1. Introduction to Computer Networks

Overview of OSI layer model

- i) Established in 1947 the International standard organization (ISO)
- ISO is the organization & OSI is the model.
- open system is a set of protocols that allows any two different systems to communicate regardless of their underlying architecture.
- OSI model show how to facilitate comm^{n} bet. different systems without requiring changes to the logic of underlying software & hardware.
- OSI model is not protocol.
- It is a layered framework for the design of n/w systems that allows comm. bet^{n} all types of computer system.
- It consist seven layers.

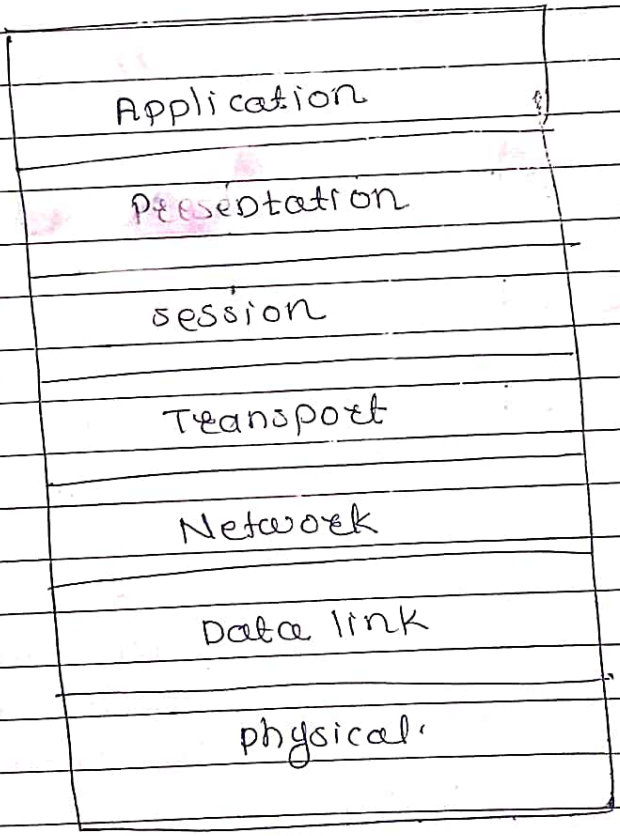

fig → seven layer of OSI model

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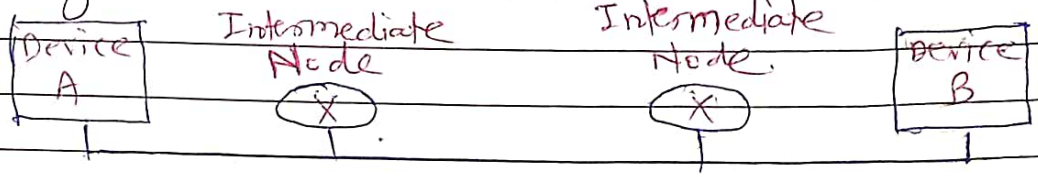
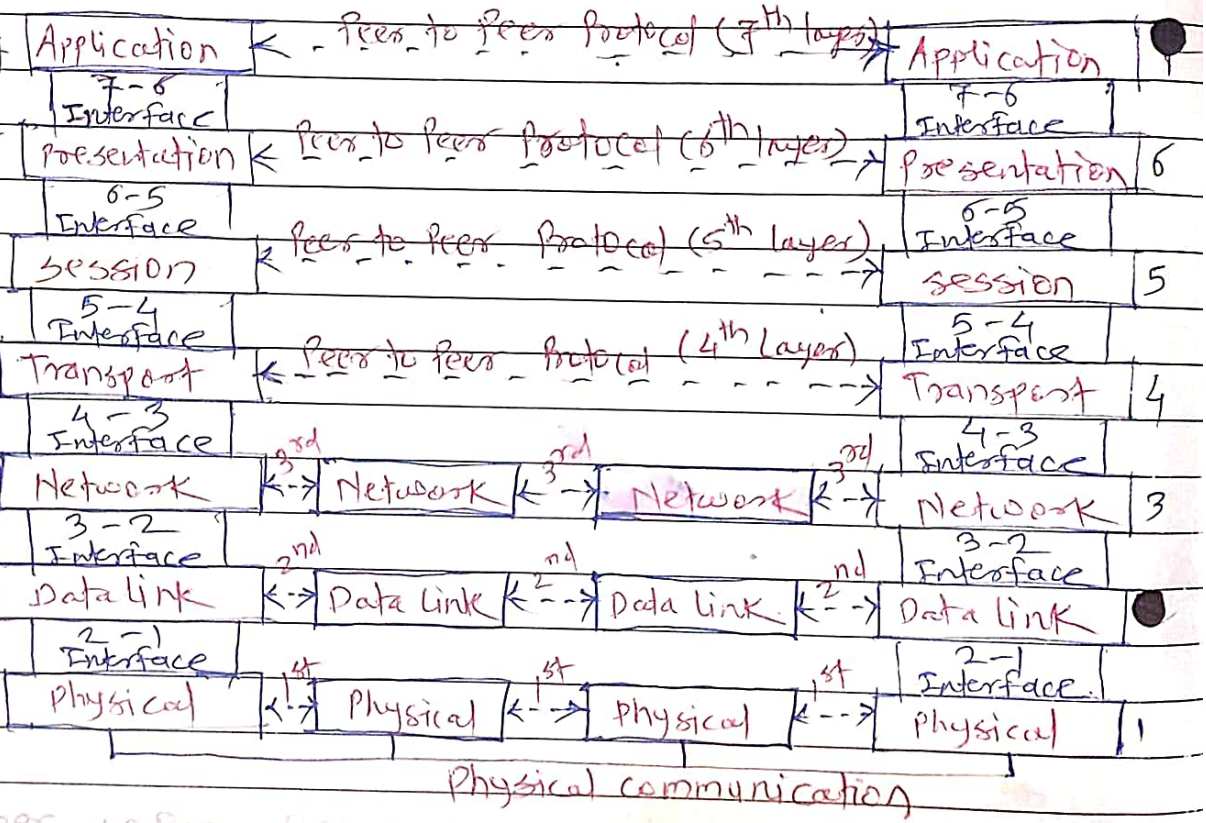
Layered Architecture

- The OSI model contains seven layer. ; i) physic layer ii) data link, iii) network iv) transport v) session, vi) Presentation vii) Application.
- Fig. shows the layers involved when a message is sent from device A to device B.
- Message travel from A to B it may pass through many intermediate nodes.





- As the physical layer communication is direct.
- Each layer in the sending device adds it's own information to the message it receives from the layer just above it & passes the whole package to the layer just below.

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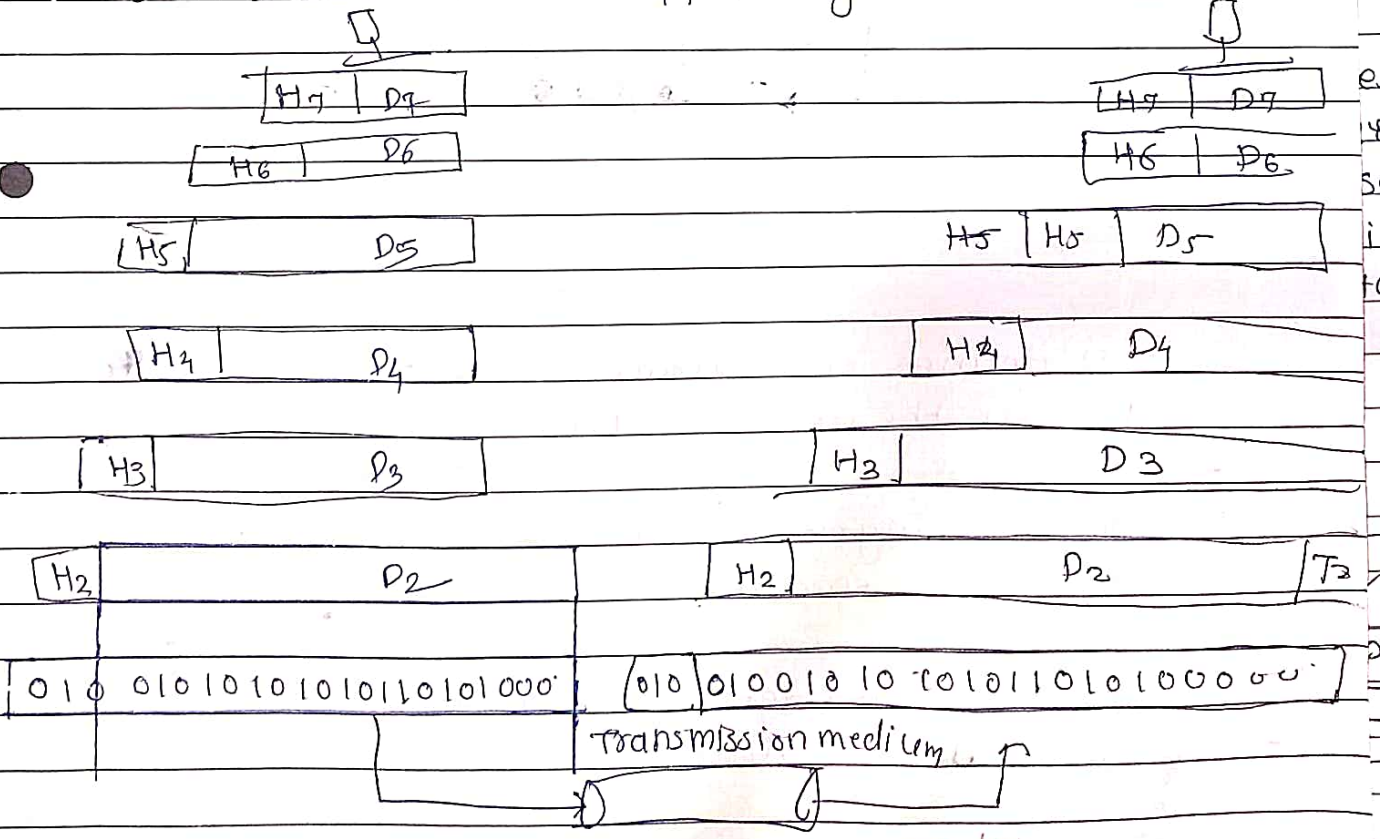
Interface bet. layers

- The passing of the data & network information down through the layer of the sending device & back up through the layers of the receiving device is made possible by an interface bet. each pair of adjacent layer
- Each interface defines the information & services a layer must provide for the layer above it.

Organization of the layers

- The seven layers can be though of as belonging to 3 subgroups. layer 1, 2 & 3 Physical, data link & network are the network support layers, they deal with the physical aspect of moving data from one device to another
- Layers 5, 6, 7 – session, presentation & appln can be thought of as the user support layers.
- Layer 4, transport layer, links the two subgroups & ensures that what the lower layers have transmitted is in a form that the upper layers can use.



Eg → An exchange using OSI model

Encapsulation

- A packet at level 7 is encapsulated in a packet at level 6. The whole packet at level 6 is encapsulated in a packet at level 5 & so on.
- The data portion of a packet at level N-1 carries the whole packet from level N. The concept is called encapsulation.

Layers in OSI model

1) Physical layer

- It deals with the mechanical & electrical specification of the interface & transmission medium.
- The physical layer is responsible for movements of individual bits from one hop to next.

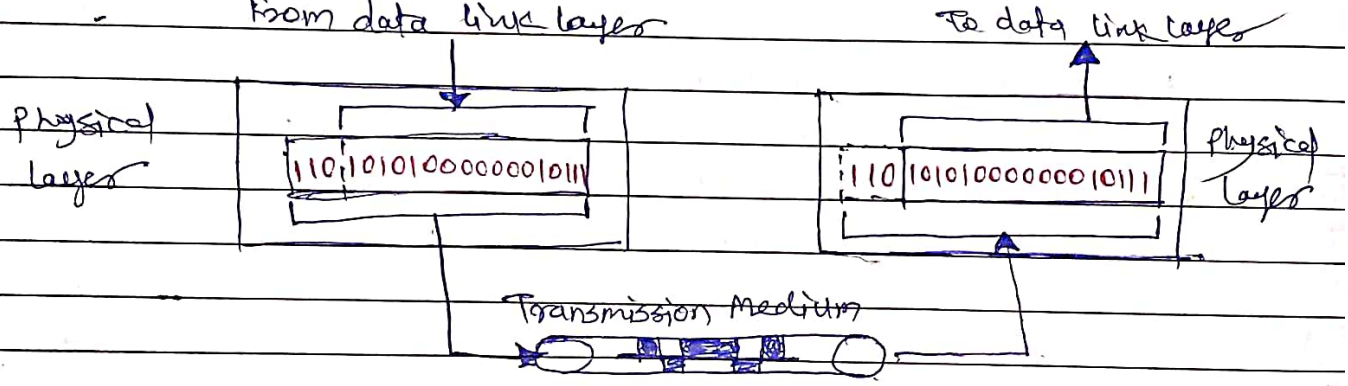


Fig. : Physical layer

i) Physical characteristics of interface & medium

- It defines the characteristics of the interface between the devices & transmission medium.

ii) Representation of bits

Physical layer consist stream of bits. means 0 & 1 It defines encoding

iii) Data rate

- Physical layer defines by the duration of bit which is how long it lasts.

iv) synchronization of bits

The sender & receiver clocks must be synchronized.

4) Routing

When independent nlw or links are connected to create internetworks or a large nlw, the connecting devices route or switch the packets to their final destn.

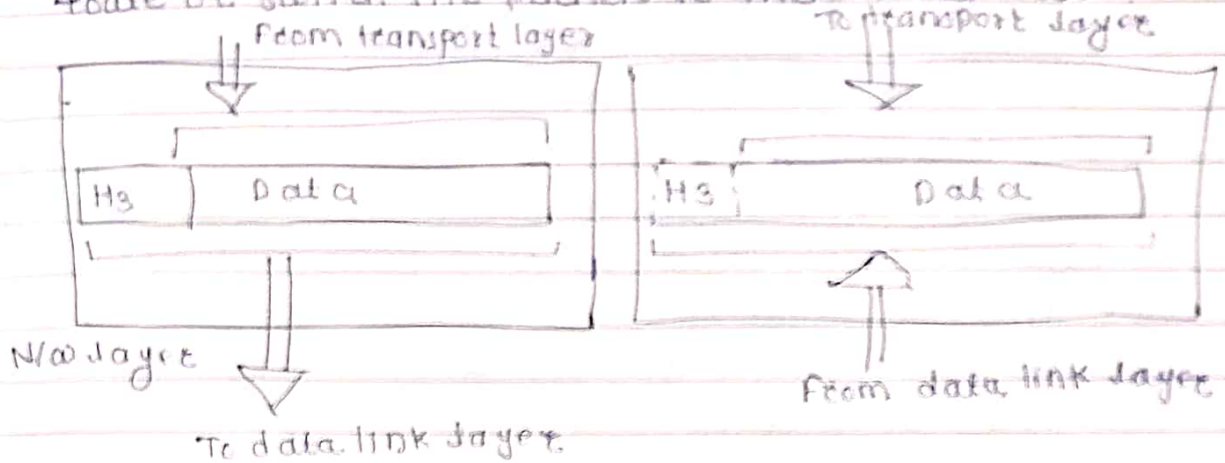
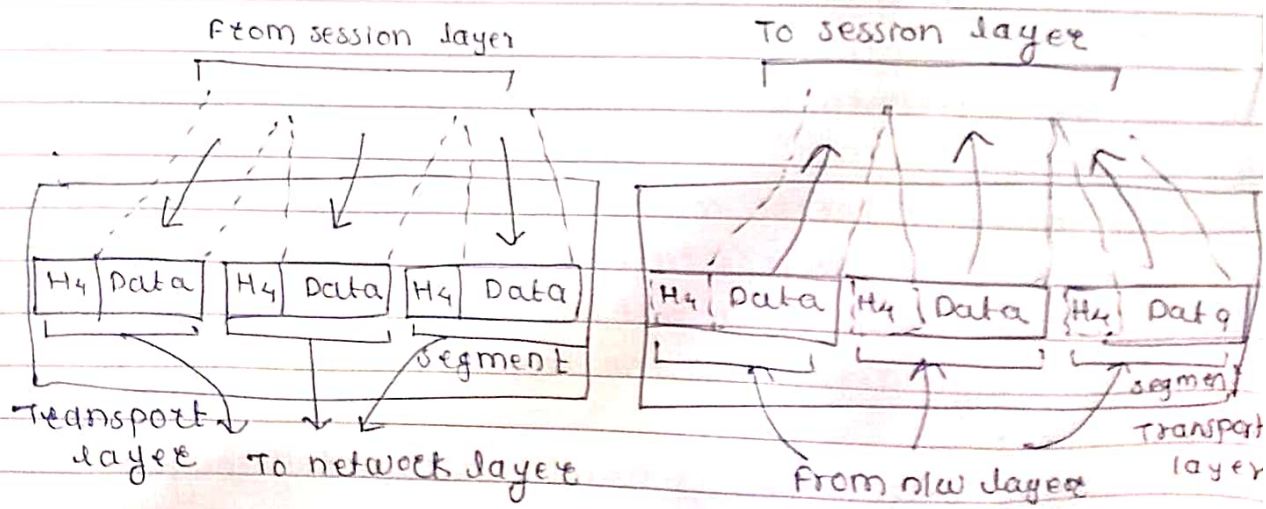


fig → Network layer

4) Transport layer

1) Transport layer is responsible for process to process delivery of the entire message

- A process is an application program running on a host
  whereas the nlw layer oversees source to destination delivery of individual packets.
- The transport layer ensures that whole message arrives intact & in order overseeing both error control & flow control at the source to destination level.
- The transport layer is responsible for the delivery of message from one process to another.



Transport layer

Responsibilities.

1) Service point addressing
- Computers often run several programs at the same time for this reason, source to dest^n delivery means delivery not only from one computer to the next but also from a specific process on one computer to a specific process on the other.
- The transport layer header must therefore include a type of address called a service point address.
- The n/w layer get each packet to the correct compute, transport layer gets the entire msg. to the correct process on computer.

2) Segmentation & reassembly
- Message is divided into transmitted segments, with each segment containing sequence no.
- These no. enable the transport layer to reassemble the msg. correctly upon arriving at the dest^n & to identify & replace packets that were lost in transmissi

3) connection control
- The transport layer can be either connectionless or connection oriented.
- A connectionless transport layer treats each segment as an independent packet & delivers it to transport layer at the dest^n machine.
- A connection oriented transport layer makes a connection with the transport layer at the destinati machine 1st before delivering the packet.

4) Flow control
It performed end to end rather than across single link

5) Error control
- However, error control at this layer is performed process-to-process rather than across a single link.
- The sending transport layer makes sure that the entire message arrives at the receiving transport layer without error.
- Error correction is usually achieved through retransmis

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v) Line configuration

- In point to point configuration, two devices are connected through a dedicated link.
- In a multipoint configuration a link is shared among several devices.

vi) Physical topology

Devices can be connected by using mesh topology, star topology, ring topology, bus & hybrid topology.

vii) Transmission mode

Physical layer defines direction of transmission between two devices ~~keyboard monitor~~ Relationship

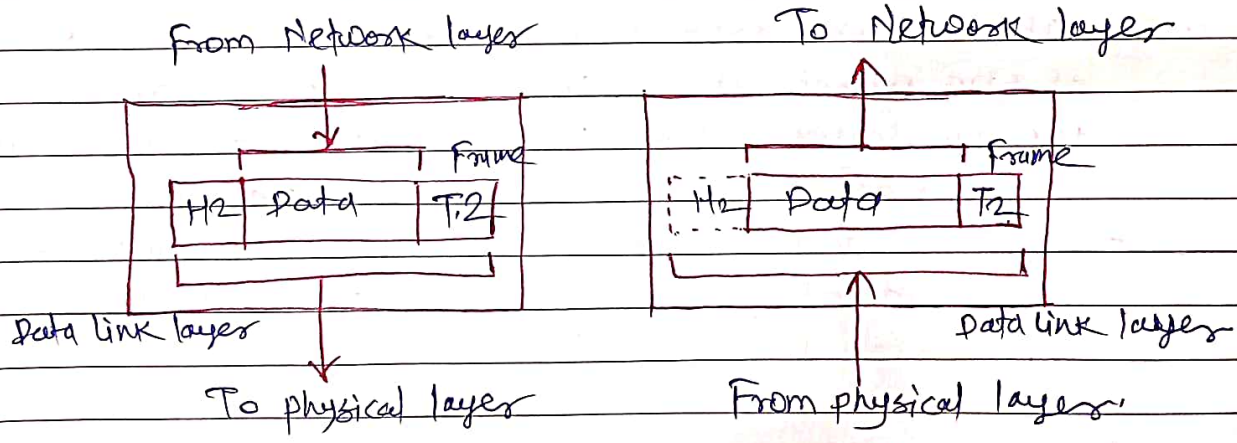
a) simplex → one device can send, other can only receive ~~one way road~~

b) half duplex → two devices can send & receive but not at the same time. e.g - walkie-talkies, ~~one way road~~

c) Full duplex → two devices can send & receive at the same time - telephone.

(2) Data link

1) The data link layer is responsible for moving frames from one hop to the next.



Responsibility

1) Framing -

The data link layer divides the stream of bits received from the network layer into manageable data units called frames.

2) Physical addressing

If frames are to be distributed to different systems on the n/w, data link layer adds a header to the frams to define the sender & receiver of the frame.

iii) Flow control

If the rate at which the data are absorbed by the receiver is less than the rate at which data are produced in the sender, data link layer impose a flow control mechanism to avoid overwhelming the receiver

iv) Error control

The data link layer adds reliability to the physical layer by adding mechanism to detect & transmit damaged or lost frames.

- Error control is normally achieved through a trailer to the end of the frame.

v) Access control

When two or more devices are connected to the same link, data link layer protocols are necessary to determine which device has control over the link at any given time.

3) Network layer

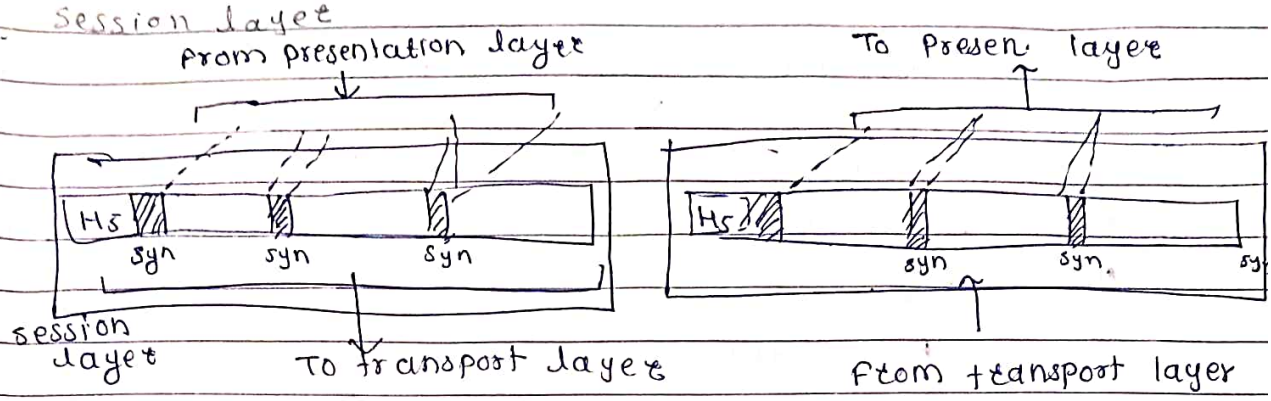
- The nlw layer is responsible for the source to dest. delivery of packet
- whereas the data link layer oversees the delivery of the packet between two systems on the same nlw, the nlw layer ensures that each packet gets from its point of origin to it's final destination
- The nlw layer is responsible for the delivery of individual packets from the source to the destination host.

Responsibility

i) logical addressing

- If a packet passes the nlw boundary, we need another addressing system to help distinguish the source & destn system.
- The nlw layer adds a header to the packet coming from the upper layer that among other things, includes the logical addresses of the sender & receiver.

Session layer



Session layer

- The session layer is responsible for dialog control & synchronization.
- The session layer is like dialog controller.
- It establishes, maintains & synchronizes the interaction among communicating system.

Responsibility

1) Dialog control

Session layer allows two systems to enter into a dialog.
- It allows the communication between two processes to take place in either half duplex or full duplex mode.

2) Synchronization

The session layer allows a process to add checkpoints or synchronization points, to stream of data.

6) Presentation layer

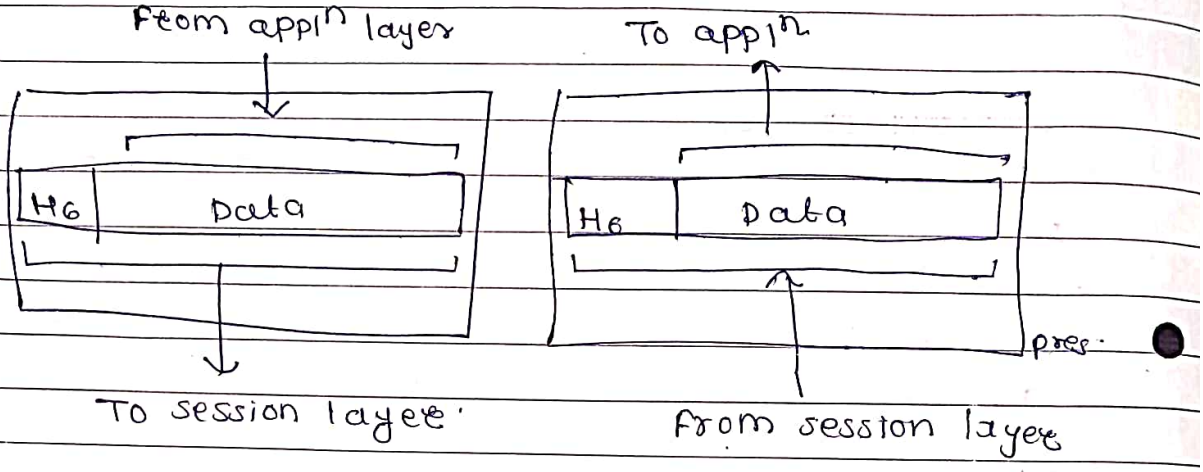
- It is concerned with the syntax & semantics of the info. exchanged between two systems.
- The presentation layer is responsible for translation, compression & encryption.

1) Translation

- The processes in two systems are usually exchanging info. in the form of character strings, number & so on.
- The info. must be changed to bit stream before being transmitted because different computers use different encoding systems, the presentation layer is responsible for interoperability between these different encoding methods..

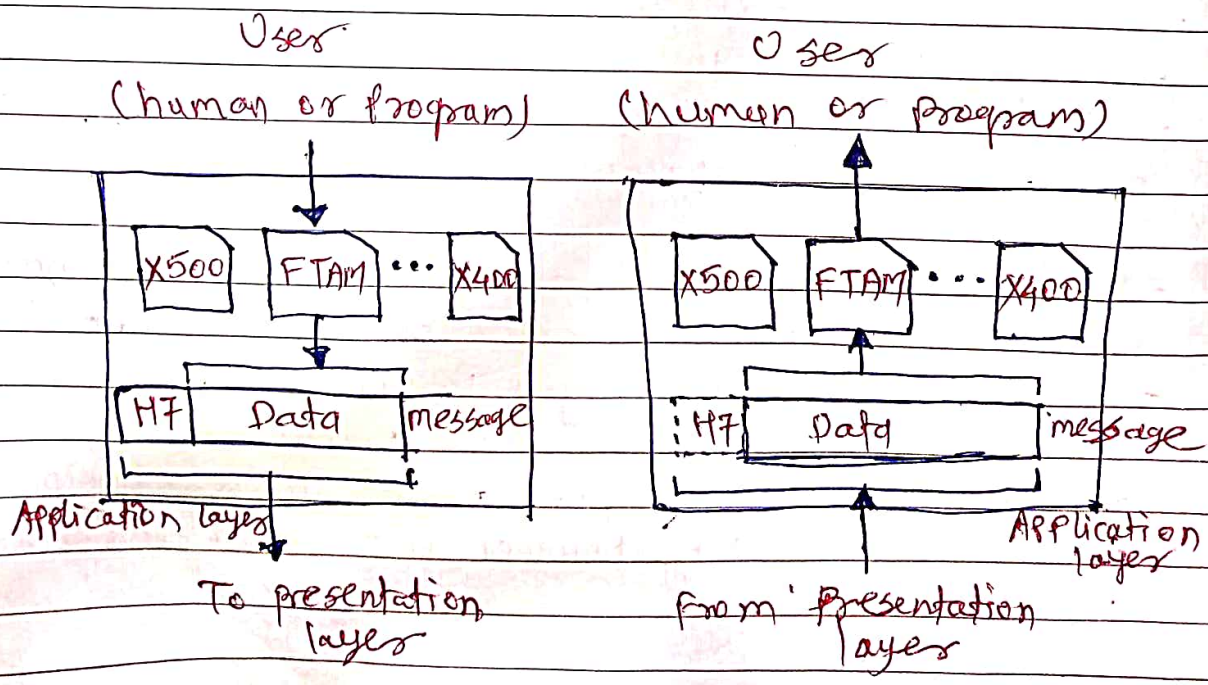
ii) Encryption -

- To carry sensitive info, a system must be able to ensure privacy.
- Encryption means that the sender transforms the original info. to another form & sends the resulting msg out over the network.



7) Appln layer

- It enables the user, whether human or else to access the network.
- It provides user interface & support for services such as electronic mail, remote file access & transfer shared database management & other types of distributed information services.



Visual studio

i) Network virtual terminal
- It is a software version of physical terminal & it allow a user a log on to remote host.

ii) file transfer, access & management
It allows user to access in a remote host to retrieve files from remote computer in a remote host for use in the local computer & to manage or control files in remote computer locally.

iii) Directory services
It provides distributed database sources & access for global info. about various objects & services.

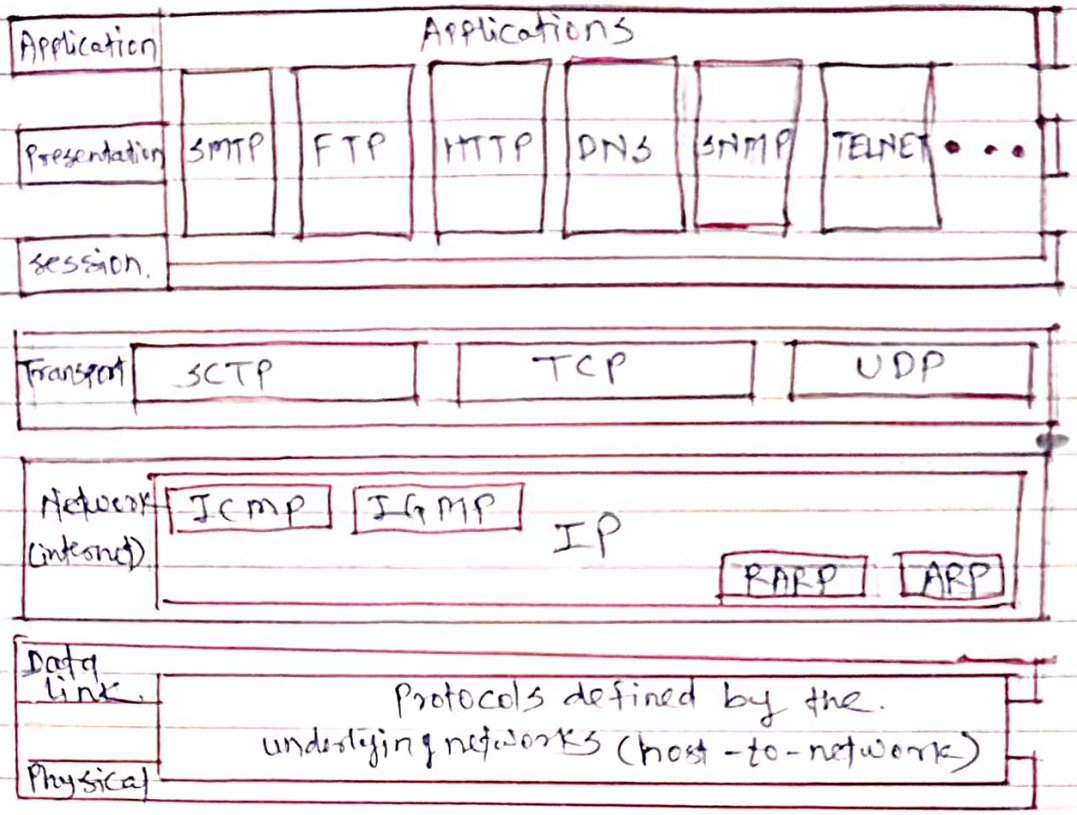
iv) mail service
It provides basis for email forwarding & storage

TCP/IP

- TCP/IP protocol suite was developed prior to the OSI model
- The original TCP/IP protocol suit was defined as having four layer
  a) host - to - network
  b) Internet
  c) Transport
  d) Application

- However, when TCP/IP is compared to OSI, we can say that the host to network layer is equivalent to the combination of the physical & data link layer.
- The internet layer is equivalent to the network la & the application layer is roughly doing the job of session, presentation & Application layer with the transport layer in TCP/IP taking care of part of duties of the session layer.

- The 1st four layers provide physical standards, network interfaces, internetworking & transport fun. that corresponds to the 1st four layers of OSI model.



Physical & Data link layers

- At the physical & data link layers, TCP/IP does not define any specific protocols.
- It supports all the standard & proprietary protocols
- A network in TCP/IP internetwork can be local area network or wide area network.

Network layer

- At the network layer TCP/IP supports the Internetworking protocol
- IP in turn uses four supporting protocols, ARP, RARP, ICMP & IGMP.
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Internet protocol

- IP is the transmission mechanism used by TCP/IP protocols
- It is an unreliable & connectionless protocol, a best effort delivery service.
- The term best efforts means that IP provides no error checking or tracking.

- IP transport data in packets called datagrams, each of which is transported separately

ARP

- It is used to associate a logical address with a physical address.
- ARP is used to find the physical address of the node when it's Internet address is known.

RARP

- It allows a host to discover it's internet address when it knows only its physical address.
- It is used when computer is connected to a network for the 1st time or when diskless computer is booted.

ICMP

It is mechanism used by hosts & gateways to send notification of datagram problems back to sender
- It send query & error reporting msg.

IGMP

It is used to facilate the simultaneous transmission of msg to a group of recipient

Transport layer

- Transport layer was represented in TCP/IP by two protocols TCP & UDP.
- IP is a host-to-host protocol meaning that it can deliver a packet from one physical device to another.
- UDP & TCP are transport level protocols responsible for delivery of msg. from process to another process.

UDP

It is simplest of two standard TCP/IP transport protocol. It is process to process protocol that adds only port address, checksum, error control & length info. to the data from the upper layer.

TCP

- It provides full transport layer services to applications.
- TCP is a reliable stream transport protocol.
- The term stream in this context means connection-oriented.
- A connection must be established between both ends of transmission before either can transmit data.
- At the sending end of each transmission, TCP divides a stream of data into smaller units called segments
- Each segment includes a sequence no. for reordering after receipt, together with an ack. no. for segment received.

SCTP

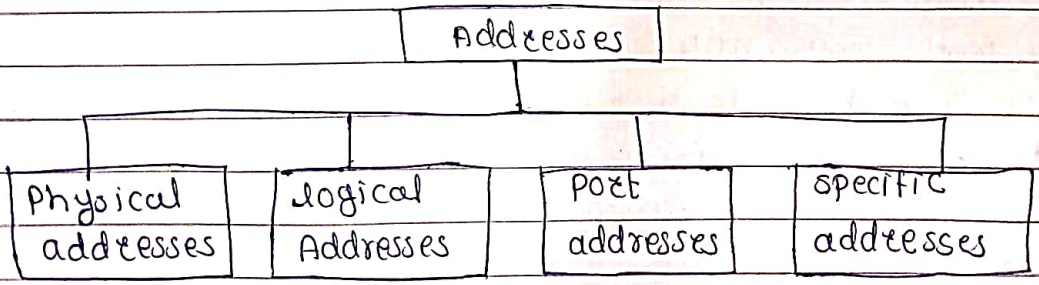
- It provides support for newer application such as voice over the internet.
- It is a transport layer protocol that combines best features of UDP & TCP.

Application layer

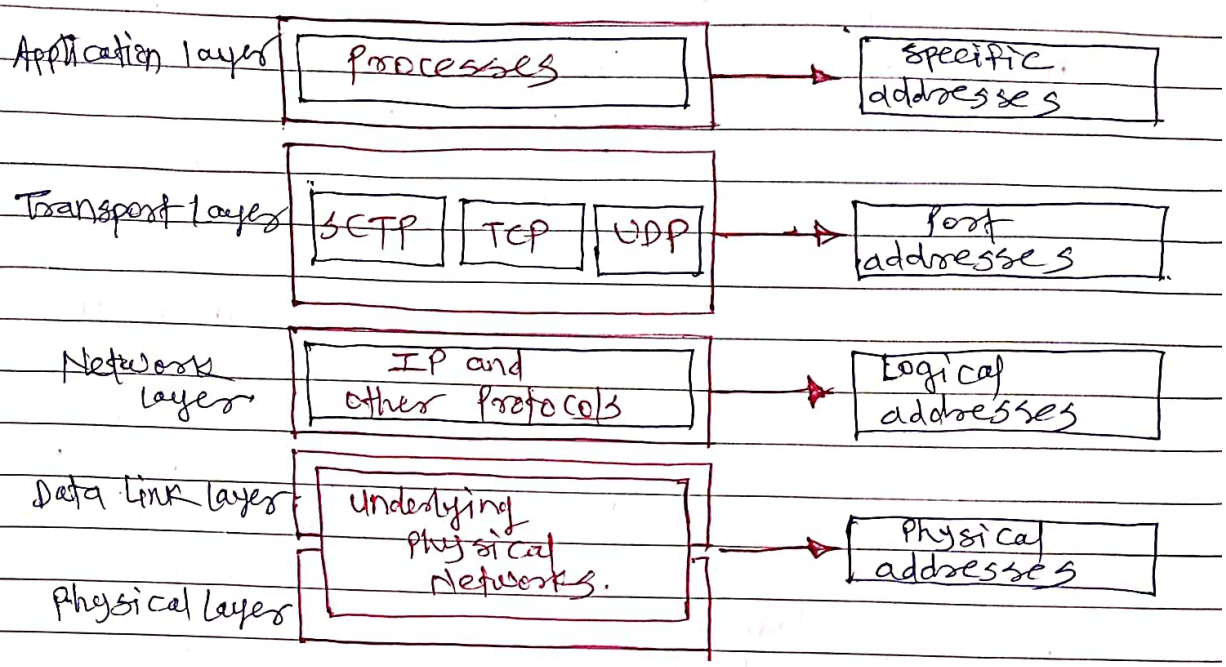
It is equivalent to the combined session, presentation & appln layers in the OSI model.

Addressing

Address in TCP/IP



Rel^n of layers & addresses in TCP/IP



1) Physical Addresses

- It is also known as the link address.
- It is the address of node as defined by it's LAN or WAN.
- It is included in the frame used by data link layer
- It is lowest level address.
- The size & format of these addresses vary depending on the network. e.g. Ethernet uses a 6byte physical address that is imprinted on the NIC

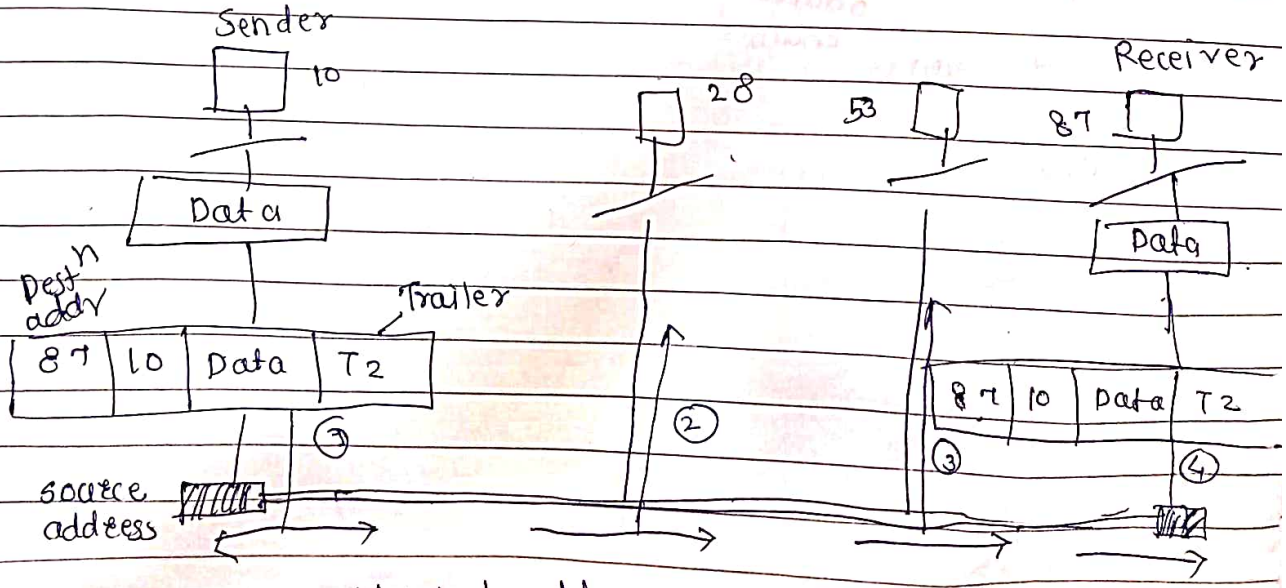
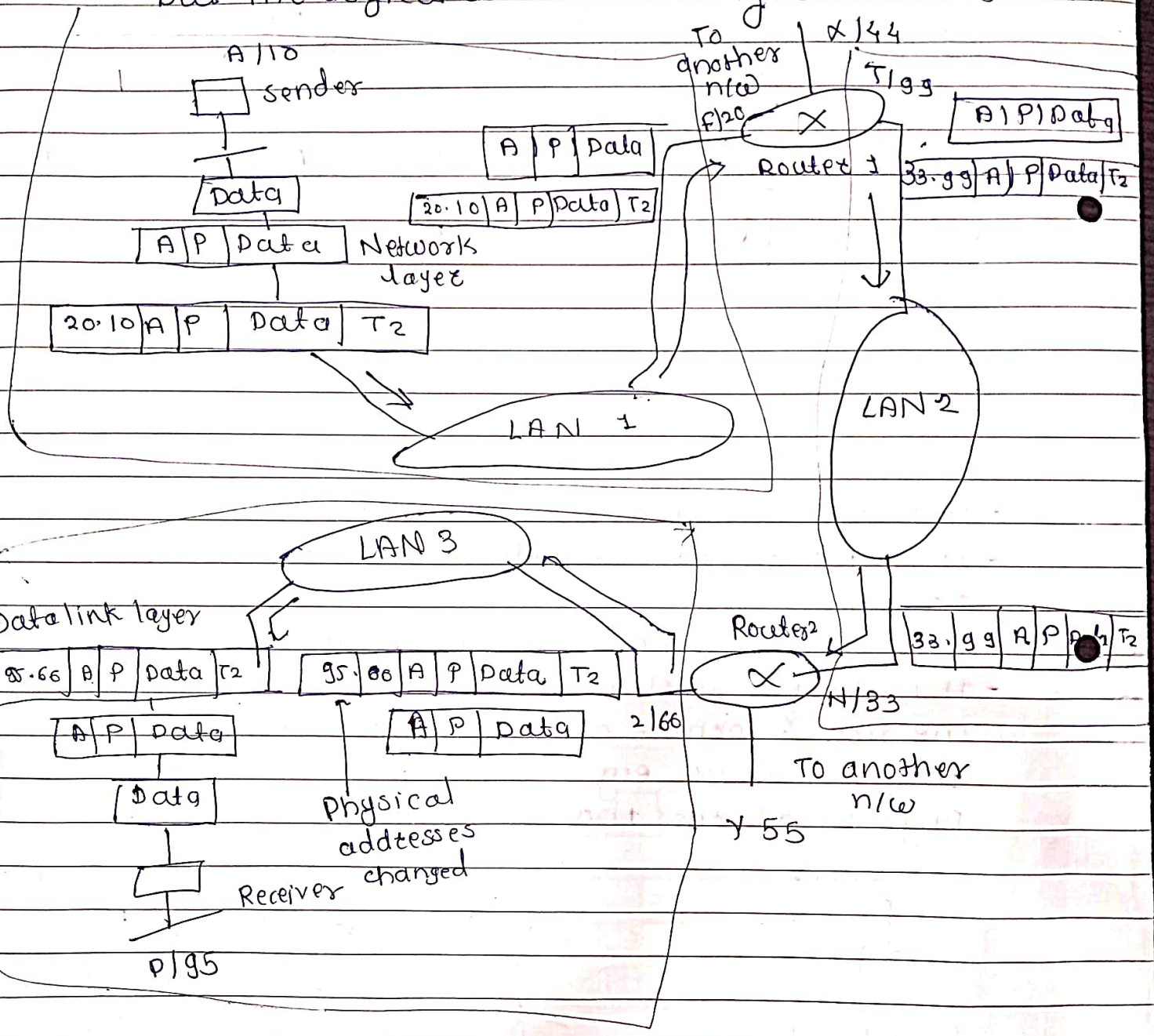


fig- Physical address

logical Addresses

- It is necessary for universal communication that are independent of underlying physical networks.
- logical address in the internet is currently 32-bit addressing that can uniquely define a host connected to the internet
- The physical address will change from hop to hop but the logical addresses usually remain the same.



- Port address
  - Computer A can communicate with computer B by using Telnet. At same time computer A communicate with computer B by using the FTP. For these purpose process to receive data simultaneously, we need a method to label the different processes
  - They need addresses, in TCP/IP, the label assigned to a process is called port address.
  - Port address in TCP/IP is 16 bits. in length
  - The physical addresses change from hop to hop but the logical & port addresses usually remain the same.

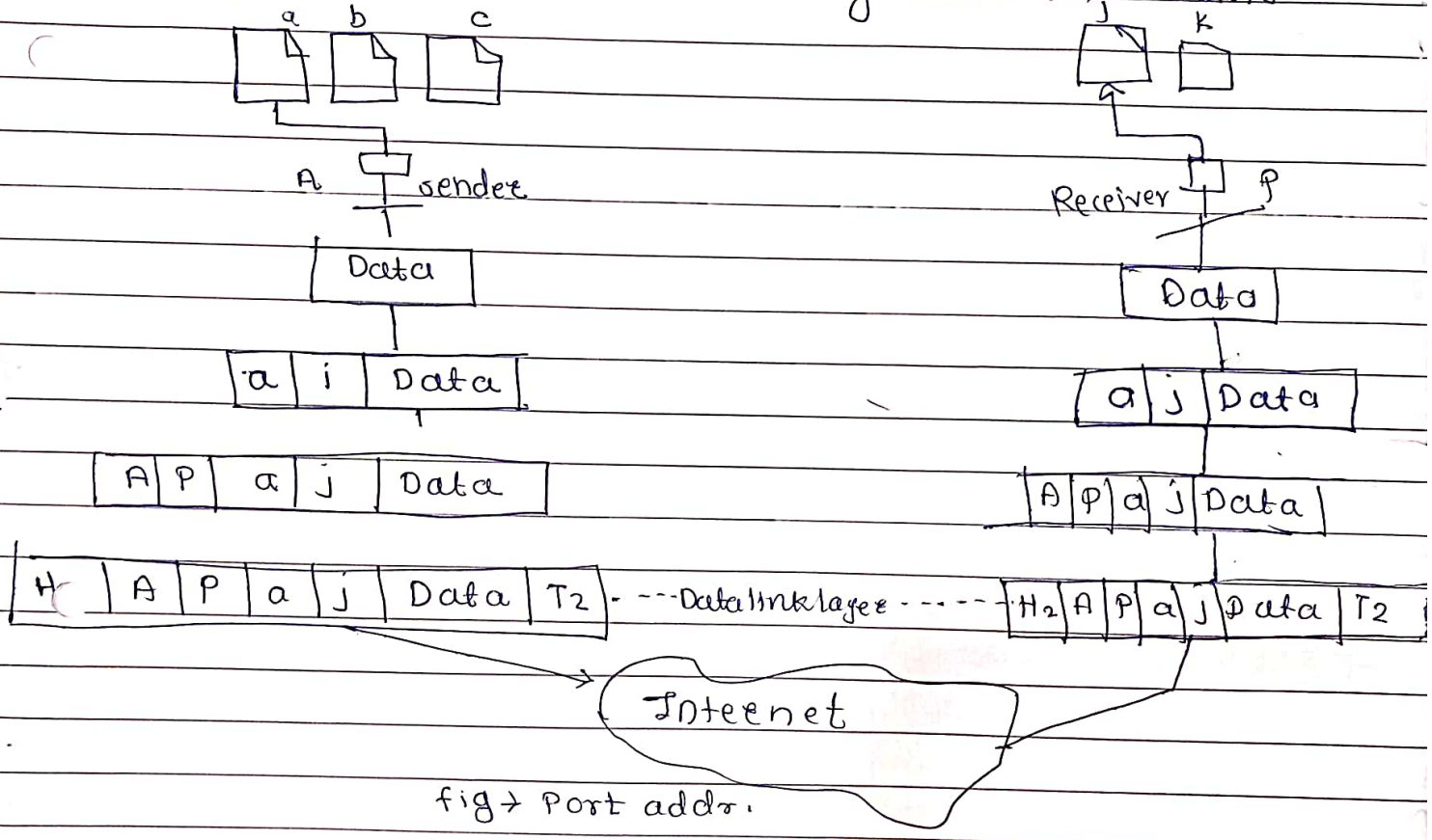


fig → Port addr.

Specific Addresses

- Some appln have user friendly addresses are designed for that specific address.
- Examples include the email address & Universal Resource Locator. The 1st define recipient of an email & the second is used to find document on the world wide web.
- These addresses, however get changed to the corresponding port & logical addresses by sending computer.

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Physical Address

- Local Area Network (LAN) is a data communication network connecting various terminals or computers within a building or limited geographical area.
- The connection among the devices could be wired or wireless.
- Ethernet, Token Ring & wireless LAN using IEEE 802.11 are examples of standard LAN Technology.
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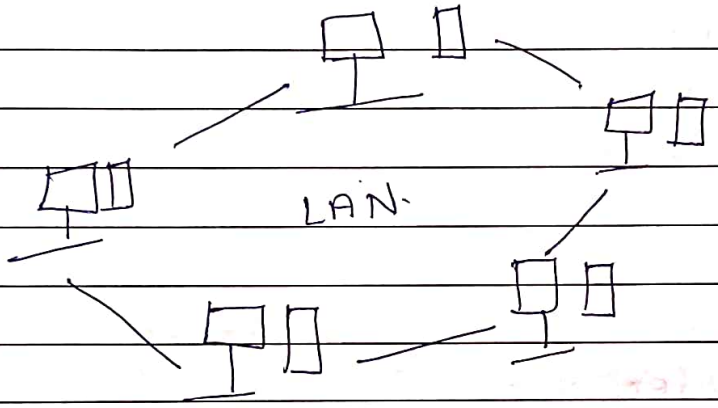

- It is a n/w which consist of less than 5000 interconnected devices across several building
- LAN will be used one type of transmission medium.
- It is a private network. so an outside regulatory body never control it.
- LAN operates at relatively higher speed compare to other WAN system.
- Computer resources like hard disk, DVD-Rom & printers can share in LAN.
- Data of all n/w users can be stored on a single hard disk of the server computer.
- You can easily transfer data & msg. over networked computers.

Ethernet

- It is most widely used LAN Technology, which is defined under IEEE standards. 802.3.
- The reason behind it's wide usability is Ethernet is easy to understand, implement, maintain & allows low-cost n/w implementation.
- Ethernet operates in two layers of the OSI model physical layer & Data link layer.
- In order to handle collision, the access control mechanism used in Ethernet is CSMA/CD.

i) Fast ethernet
ii) Gigabit ethernet
iii) 10 Gigabit ethernet

i) Fast ethernet
Fast ethernet refers to an Ethernet network that can transfer data at a rate of 100 mbit/s.

ii) Gigabit Ethernet
Gigabit ethernet delivers a data rate of 1,000 mbits/s (1Gbits/s)

iii) 10 Gigabit Ethernet
- 10 gigabit ethernet is the recent generation & delivers a data rate of 10Gbit/s (10,000 mbits/s)
- It is generally used for backbones in high-end appln requiring high data rate.

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Token ring consist of 3 bytes of which starting & ending delimiters are used to indicate the begining & end of token bus. & middle byte of token frame is an access control byte.

SD	AC	ED

A) Token frame format

Bytes 1	1	1	2/6	2/6	No limit	4	1	1
SD	AC	FC	Dest. Addr (DA)	Src Addr (SA)	Data	checksum	ED	FS

(B) Data Frame format

1) SD - Start Delimeter → 1st field of data frame & one byte long & used to alert the receiving station to arrival of fram as well as allow it to synchronize its reteieval timing.

2) Access control (AC) → It is 1 byte long & contain two fields 1st bit contains type of info contained in the Protocol Data Unit (PDU)

3) DA (Destⁿ addr) → It is 2 to 6 byte, it contains physical address of frames next dest.

4) SA (Src addr) - It is 2-6 bytes, contains physical address of the station.

5) Data - Data length 45000 bytes & contain PDU. token ring frame not include PDU length or type field.

6) checksum - 4 byte. It is used to cross check data at sending & to station. The no. is checked at receiver end after counting bytes in received frame.

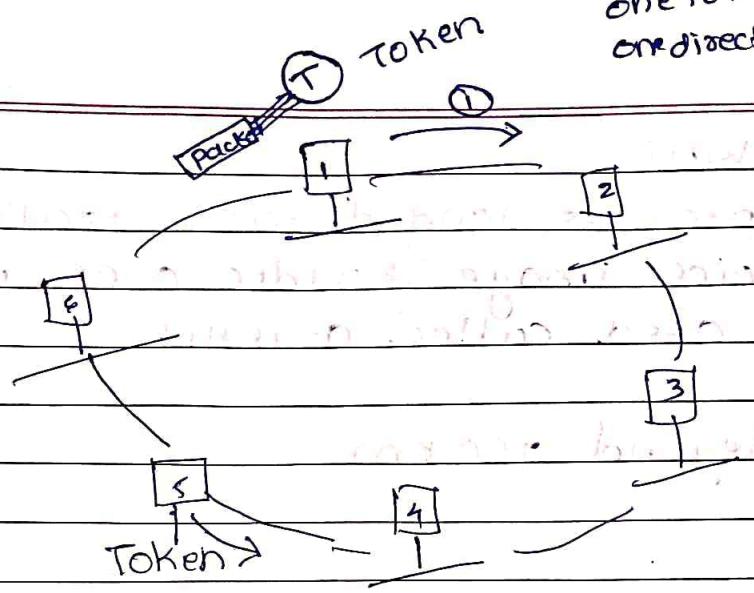
7) ED (End Delimeter) - indicates end of data / frame

8) Frame status - It can be set by receiver to indicate that frame has been read or monitor to indicate that frame has already been around ring.

Token Ring

- Token ring is formed by the nodes connected in a ring format as shown in fig.
- The principle used in the token ring n/w is that a token is circulating in the ring & whichever node grabs that token will have right to transmit the data
- whenever the token rotates in the ring it is guaranteed that every node gets the token with
- whenever a station wants to transmit a frame it inverts a single bit of the 3 byte token which instantaneously changes it into a normal data packet. because there is only one token, there can atmost be one transmission at a time.
- Since the token rotates in the ring it is guaranteed that every node gets the token with in some specified time. So there is an upper bound on the time of waiting to grab the token so that starvation is avoided.
- There is also an upper limit of 250 on the no. of nodes in the n/w.
- To distinguish the normal data packets from token a special sequence is assigned to the token packet.
- when any node get the token it 1st sends the data it wants to send, then recirculates the token.
- If node transmits the token & nobody wants to send the data token comes back to the sender.
- If the 1st bit of the token reaches the sender before the transmission of the last bit, then error situation arises. so to avoid this

Not collision
one token
one direction



- Ring topology is used.
- one direction of data flow, unidirection

i) Topology → Ring
ii) Access control → Token Passing
iii) ACK → Pigg backing
iv) Encoding - DME Differential manchester Encoding
- converts data bits into single.
v) Data flow - Unidirection
vi) Data rates = 16 mbps.
- Used in Real time application.

RL - Ring Latency - Round.

THT - Token Holding Time :-

i) Delayed Token Reinsertion → (DTR) $THT = T_t + RL$ (transmission time / Ring Latency)
ii) Early token Reinsertion

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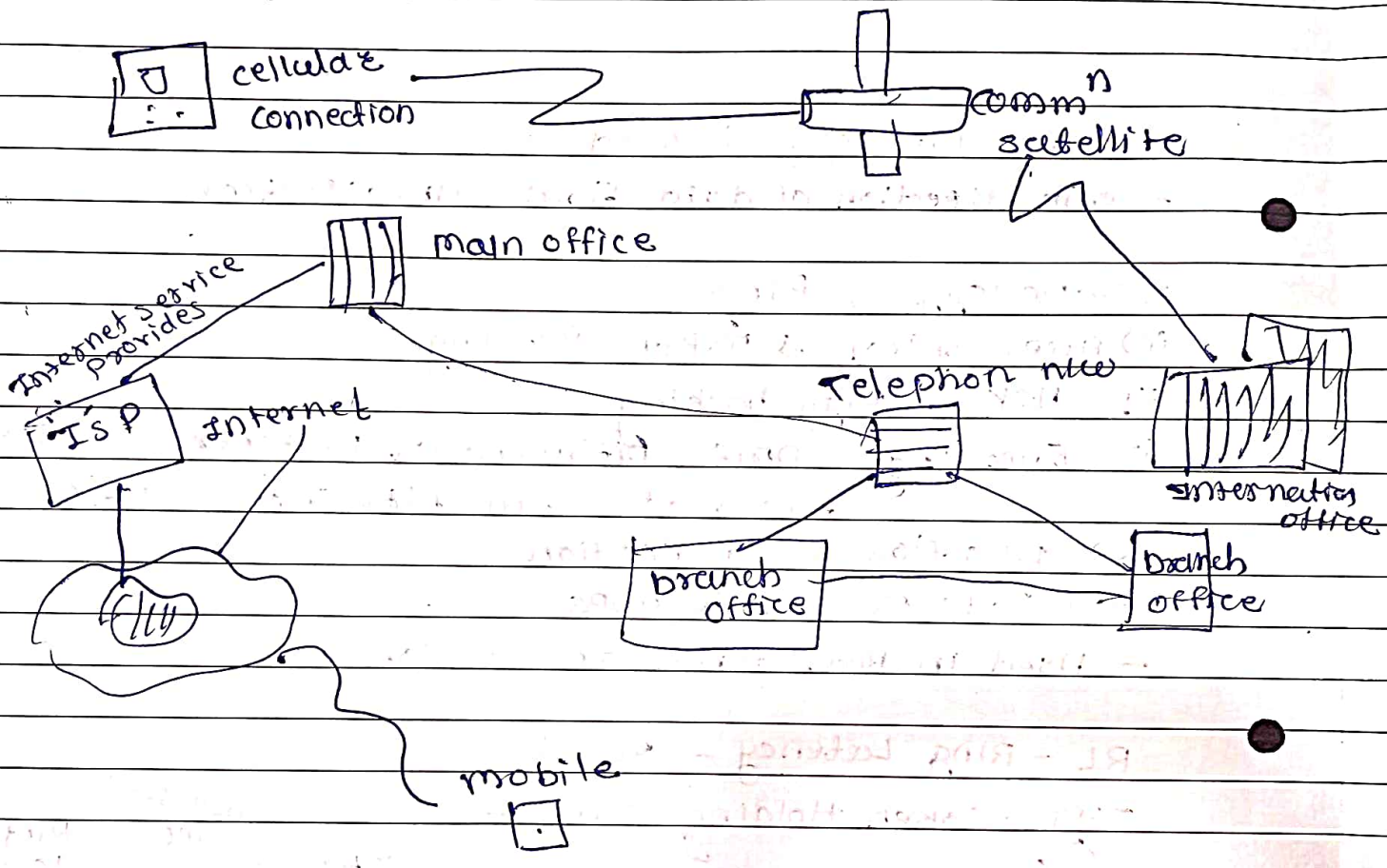
WAN

- N/w that provides long distance transmission of data, voice, image & video over large geographic area called as WAN

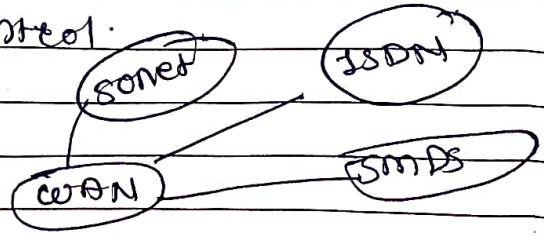
- Range - Beyond 100 km

- Example



Technology used in WAN

1) ISDN (Integrated service digital Network)
2) SMDS (Switched multimegabit data service
3) Sonet (Synchronous optical N/w
4) HDLC (High data link control
5) SDLC (Synchronous



ATM –

- Asynchronous Transfer mode

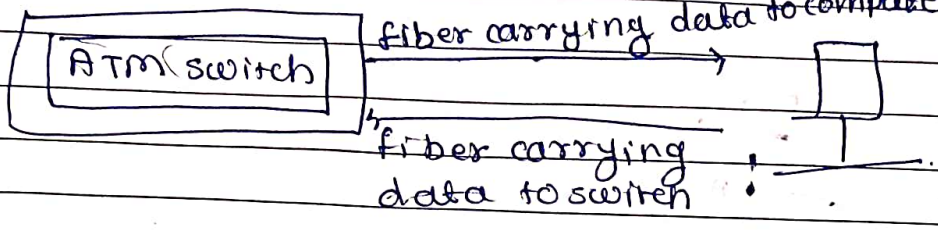


fig – connection betn ~~not~~ ATM switch & computer

- Each connection consists of a pair of optical fibers.
- one fiber carries data to the switch & other carries data to the computer

– ATM is circuit switched comm. procedure

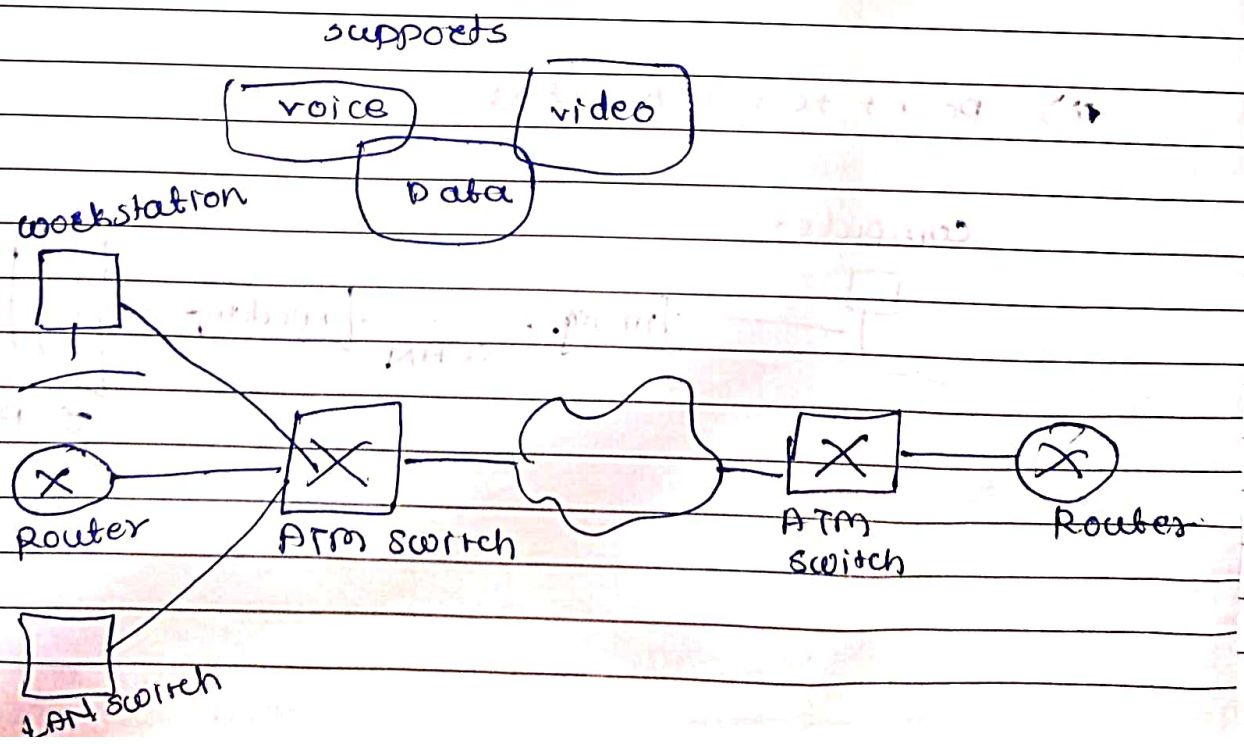
Goals.

–i) To handle conventional telephone voice traffic as well as data traffic.

–ii) To serve as local area tech. as well as wide area tech.

– comm^n using voice, data, video

– It is used fixed length cells.

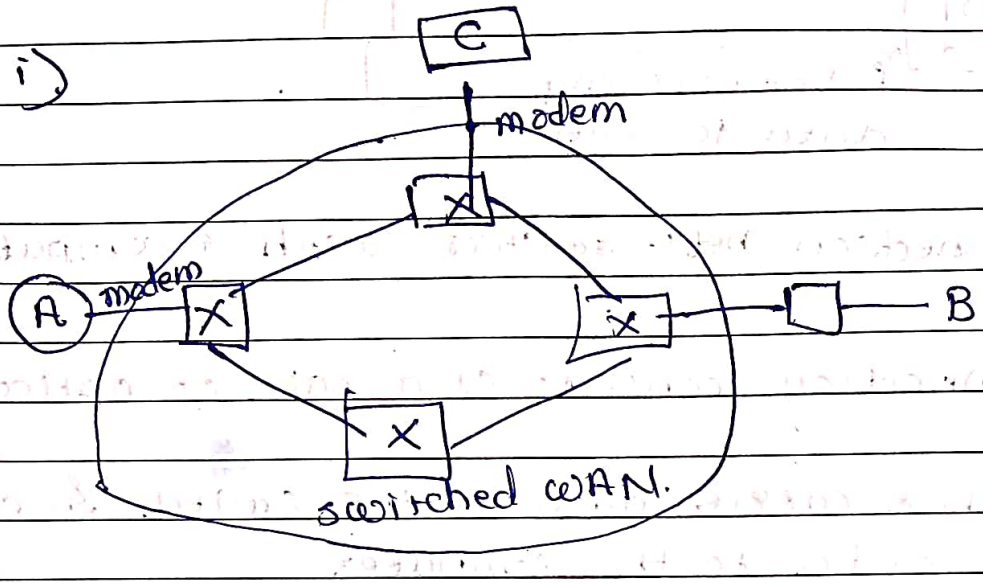


Two types of WAN

i) switched WAN

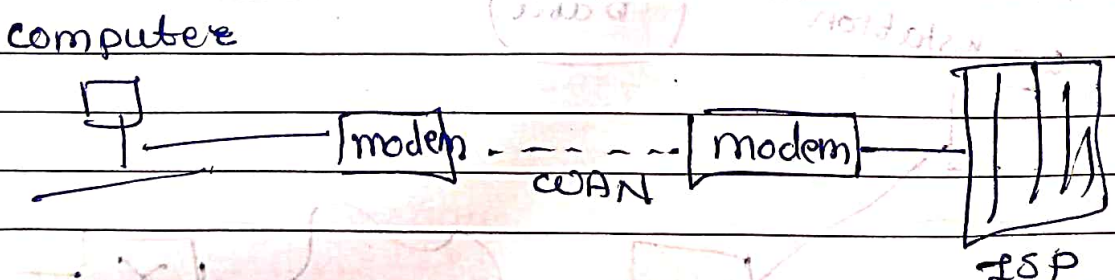
ii) Point to point WAN

i)



- It is nice having more that 2 end &
- combination of several points to points WAN that are connected through switch
- It is used in global comm^n.
- It is used in ,

ii) Point to point WAN



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Switched WAN Tech

In switched WAN nlw data sent from source node is routed to the dest. node by being switched from one node to another in the nlw.

- It is suitable for long distance transmission

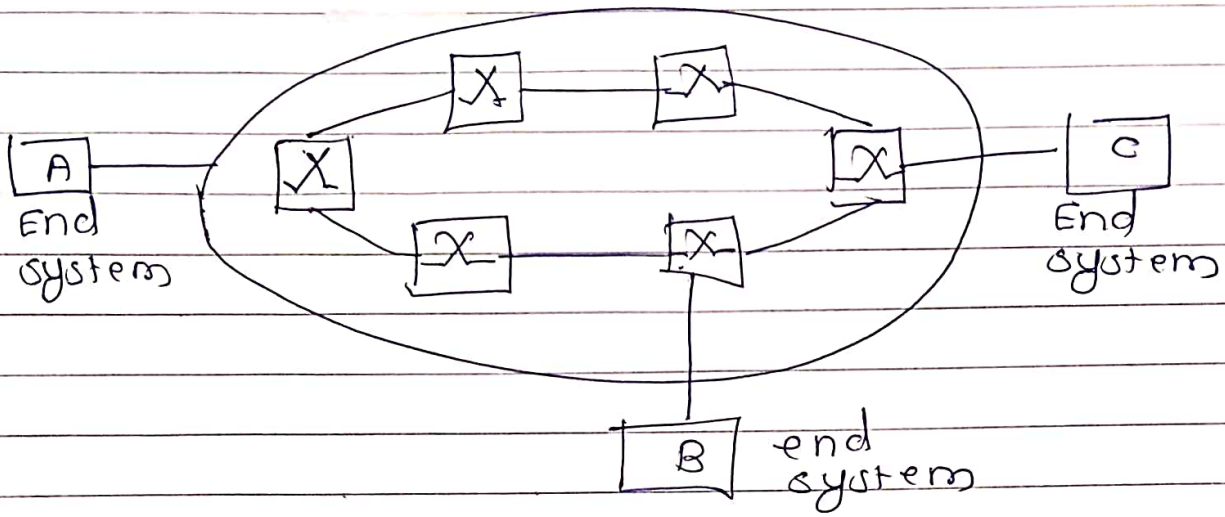

fig. switched WAN

It uses connection oriented technology where switches are used to establish path betn source to dest.

- If src node wants to send data to the dest. node at 1st path is established betn them & then data is transmitted over the estabishes path. once comm. is over the path betn sender & received is terminated