INTRODUCTION TO COMPOTER NETWORKS

CONTENTS

- Communicating in a Network Centric World
- Network as Platform
- Architecture of Internet
- Classification of Networks
- Layered Models
- Network Addressing
- Components of Network
- Network Topologies
- Transmission Mode
- Internetworking Devices

COMMUNICATING IN A NETWORK CENTRIC WORLD

- Humans are social animals who depend on the interaction with others for daily needs
- The ways in which human interact are constantly changing. As technical developments throughout history have come about, the method of human communication as developed as well.
- At one time, sounds and gestures were all humans used to communicate, but now the Internet allows people to instantaneously share all types of communication — documents, pictures, sound, and video — with thousands of people near and far away using computers
- The use of Internet spread quickly as connectivity became available in the 1990s
- Internet became an integral part of our daily routines.
- Technology is perhaps the most significant change agent in the world today, as it helps to create a world in which national borders, geographic distances and physical limitations become less relevant and present ever-diminishing obstacles.

NETWORK AS A PLATFORM

- The abki ability to reliably communicate to anyone, anywhere, is becoming increasingly important to our personal and business lives.
- The task of reliably delivering millions of messages simultaneously would be too much for any network to perform
- Therefore, a web of smaller, interconnected network of various sizes and capabilities delivers the many messages and data streams around the world

ELEMENTS OF NETWORK

- **RULES / AGREEMENTS**

Early networks had varying standards and, as a result, could not communicate easily with each other. Now global standardization of these elements enables easy communication between networks regardless of the equipment manufacturer Eg: CAR and CAR driver

- **MESSAGES**

Messages is a generic term that encompasses web pages, e-mail, instant messages, telephone calls, and other forms of communication enabled by the Internet.

- **Medium**

The medium that physically carries the message can change several times between the sender and receiver. Network connections can be wired or wireless.

- **Devices**

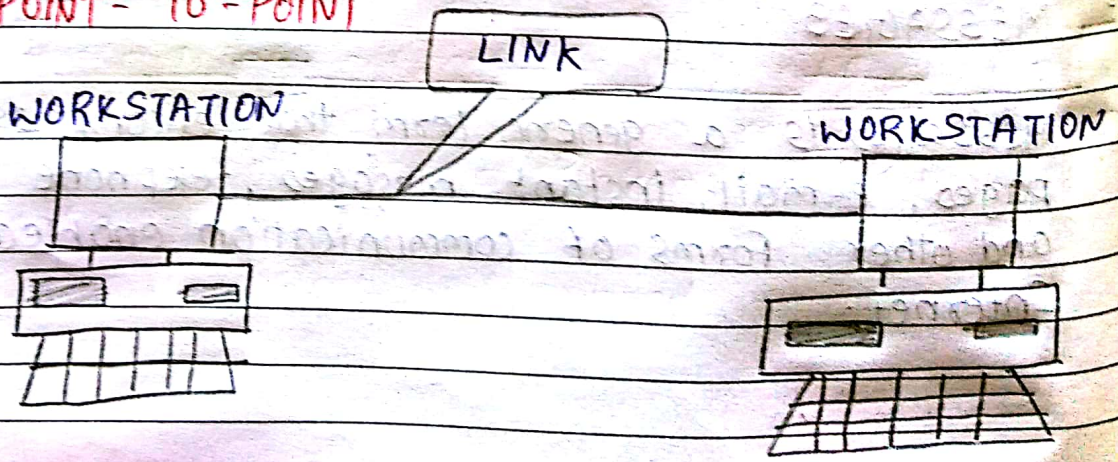
Several devices, such as switches and routers, work to see that the message is properly directed from the source, or originating devices, to the destination device.

LINE CONFIGURATION

POINT-TO-POINT

MULTIPOINT

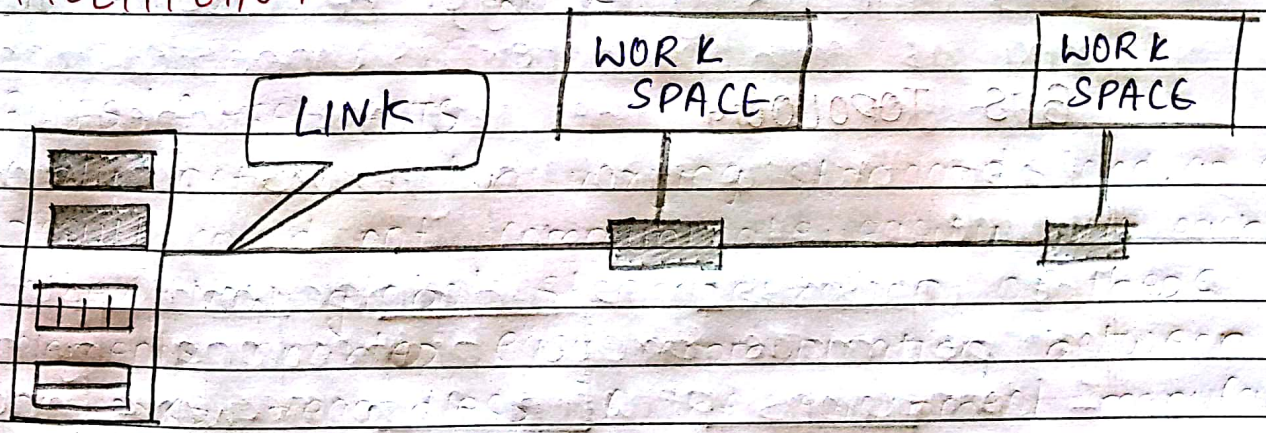
[1] POINT-TO-POINT



- A point-to-point connection provides a dedicated link between two devices
- The entire capacity of the link is reserved for transmission between those two devices
- Point-to-point network topology is considered to be one of the easiest and most conventional network topologies
- It is also simplest to establish and understand

Example: Remote control and Television for changing the channels

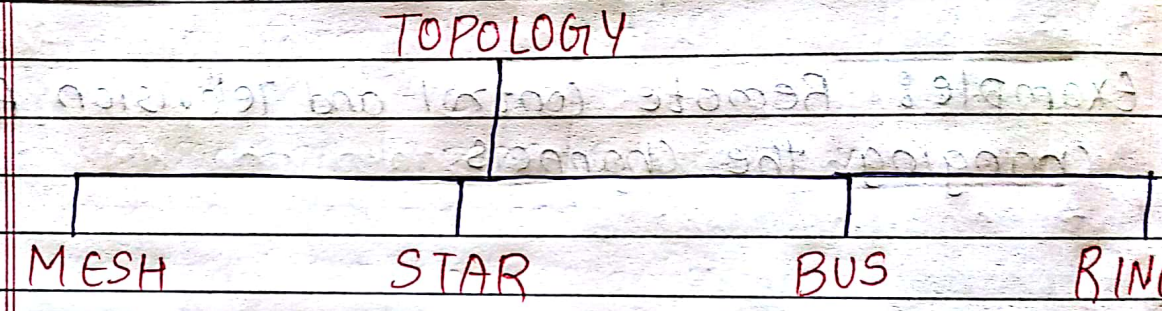
2] MULTIPOINT



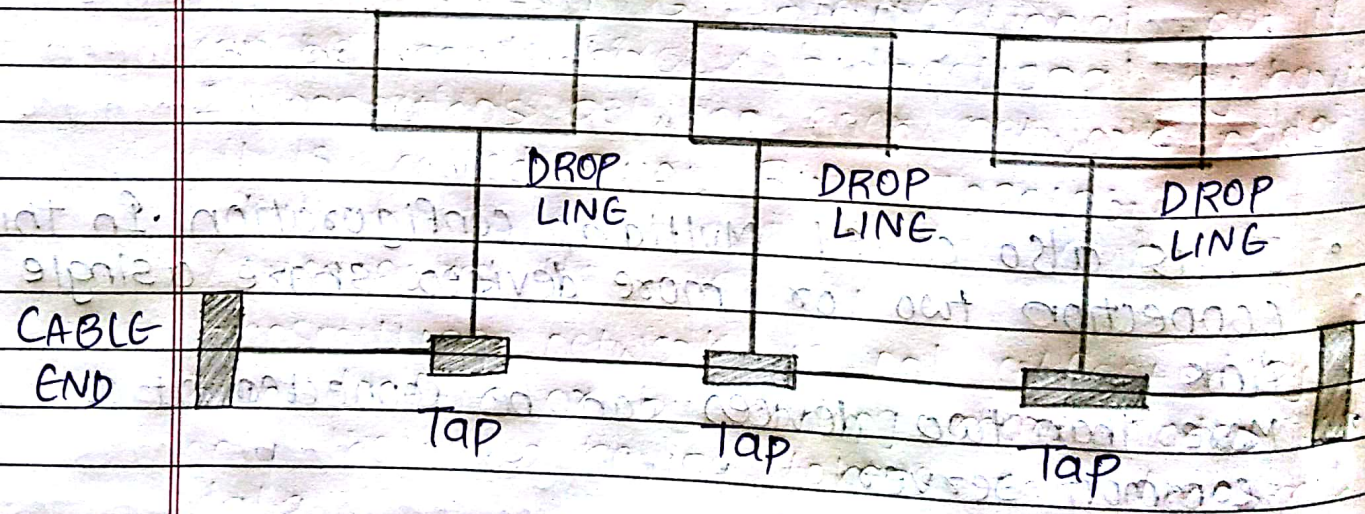
- It is also called Multidrop configuration. In this connection two or more devices share a single link
- More than two devices can be connected at a common server.

NETWORK TOPOLOGY

Network Topology is the schematic description of a network arrangement, connecting various nodes (Sender & Receiver) through lines of communication.



BUS TOPOLOGY



- Bus topology is a network type in which every computer and network device is connected to single cable
- When it has exactly two end points, then it is called LINEAR BUS TOPOLOGY

FEATURES OF BUS TOPOLOGY

- It transmits data only in one direction
- Every device is connected to a single cable

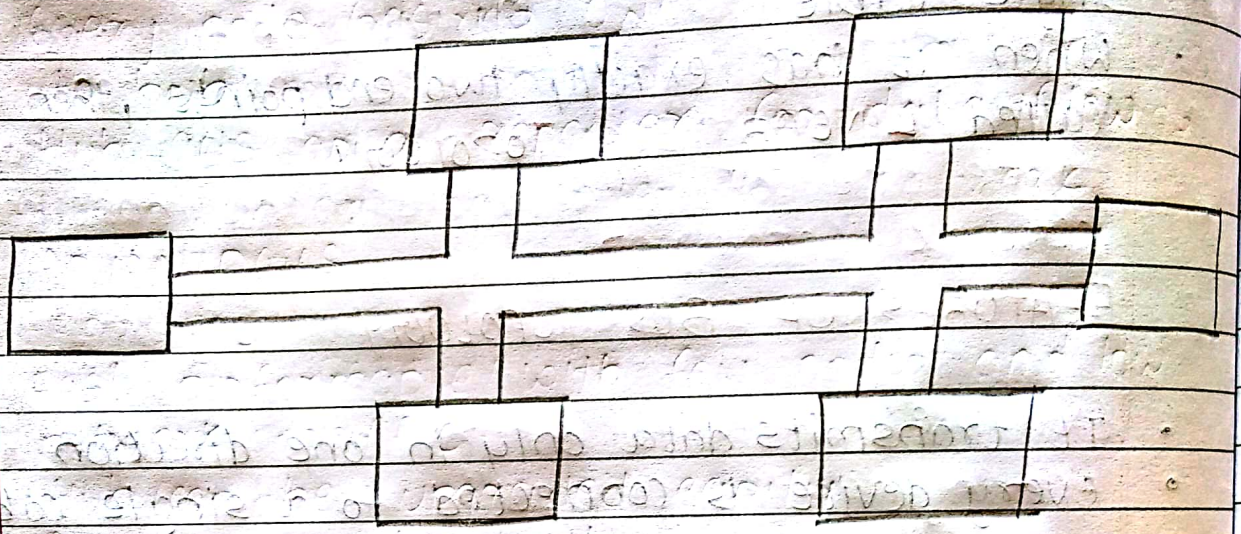
ADVANTAGES

- Cost effective
- Cable required is least compared to other network topology
- Used in small networks
- Easy to expand joining two cables together
- Easy to understand

DISADVANTAGES

- Cable fails then whole network fails
- Cable has limited length
- Slower than the ring topology
- If network traffic is heavy or nodes are more the performance of network decreases.

RING TOPOLOGY



- It is called Ring Topology because it forms a ring as each computer is connected to another computer with the last one connected to first. Exactly two neighbours for each device.
- The transmission is unidirectional, but it can be made bidirecti bidirectional by having 2 connections between each network node, it is called DUAL RING TOPOLOGY

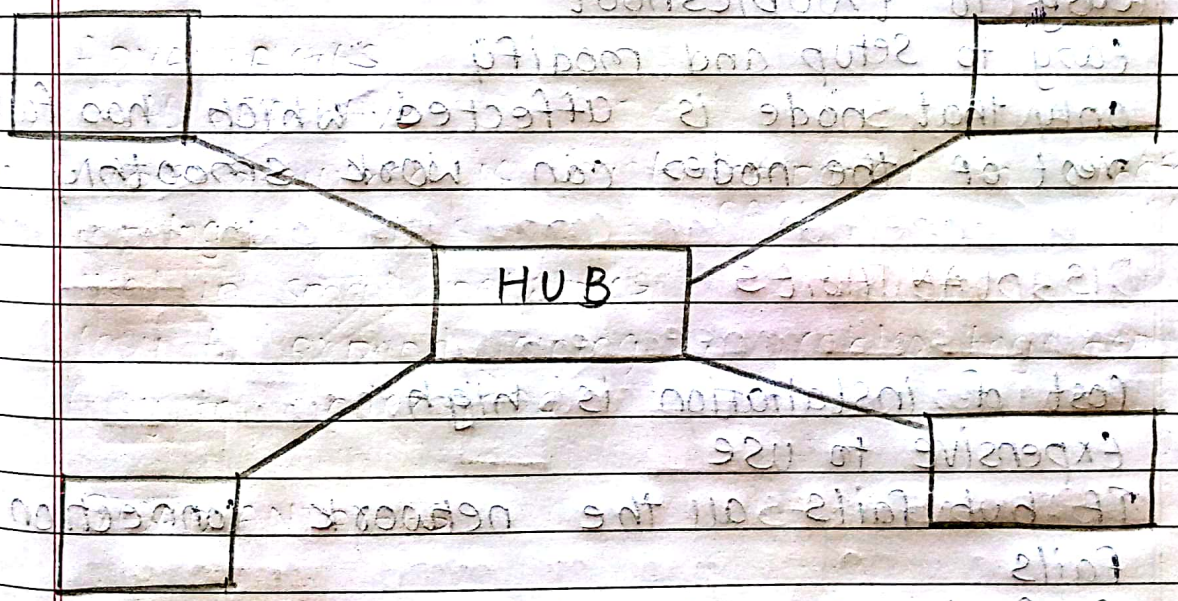
ADVANTAGES

- Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data
- Cheap to install and expand.

DISADVANTAGES

- Troubleshooting is difficult in ring topology
- Adding or Deleting the computers disturbs the network activity
- Failure of one computer disturbs the whole network

STAR TOPOLOGY



- In this type of topology all the computers are connected to a single hub through a cable. This hub is the central node and all other nodes are connected to central node.

FEATURES

- Every node has its own dedicated connection to hub
- Hub acts as a repeater for data flow

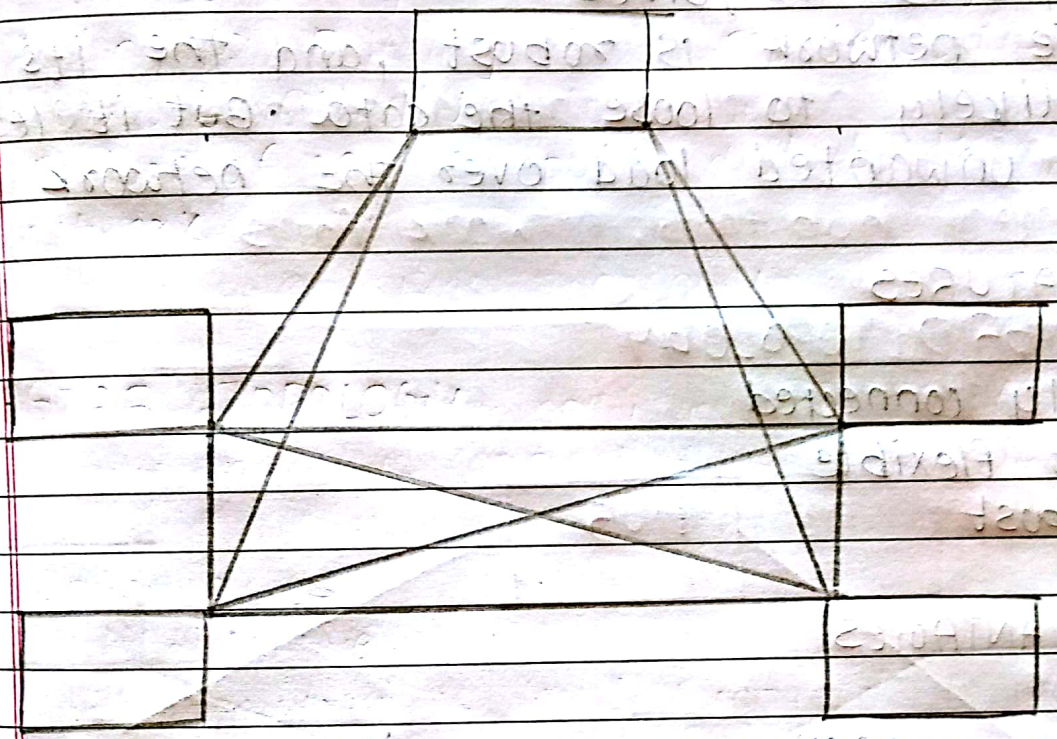
ADVANTAGES

- Fast performance with few nodes and low network traffic
- Hub can be upgraded easily
- Easy to troubleshoot
- Easy to setup and modify
- Only that node is affected which has failed, rest of the nodes can work smoothly

DISADVANTAGES

- Cost of installation is high
- Expensive to use
- If hub fails all the network connection fails
- Performance is based on the hub that is it depends on its capacity

MESH TOPOLOGY



- It is a point-to-point connection to other nodes or devices. All network nodes are connected to each other.
- Mesh has n(n-1)/2 physical channels to link n devices.
- There are two techniques to transmit data over the Mesh topology, they are:
  1. Routing
  2. Flooding
- In routing, the nodes have a routing logic, as per the network requirements. Like routing logic to direct data to reach the destination using the shortest distance.

- In flooding, the same data is transmitted to all network nodes, hence no routing logic is required
- The network is robust, and the its very unlikely to loose the data. But it leads to unwanted load over the network

FEATURES

- Fully connected
- Not flexible
- Robust

ADVANTAGES

- Each connection can carry its own data load
- It is robust
- Fault is diagonsed easily
- Provides security and privacy

DISADVANTAGES

- Bulk wiring is required
- Cabling cost is more
- Installation and configuration is difficult

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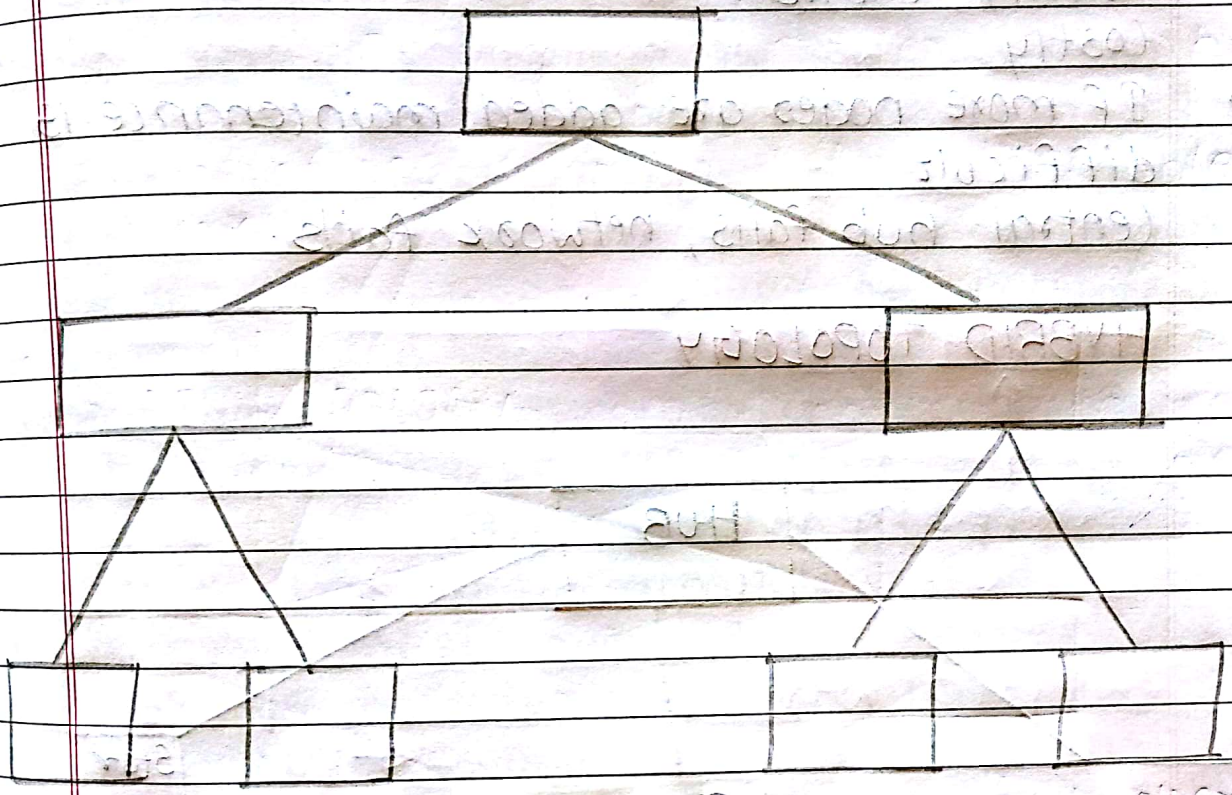
TREE TOPOLOGY



- It has a root node and all other nodes are connected to it forming a hierarchy. It is also called hierarchical topology. It should atleast have three levels to the hierarchy.

FEATURES

- Ideal if workstations are located in groups
- Used in wide area Network

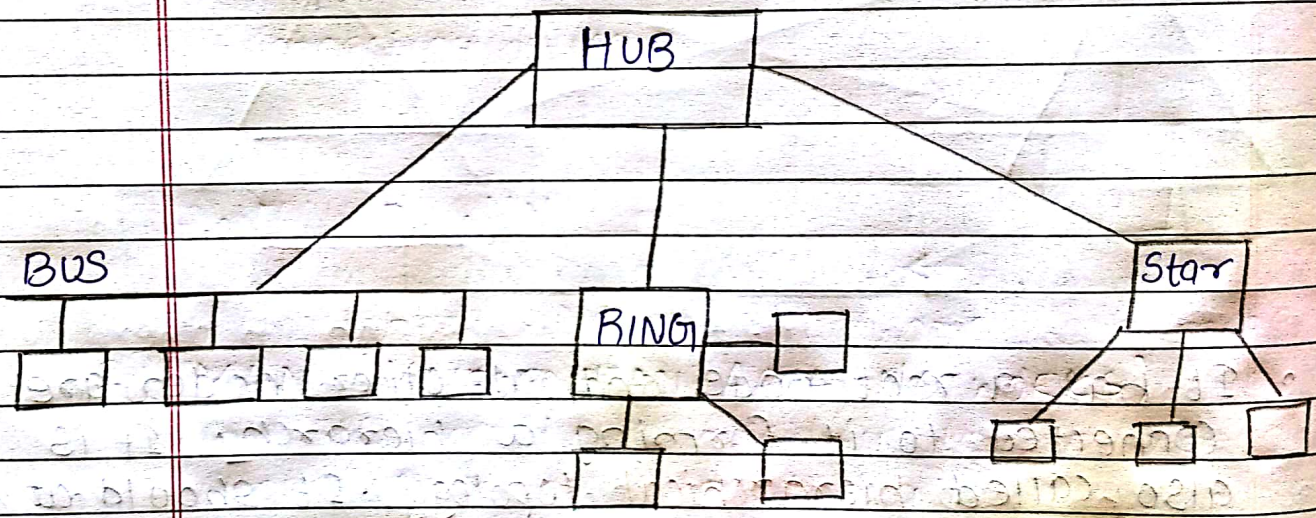
ADVANTAGES

- Extension of bus & star topologies
- Expansion of nodes is possible and easy
- Easily managed and maintained
- Error detection is easily done

DISADVANTAGES

- Heavily cabled
- Costly
- If more nodes are added maintenance is difficult
- Central hub fails, network fails.

HYBRID TOPOLOGY



FEATURES

- Combination of two or more topology
- Inherits the advantages and disadvantages of the topologies included

ADVANTAGES

- Effective
- Flexible
- Scable as size can be increased easily
- Reliable as Errors detecting and troubleshooting is easy

DISADVANTAGES

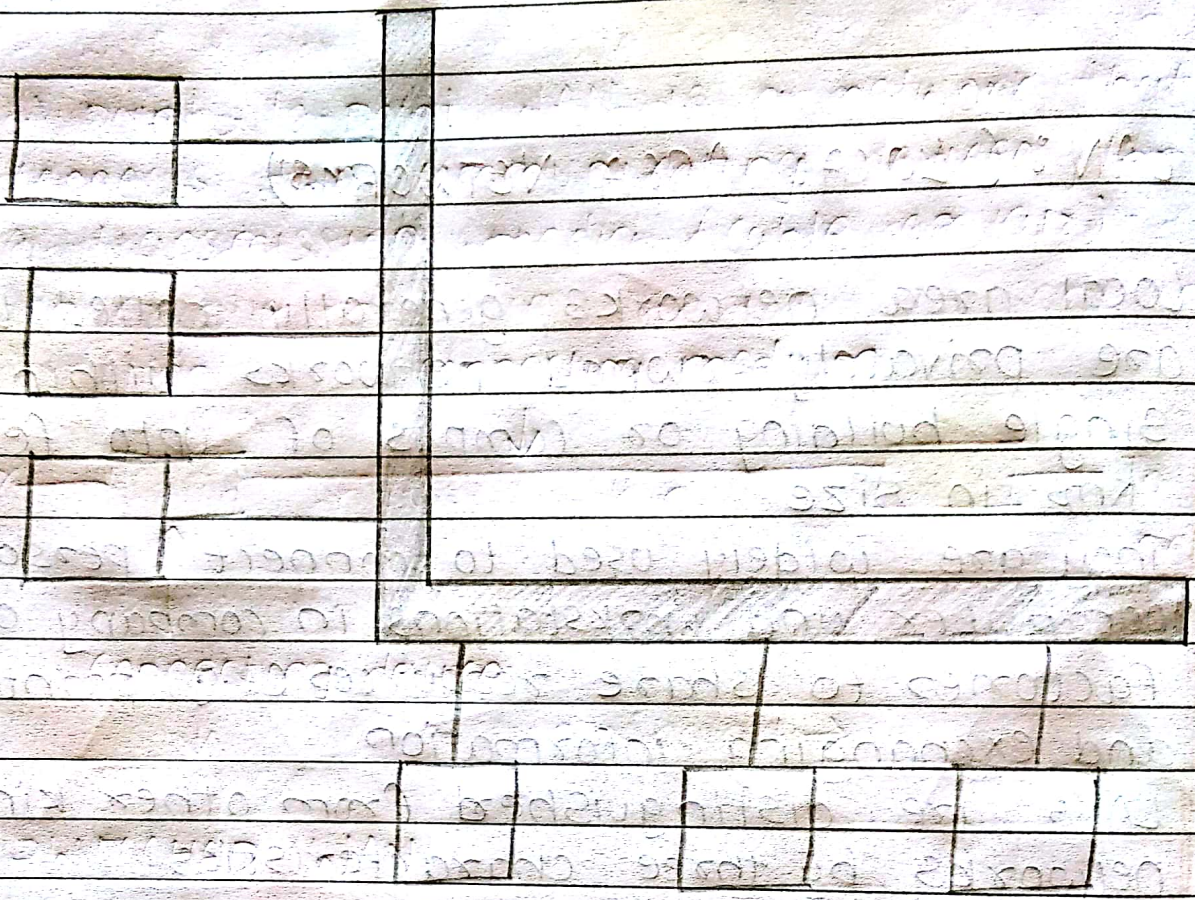
- Costly
- Complex in design

CLASSIFICATION OF NETWORK

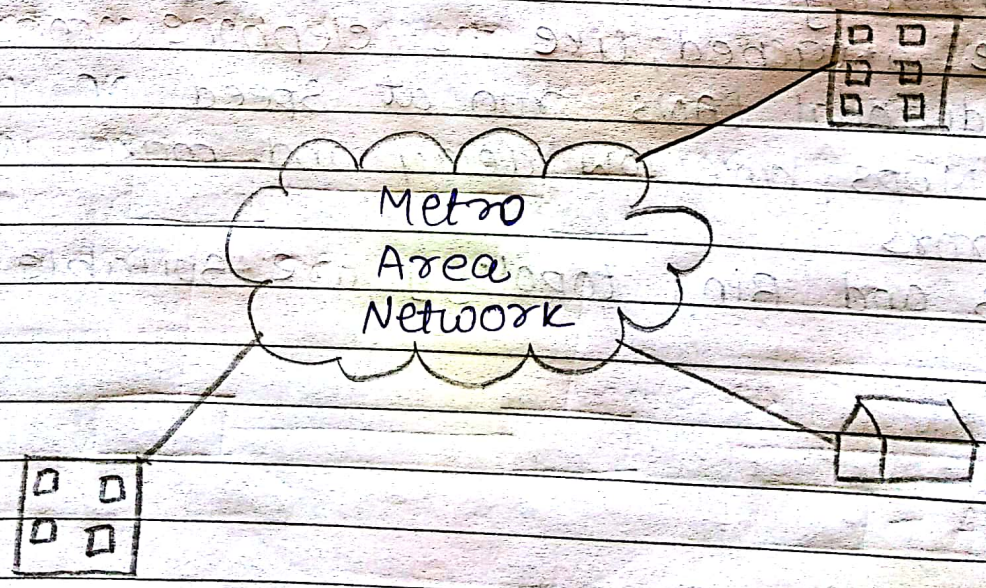
10] LAN: (LOCAL AREA NETWORKS)

- Local area networks, generally called LAN's, are privately-owned networks within a single building or campus of upto few kms in size
- They are widely used to connect personal computer and workstations in company offices & factories to share resources (e.g, printers) and exchanging information
- LANs are distinguished from other kind of networks by three characteristics
  1) their size
  2) their transmission topology
  3) their topology
- LANs may use a transmission technology consisting of a cable to which all the machines are attached, like the telephone company lines
- Traditional LANs run at speed of 10Mbps to 100Mbps, have low delay and make very few errors
- Bus and Ring topology are suitable for LAN

SINGLE BUILDING LAN



2] MAN (METROPOLITAN AREA NETWORKS)



- A metropolitan area network is a computer network that interconnects user with computer resources in a geographic area or region larger than that covered by even a large Local Area Network but smaller than area covered by a Wide Area Network.

- Recent development in high-speed wireless Internet access resulted in the advanced MAN, which has been standarized as IEEE 802.16

3.) WAN (WIDE AREA NETWORK)

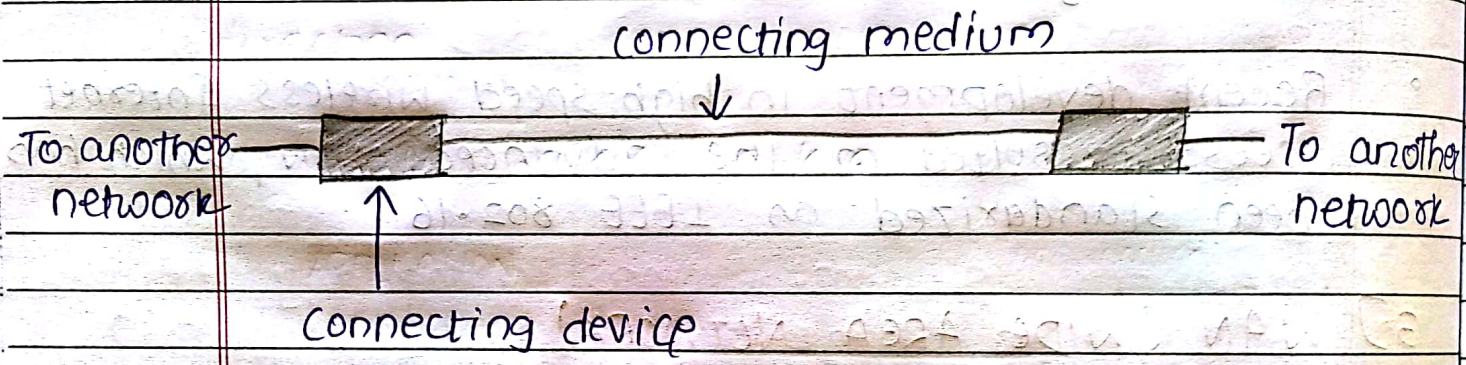
- A wide area network spans a large geographical area, often a country or continent. It contains a collection of machines intended for running user (i.e, application) programs

- However, there are some differences between a LAN and WAN. A LAN is normally limited in size, spanning an office, a building, or a campus; a WAN has a wider geographical span, spanning a town, a state, a country, or even the world.

- A LAN is normally privately owned by the organization that uses it; a WAN is normally created and run by communication companies and leased by an organization that uses it.

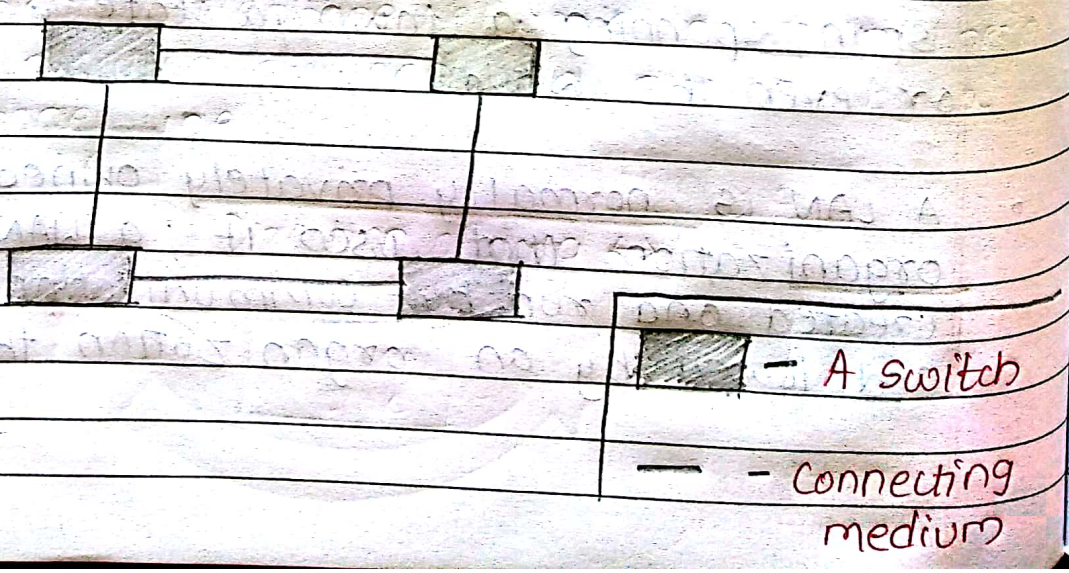
POINT-TO-POINT WAN

A point-to-point WAN is a network that connects two communicating devices through a transmission media (cable or air)



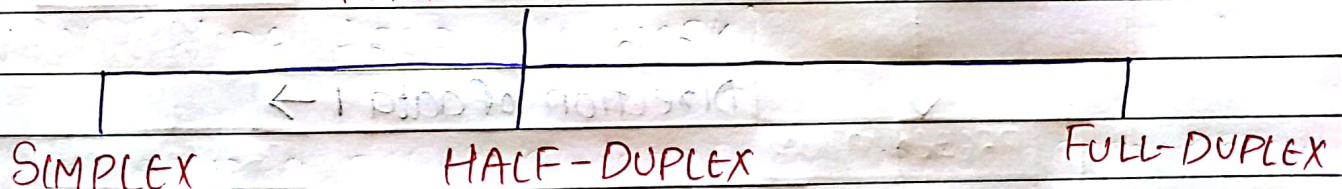
SWITCHED WAN

A switched WAN is a network with more than two ends. A switched WAN, as we will see shortly, is used in the backbone of global communication today.



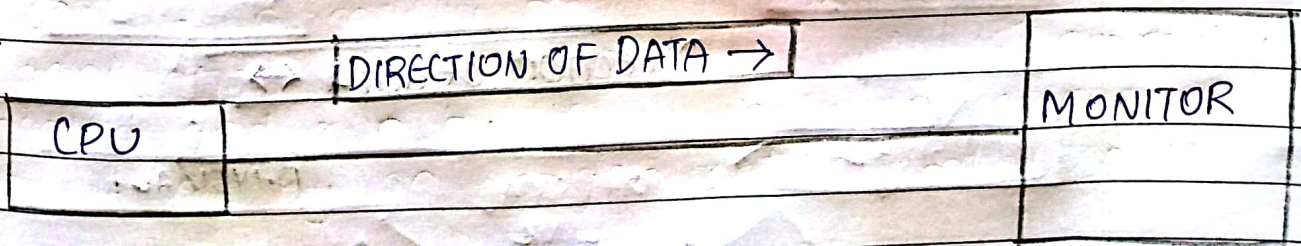
TRANSMISSION MODES

- Transmission mode means transferring of data between two devices. It is also called as communication mode.
- These modes direct the direction of flow of information. There are three types of transmission mode



1] SIMPLEX Mode

- In this type of transmission mode data can be sent only through one direction i.e communication is unidirectional
- We cannot send a message back to the sender. Unidirectional communication is done in simplex systems.
- Examples: Loudspeaker, Television Broadcasting, keyboard and monitor

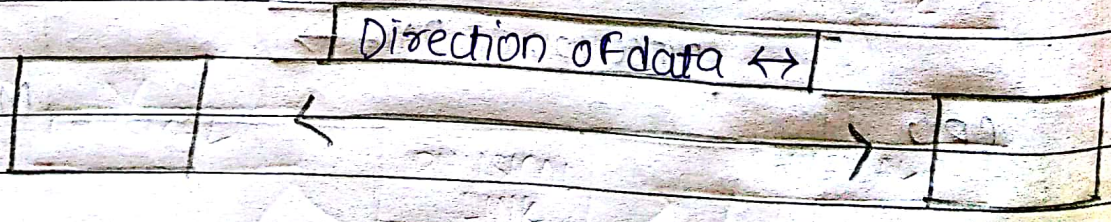


HALF DUPLEX MODE

- In half duplex system we can send data in both directions but it is done one at a time that is when the sender is sending the data then at that time we can't send the sender our message. The data is sent in one direction
- Example : Walkie-talkie

FULL DUPLEX MODE

- In full duplex we can send data in both direction as it is bidirectional. Data can be sent in both direction simultaneously. We can send as well as receive the data.
- Example : A Telephone Network in which there is communication between two persons by a telephone line.



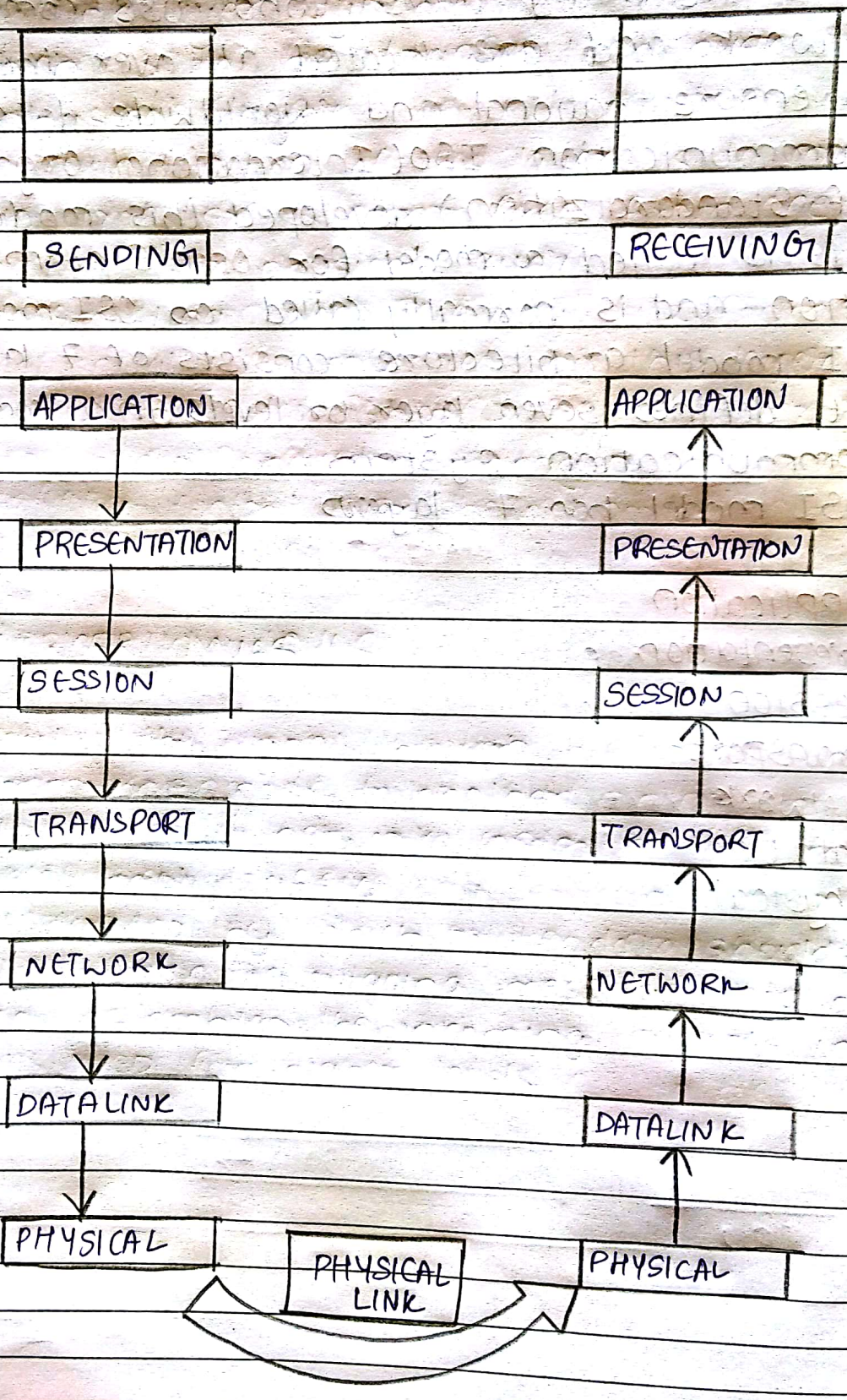
ISO OSI MODEL

- There are many users who use computer network and are located all over the world
- To ensure national and worldwide data communication ISO(International Organization of Standardization) developed this model
- This is called a model for Open System Interconnection and is normally called as OSI model
- OSI model architecture consists of 7 layers. It defines seven layer or levels in a complete communication system.

OSI model has 7 layers

Application
Presentation
Session
Transport
Network
Data Link
Physical

PRINCIPLES FOR DEFINING LAYER



- A layer should be created where a different abstraction is needed
- Each layer should perform a well defined function
- The function of each layer should be choosen to minimize the information across boundaries
- The function of each layer should be choosen with an eye of toward defining internationally standardized protocol
- The number of layers should be large enough to keep distinct functions in seperate layers and small enough that architecture does not become unwieldy.

PHYSICAL LAYER

1. It is the lowset layer of the OSI model
2. It activates, maintains and deactivates the physical connection
3. It is responsible for transmission is defined in the physical layer
4. Voltages and data rates needed for transmission is defined in the physical layer
5. It converts the digital/analog bits into electric signal or optical signals
6. Data encoding is also done in this layer.

DATA LINK LAYER

1. Data Link layer synchronizes the information which is to be transmitted over the physical layer.
2. The main function of this layer is to make sure data transfer is error free from one node to another over physical layer.
3. Transmitting and Receiving data frames sequentially is managed by this layer.
4. This layer establishes a logical layer between two nodes and also manages the frame traffic control over the network.

NETWORK LAYER

1. Routes the signal through different channels from one node to another.
2. It acts as a network controller. It manages the subnet traffic.
3. It decides by which route data should take.
4. It decides the outgoing message into packets and assembles the incoming packets into messages for higher levels.

TRANSPORT LAYER

1. It decides if data transmission should be on parallel path or single path
2. Function such as multiplexing, segmenting or splitting on the data are done by this layer
3. It receives messages from the session layer above it, convert the message into smaller units and passes it on the Network layer
4. Transport layer can be very complex, depending upon the network requirements.

SESSION LAYER

1. Session layer - manages and synchronize the conversation between two different applications
2. Transfer of data from source to destination session layer streams of data are marked, and are resynchronized properly, so that the ends of the messages are not cut prematurely and data loss is avoided.

PRESENTATION LAYER

1. Presentation layer take cares that the data is sent in such a way that the receiver will understand the information and will be able to use the data.
2. While receiving the data, presentation layer transform the data to be ready for the application layer
3. Language can be different of the two communicating systems under this condition presentation layer plays a role of translator.
4. Performs Data compression, Data encryption, Data conversion etc.

APPLICATION LAYER

1. It is the topmost layer.
2. Transferring of files disturbing the results to the user is also done in this layer. Mail Services, Directory Services, Network resource etc are services provided by application layer
3. This layer mainly holds application programs to act upon received and to be sent data

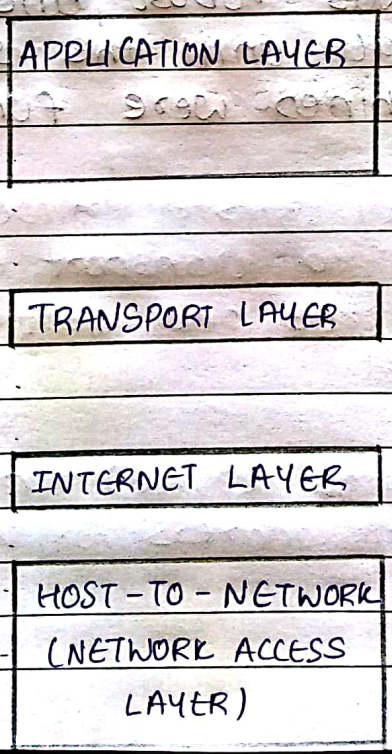
MERITS of OSI Model

- Distinguishes well between the services, the interfaces and protocols
- Protocols of OSI model are very well hidden
- Protocols can be replaced by new protocols as technology changes
- Supports connection oriented services as well as connectionless services.

Demerits of OSI Model

- Model was devised before invention of protocols
- Fitting of protocols is tedious task
- It is just used as a reference model.

TCP IP MODEL



- TCP/IP means Transmission Control Protocol and Internet Protocol. It is the network model used in the current Internet Architecture as well
- These protocols describe the movement of data between the source and destination or the internet. The protocols offer simple addressing and naming schemes.

OVERVIEW OF TCP/IP Reference Model

- TCP/IP was developed by Department of Defense's Project Research Agency as a part of research project of network interconnection to connect remote machines.
- Support for a flexible architecture. Adding more machines to network was easy.
- The network was robust, and connections remained intact until the source and destination machines were functioning.

Layer 1: Host-to-network Layer

- Lowest layer of the all
- Protocol is used to connect to the host, so that packets can be sent over it.
- Varies from host to host and network to network

Layer 2: Host-to-Network Layer

- Selection of a packet switching network which is based on a connectionless internetwork layer is called a internet layer.
- It is the layer which holds the whole architecture together
- It helps the packet to travel independently to the destination
- order in which packets are received is different from the way they are sent
- IP(Internet Protocol) is used in this layer.

TRANSPORT LAYER

- It decides if data transmission should be on parallel path or single path
- Functions such as multiplexing, segmenting or splitting on the data is done by transport layer
- The applications can read or write to the transport layer
- Transport layer adds header information to the data

- Transport layer breaks the message into small units so that they are handled more efficiently by a Network layer
- Transport layer also arrange the packets to be sent, in sequence

APPLICATION LAYER

- The TCP/IP specification describe a lot of applications that were at the top of the protocol stack. Some of them were TELNET, FTP, SMTP, DNS etc
- TELNET is a two-way communication protocol which allows connecting to remote machine and run applications on it.
- FTP (File Transfer Protocol) is a protocol that allows File transfer amongst computer user connected over a network. It is reliable, simple and efficient
- SMTP (Simple Mail Transfer Protocol) is a protocol which is used to transport electronic mail between a source and destination, directed via a route.
- DNS (Domain Name Service) resolves an IP address into a textual address for the Hosts connected over network

DIFFERENCE BETWEEN OSI and TCP/IP

OSI	TCP/IP
In OSI model transport layer gurantees the delivery of packets	In TCP/IP model the transport layer does not gurantees delivery of packets. Still the TCP/IP model is more reliable
Follows vertical approach	Follows horizontal approach
OSI model has seperate Presentation and Session Layer	TCP/IP does not have a seperate Presentation & session Layer
Transport Layer is connection oriented	Transport layer is both connection oriented and connectionless.
Network Layer is both connection oriented and connectionless	Network Layer is connection less
OSI is a model around which the networks are built. Generally it is used as a guidance tool	TCP/IP is, in a way implementation of the OSI model
OSI model has the problems of fitting protocols into model	TCP/IP model does not fit any protocol
Protocols are hidden is OSI model and are easily replaced as technology changes	In TCP/IP replacing protocols is not easy
It has 7 layers	It has 4 layers.

THE INTERNET

- The Internet has revolutionized many aspects of our daily lives. It has affected the way we do our business as well as the way we spend our leisure time
- The Internet is a communication system that has brought a wealth of information to our fingertips and organized it for our use.

ARCHITECTURE OF INTERNET

- The term network architecture refers to the conceptual plans on which a physical network is built.
- The Internet has far exceeded the original expectations of size and use, which is a testament to how strong the foundations of the Internet were planned and Implemented.

FAULT TOLERANCE NETWORK ARCHITECTURE

- Fault tolerance, simply stated, means that the Internet will continue to function normally even when some of components of the network fails.
- Redundancy, or the duplication of equipment and media, is a key factor in fault tolerance.
- If a server fails, a redundant server performing the same functionalities should be able to pick up the work until repairs are made. If a data links fails on a fault-tolerant network, messages will be routed to a destination on a duplicate route.

SCALABLE NETWORK ARCHITECTURE

- Scalability describes the network abilities to grow and react to future changes.
- A scalable network can accept new users & equipment without having to start over on the design.
- A scalable network will be able to grow internally, and externally, joining other networks to form an internetwork that can grow to keep pace with user demand.

QoS NETWORK ARCHITECTURE

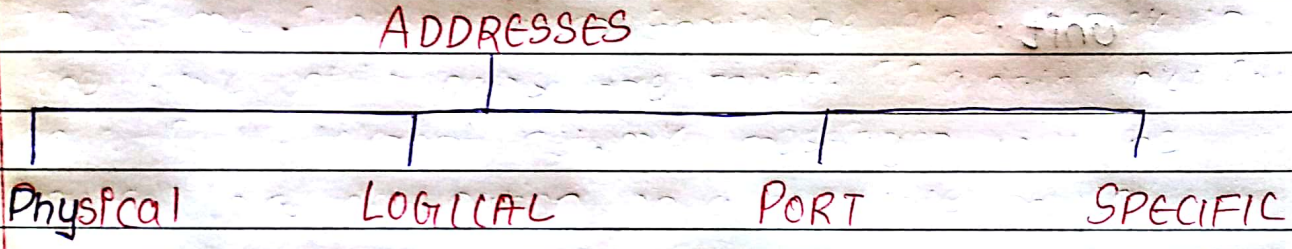
- QoS indicates the performance level of services offered through the network.
- Services such as live video or voice can require more resources than services such as email.
- Because many technologies are converged onto one platform, the seperation of type of services on that platform can allow higher priority for one service over another.

NETWORK SECURITY IN NETWORK ARCHITECTURE

- The Internet has proven to be fertile ground for business and business-to-business transactions and e-commerce are sustaining significant growth every year. The same environment that attracts legitmate business, however also attracts scam artists and vandals
  - Ensuring confidentauity
  - Ensuring Integrity
  - Ensuring Availability.

NETWORK ADDRESSING

- Four levels of addresses are used in an internet employing the TCP/IP protocols: physical, logical, port, and specific



1. PHYSICAL ADDRESS

- A physical address is the hardware-level address used by the Ethernet Interface to communicate to the network
- Every device must have a unique physical address
- An Ethernet physical address is six bytes long and consists of six hexadecimal numbers, usually seperated by colon characters (:)

2. LOGICAL ADDRESS

- A logical address is a network-layer address that is interpreted by a protocol handler.
- Logical addresses are used by networking software to allow packets to be independent of the physical connection of the network.

3.] PORT ADDRESS

- A port number is a way to identify a specific process to which an Internet or other network message is to be forwarded when it arrived at a server
- A port number is a 16-bit Integer that is put in the header appended to a message unit.