Computer Networks

Satvik Gupta

February 14, 2023

Computer Networks

Introduction

Network: Connection between objects or a group of objects **Computer network**: A set of communication elements connected by communication link.

Communication link:

- **Wired**: Optical Fiber, Coaxial Fiber, Twisted pair cable.
- **Wireless**: Radio wave, satellite connection, microwave.

Goals of Networks

- Efficient resource sharing
- Scalable
- Reliability
- Communication
- Application of Networks
- Remote data access.
- Remote software access.
- Emailing
- FIle transfer

Data communication

It is the exchange of data between two or more devices via some transmission medium

Components of Effective Data Communication

- Delivery: The data should be delivered to the destination it was intended to.
- Accuracy
- Timeliness
- Jitter free

Components of Data communication system

- Sender
- Receiver
- Message
- Protocols
- Communication/Transmission medium

Types of Communication

- Simplex: Unidirectional communication.
- Half Duplex: Bidirectional communication but only one direction at a time.
- Full Duplex: Two simplex connections in opposite directions.

Physical Structure

- Point to point
- Multipoint

Physical Topology

It tells how systems are physically connected through links. It is a geometric representation of the network.

Bus Topology

Only one connection.

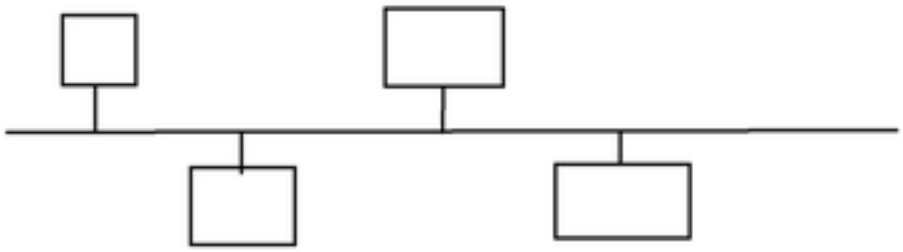


Figure 1: Bus Topology

Advantages

- Easy to install
- Cheap
- Easy to expand

Disadvantages

- Only one device can transmit at a time, which makes it low speed.
- Single point of failure - faulty cable can bring down the whole system.

Ring Topology

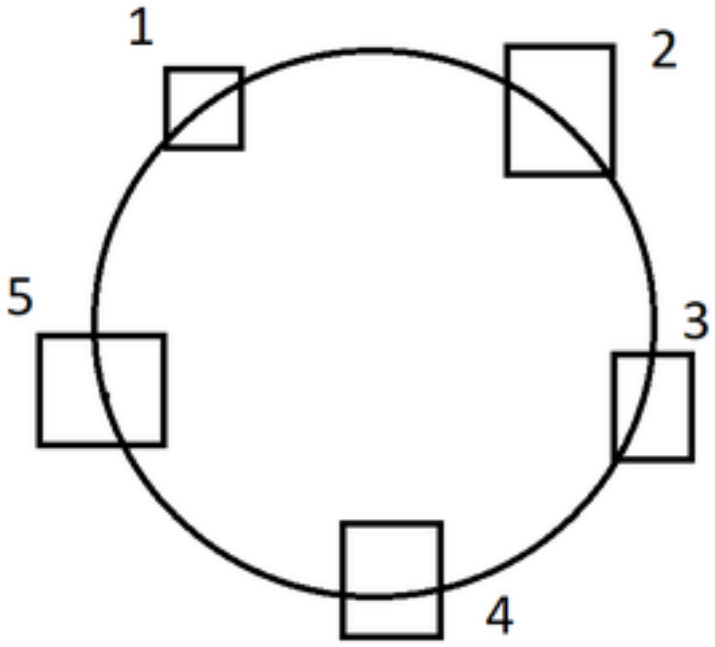


Figure 2: Ring Topology

Tokens are used to transfer data. Only one system can hold the token at a time. Token passing is done.

***Advantages**

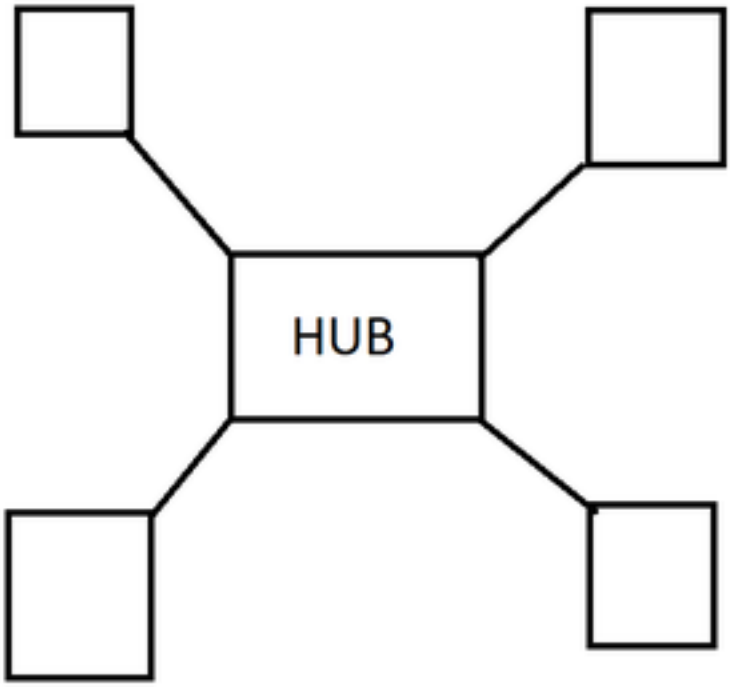
- Cheap

Disadvantages

- Not easy to install.
- Not easy to expand.
- If one system/one link goes down the entire ring will go down.

Star Topology

Uses a central hub.



;

__ **Advantages and disadvantages same as of any centralized system**__ Hub can also be expensive.

Mesh Topology

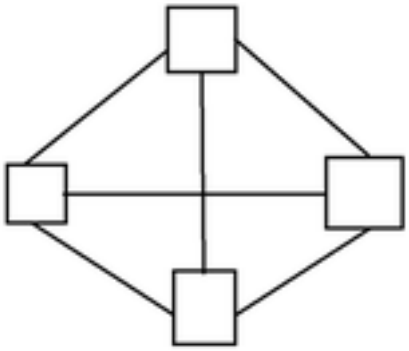


Figure 3: Mesh

Advantages

- Less traffic
- No single point of failure
- Messages can be sent directly without any routing

Disadvantages

- Cabling cost will be higher
- Maintenance cost will be higher.

Tree Topology

Tree structure.

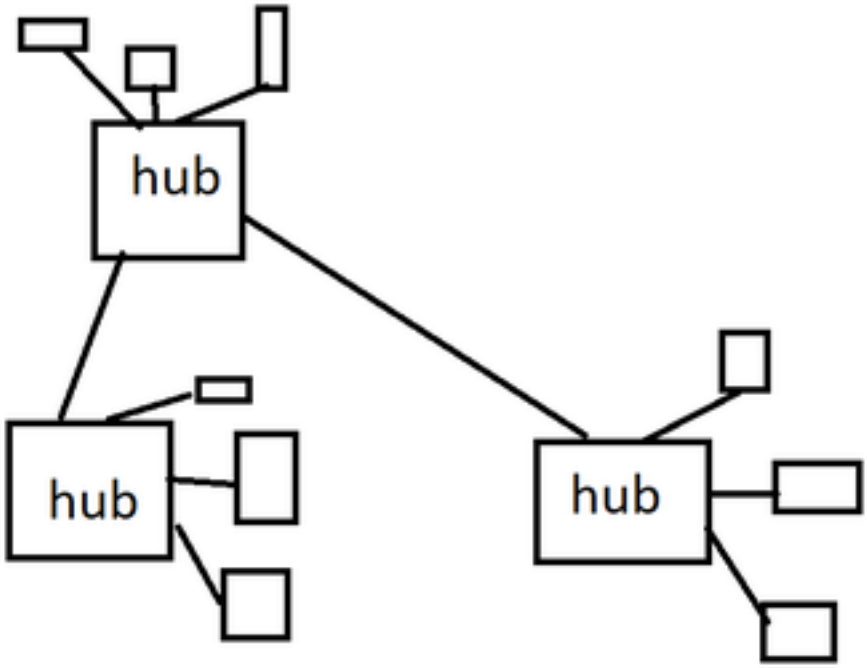


Figure 4: Tree Topology

Networks Based on Geographical Area

- LAN - Local Area Network
- MAN - Metropolitan Area Network
- WAN - Wide Area Network

Differentiate based on cables, cost, etc.

OSI Model - Open Systems Interconnection

Given by ISO.

The OSI model is a layered framework for the design of network systems that allows communication btw all types of computer systems.The purpose of OSI model is to facilitate communication btw different systems without requiring changes to the logic of underlying hardware and software.

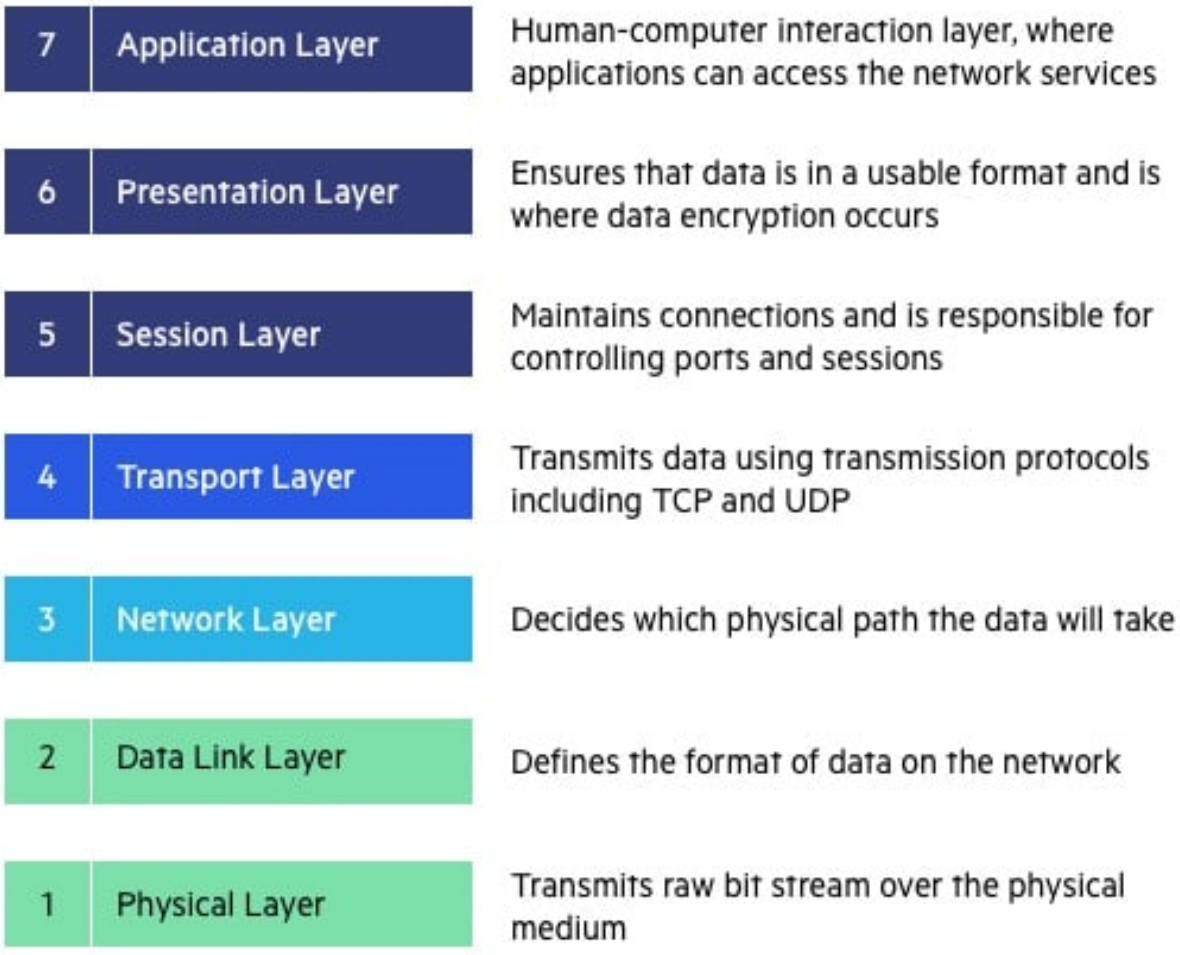


Figure 5: OSI

Data in layers:

S.No	Layer	Data	Responsibility	Protocols
1	Application Layer	Data	To allow access to network resources	Telnet, SMTP,DNS, HTTP
2	Presentation Layer	Data	To translate, encrypt and process the data	
3	Session Layer	Data	To establish, manage and terminate session	
4	Transport Layer	Segment	Process to Process msg delivery, error recovery	TCP, UDP

S.No	Layer	Data	Responsibility	Protocols
				(Port/Socket Address)
5	Network Layer	Packet	Move packet from source to destination.	IP, ARP, RARP, ICMP (Logical/IP Address)
6	Data Link Layer	Frame	Hop to hop delivery, organize the frames	IEEE 802 Std., TR,PPP (Physical/MAC Address)
7	Physical Layer	Bit	Transmit bits over a medium, provide mechanical and electrical specification	Transmission media

ARP - Address Resolution Protocol - Maps IP to MAC.

RARP - Reverse Address Resolution Protocol - Maps MAC to IP.

Physical Layer

It is responsible for moving physical bits. It defines:

- a transmission medium (wireless/wired)
- types of encoding to be used
- data rate
- synchronization of bits
- physical topology

Transmission Media

Wired/Guided Media:

- Optical Fiber

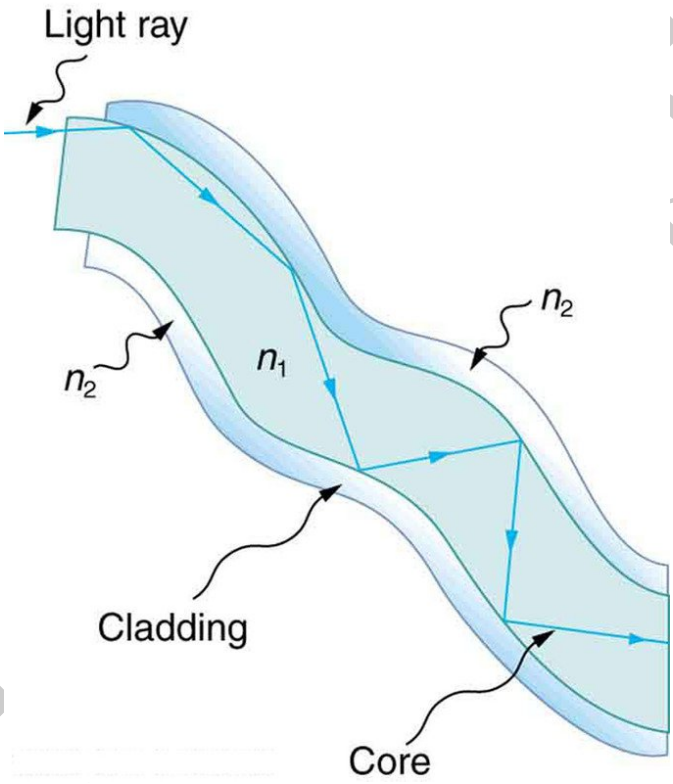


Figure 6: Transmission through Optical Fiber

- Coaxial Fiber

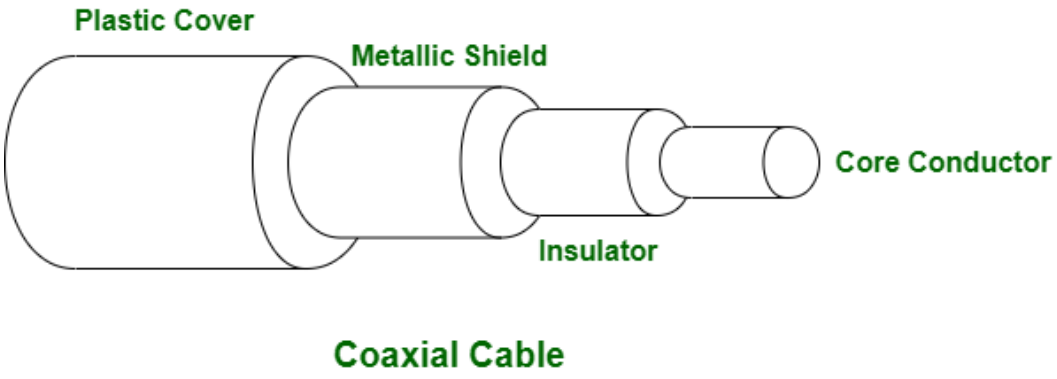


Figure 7: Coaxial Fiber

- Twisted pair cable

Figure 8: Twisted Pair Cable

- Unshielded Twisted Pair (USTC)

Figure 9: USTC

- Shielded Twisted Pair (STC)

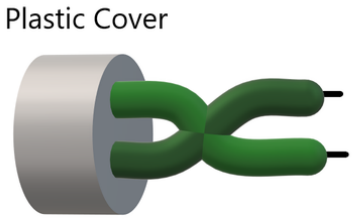


Figure 10: STC

Wireless/Unguided Media:

Radio wave, microwave, and infrared

Electromagnetic Spectrum for Wireless Communication

- 3KHz - 300 GHz => Radio Waves and Microwaves
- 300Ghz - 400 THz => Infrared
- 400 THz - 900 Thz => Light waves (not used for transmission)

Propagation Methods

Ground, Sky, Line of Sight

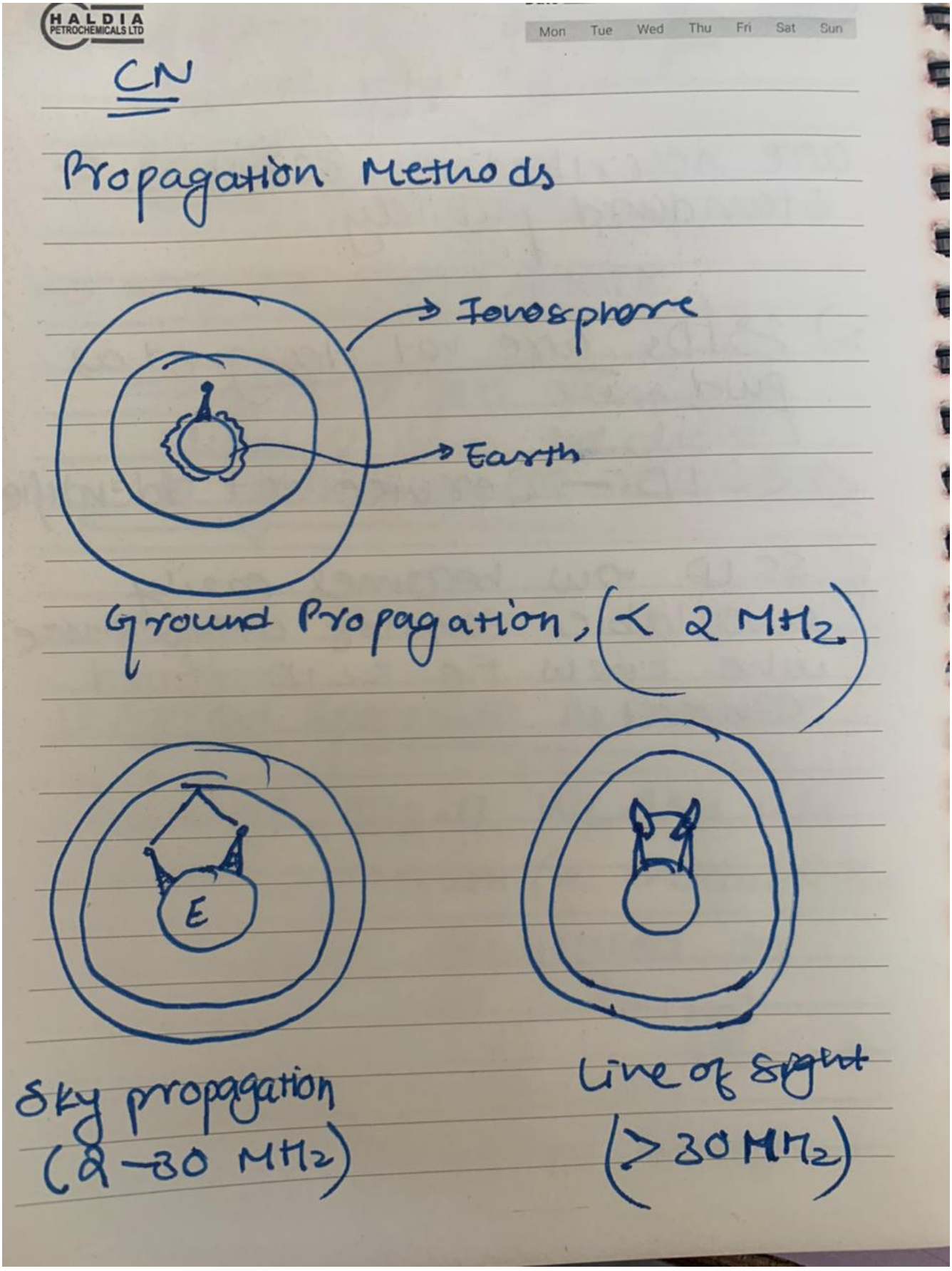


Figure 11: Propagation Methods

Bands

Band	Range	Propagation	Application
Very Low Freq.	3-30 KHz	Ground	Long range radio navigation
Low Freq.	30-300KHz	Ground	Radio and Navigation Locator
Medium Freq.	300KHz-3MHz	Sky	AM radio
High Freq	3-30 MHz	Sky	Citizen Band(Ship/Aircraft Communication)
Very High Freq.	30-300 MHz	Sky/Line of Sight	Cellular Phone, Satellite
Super high freq.	3-30 GHz	Line of Sight	Satellite Communication
Extremely high freq.	30-300 GHz	Line of Sight	Radar/Satellite Communication

High Frequencies cannot travel through walls, lower frequencies can.

High Frequency have less distance, lower frequencies have higher distance.

Switched Networks

Large networks cannot have all nodes directly connected with each other. Therefore, to send data from one node to another, it has to be sent through other nodes.

Suppose there's a network with many nodes, and node A wants to send some data to node B. There are two ways of doing so.

1. **Packet Switching**

   A sends the data to the next node, and the next node decides where to send it further, based on the destination. At each point the decision is made by the node as to the direction in which the packet must be sent, in order to get it to its desired destination.

2. **Circuit Switching**

   A special path is set up for the transmission, and the intermediate nodes are already decided before the data transmission takes place. There is a dedicated path set up for the transmission of that packet.