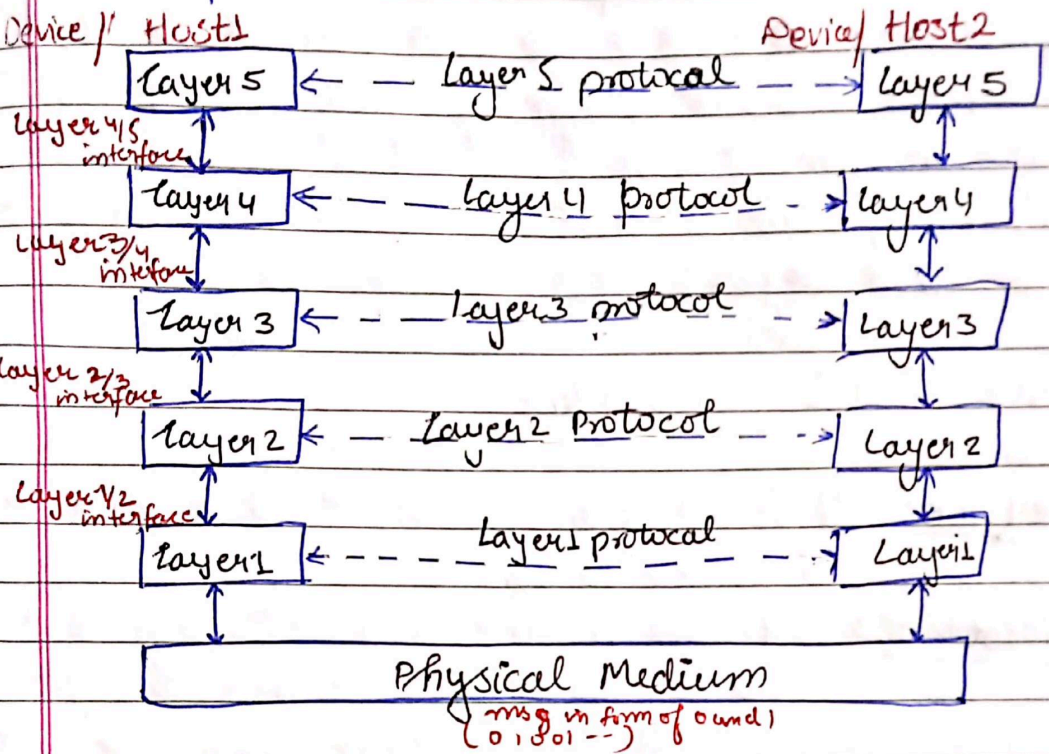
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Layered Architecture:-

(1) The main aim of L.A is to divide the design into small pieces



(2) To reduce the design complexity, most of the networks are organized as a series of layers or levels each one build upon one below it

(3) The purpose of each layer is to offer certain services to the higher layer, shielding those layers from the details of how the offered service are implemented

(4) This permits changes in a layer without affecting other layers

(5) Each lower layer adds its service to the higher layer to provide a full set of services to

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to manage communications & run the applications

(6) It ensure the independence b/w layers by providing the services from lower to higher layer without defining how the services are implemented Or by hiding the details of how the services are implemented from the layers above.
∴ Modification in a layer will not affect the other layer.

The basic elements i.e :-

- Service :- It is a set of actions that a layer provides offer to higher layer.
- Protocol :- It defines a set of rules that a layer uses to exchange the information with peer entity. These rules mainly concern about both the contents & order of the messages used.
- Interface :- It is way through which the message is transferred from one layer to another layer.

- In a layer 'n' architecture, layer 'n' on one machine will have a communication with the layer 'n' on another machine & the rules used in a conversation are known as a Layer n protocol.

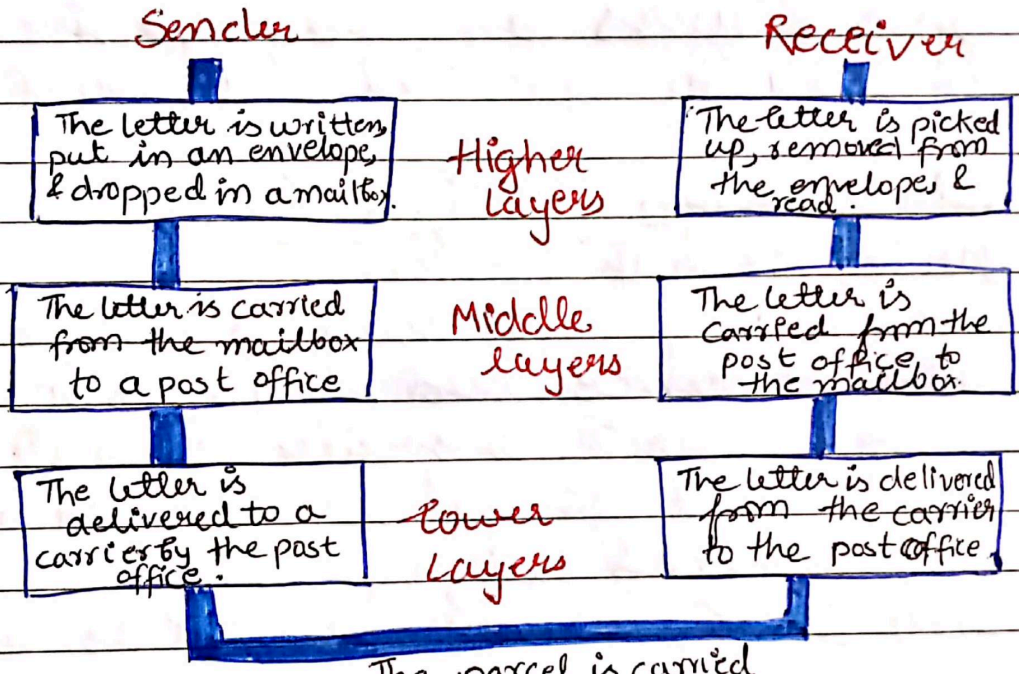
- No data is transferred from layer n of one machine to layer n of another machine. Instead each layer passes the data to the layer

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immediately just below it, until the lowest layer is reached.

- Below layer 1 is the physical medium through which the actual communication take place
- Data is pass from upper layer to lower layer through an interface
- A set of layers & protocols is known as network architecture.



- Increases network lifetime

Advantages:-

(1) This approach reduce the complexity of the design such that unmanagable tasks are divided into small & manageable task.

(2) It provides modularity, layer are independent to each other which is easier to understand & implement.

(3) It ensures that independence of layers so that

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implementation in one layer can be changed without affecting other layer. [Easy to modify]
- Each layer of the layered architecture can be analysed & tested individually. [easy to test]
- lower layer can be changed without affecting the upper layers.
- Upper layers can ~~ed~~ secured the functionality provided by lower layer.

Design issue for Layer

- Identify the sender & Reciver.
- Some form of addressing is needed in order & hence need for provision for ~~proper~~ to specify a specific destination.
- There should be rules for data transfer- Half duplex & full duplex.
- Error control:- Both ends of the connection must agree on error detecting & error correcting codes.
- Sequencing reassembly:- Msg may arrive out of order & hence need for provision for proper reassembly.
- Flow control:- If the rate at which data is produced by the sender is higher than the rate at which data is received, there are chances of over flowing the receiver. So a proper flow control mechanism

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needs to be implemented.

(6) Inability of all process to accept arbitrarily long msg. This property leads to mechanism for disassembling, transmitting & reassembling msg.

Protocal hicarchy:- Communication b/w Host 1 & Host 2. The data stream is passed through a no. of layer from one host to other. Virtual communication is represented using dotted lines between peer layers. Physical → solid arrow b/w adjacent layers. The layers at same level known as pers & have a set of protocols for communicatos

Connection Oriented & Connection less Serives:- Both are used for the connection estabishment b/w 2 or more than two devices

- Network layer offer those types of services to its predecessor layer for transfer of my data.

(a) Connection Oriented service:- It is related to the telephone system.

(1) 1st connection
2- data

When I pick up the phone, it have an open circuit & the dial tone carrier signal allows me to connect to a destination of my choosing

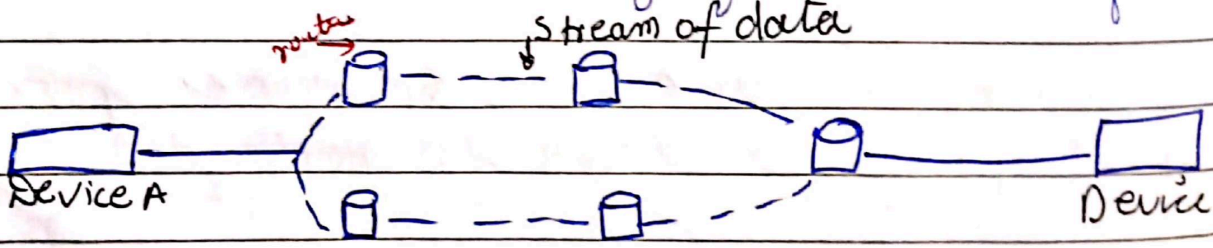
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- There is a sequence of operation to be followed by the users of connection oriented service. These are.

(1) Connection is established
(2) Information is sent
(3) Connection is released.

- In connection oriented service we have to establish a connection before starting the communication.
- When connection is establish., we send the information & then we release the connection.
- In this service, the data streams / Packets are delivered to the receiver in the same order in which they have been sent by the sender.
- It is reliable service, we can resend the message if there is an error at receiver end.
- It uses handshake process to establish the connection b/w the sender & receiver.
- It uses ckt switching for transmission of data



[receiver can send ask about state of Pkt]

E.g:- Transmission control Protocal (TCP)

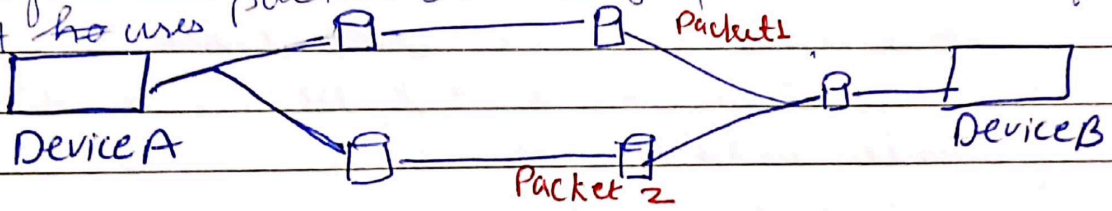
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(b) Connectionless service :- It is related to the postal system.

- It does not include any connection establishment & connection terminated for transferring data.
- Each msg carries the full destination address & each one is routed through the system oth independent of all the others
- Each packet is treated as individual entity, which allows communication entities to send data before establishing commication.
- Here packets don't follow a fixed path therefore packets receive at the receiver can be out of order
- It uses packet switching for transmission of data



- In this service, the data is tranferred in one direction from source to destination without checking that destination is prepared to accept the msg.
- Authentication is not needed in connected less service.
- It does not give the guarantee of reliability
- It does not guarantee a msg delivery

eg:- Internet protocol (IP)
User Datagram Protocol (UDP)

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Connection oriented Services	Connection less Service
• In this, we have to establish a connection b/w communicating devices before starting the communication.	• It does not include any connection establish & connection termination for transferring data.
• It can be implemented by using circuit switching & virtual circuit	• It is implemented by using Packet switching
• Packets sequentially travel to their distination device & follows the same route.	• Packets reach the destination device randomly without following the same route.
• In connection oriented service authentication is needed.	• It does not need any authentication.
• Connection Oriented protocol makes a connection & checks whether msg is received or not & resend msg if an error occurs	• Connectionless service protocol does not guarantees a message delivery.
• There is more delay in transfer of information but once connection established ~~tasks~~ faster delivery.	• There is no delay in tranfer of information due to absence of connection establishment phase.

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• There is • It is suitable for long & steady communication. • It is more reliable acknowledge transmitted packets • Connection oriented it's stream based. • Acknowledgment is required about the delivery of the msg. • Ensure error free delivery of packets at distination Eg:- TCP	• It is suitable for bursty transmission • It is not reliable, no acknowledgment • It is msg based. • No acknowledgment is done • Packets are not guarnateed to be error free. Eg:- UDP.

Service Primitives:- Service generally includes set of various primitives.

A primitive simply means operations.
A service is formally defined by a set of primitives / operations available to a user process to access the service. All these primitive simply tell the service to perform some action or to report on action that is taken by peer entity. Primitives are called calling functions b/w the layers that are used to manage communication among the adjacent protocol layers i.e. among the same communication node.

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Classification of Service Primitives

Primitive

Request – It represent entity that wants or request service to perform some action or work.

Indication – It represent entity that is to be informed about event.

Response – It represent entity that responding to event. (receiver is simply sending the permission or allowing to connect)

confirm – It represent entity that acknowledge the response to earlier request that has come back. (Sender just acknowledge the permission to get connected to the remote host).

Primitives of Connection-Oriented Service:-

Listen- When sever is ready to accept request of incoming connection, it simply put this primitive into action. Listen primitive simply waiting for incoming connect request.

connect — It is used to connect the server simply by creating or establishing connection with waiting peer.

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Accept- It simply accepts incoming connection from peer.

Receive- These primitive simply wait for incoming msg.

send- It put into action by the client to transmit its request that is followed by putting receive primitive into action to get the reply.
simply sends or transfer the message to the peer

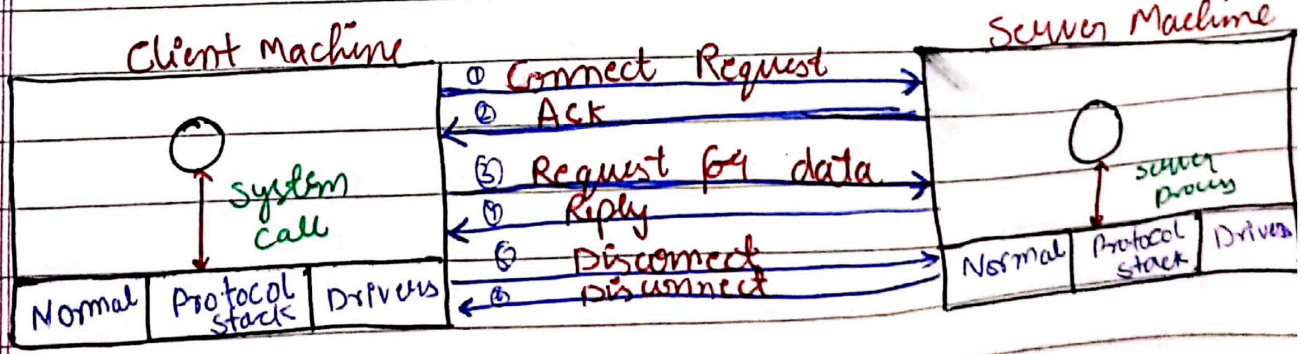
Disconnect- It simply used to terminate or end connection after which no one will be able to send any of the msg.

Primitives of Connectionless Service:-

Primitive —

untidata- It simply required to send packet of data or information.

facility Report - It is required for getting detail about the performance & looking of the network such as delivery statistics or report.



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ISO-OSI Model :-

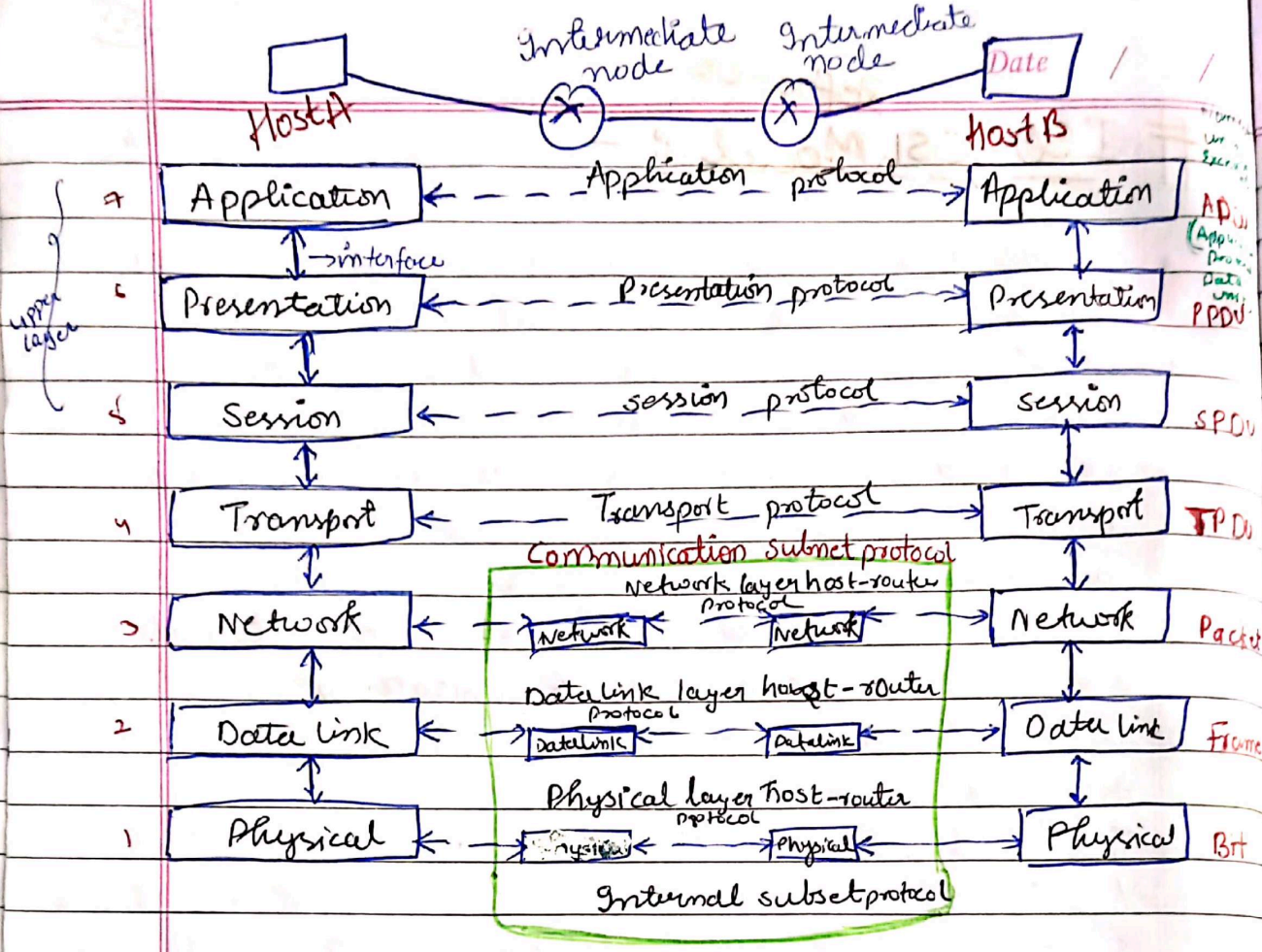
- There are n number of users who use computer network & are located over the world.
- So to ensure national & worldwide data communication system must be developed which are compatible to communicate with each other.
- For this ISO (International organisation of Standardization - International Standards organizations) has developed a model called OSI (Open System Interconnection) [1970s]
- This Model is called ISO-OSI Reference Model bcz it deals with connecting open systems that is System that are open for communication with other System.
- "OSI model describes the flow of information from one computer to another"

- Seven layers of OSI model
  - 7 - Application → To allow access to network resources.
  - 6 - Presentation → To translate, encrypt, & compress data
  - 5 - Session → To establish, manage, & terminate sessions
  - 4 - Transport → To provide reliable process-to-process message delivery & error recovery.
  - 3 - Network → To move packets from source to destination; to provide internetworking
  - 2 - Datalink → To organize bit into frames; to provide hop-to-hop delivery.
  - 1 - Physical → To transmit bit over a medium; to provide mechanical & electrical specification.

- OSI model is a layer framework for the design of network systems that allow communication b/w all types of computer system.

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Principle of OSI Reference Model :-

1. A layer should be created where a different abstraction is needed. (hide details show only necessary details)
2. Each layer should perform a well defined function.
3. The function of each layer should be chosen with an eye toward defining internationally standardized protocols.
4. The layer boundaries should be chosen to minimize the information flow across the interface.
5. The no of layers should be large enough that distinct functions need not be thrown together.

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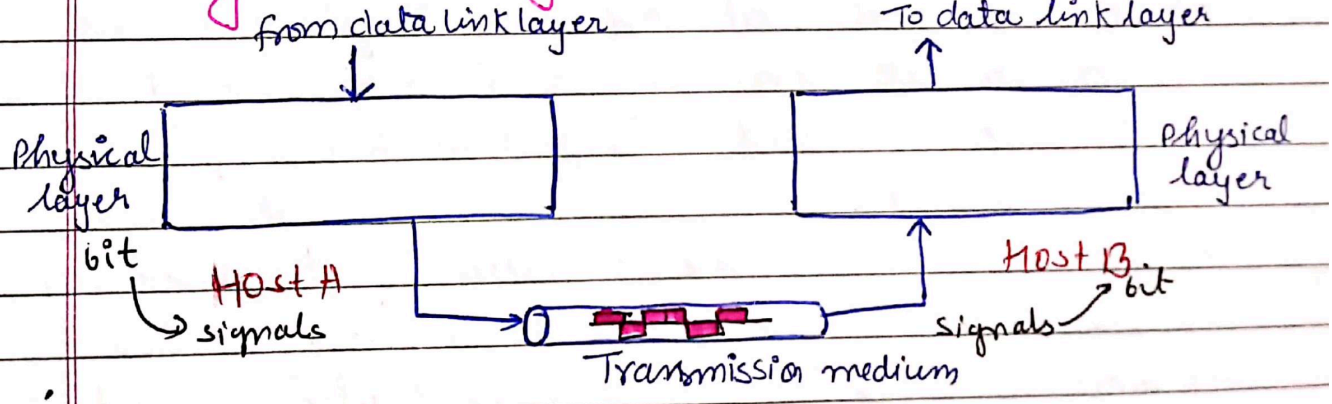
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in the same layer out of necessity & small enough that architecture does not become unwieldly.

Features of OSI Model :-

1. Big picture of communication one network is understanable through this OSI Model.
2. We see how hardware & software work together.
3. We can understand new technologies as they are developed.
4. Troubleshooting is easier by separate network.
5. Can be used an compare basic functional i.e cationships on different networks

1. :- Physical layer :-



- It is the lowest layer of the OSI model.
- The physical layer coordinates the functions required to transmit a bit stream over a physical medium.
- It activates, maintains & deactivates the physical connection

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- It is responsible for transmission & reception of the unstructure raw data over network
- Voltage & data rates (no. of bits/sec) needed for transmissi is defined in the physical layer.
- Data in this layer consists of stream of bits
- This bits must be encoded into signals for transmission. The physical layer defines the type of encoding i.e how 0's & 1's are changed to signal.
- physical layer also deals with synchronization of the transmitter & receiver. The sender & receiver must be synchronized at the bit level. The clocks must be synchronized.
- Physical layer also deals with line ~~confi~~ configuration. In a point-to-point configuration two device are connected together through a dedicated link & in a multipoint configuration a link is shared b/w several devices
- It also deals with type of physical topology used to connect two devices in a network Devices can be connected using a mesh, bus, star or ring topology.
- It also defines the direction of transmission b/w two devices (i.e transmission mode)
- simplex, half duplex or full duplex.
- Devices work under physical are Hub, repeaters, cables etc

[Cables & connections, Physical topology, Hardware (Hub, repeaters), Transmission mode, Encoding, Multiplexing]

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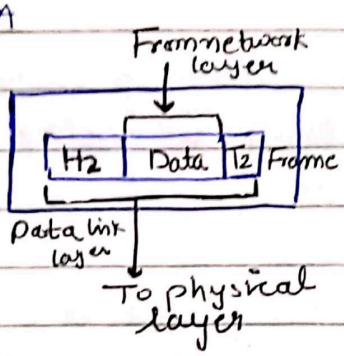
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L2 Data Link Layer :-

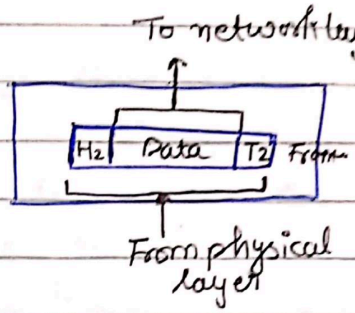
It is responsible for transmitting frames (error-free) from one node to next

- It provides connection b/w host on same network

Host A



T → Trailer
H → Header



Host B

- It provides a reliable & efficient communication b/w two or more devices.

Functions of data link layer :-

(1) **Framing** :- DLL divide the stream of bit received from network layer into data units called frame.

- DLL add the header & trailer to the frame
- Header contain hardware destination & source. (Mac address — Physical) ↓ manufacturer

(2) **Physical Addressing** :- The DLL adds a header to the frame in order to define physical address of the send / receiver of the frame, if the frames are to be distributed to different systems on the network.

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(3) Flow control - If the rate at which the data are absorbed by the receiver is less than the rate produced in the sender, the DLL imposes a flow control mechanism so that constant data rate is maintained on both the sides & no data get corrupted.

(4) Error control :- Error control is used for detecting & retransmitting damaged or lost frames & to prevent duplication of frames.

- DLL achieve this by adding trailer at the end of the frame before it is send to the physical layer.
- If any error seems to occur, then the receiver send the acknowledgement for the retransmission of the corrupted frames.

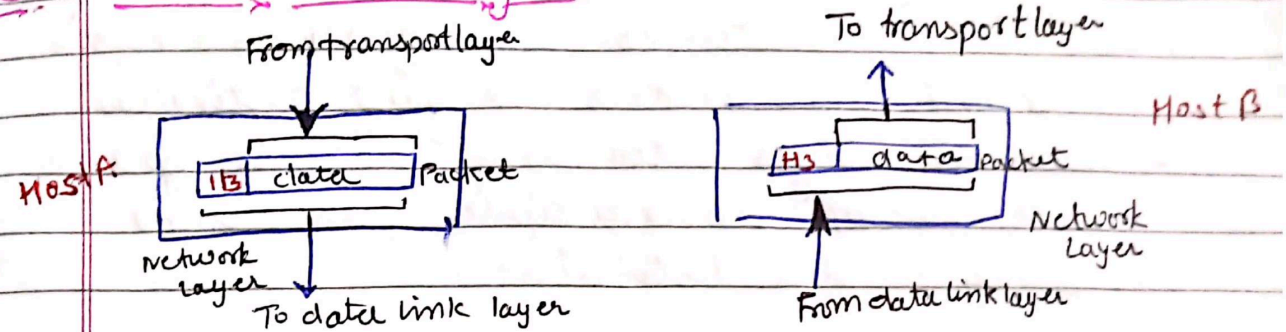
(5) Access control :- When two or more devices are connected to the same communication channel, then the DLL protocols determine which of the device has control ~~ove~~ over the link at any given time.

- Devices works under DLL are - switch, bridge & NIC
- Protocols used under DLL are - PPP, PPTP etc

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L3:- Network Layer:-



- It provides connection b/w hosts on different network
- It is mainly required, when it is necessary to send information from one network to another.
- It divided the outgoing message into packets & assembles the incoming packets into messages for higher levels
- Devices work under this layer are router & brouter
- Protocols used under this layer are- IPV4, IPV6 & ICMP
- Two types of services provided by network layer- Connection oriented & connection service.

Functions of Network Layer:-

(1) **Logical addressing**- If a packet passes the network boundary, we need another addressing system for source & destination called logical address.
- Addressing is used to identify the device on the internet
- Network layer adds the source & destination address to the header of the frame

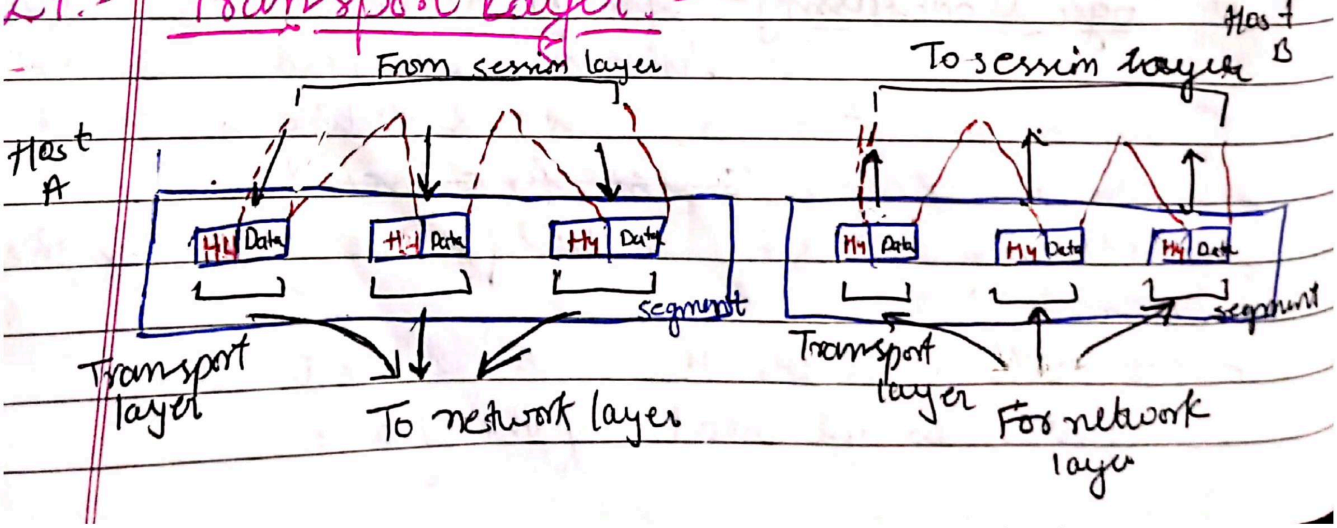
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(2) **Routing:-** The devices which connect various networks called routers & responsible for delivering packets to find distination.
- Network layer determines the best optimal path out of the multiple paths from source to the destination

(3) **Congestion control:-** A router can be connected to 4-5 networks. If all the networks send packet at the same time with maximum rate possible then the router may not be able to handle all the packets & may drop some or all packets
- The control of such congestion is also a function of network layer.
- Network layer doesn't guarantee that the packet will reach to intended destination
- There ~~will~~ are no reliability guarentee

L4.- Transport Layer:-



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- It is responsible for process to process delivery
- It also ensures whether the msg arrives in order or not. It ensures that msg are transmitted in the order in which they are sent.
- It receive the data from upper layer & converts them into smaller unit called as segment.
- Protocols works under this layer are TCP & UDP

Function of Transport layer:-

(1) **Port addressing:-** Computers run several programs simultaneously due to this reason, the transmission of data from source to the destination not only from one computer to another computer but also from one process to another process.
- Transport layer thus adds the header that contain the port address.
- It is the responsibility of the transport layer is to transmit the message to the correct process.

(2) **Segmentation & reassembly:-** Transport layer divides the message received from upper layer into multiple segment & each segment is assigned by a sequence number.
These sequence numbers are arranged correctly on the receiving side by this layer.

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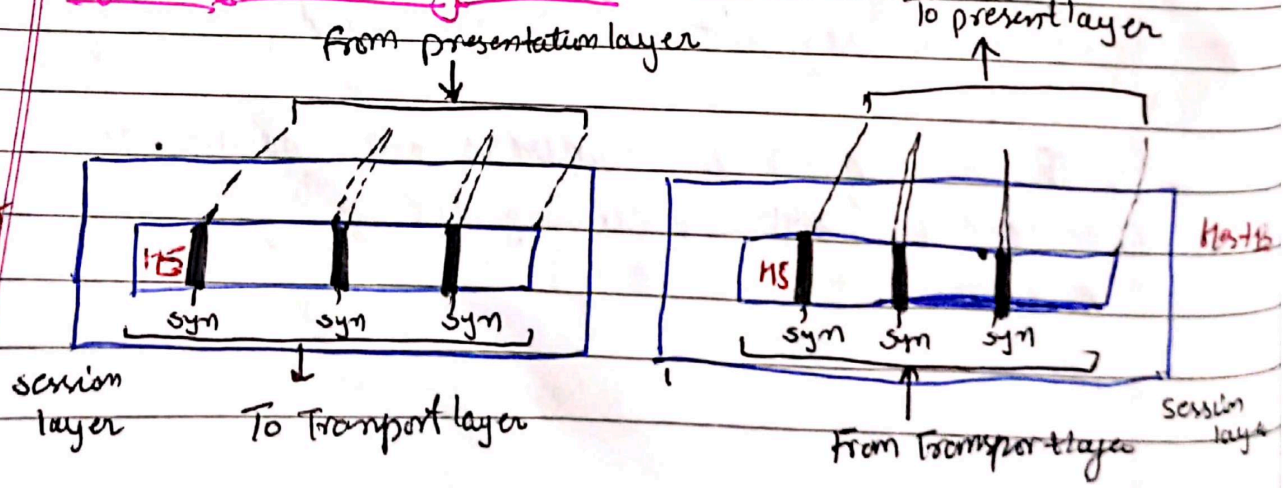
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(3) Connection control – Transport layer provides the services connection-oriented service & connectionless service.
- The connection treats each segment as a individual packet & delivers to the destination.
- The connection orientia makes connection on the distination side before the delivery. After the delivery the tiemination will be terminated.

(4) Flow control – The transport layer also responsible for flow control but it is performed process to process. (end to end)

(5) Error control – Error control is performed process to process. The sender transport layer ensures that message react at the destination without any error.

25 – Session Layer :-



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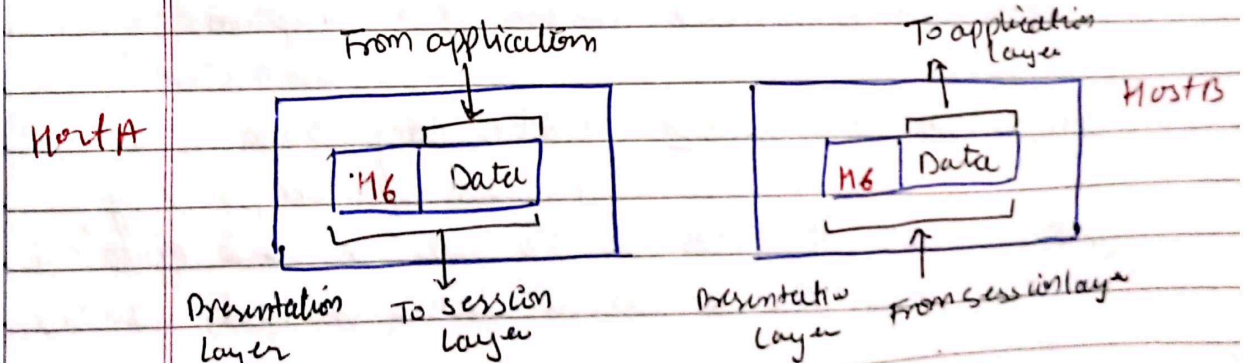
- This layer establishes, manages & terminates connection b/w application
- Protocols works under this layer are TCP & UCP

Function of session layer:-

(1) **Dialog control:-** Session layer creates a dialog b/w two process
- Session allows two system to enter into a dialog either in half duplex or full duplex

(2) **Synchronization:-** Session layer adds checkpoint into stream of data.
If some error occurs in the middle of the transmission of data then the transmission will take place again from the checkpoint.
- This process is known as Synchronization & recovery

26:- Presentation Layer:-



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- This layer ~~comes~~ concerned with the syntax & semantics ~~systems~~ of information exchange b/w two system
- This layer converts the data from one presentation format to another format
- Protocols used — SSL protocol

Functions of Presentation layer :-

(1) **Translation** :- Different computer use different encoding system. Under this condition presentation layer plays a role of translator
- It converts the data from sender-dependent format into a common format & changed the common format into receiver dependent format at the receiving end.

(2) **Encryption & decryption** :- Encryption is needed to maintain privacy.
- Encryption means that sender transforms the original information to another form & sends the resulting message ~~over~~ over the network.
- Decryption is reverse procss of encryption

(3) **Compression & expansion** :- Data compression is a process of compressing the data. It reduces the no. of bit contained in the information particularly in text, audio & video.

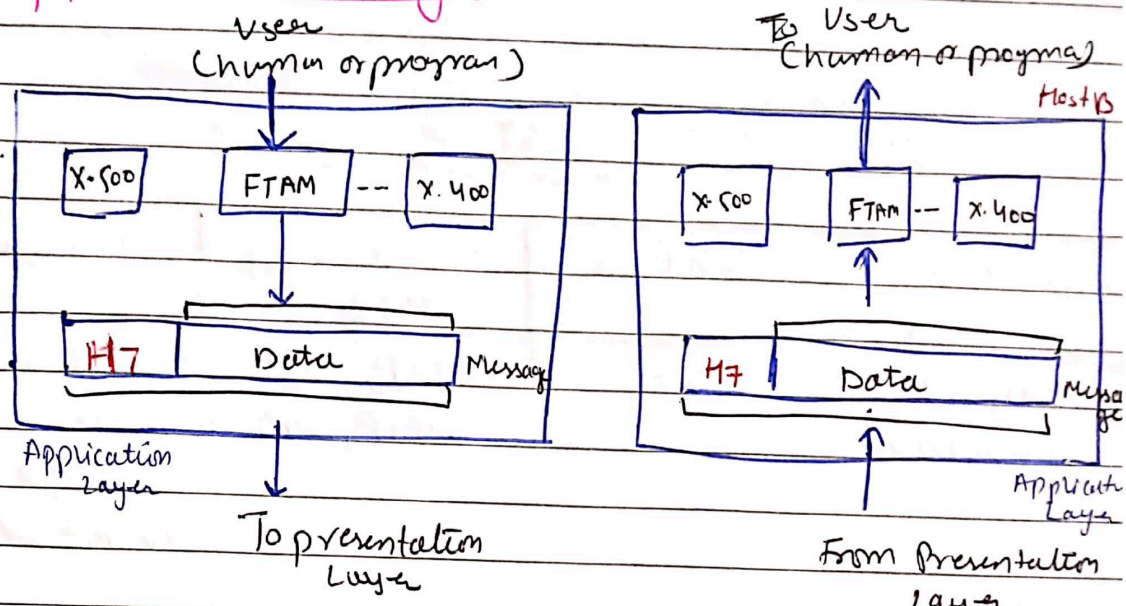
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- Expansion is reverse process of compresion

L7 Application layer:-



- The application layer is responsible for providing services to the user.
- The application layer contain a variety of protocols that are commonly needed by users.
- One widely used application protocol is HTTP (Hypertext Tranfer Protocol)
- It is the basis for world wide web. When a browser wants a webpage, it sends the name of page it wants to the server hosting the page using http.
  The server then sends the page back.

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- other application protocols are - file transfer (FTP) email (SMTP) etc
- Application layer allows users to access files in a remote host, provides email forwarding & storage etc
FTAM - File transfer, Access & Management.

ISO-OSI Refrence

Layer No. & Layer Name	Data Unit	Protocols used	Functions
Layer 7 Application	APDU	HTTP, FTP SMTP, DNS	provide services to user. It allows access to network resource
Layer 6 Presentation	PPDU	compression & encryption protocol JPEG, MPEG, --	It translate, encrypt & compress data
Layer 5 session	SPDU	PLP, SQL, NFS	It establishes, manages & terminate connected b/w application - Dialog control - Synchronization
Layer 4 Transport	segment	TCP, UDP	It provide reliable process to process

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			msg delivery & error recovery - port addressing - segment & reassembly - connection control - flow & error control
layer 3 Network	Packet devices used Router	IP, ICMP IGMP	It provides connection b/w hosts on different network - Logical addressing - Routing - congestion control.
Layer 2 Data link	Frame Devices used switch Bridge	Ethernet	It provides connection b/w hosts on same network.
Layer 1 physical Layer	Bit Devices used Hub, Repeater	Coax, Fiber, wireless	It transmits bit stream on physical medium. • synchronization • line configuration • physical topology • transmission mode

① Circuit switching [10 switch hub] → booked · hole circuit for particular min.

② packet switching Data → bit form [move in sequence at 1 time L bit will move] to last

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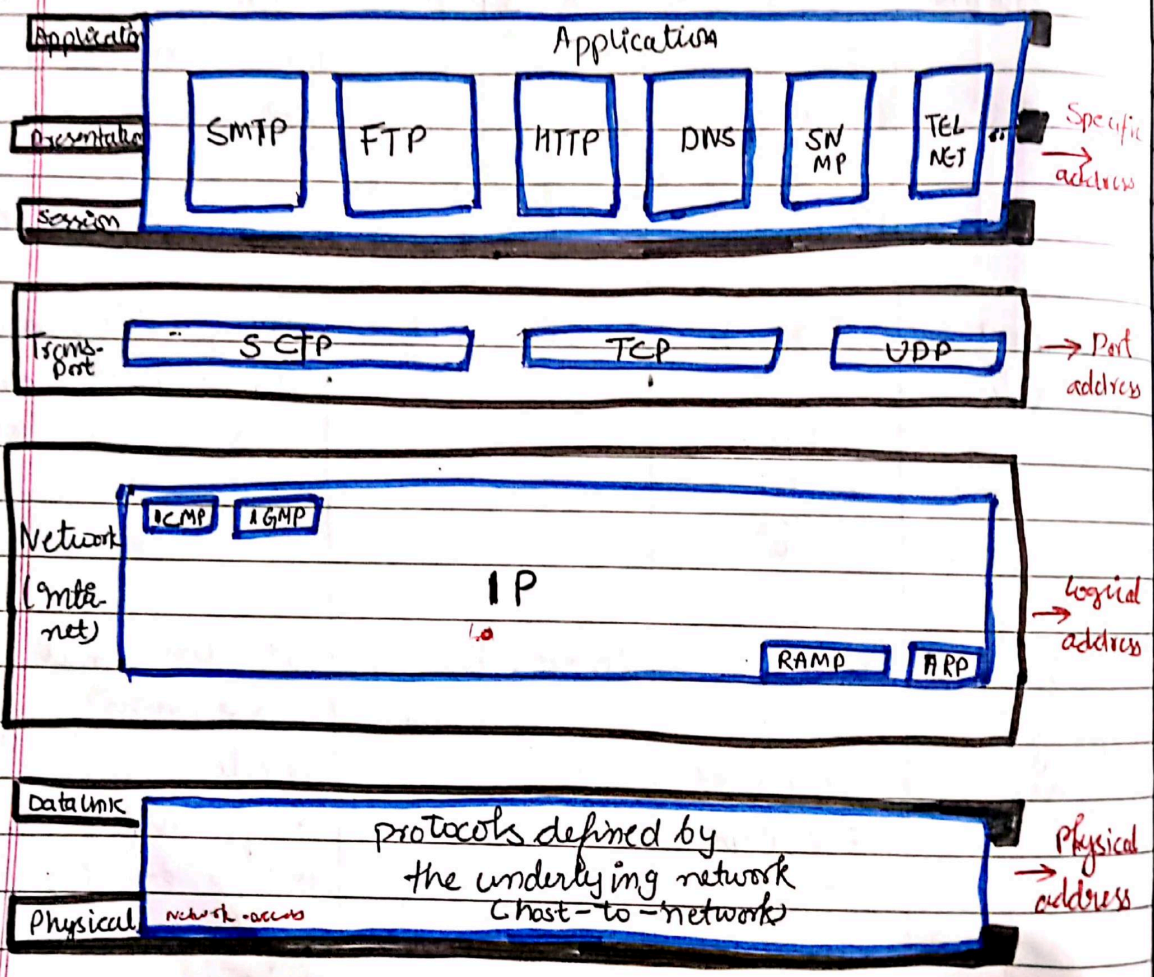
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TCP/IP Model :-

TCP - Transmission control protocol
IP - Internet protocol.

- TCP/IP is a suite of communication protocols used to interconnect network devices on the internet & also in private network.



- TCP/IP specifies how data is exchanged over the internet by providing end to end communication that identify how it should be broken into packets,

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addressed, transmitted, routed & received at the destination.
- It is designed to make network reliable with the ability to recover automatically from the failure of any device on the networks.
- TCP/IP model is developed before OSI model
- Developed by the united states defense department during the year 1970s.
- TCP/IP suite of protocols in classified as stateless which one means each client request is considered new bcz it is unrelated to previous requests.

Functionality:-

(1) Application layer:- This layer includes OSI session, presentation & Application layers
- It includes all of the processes that involve users interaction
- The application determines the presentation of the data & controls the sessions
- Application layer protocols in TCP/IP are SMTP & used for email, HTTP used for WWW & FTP.

(2) Transport layer:- It is designed to allow peer entities on the source destination hosts to carry on a conversation.
- Same as in OSI transport layer.
- It divides the msg received from the session application layer into segments & no. them to

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a sequence.
- It provides flow control, error control, multiplexing & reliability.

(3) Internet layer:-
- It is responsible for creating the packets that move across the network.
- It use IP address to identify the packet's source & destination
- It is also responsible for routing of IP data
- It uses connectionless service
- Protocols used in Internet layer
  IP, ICMP, ARP, RARP

(4) Network Access -
This layer corresponding to the combination of Data link layer & physical layer of the OSI model.
- It looks for hardware addressing (MAC address) & the protocols presentation in this layer allows for the physical transmission of data.
- Protocol used - Ethernet, token ring, X25
- It defined details of how data is physically sent through the network, including how bits are electrically or optically signaled by hardware devices that interface directly with a network medium such as coaxial cable, optical fibre or twisted pair copper wire

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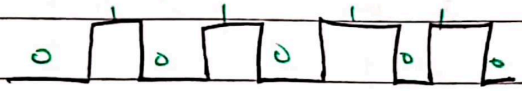
OSI Model	TCP/IP Model
- It has 7 layer	- It has 4 layer
- It is a Reference Model	- It is an implentation of OSI model
- Open System Interconnection	- Transmission control protocol/ Internet protocol Model.
- A vertical approach	- Horizontal approach
- theoretical model	- Model around which internet is developed
- stricter boundaries for the protocols	- Protocols are not strictly defined
- protocol independent standard	- Protocol dependent standard
- combines the session & presentation layer in the application layer	- Has sparate session & presentation layer
- Model was developed before the development of protocols	- Protocol were developed 1st & then the model was developed
- considered a reference tool	- considered more reliable

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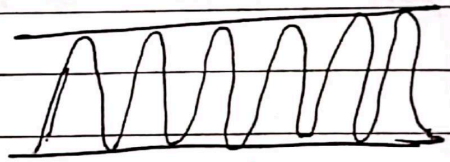
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Modulations :- Data Modulations is a process that converts analog signals into digital signals & digital signals into analog signals. Computer store & process data in digital format. Data modulation allows computers to store & process analog signals.

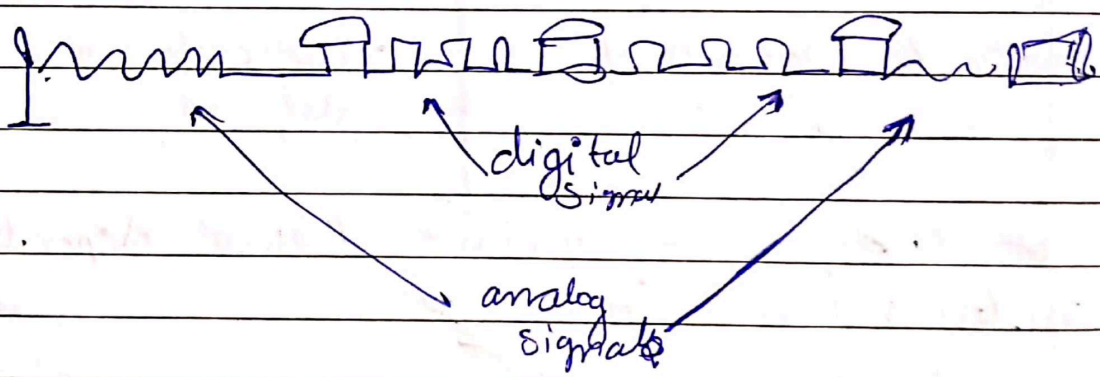


Digital



Analog

eg:- When you record & play an audio clip,



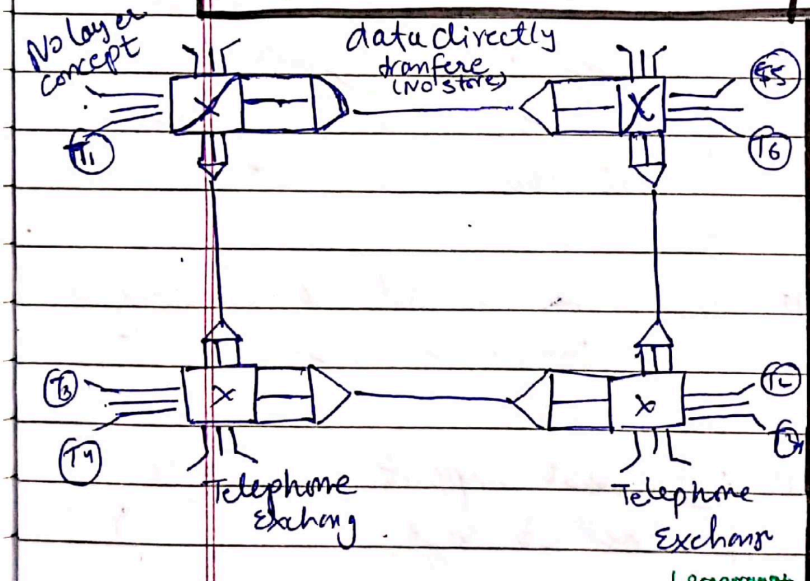
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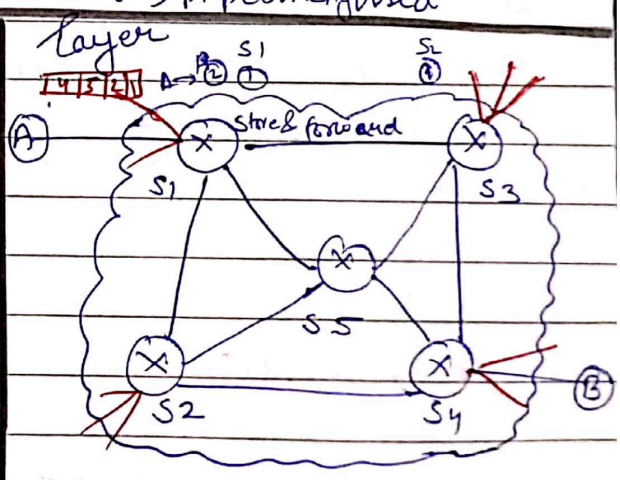
- Datagram
- ~~Circuit~~ Virtual Network

Date / /

Circuit Switching	Packet Switching
• Connection oriented	• Connection less
• Entire Message have to follow same route during transmission	Entire Message can be divided & routed independently.
• Implemented at physical layer	• Implemented at network layer.
• Waste of bandwidth if idle	• No waste of bandwidth if idle.
• Initially designed for voice Transmission	• Initially designed for data Transmission.
• Delicated path, not Out of flow (in order) Efficiency less, delay less	• Data link & Network layer, store & formed (packet), Efficiency, delay, Pipelining used



Total time = Setup time + TT + PD + TearDown time
(Transmission time)



data tranfer in packet form.

Types
Datagram, Virtual
↓ Network layer
Data link layer

Total time = n(TT) + PD

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