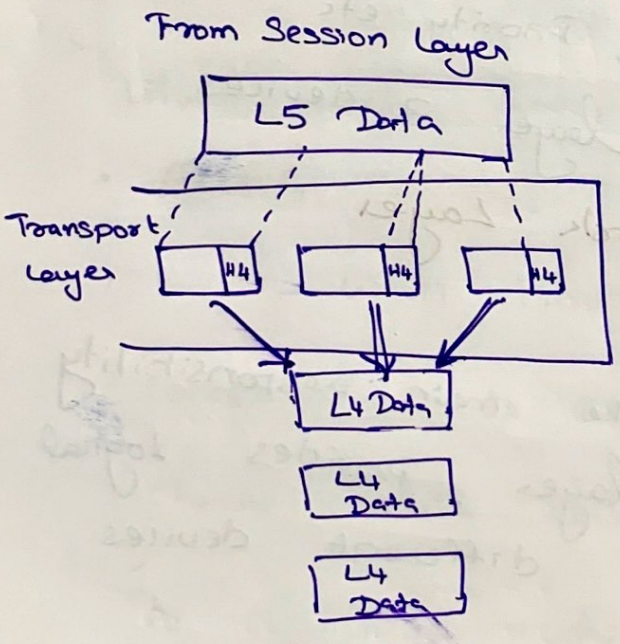
- Routing

  - It determines the best optimal path out of the multiple paths from source to destination

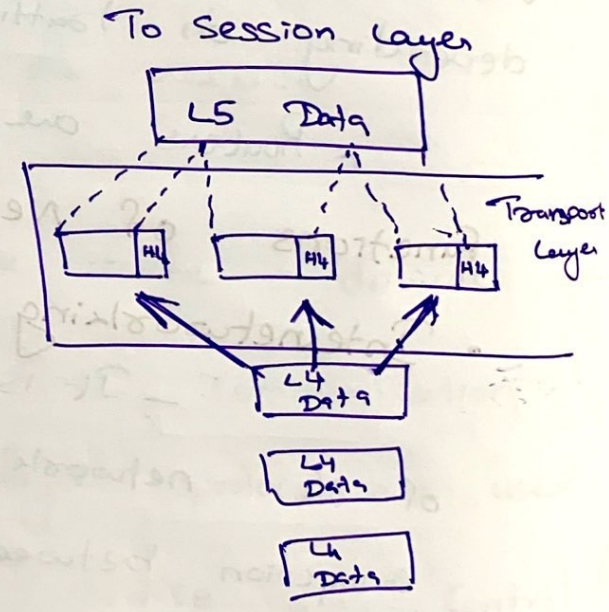
- Packetizing

  It receives the packets from the upper layer and converts them into packets This process is known as packetizing. It is acheived by internet protocol (IP)

(IV) TRANSPORT LAYER



To network Layer



From Network Layer

- It is responsible that messages are transmitted in the order in which they are sent (ie) without duplication

- It responsible for transporting data completely

. It converts data from upper layer into smaller units known as segments

- It can be termed as an end to end layer as it provides a point to point connection between source and destination

The two protocols used in this layer are

- Transmission Control Protocol (TCP)
  - standard protocol that allows system to communicate over internet
  - Establish and maintain a connection between Hosts
  - when data is sent over the TCP connection, the TCP protocol divides the data into smaller units called segements
  - Each segement travel in Different route and reach the destination
  - TCP reorders the packets in the correct order at the receiving end.

- User Datagram Protocol

- It is a transport layer protocol
- It is unreliable as the user does send any acknowledgement when the packet is received
- But the speed of transmission is high.

Functions of Transport Layer:-

- Sevice - Point addressing:
  - Sinle many process takes place in each Computer datas have to be transmitted correctly for this purpose This layers adds "Header" that contain the address known as "Sevice - point address or Port address"
  - The responsibility of Network laye is to transmit the data from one computer to another computer and the responsibility of the transport layer is to transmit the message to the correct process

- Segementation and reassembly :-

- Each segment is assigned with a sequence number that uniquely identifies each segement
- when the message has arrived at the destination, then the transport layer reassembles the message based on their sequence numbers

- Connection Control
  - It provides two sevice connection oriented and connection less sevice.
  - connection less sevice treats each segement as an individual packet and they travel in different route to reach the destination
  - connection oriented sevice makes the connection at the destination machine before delivering the packes all segements travel in a single route.

- Flow control
  - Responsible for flow control but is it is performed end to end rather than across a single link.

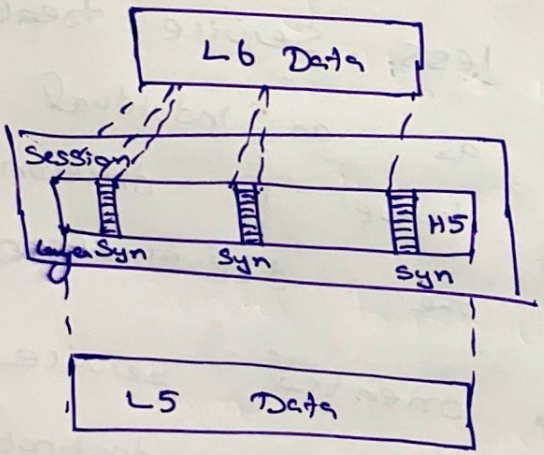
- Error Control

- It is also performed end to end rather than across the single link.

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

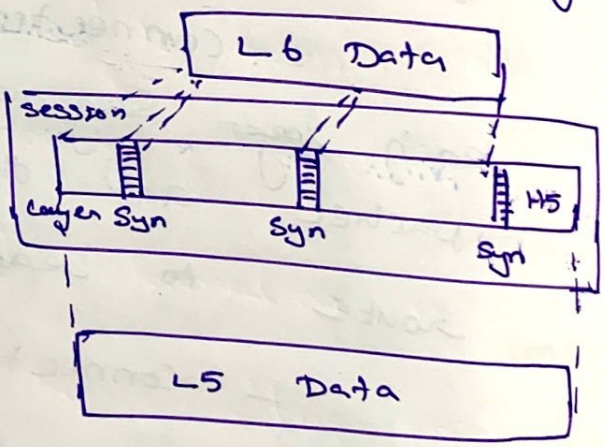
(V) SESSION LAYER

From Presentation



To transport Layer

To Presentation layer



From transport layer.

It is used to establish, maintain and synchronizes the interaction between Communicating Devices

* Functions of Session layer

- Dialog Control

  - It creates a Dialog between two process

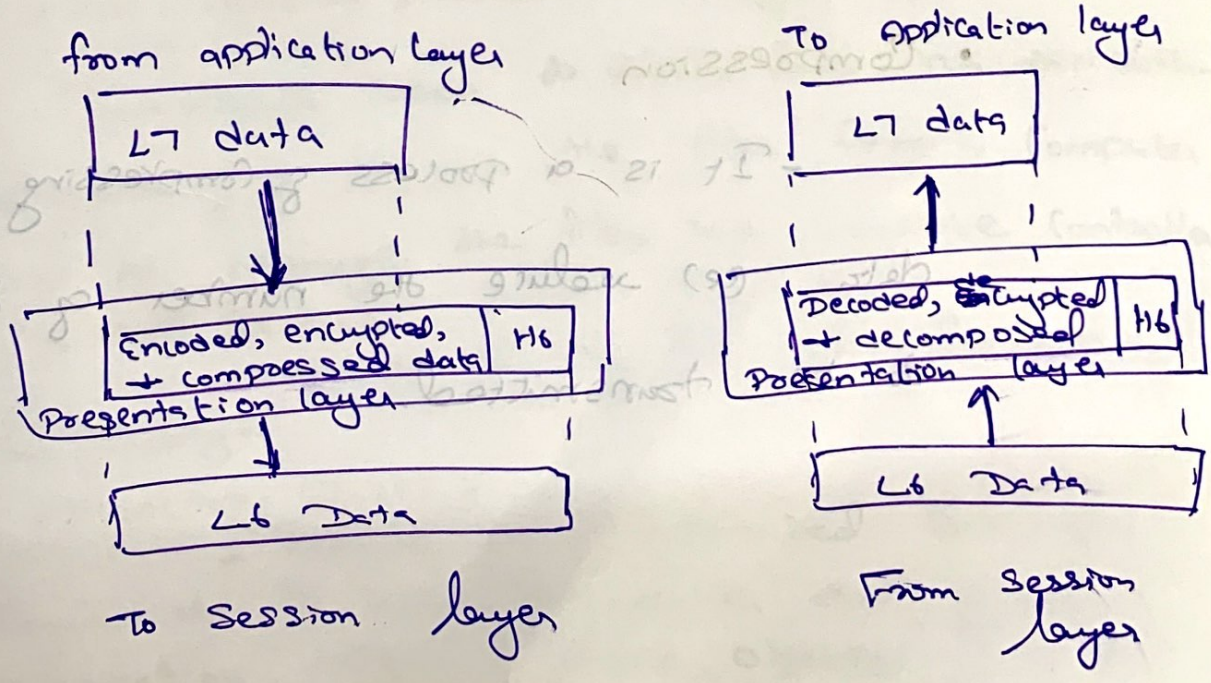
  - It allows communication between two processes which can be either half-duplex or full duplex

- Synchronization

  - Session layer adds some checkpoints when transmitting the data in a sequence

  - If some error occurs in middle of the transmission of data, then the transmission will take place again from that checkpoint

(vi) Presentation Layer

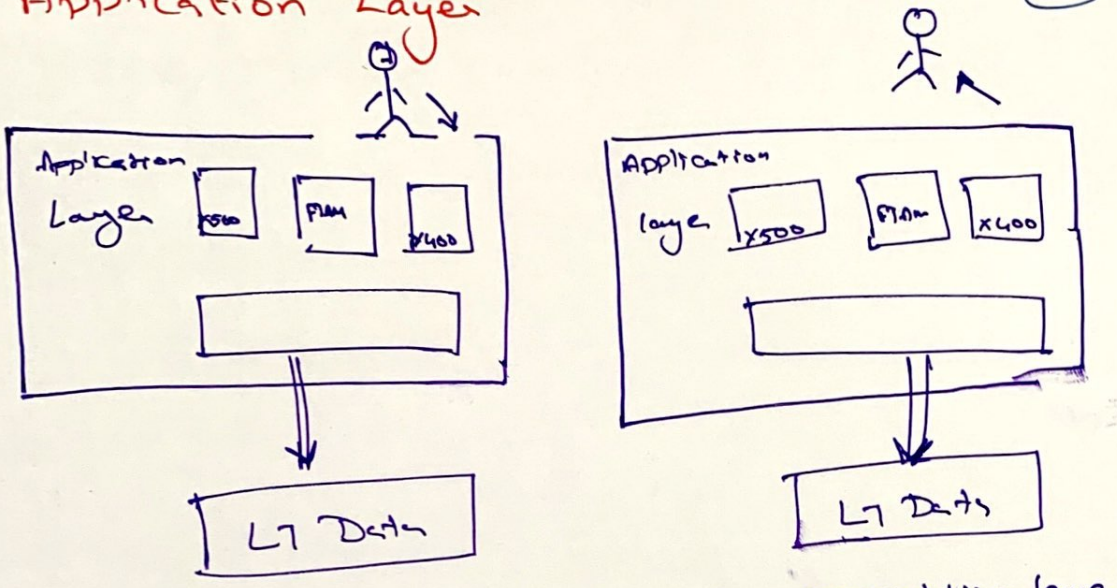


- mainly concerned with Syntax & Semantics
- It acts as data transfer for a netwo
- Converts data from one format to othe

* Functions of Presentation Layer

- Translation
  - Encoding & Decoding are done here
- Encryption
  - It is needed to maintain Privacy
  - It is a process of converting the sender transmitted information in another form and sends the resulting message over the internet
- Compression
  - It is a process of compressing the data (ie) reduce the number of bits to be transmitted.

(Vii) Application Layer



To Presentation Layer

From Presentation layer

- Acts as a window for user + Applications process to access network Service
- It handles issues such as n/w transparency resource allocation etc
- It provides n/w Service to end users

* Functions of Application Layer

- File Transfer, Access + Management (FTAM)
  - Allows user to access files in a remote computer, to retrive the files from a computer and to manage the files in a remote controller
- mail Service
  - Provides facility for email forwarding + Storage
- Directory Service :-
  - Provides the distributed database Sources + is used to provide that global information about various objects.