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AP - CSE

Computer Networks.

1. EVOLUTION OF COMPUTER NETWORKS:-

- Computer Networks also known as Data Communicati or data transmission networks represent a logical result of the two most important technical branches namely computing and telecommunications.

- Computing:- A Group of computers operate in a coordinated manner to perform a set of inter related tasks by exchanging data in an automated mode.

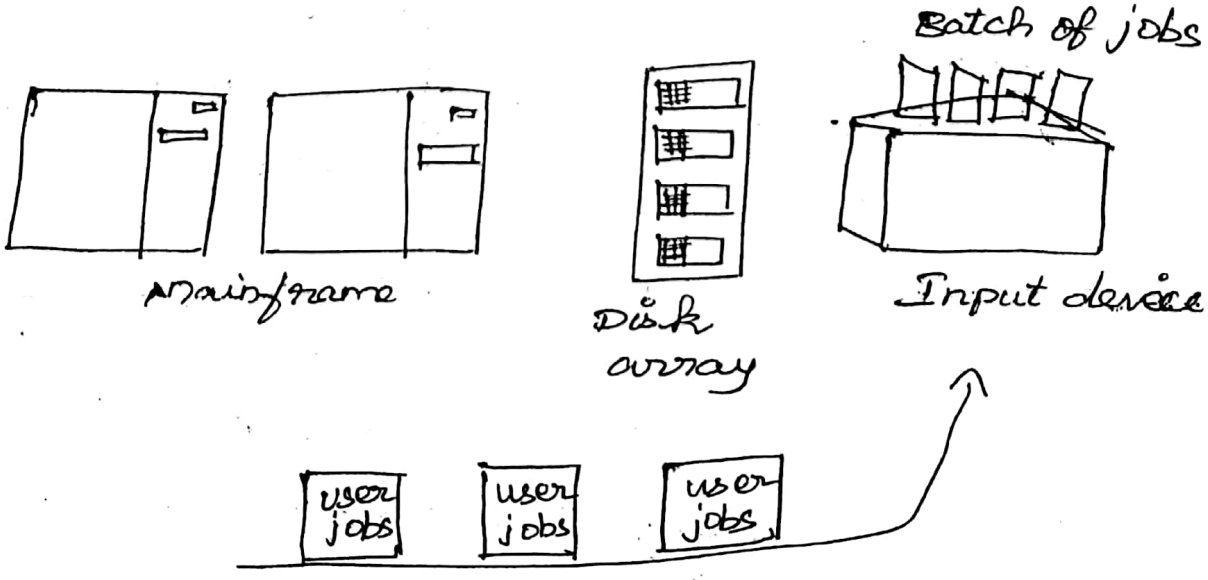
- Telecommunications :- A means for transmitting data over long distances. It implements various methods of data encoding and multiplexing to transmit the information

So, The Computers and Communications have been merged together to form Computer Networks.

- These are all happened during 20th century that is in late 1960's.
- Before 1950, for computation, we were using Batch processing system.

Batch processing system :-

- In 1950s - large, bulky and expensive computer were intended for a small no. of privileged users.
- Such computers were not able to serve users interactively.
- Instead, they batched jobs and delivered results later.



- Batch processing systems were based on mainframe computers which were more powerful and reliable universal computers.

— Users would prepare punched cards containing data and program code and then would transfer these cards to the Computing Center.

— Operators would enter these cards into the computer and users would receive the results a day later in the form of a print out.

— This is a tedious prouss, and users have to wait for a period of 24 hours to get the result.

— The end users preferred an interactive mode of operating that allows them to manage the prousing of their data on the fly from the terminal itself.

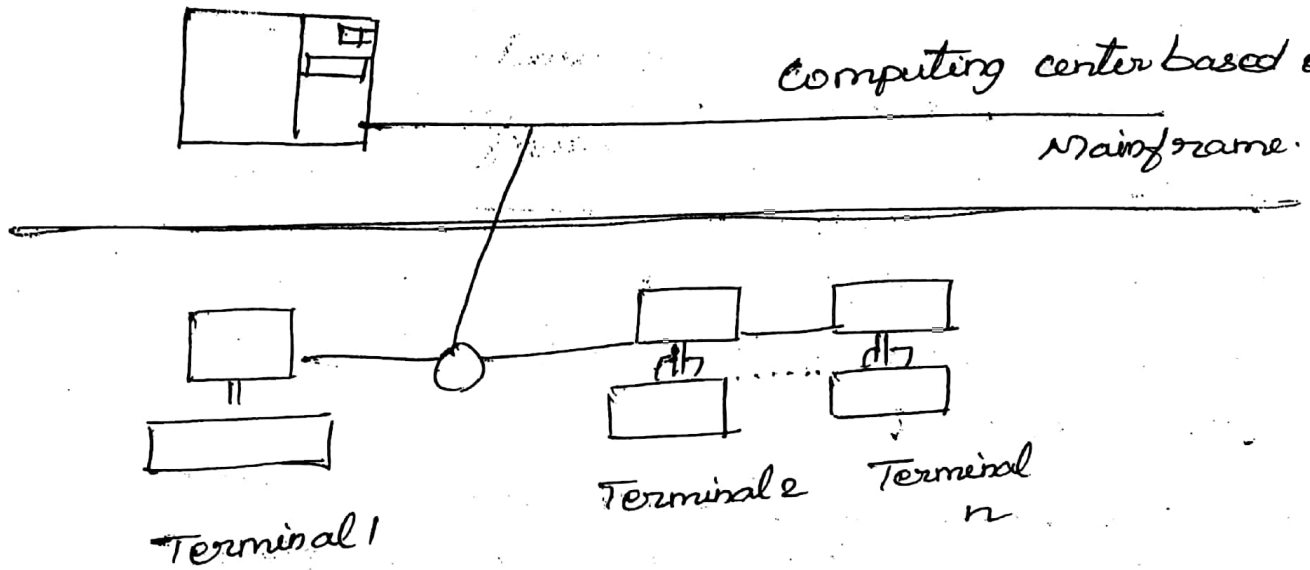
— As processors became cheap in 1960s, multiterminal systems evolved.

— End users had their own terminal to communicate with the computer.

— Then Terminals moved onto desktops, where data inputs and outputs became distributed.

— The users could access shared files and peripheral devices and maintain the illusion of using the Compater in an exclusive mode

- The user could start any required program at any moment and received the results almost immediately.



Definition of Computer Networks:-

- Two computers are said to be interconnected if they interchange information.
- The connection between separate computers can be done via a copper wire, fibre optics, microwaves or satellite communication.
- Node:- A computer, a printer or any machine that is capable of communicating on the network is referred to as a device or node.

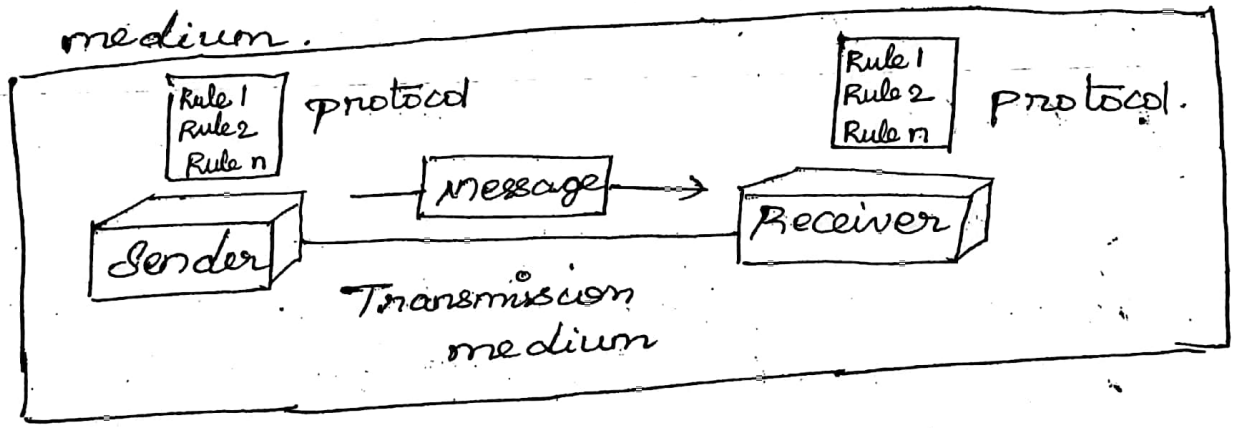
- A Computer Network is an interconnection of various computers to share software, hardware, resources and data through a communication medium between them.

Requirements :- for COMPONENTS OF DATA COMMUNICATION

- Any Computer networking communication need a sender, a receiver and a communication medium to transfer signal or data from sender to receiver.

Uses :-

1) Resource sharing
2) For providing high reliability
3) To save money
4) It can provide a powerful communication medium.



Message :-

The message is the information to be communicated. popular forms of information include text, numbers, pictures, audio & video.

Sender :-

The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera and so on.

Receiver :-

The receiver is the device the receives the message. It can be a computer, workstation, telephone handset, television and so on.

Transmission medium :-

Transmission medium is the physical path by which message travels from sender to receiver. Some examples of transmission medium are twisted pair wire, coaxial cable, fibre optic cable, radio waves.

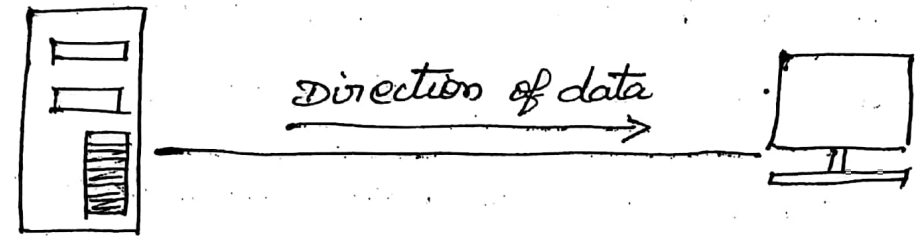
protocol :-

A protocol is a set of rules that govern data communications. It represents an agreement between communicating devices.

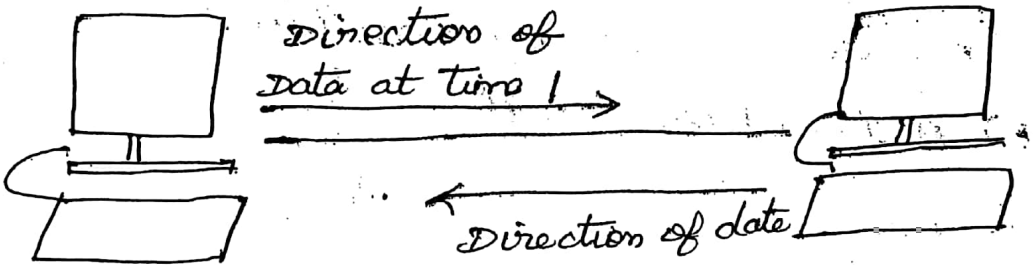
Data flow :-

Communication between two devices can be

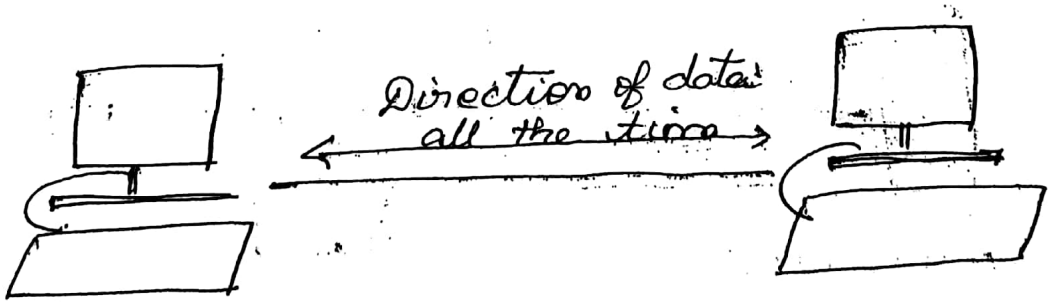
1) Simplex
2) Half - duplex
3) Full - duplex.



1) Simplex.



2) Half - duplex.



3) Full - duplex.

Types of Connection:-

1) point - to - point
2) Multipoint.

Point - to - point :-

- provides a dedicated link betn 2 devices.
- The entire capacity of the link is reserved for transmission of these two devices.

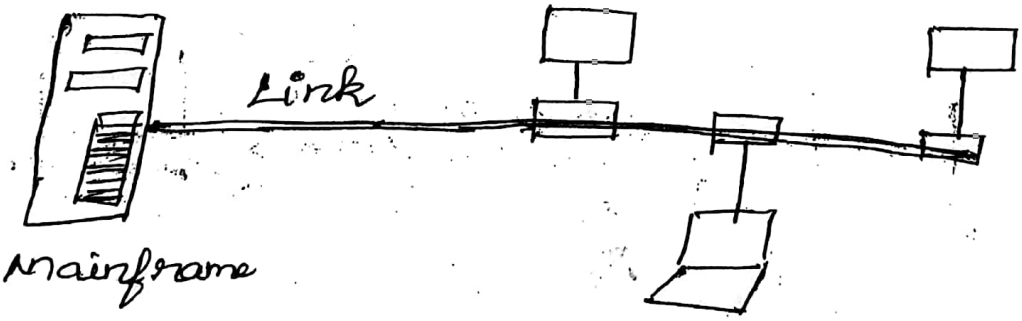
Eg :- when we change television channels by infrared remote control, we are establishing a point-point connection.

2) connection to ISP (Internet service provider) through modem.

3) A telephone call

Multipoint :-

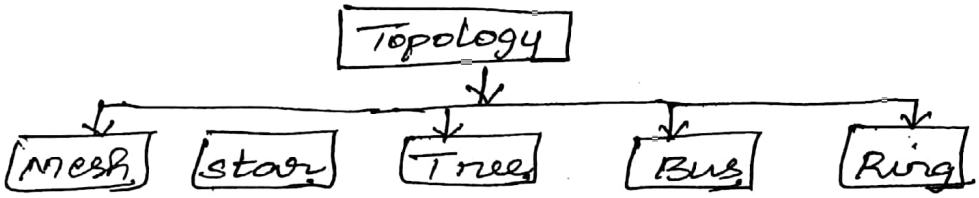
- A Multipoint connection, more than 2 devices share a single link.



- The capacity of the channel is shared.
- several devices can link simultaneously is spatial connection. if take turns means timeshared connection.

Network Topology:-

- Topology refers to the way of how a network is laid out physically or logically.
- Two or more devices connect to a link and two or more links forms a topology.
- It is the geometrical representation of the relationship of all the links and linking device (usually called nodes) to each other.



Two ways of relationship :-

→ peer-to-peer (Ring & Mesh)
→ primary-secondary (Star & Tree).

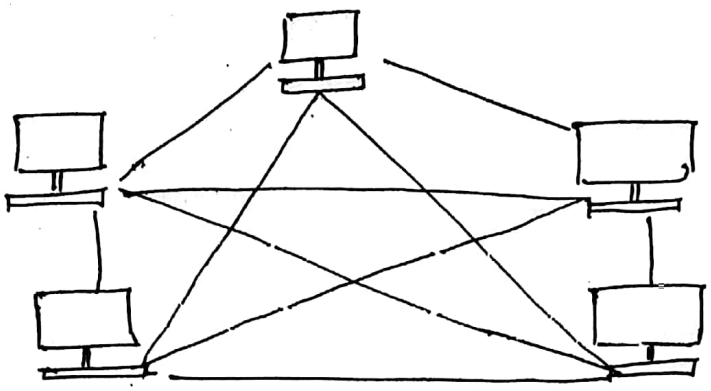
1) Mesh :-

- dedicated point-to-point link betn each device

No. of links = $n(n-1)/2$

No. of I/O ports = $n-1$

- link carries traffic only betn the two devices.



Adv:-

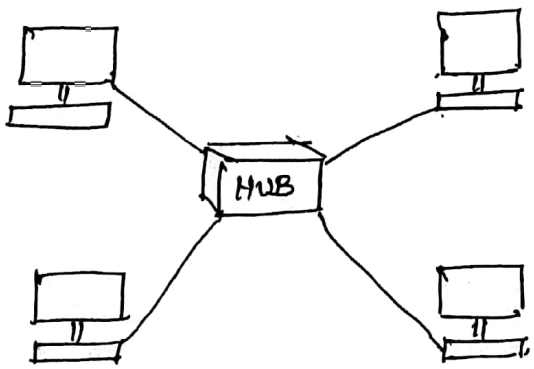
1) dedicated links - no traffic problems
2) Robust - If one link fails other links will not be affected.
3) dedicated line - provides security
4) Fault identification & isolation is easy.

Disadv:-

1) More cabling is required.
2) Wiring required can be more than available space.
3) Hardware (Cable & I/O ports) are expensive.

2) Star:-

- Each device has a dedicated point-to point link to only a central controller called hub.
- Devices are not directly linked to each other.
- Star doesnot allow direct traffic betn devices. Hub acts as an exchange to transmit data.



Adv:-

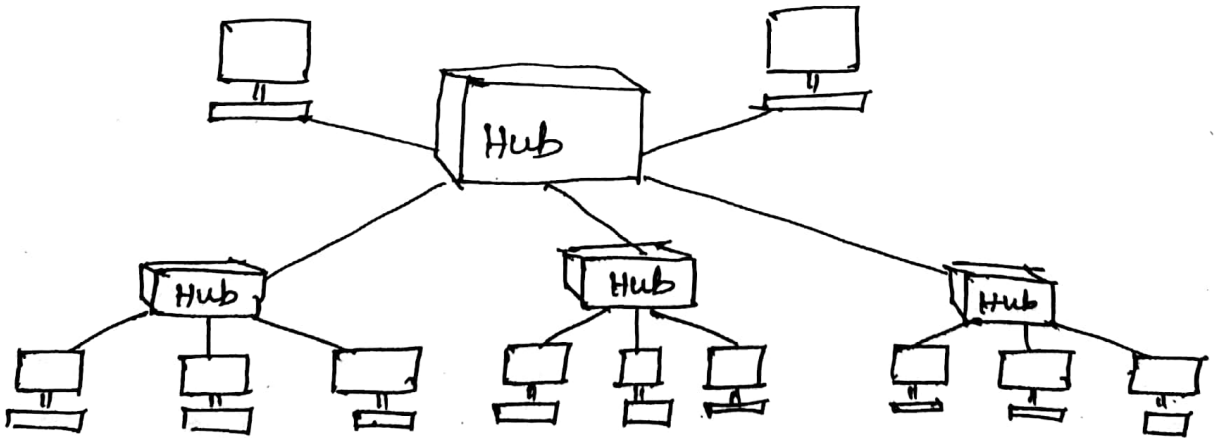
1) Less expensive — only one link & I/O port to connect to the hub.
2) Easy to install & reconfigure.
3) Less cabling
4) Robust.
5) Easy fault identification & isolation.

Disadv:-

1) If Hub fails due to some reasons, the entire network fails.

3) Tree:-

- A tree is a variation of star.
- central hub & secondary hub.
- central hub is an active hub [repeats & regenerates messages].
- Repeaters strengthens transmissions & increases the distance, message can be travelled.



- ~~Active hub~~ passive hub provides a simple physical connection betn attached devices.

Adv:-

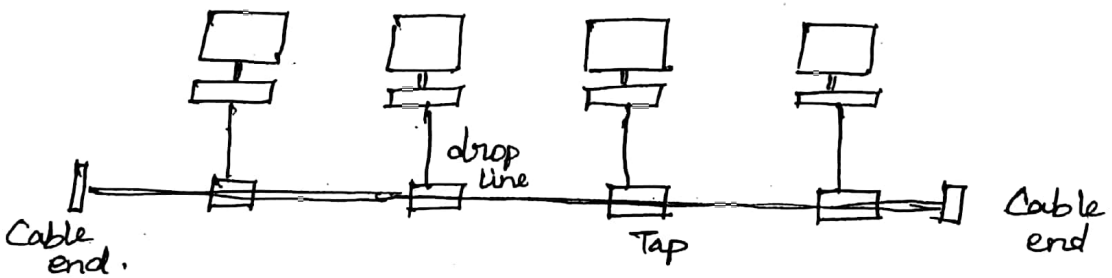
1) more devices can be connected to central hub.

Ex:-

Cable TV technology.

4) Bus:-

- Bus topology is a multipoint connection.
- one long cable acts as a backbone to all the devices.
- Nodes are connected by drop lines & Taps.
- Drop line is the connection running betn device & main cable.
- A tap is a connector that splices into main cable.



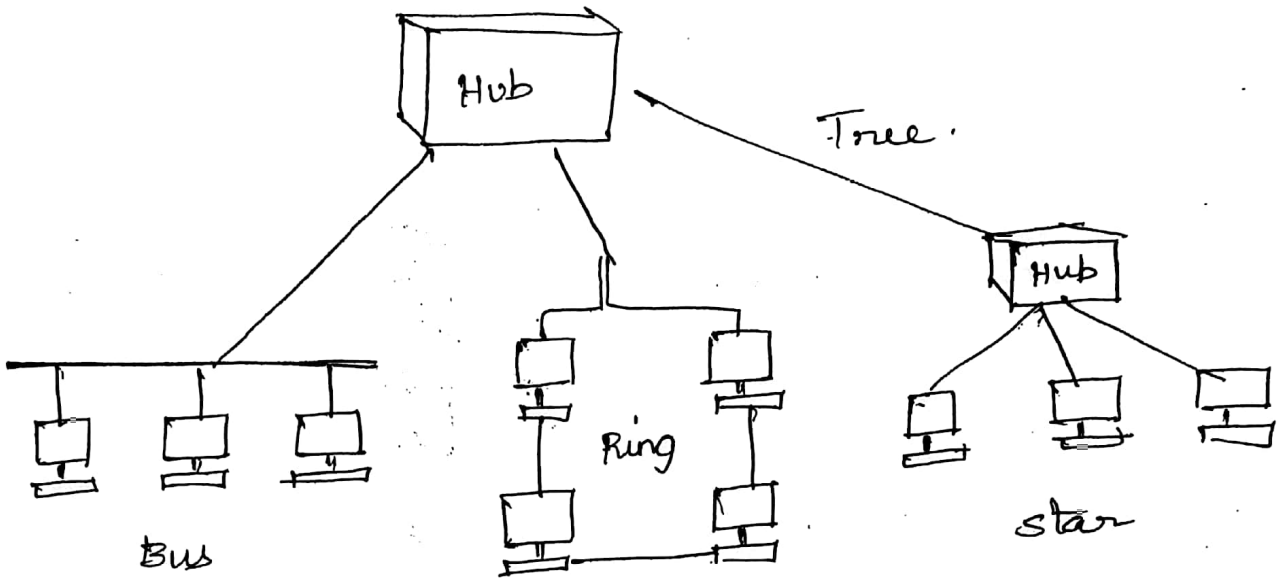
Adv:-

1) less cabling

2) Disadv:-

1) Difficult reconfiguration
2) A fault or break in main cable stops all transmission.

· Hybrid :-



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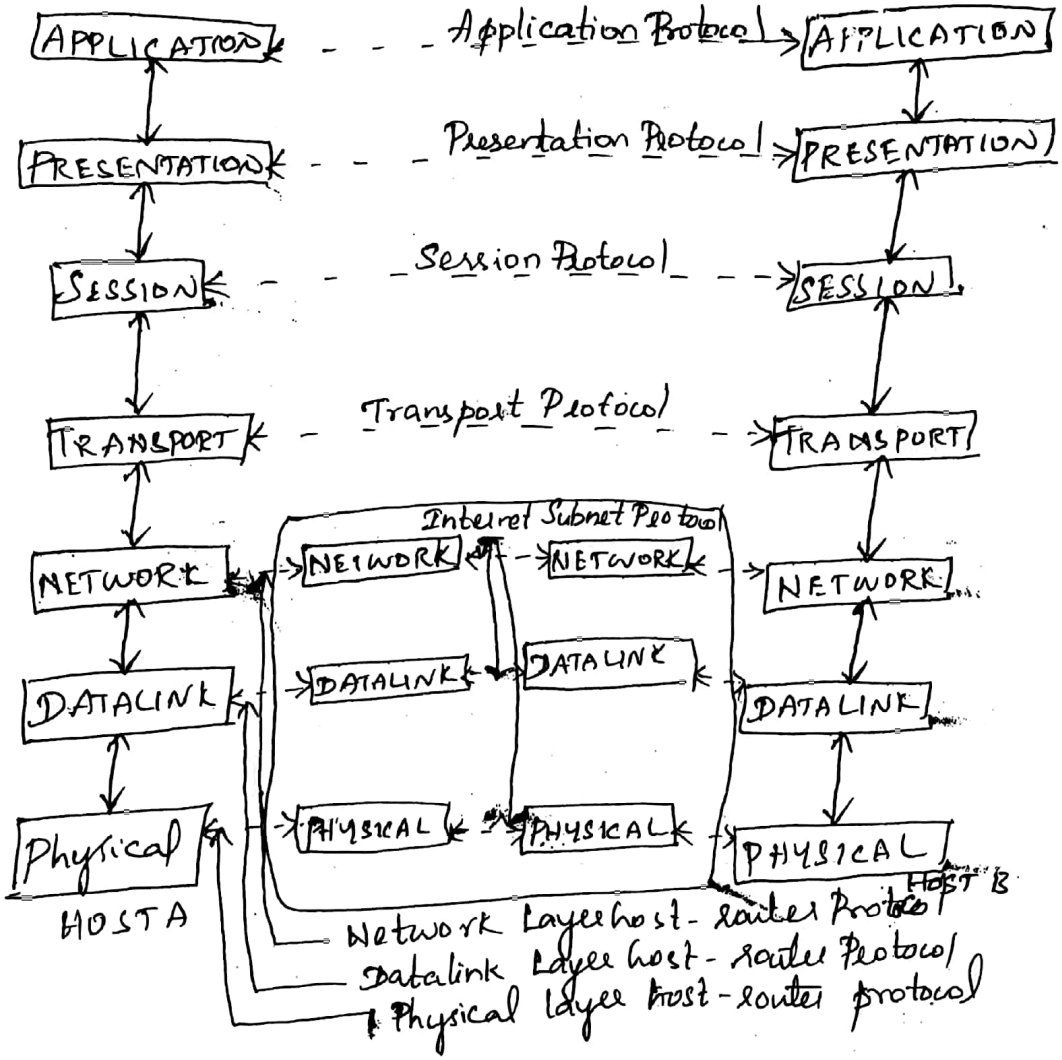
OSI Reference Model



OSI Model

- ISO (International Standards of organisation) dedicated to world wide agreement on international standards.
- OSI (Open system Interconnection).
- An open system is a model that allows any two different systems to communicate regardless of their underlying architecture.
- OSI is a layered architecture, It contains 7 layers namely.
    1) physical layer
    2) Data - link layer
    3) N/w layer
    4) Transport layer
    5) session
    6) presentation
    7) Application.

Dia. for layers

Interface betn layers:-

Interface defines what information & services a layer must provide for the layer above it.

physical layer:-

1) physical characteristics of interface & medium
2) Representation of bits
    - ↳ streams of bits (0's & 1's).
    - ↳ encoded into signals (electrical or optical)

3. Data rate
   ↳ number of bits sent each second.
4. Synchronization of bits
   ↳ Sender & receiver must be synchronized at the bit level.
   ↳ sender & receiver clocks must be synchronized
5. Line configuration.
   ↳ point-to-point
   ↳ Multipoint
6. physical topology
7. Transmission mode.

Data link layer :-

- Data link layer is responsible for node to node delivery.
- It makes physical layer to appear error free to the upper layer.

1. Framing :-
   ↳ DLL divides the stream of bits received from physical layer into manageable data units called frames.
2. physical addressing :-
   → If frames to be distributed in same network DLL adds a header to the frame to define physical addr of sender and receiver of the frame.
   → frame to be delivered outside the n/w means the

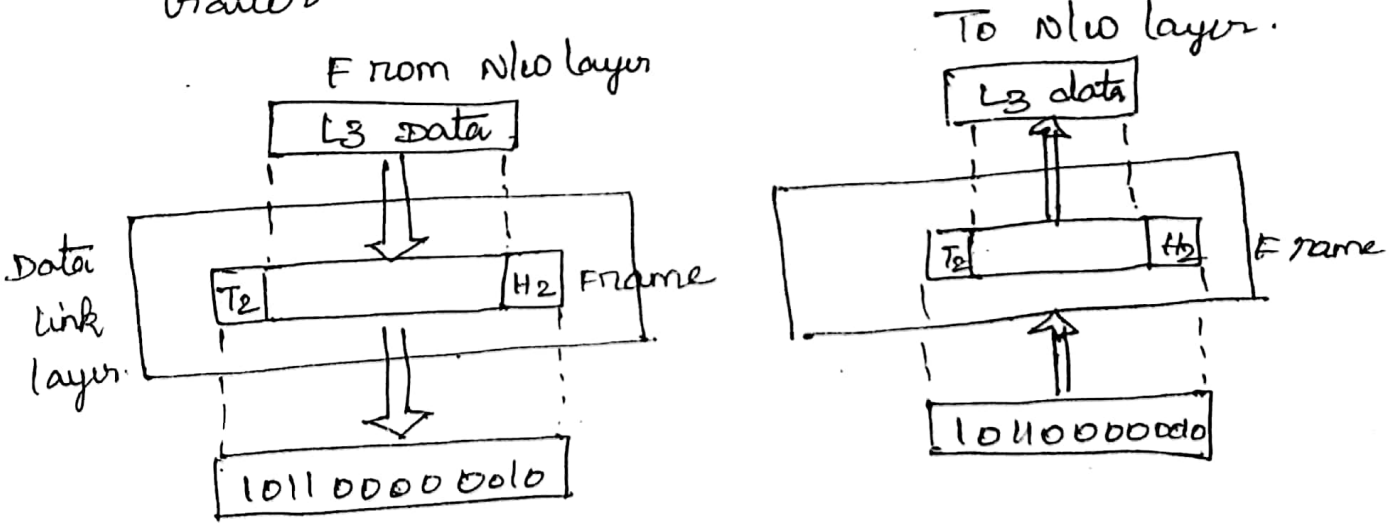
the recv addr is the addr of the device that connects one n/w to the next.

3) Flow control :-

Recv absorption of rate of data is less than the rate produced in the sender, DLL provides a flow control mechanism.

4) Error Control :-

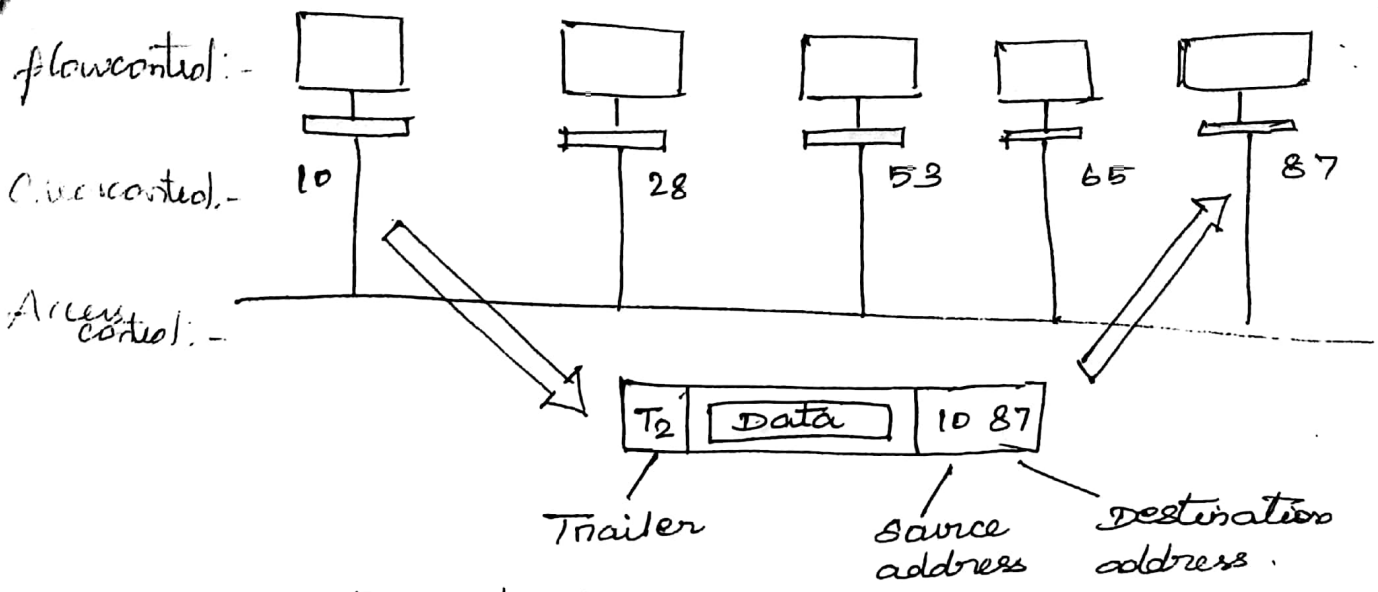
- detect & retransmit damaged or lost frame.
- mechanism to prevent duplication of frames.
- Error control is achieved by adding a trailer.



5) 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.

(4)



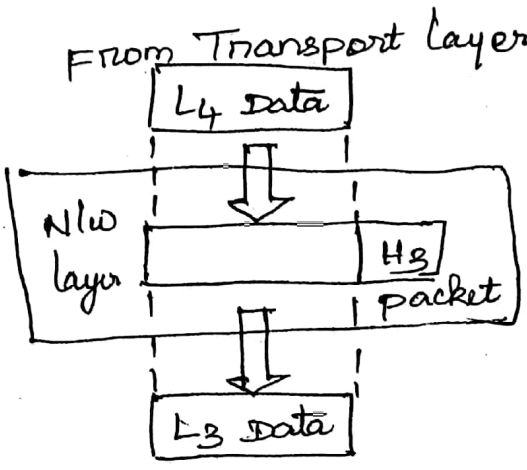
Example for Data link layer.

3) Network layer:-

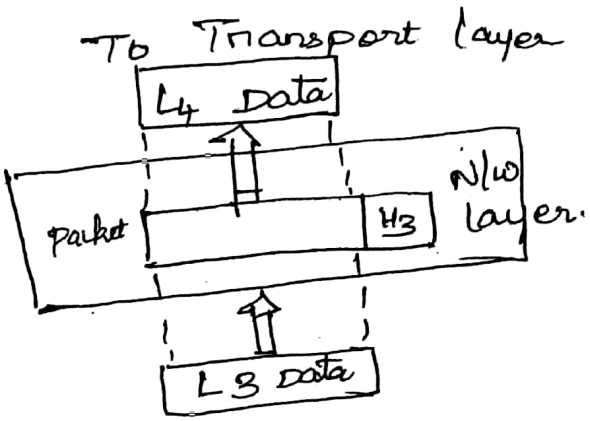
→ N/w layer is responsible for source to destination delivery of a packet across multiple networks.

→ If two nodes are connected to same link there is no need for n/w layer.

→ If two systems are attached to two different N/w's with connecting devices (Routers, Gateways) there is a need for N/w layer.



To data link layer



From data link layer.

1) Logical addressing :-

→ physical addressing by implemented by DLL handles addr problems locally.

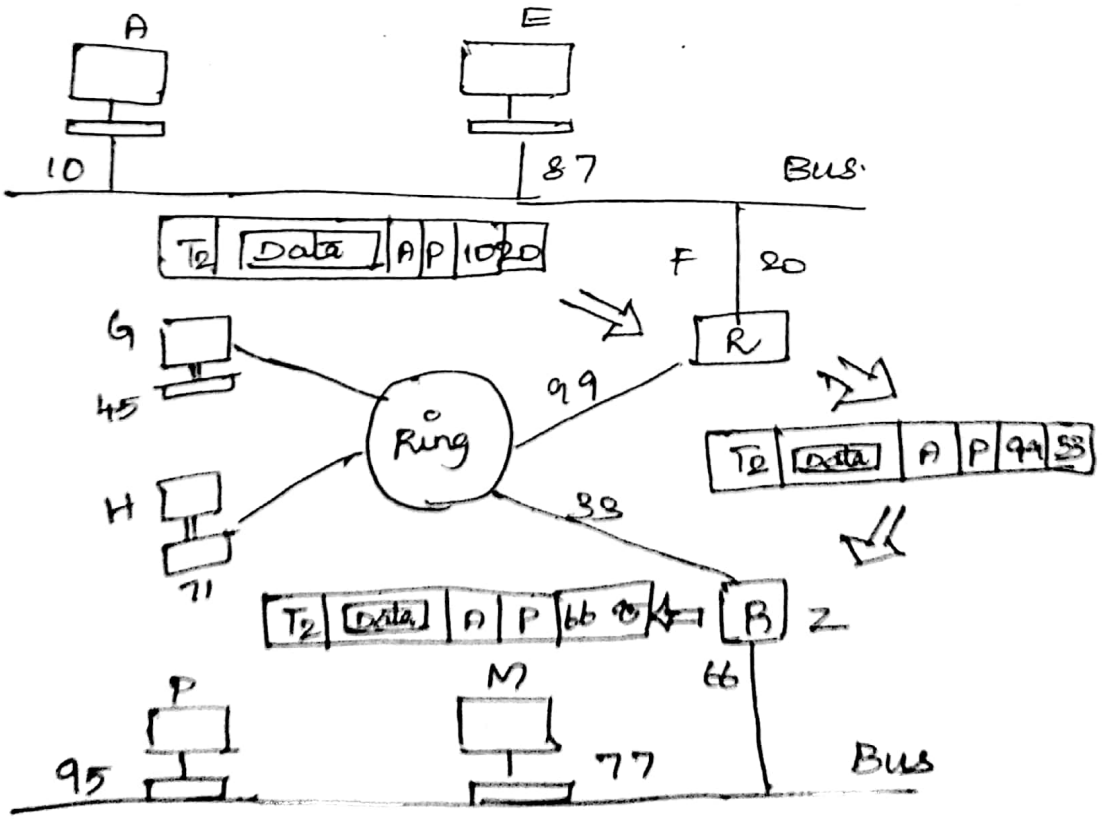
→ N/w layer implements logical addressing for transfer packets from source present in one N/w to destination present in other N/w.

→ The N/w layer adds a header to the packet that includes logical addresses of sender & RECV.

2) Routing :-

→ Routing devices (Routers & Gateways).

↳ Connects independent N/w's forming N/w of N/w's.



Transport layer:-

→ Responsible for source-to-destination delivery of entire message.

→ N/w layer takes care of end-to-end delivery of individual packets, it doesnot recognise any relationship betn packets.

→ The Transport layer, ensures that whole msg arrives inorder, overseeing both error & flow control.

Security:-

→ Transport layer creats a connection betn the two end ports.

→ creating a connection involves 3 steps.

1) connection establishment
2) Data Transfer
3) Connection release.

Responsibilities:-

1) Service point addressing:-

Transport layer header must include a type of address called service point address or port address.

—. This ensures, delivery of packets not only from one computer to the next but also from a specific process on one computer to a specific process on the other.

2) Segmentation & reassembly:-

— A message is transmitted into several segments, each segment containing a sequence number.

— These numbers enable the transport layer to reassemble the message correctly upon arriving at the destination.

— Also helps to identify and replace the lost packets.

3) Connection Control:-

1) connection oriented
2) Connection less.

— connection - oriented transport layer makes a ~~transmission~~ connection with the transport layer of the destination machine first before delivering packets.

— After all the data are transferred, the connection is terminated.

— A connectionless transport layer treats each segment as an indepent packet and transfers to the transport layer at the destination machine.

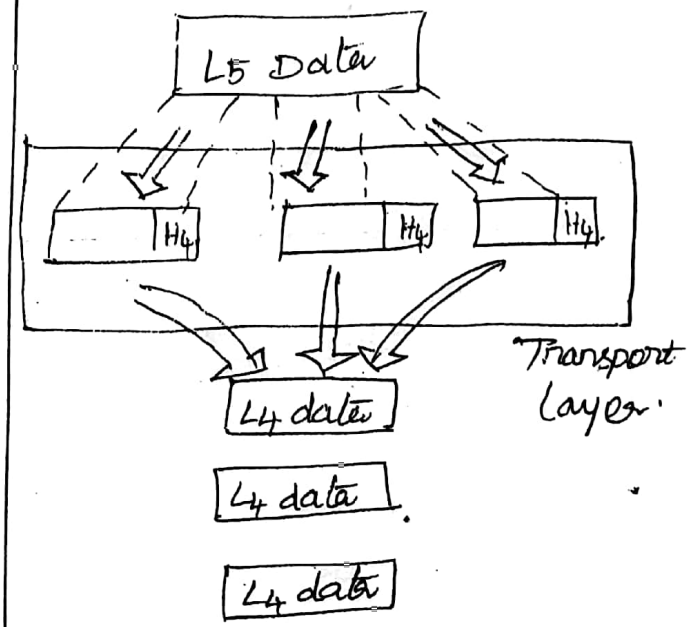
4) Flow control:-

Flow control at this layer is performed end to end rather than across a single link.

5) Error Control:-

- The sending transport layer makes sure that the entire message arrives at the receiving transport layer without error (damage, loss or duplication.

- Error correction is achieved through retransmission.



5 Session layer:-

→ This layer allows users on different machines to establish sessions between them.

→ Session layer is the network dialog controller.

→ It establishes, maintains and synchronizes the interaction between communicating systems.

1. Dialog control:-

→ The session layer allows two systems to enter into a dialog.

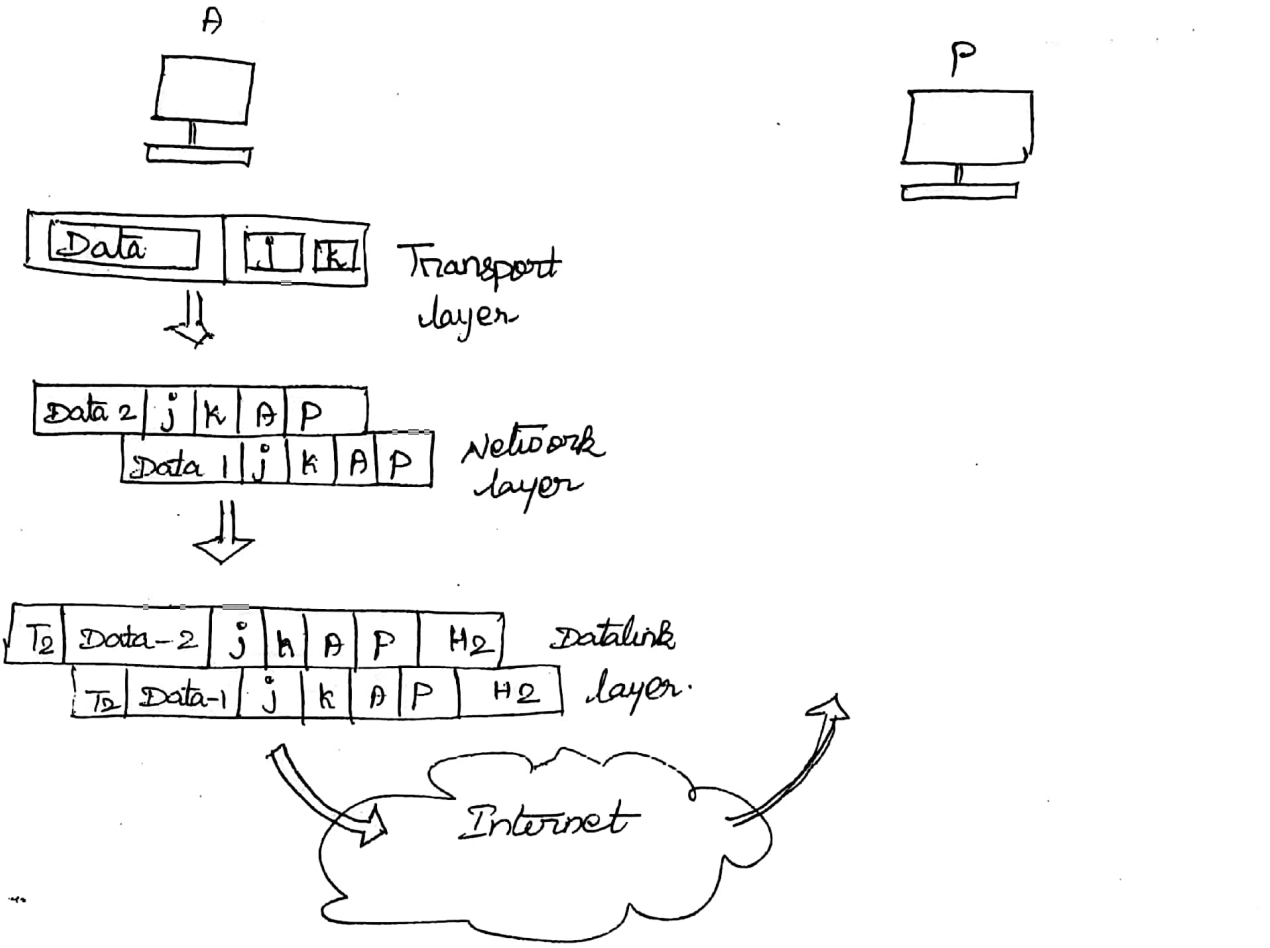
→ It allows the communication between two processes either in half-duplex or full-duplex mode.

2. Synchronization:-

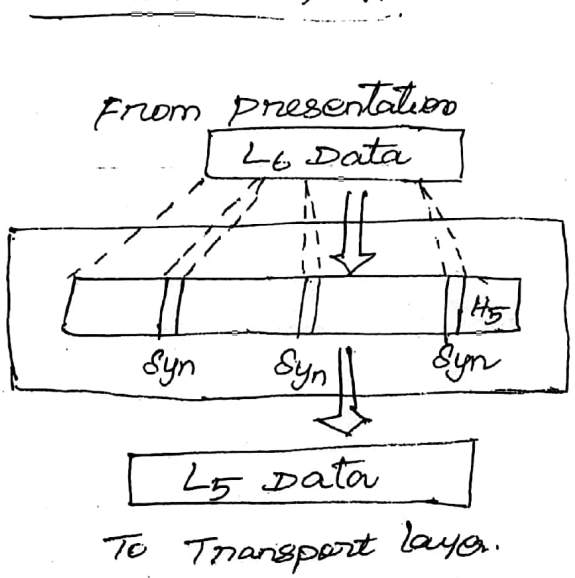
→ The session layer allows to add checkpoints to a stream of data.

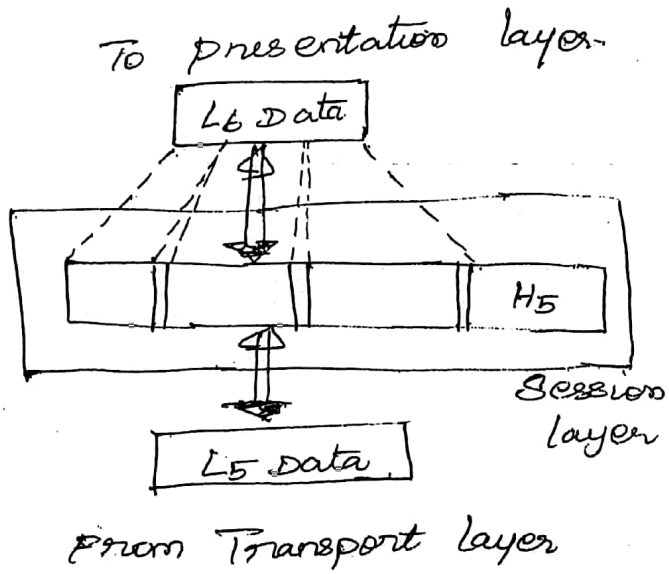
Eg:- if a sys. sending a file of 2000 pages, it is advisable to insert checkpoints after every 100 pages, to ensure that each 100 page is received and acknowledged independently.

If a crash happens during transfer of page 523, retransmission begins at page 501. pages 1 to 500 need not be retransmitted.



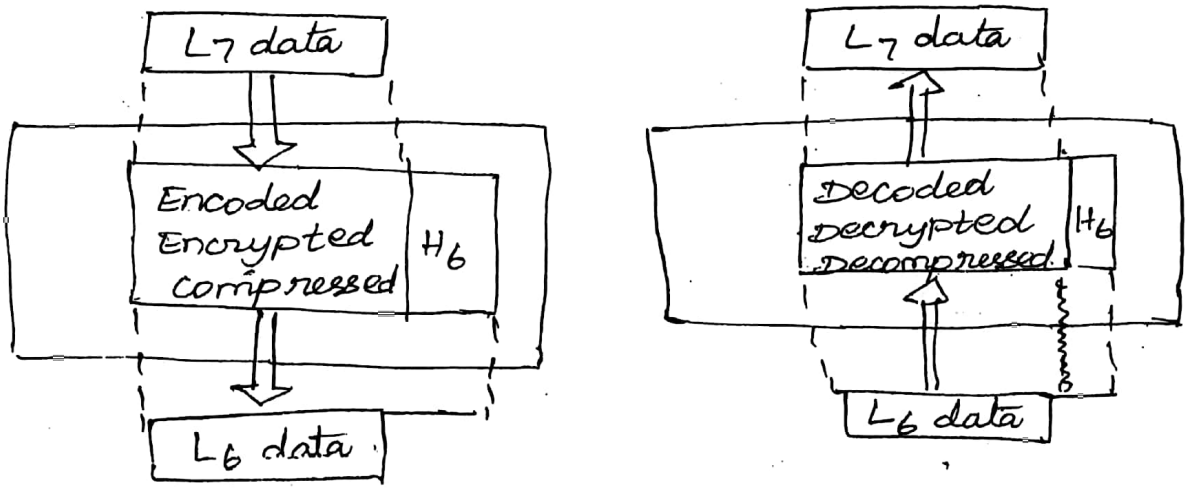
SESSION LAYER :-





6. Presentation layer:-

— The presentation layer is concerned with the syntax and semantics of the information exchanged between two systems.



i) Translation:-

→ The presentation layer is responsibility for the interoperability between two systems using two different encoding techniques.

→ Sender-dependent format → to → common format → to → Receiver dependent format.

ii) Encryption:-

→ To carry sensitive information, a system must be able to assure privacy.

→ Sender transforms original information into another form and sends over the n/w. The receiver decrypts the info and reads the original msg.

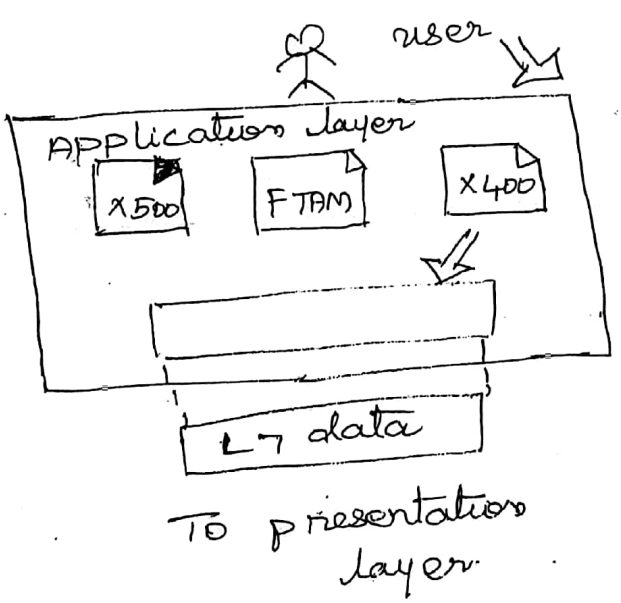
g) Compression:-

Data compression reduces the number of bits to be transmitted. Data compression becomes particularly important in transmission of multimedia such as audio, video & text.

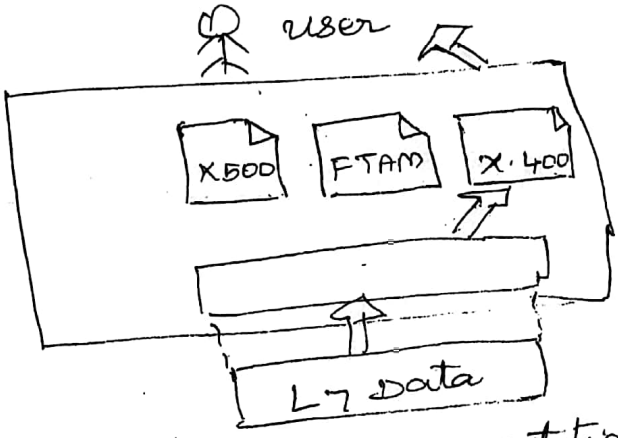
APPLICATION LAYER:-

— The application layer provides user interfaces and support for services such as e-mail, remote file access and transfer, shared database management etc.

→ Network virtual terminal
→ File transfer, Access, Management (FTAM) from Remote host.
→ Mail services
→ Directory services. (distributed databases).



To presentation layer.



From presentation layer.

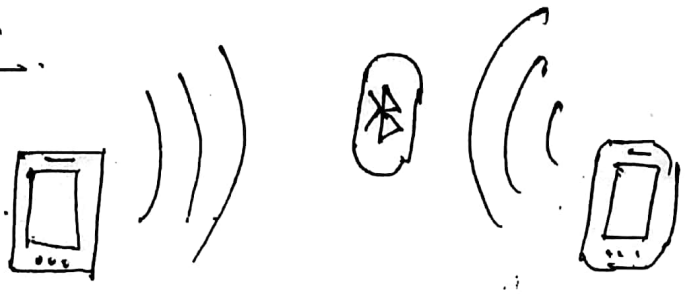
PERSONAL AREA NETWORK (PAN):-

- A personal area Network (PAN) is smallest network which is very personal to user.
- This may include bluetooth enabled devices or infra-red enabled devices.
- PAN has connectivity range upto 10 meters.
- PAN may include wireless computer keyboard, wireless mouse, Bluetooth enabled headphones, wireless printers and TV remotes.
- For example, PICONET is bluetooth-enabled personal network which may contain upto 8 divices connected together in a master-slave fashion.

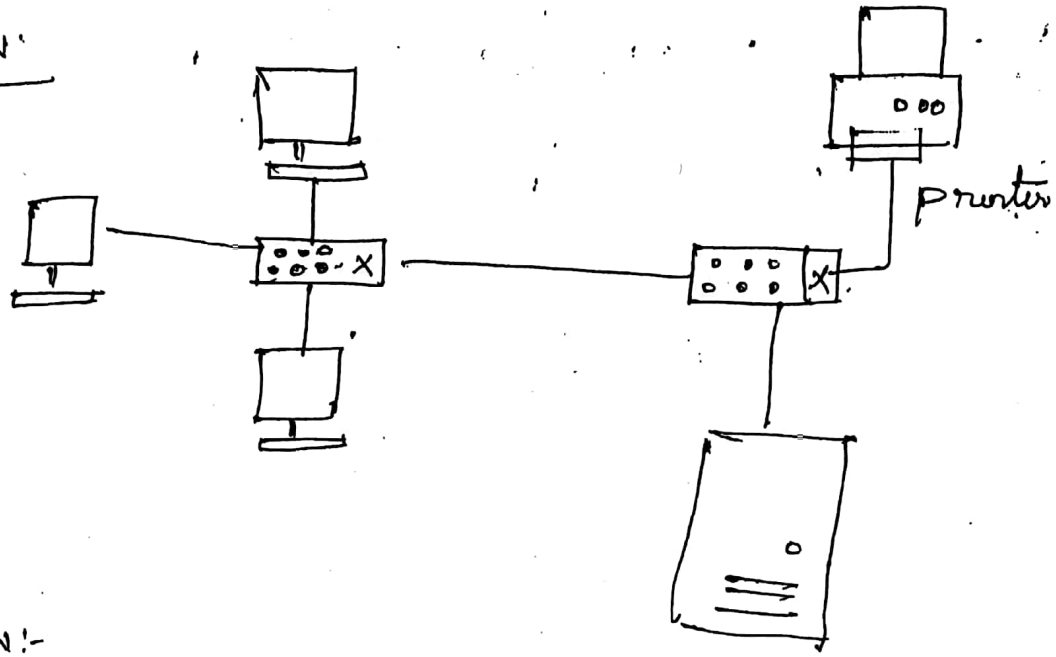
LOCAL AREA NETWORK (LAN):

- A Computer network spanned inside a building and operated under single administrative system is generally termed as Local area Network (LAN).
- Usually, LAN covers an organization's offices, schools, colleges or Universities.

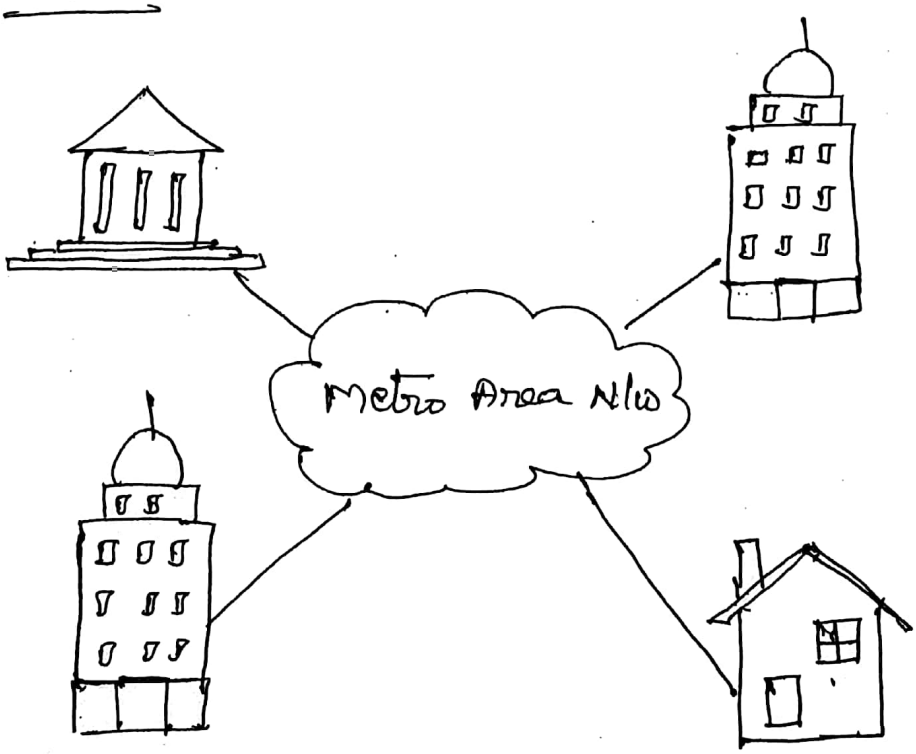
PAN



LAN



MAN :-



- For example, MAN can help an Organization to connect all of its offices in a city.
- Backbone of MAN is high-capacity and high-speed fiber optics.
- MAN works in between LAN & WAN.
- MAN provides uplink for LANs to WANs or internet.

WIDE AREA NETWORK:

- WAN covers a wide area which may span across a whole country.
- Generally, telecommunication networks are wide area network.
- Since they are equipped with very high speed backbone, WANs use very expensive network equipment.
- WAN may use advanced technologies such as Asynchronous transfer mode (ATM), Frame relay and Synchronous optical Network (SONET).
- WAN may be managed by multiple administration.

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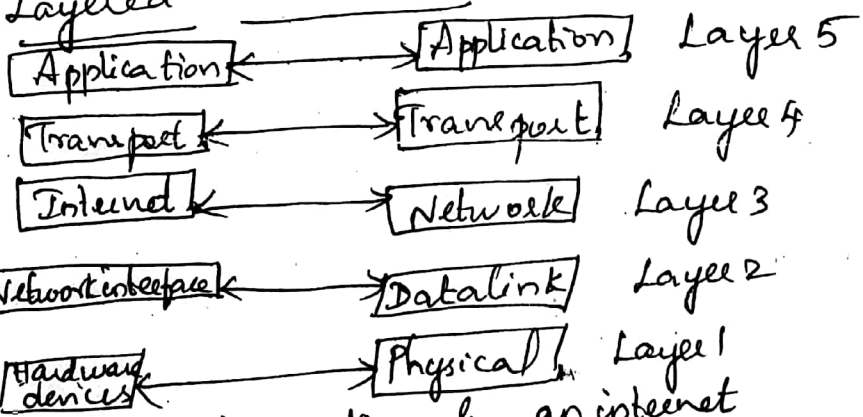
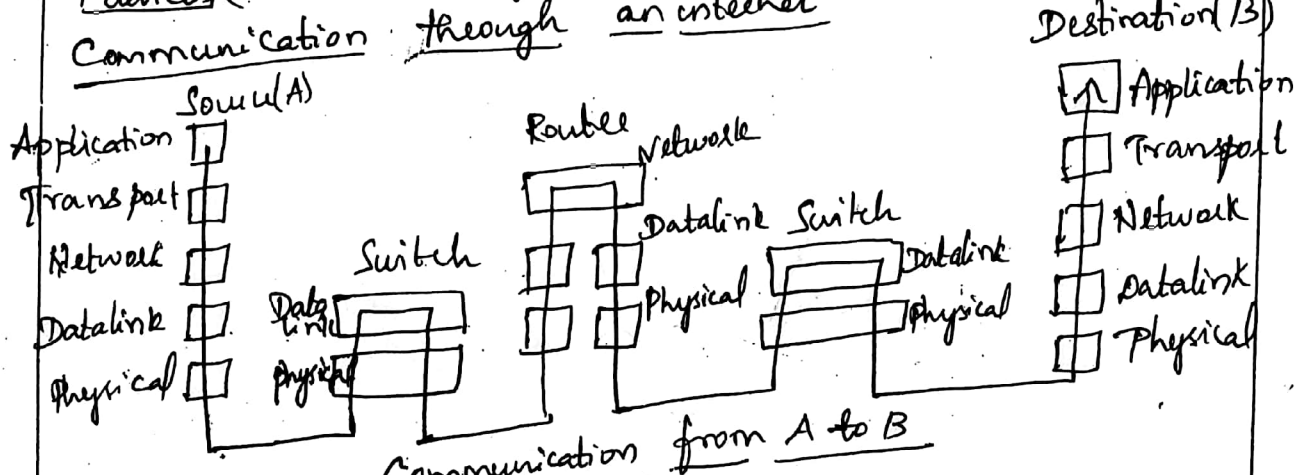
TCP/IP Protocol Suite

* It is a protocol suite which is a hierarchial protocol made up of interactive modules, each of which provides a specific functionality.
* Hierarchy means that each upper level protocol is supported by the services provided by one or more lower level protocols.
* It is a five layer model.

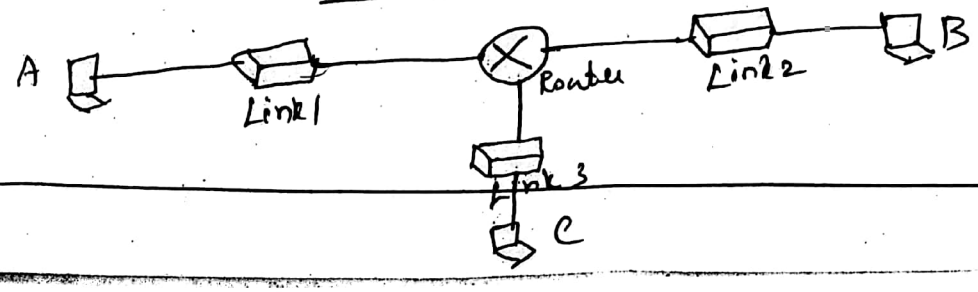
Layered architecture:



Communication through an internet



Communication from A to B



Layers in TCP/IP :

(A) **Physical Layer :-** (Lowest Layer of TCP/IP)

* It is responsible for carrying individual bits in a frame across the link.
* Logical communication between two devices takes place in the physical layer.
* Two devices are connected by transmission medium such as cable or air.
* Data is represented interms of Bit(0's or 1's) and encoded into signals for transmitting from one node to another node.

(B) **Data Link Layer :-**

* This layer is responsible for a datagram can travel from source to destination.
* The Routers are responsible for choosing the best links.
* Link can be either wired Wired LAN or a link layer switch, or a wireless LAN, or a wireless WAN.
* Any protocol that can take datagram and carry it through the link suffices for the network layer.
* The data link layer takes a datagram and encapsulates it in a packet called a frame.

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(C) Network Layer:-

* It is responsible for creating a connection between the source computer and the destination computer. ie) from host to host routing the packet through possible routes.

* Reason - why routing duty added to transport layer and dropped in this layer:-

(1) Separation of different tasks between different layers.

(2) Routers do not need the application and transport layers.

* This network layer includes Internet Protocol (IP) that defines the format of the packet called datagram at the network layer.

* Internet Protocol

↳ Defines the format and structure of address.

↳ responsible for routing a packet from its source to destination.

↳ is a connectionless protocol which provides no flow control, error control and no congestion control services.

* Network layer also includes unicast (one to one) and multicast (one to many) routing protocols.

* Network layer also has some auxiliary protocols which helps IP in its delivery & routing tasks.

(i) ICMP (Internet Control Message Protocol) - helps IP to report some problems when routing a packet.

(ii) IGMP (Internet Group Management Protocol) - helps IP in multitasking.

(iii) DHCP (Dynamic host configuration Protocol) - helps IP to get the network layer address for a host.

(iv) ARP (Address Resolution Protocol) - helps IP to find the link layer address.

(D) Transport Layer:-

* This layer is responsible for giving services to the application layer.
* The transport layer at the source host gets the message from the application layer, encapsulates it in a transport layer packet and sends it through the logical connection to the transport layer at the destination host.
* This layer includes (TCP) Transmission Control Protocol which is a connection oriented protocol that first establishes a logical connection between transport layers at two hosts before transferring data.
* TCP creates logical pipe between two nodes for transferring a stream of bytes.
* TCP provides flow control, error control and congestion control.
* Transport Layer also includes UDP (user datagram Protocol) which is a connectionless protocol that transmits user datagrams without first creating a logical connection.
* i.e) In UDP, each user datagram is an independent entity without being related to the previous or next one.
* UDP does not provide flow control, error control and congestion control.
* Transport layer includes new protocol (Stream Control Transmission Protocol (SCTP) is designed to respond to new applications that are emerging in the multimedia.

(E) Application Layer:-

* This layer is responsible for communication takes place between two processes.
* ie) To communicate, a process sends a request to other process and received a response. - process to process communication is the duty of the application layer.

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*This layer includes following protocols:-

1) HTTP (Hyper Text Transfer Protocol)
2) SMTP (Simple Mail Transfer Protocol)
3) FTP (File Transfer Protocol)
4) TELNET (Terminal Network) and SSH (Secure Shell) are used for accessing a site remotely.
5) SNMP (Simple Network Management Protocol - used by an administrator to manage the Internet at global and local levels).
6) DNS (Domain Name System) - to find network layer address of a computer.

Encapsulation & Decapsulation

* It is one of the important concepts in protocol layering.

(a) Encapsulation at the source host :-

At the source, we have only encapsulation

(i) At the application layer, data to be exchanged is referred to as a message which is passed to transport layer. This message (Payload) does not have header or trailer

(ii) The transport layer adds header to message to identify the source and destination of the application programs and result as the Transport Layer Packet which is called as segment (in TCP) and user datagram (in UDP). Then this packet sent to network layer.

(iii) The network layer adds its own header to payload (message) which contains the address of the source and destination hosts and some more information used for error checking of the header, fragmentation information and so on.

The network layer passes the packet to the data link layer.

(iv) The data link layer takes the network layer packet as data or payload and add its header which contains the link layer addresses of the host or the next hop. The result is the frame which is passed to physical layer for transmission.

(b) Decapsulation at the Destination Host:-

(i) At the destination host, each layer only decapsulat the packet received, removes the payload and delivers the payload to the next higher layer protocol until the message reaches the application Layer.

Addressing

* Any communication that involves two nodes needs two addresses such as source address and destination addres.

Packet name	Layers	Addresses
message	Application layer	Names
Segment/user datagram	Transport layer	Port numbers
Datagram	Network layer	Logical address
Frame	Data link layer	link layer addresses
Bits	Physical layer	

Multiplexing & Demultiplexing:-

Multiplexing:-

It means that a protocol at a layer can encapsulate a packet from several next higher layer

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Demultiplexing:-

means a protocol can decapsulate and deliver a packet to several next higher layer protocols. (one at a time).

* For both multiplex and demultiplex, a protocol needs to have a field in its header to identify to which protocol the encapsulated packets belong.

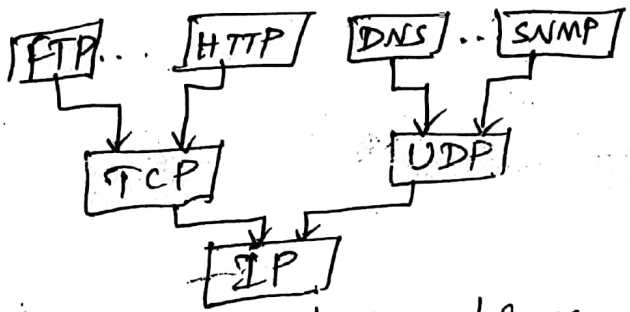

figure Multiplexing at source

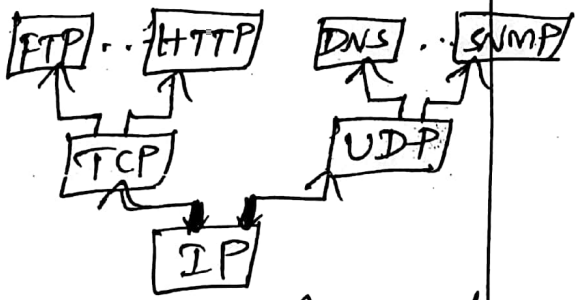

figure Demultiplexing at destination