

Data Communication & Networking

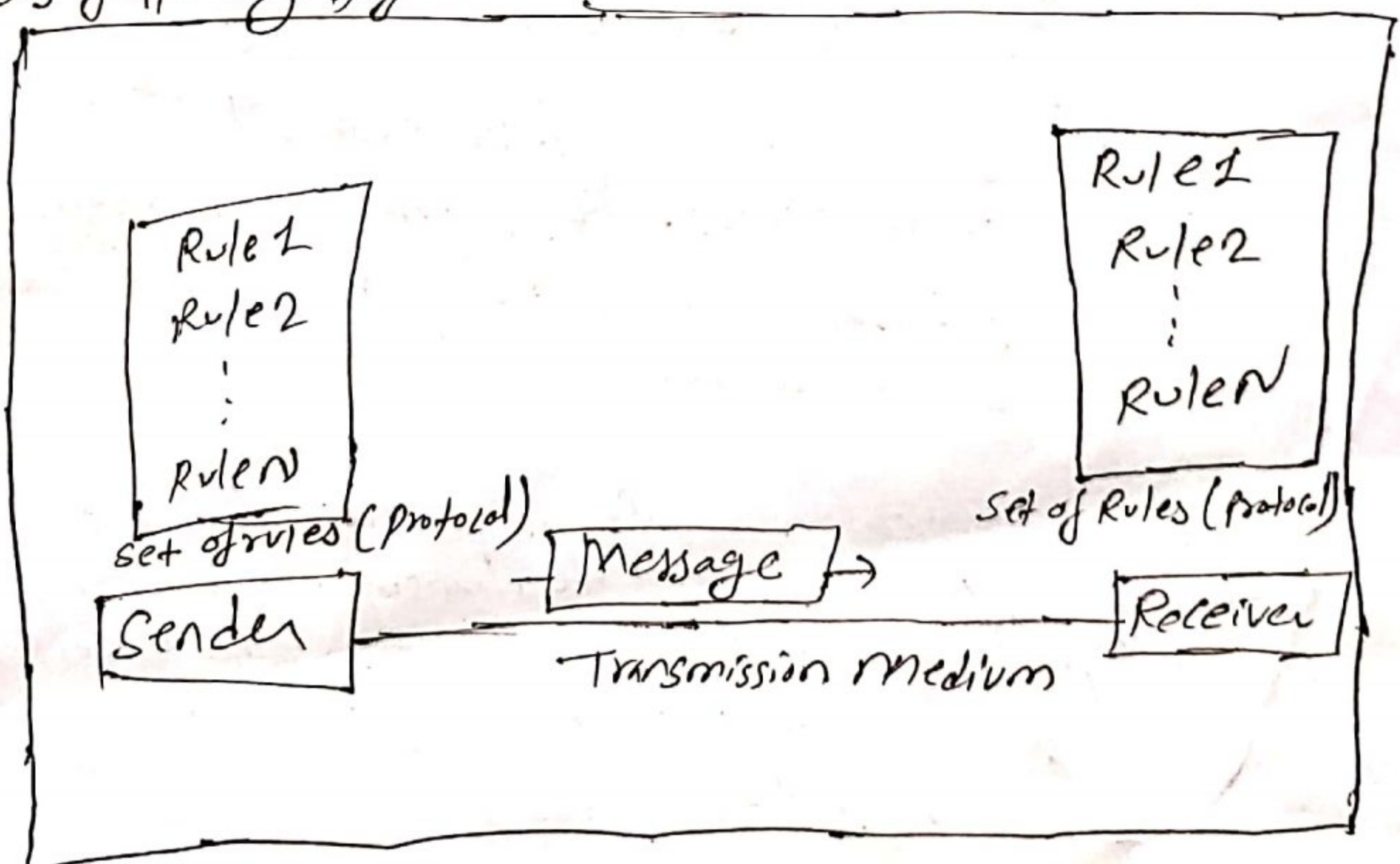
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Data communication is a process of exchanging data or information between two or more devices over a transmission medium.

Hardware and software involves for communication system. The hardware part involves the sender and receiver devices and the intermediate devices through which the data passes. The software part involves certain rules which specify what is to be communicated, how it is to be communicated and when. It is also called as protocol.

Components of Data Communication

A Data Communication system has five components as following figure:-



There are mainly five components

- i message
- ii Sender

- (iii) Receiver
- (iv) Transmission medium
- (v) Protocol

- (1) message:- message is the information to be communicated by the sender to the receiver
- (2) Sender:- The sender is any device that is capable of sending the data message.
- (3) Receiver:- The Receiver is a device that is capable of receiving data message or sender wants to communicate with.
- (4) Transmission medium:- It is the path by which the message travels from sender to receiver. It can be wired or wireless and many subtypes in both.
- (5) protocol:- It is a set of rules used by the sender and receiver to communicate data.
A protocol is a set of rules that governs data communication.

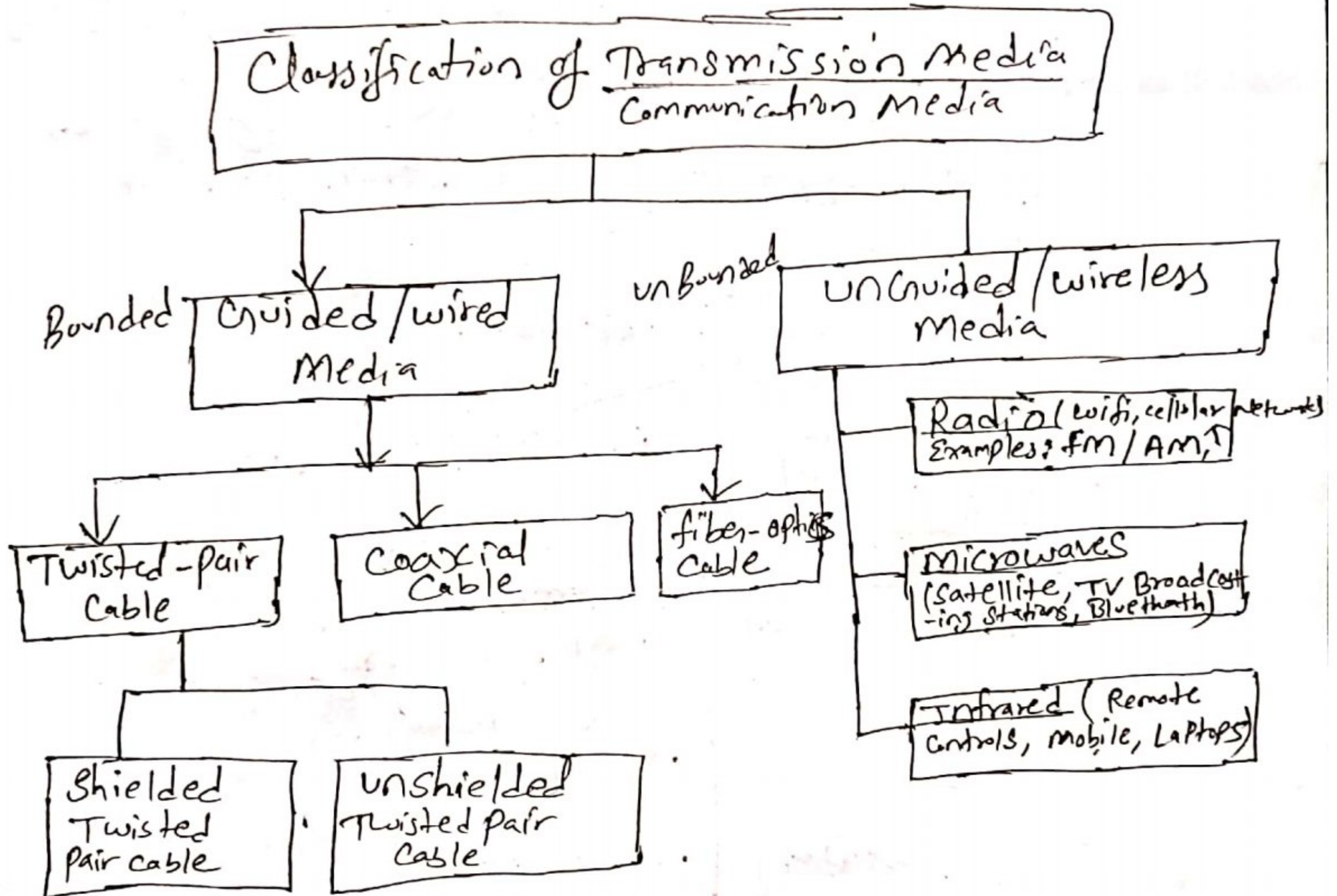
Digital Communication system refers to the process/ technologies/ methods used to transmit and receive digital signals that deals with discrete signals which are usually represented as sequences of binary numbers (0s and 1s).

Digital communication systems are used in various applications, including telecommunications, internet data transfer, satellite communications, and more. They are designed to be efficient, reliable and capable of handling a wide range of data types & communication needs.

Transmission Media

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Transmission media is the physical or logical pathways through which data is transmitted from the sender to receiver.



A transmission medium can be defined as anything that can carry information from a source to a destination.

The transmission medium is usually free space, metallic cable or fiber-optic cable.

1. Guided (wired) Transmission Media:-

Media are those that provide a physical path for signal transmission. The signal travels through a physical medium such as 2 wire or cable.

Types:-

- i) Twisted-pair Cable
- ii) Coaxial Cable
- iii) Fiber-optic Cable

① Twisted-pair Cable:- Twisted pair cable is a type of wiring used to connect devices like Computers, telephones and other communication systems. Twisted-pair cable consists of pairs of copper wires twisted together, which helps protect the signal from interference and noise.

Types

Twisted-pair cable

① Unshielded twisted pair

(Used in Ethernet Cables and telephone lines.)

Cheaper

Easy installation

Slower Data Transfer Rate

Pairs of insulated copper wire



No shielding

② Shielded Twisted pair

(Data centers, server rooms, suitable for areas with strong electromagnetic interference used in long distance also.)

Expensive

Installation is difficult

Higher Data Transfer rate

Pairs of copper wire twisted together, surrounded by a metallic shield (foil or braided).



foil shielding

② Co-axial cable

A coaxial cable is a type of electrical cable that consists of a central conductor, an insulating layer, a metallic shield, and an outer insulating layer.

Central Conductor → A thin wire, usually made of copper or aluminum, that carries the electrical signal.

Insulating Layer: A layer of non-conductive material surrounding the center conductor, which keeps the signal from coming into contact with the shield and prevents signal loss.

Metallic shield: A layer of metal (often braided or foil) that surrounds the insulating layer. It protects the signal from external electromagnetic interference and helps prevent signal leakage.

Outer insulating layer: A durable, protective coating that encases the entire assembly, providing physical protection and ensuring the cable is safe for handling and installation.

Coaxial cables are commonly used for transmitting television signals, internet data and other types of high-frequency signals.

BNC (Bayonet-Neill-Concelman) Connector is required for connecting this cable.

Broadband and cable TV take advantage of coax ability to transmit multiple signals at the same time. Coaxial has a large bandwidth, which means it can handle plenty of channels at high speeds.

③ fiber optical cable (fiber optics) :- A fiber optic cable is made of glass core at the center and transmits signals in the form of light. fiber optics cable itself is a core fiber surrounded by cladding. Light emitting diode (LED) sends the signals. A detector receives it and converts them back to the electrical impulses.

fiber optics can carry data, voice and video signals. The transmission speed of fiber optics is around 2 billion bits per second (bps) that is about 10 times faster than coaxial cable and 200 times faster than twisted pair cable.

fiber optics has ^{high} speed, strong security and enormous bandwidth. It can carry signals for extremely long distance too. It is unaffected by electromagnetic interference so it is one of the highly secured transmission media.

It is used for services like telecommunication, video conference, internet ~~connections~~ services and interactive services (High speed ~~data~~ networks). S-T connector is required to connect this cable.

2. Wireless/unbound Media refers to communication systems that transmit data through open space or air rather than through physical cables or wires. unbounded media rely on radio waves, microwaves or infrared to carry signals.

① Radio waves: Radio waves used for AM and FM (amplitude and frequency modulation) radio broadcasts, television signals, and some wireless communications.

Radio waves travel through the air and can cover large distances.

Electromagnetic waves ranging in frequencies between 3 kilohertz (kHz) to 300 gigahertz (GHz)

② microwaves:- Higher frequency waves used for transmitting data through air, having frequencies between 1 GHz (1 gigahertz) to 300 GHz.
point-to-point communication for network connections require line of sight between transmitters and receivers. for this reason, antenna must be placed on tall buildings or towers, hills and mountain peaks.

They are used in cellular phones, satellite networks and wireless LANs. It is very useful for long distance telephone communication and can carry 1000's of voice channels at the same time. Repeaters are needed for long distance communication so it is very expensive to build towers as well.

③ Infrared:- Infrared wave or signal are used for short-range communication, such as remote controls for devices and some types of wireless data transmission. Infrared signals require a clear line of sight. Bluetooth, wifi are example of infrared waves.

Topology (The geometrical arrangement of the computers or nodes.) ⁸

The physical or logical with geometrical pattern or arrangement of interconnected nodes/computers in a network is called topology.

The term topology refers to the way the computers are connected in the network.

The network topology describes the network's structure of how all components are connected to one another.

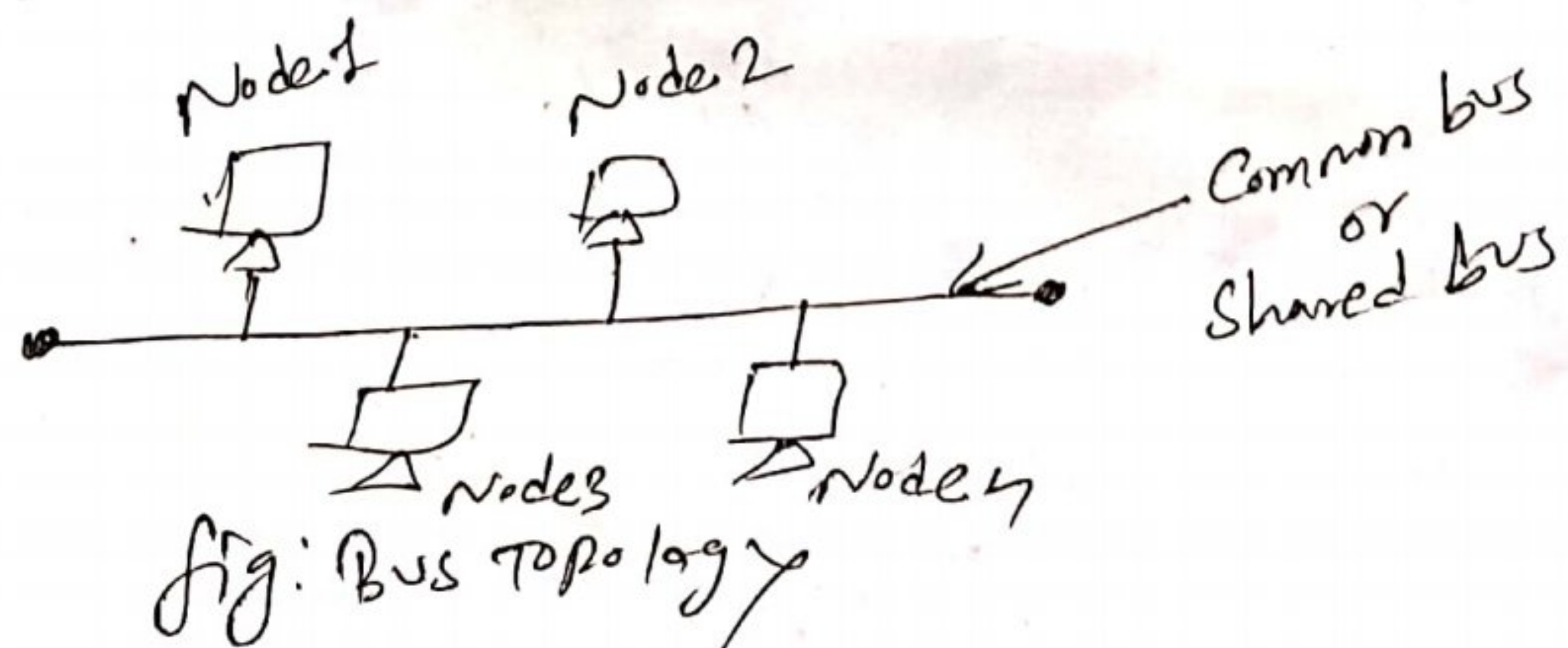
The physical network topology describes how Networking devices are connected with the help of cables or wires. It defines ~~medium~~ physical medium.

A logical topology describes the way how the data flow from one node to another. It defines the protocols meaning how they communicate.

The various types of network topologies include:-

- ① Bus Topology
- ② STAR Topology
- ③ RING Topology
- ④ MESH Topology
- ⑤ Tree Topology

① Bus Topology :- A network topology in which all of the various devices in the network are connected to a single cable or line.



- In bus topology, the data will flow through the bus (coaxial) the ~~one~~ user can communicate with others.
- The drawback of this topology is that if the network cable (bus) breaks or fails, the entire network will be down.
- Simple & easier to implement than other topology
- It is suited for small computerized networks & etc.
- Cheapest topology.
- The failure of one computer does not affect others.
- Bus cable is limited.

② Star Topology :- A network topology where each individual piece of a network is connected to a central node (often called a hub or switch)

The attachment of these network pieces to the central component is visually represented in a form similar to a star.

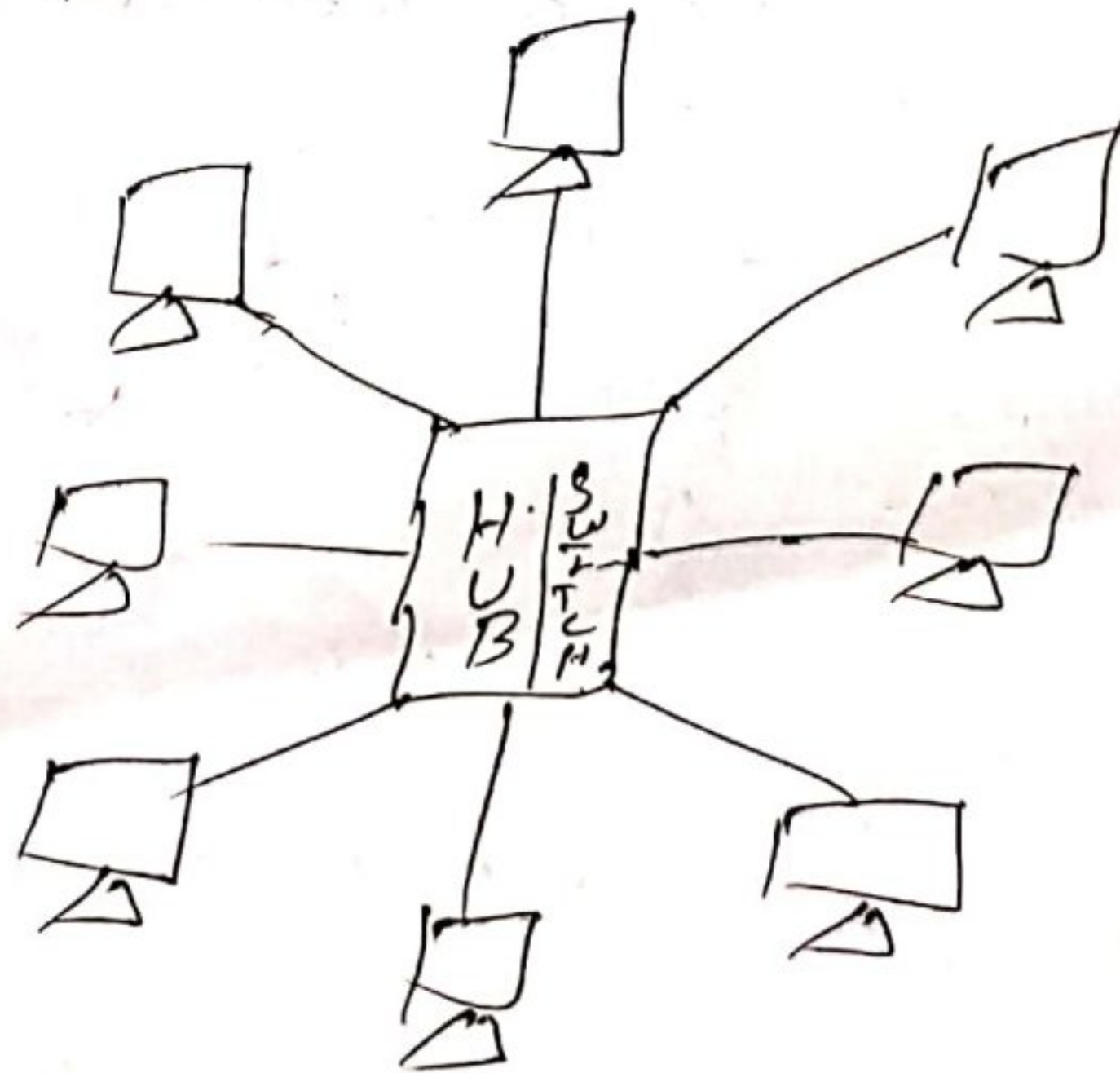


Fig: Star Topology

Mostly used in schools and colleges' network, office network.

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Data on the star network passes through the hub before reaching its destinations. It uses broadcasting mechanism for data transmission. Twisted pair cable is commonly used as transmission media.

- Easy to add and removes computer nodes.
- failure of one computer does not affect the entire network.
- useful for centralized computer control system.

Disadvantages

The failure of central port (hub or switch) affects all nodes in network.

Requires more cable.

more expensive than Bus topology

3) Ring Topology: Ring Topology is a type of network topology where each node is exactly connected to two other nodes, thus forming a single continuous path for signal transmission.

Data traffic is reduced as data flows in only one direction.

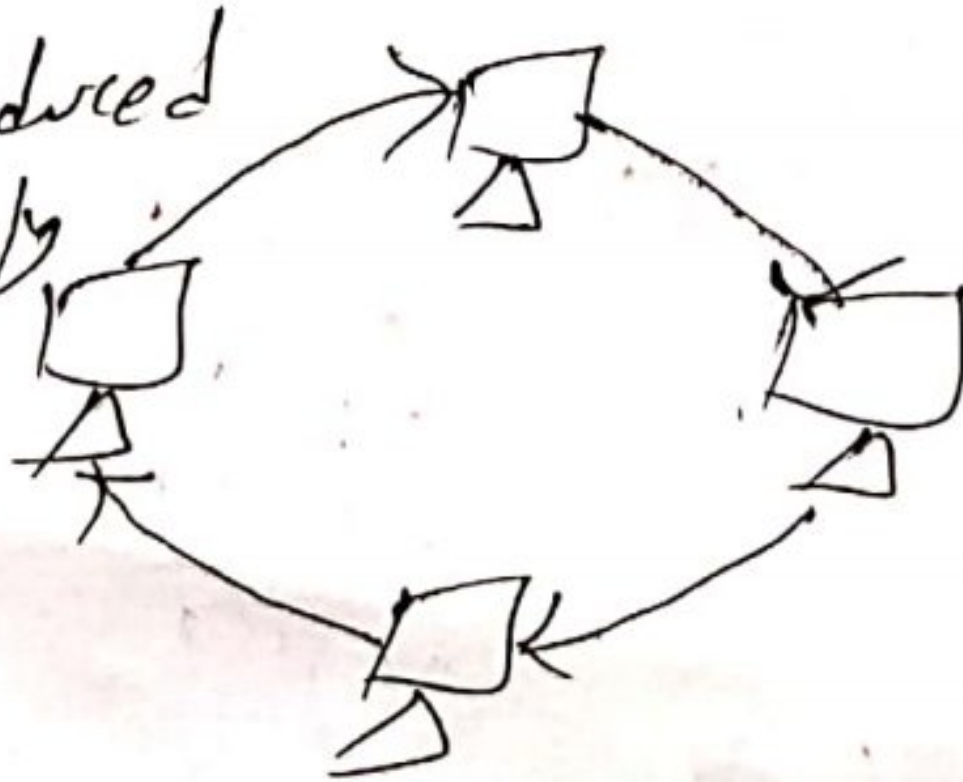


fig: Ring Topology

failure of a node can affect the entire system/network.

less flexible, difficult in adding & removing the computer nodes

Data is transmitted in only one direction either clockwise or anti clockwise at a time! The method by which the data is transmitted around the ring is called token passing.

④ mesh topology :- In this type of network, each node is connected to all other nodes in the network. It is more reliable. 11

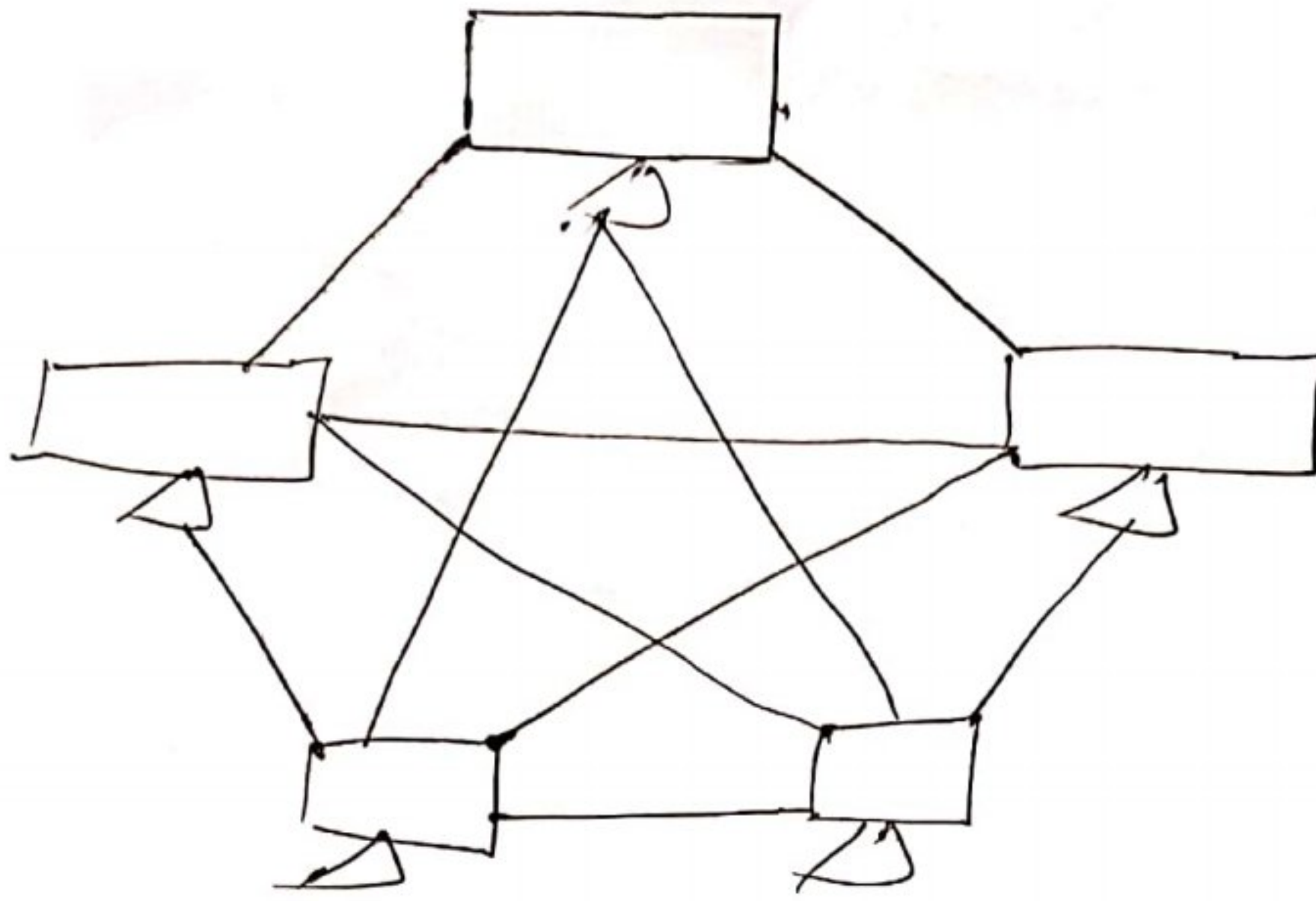


fig: mesh topology

⑤ Tree topology :- A tree topology is a special type of structure in which many connected elements are arranged like the branches of a tree. It is also known as Hierarchical structure topology.

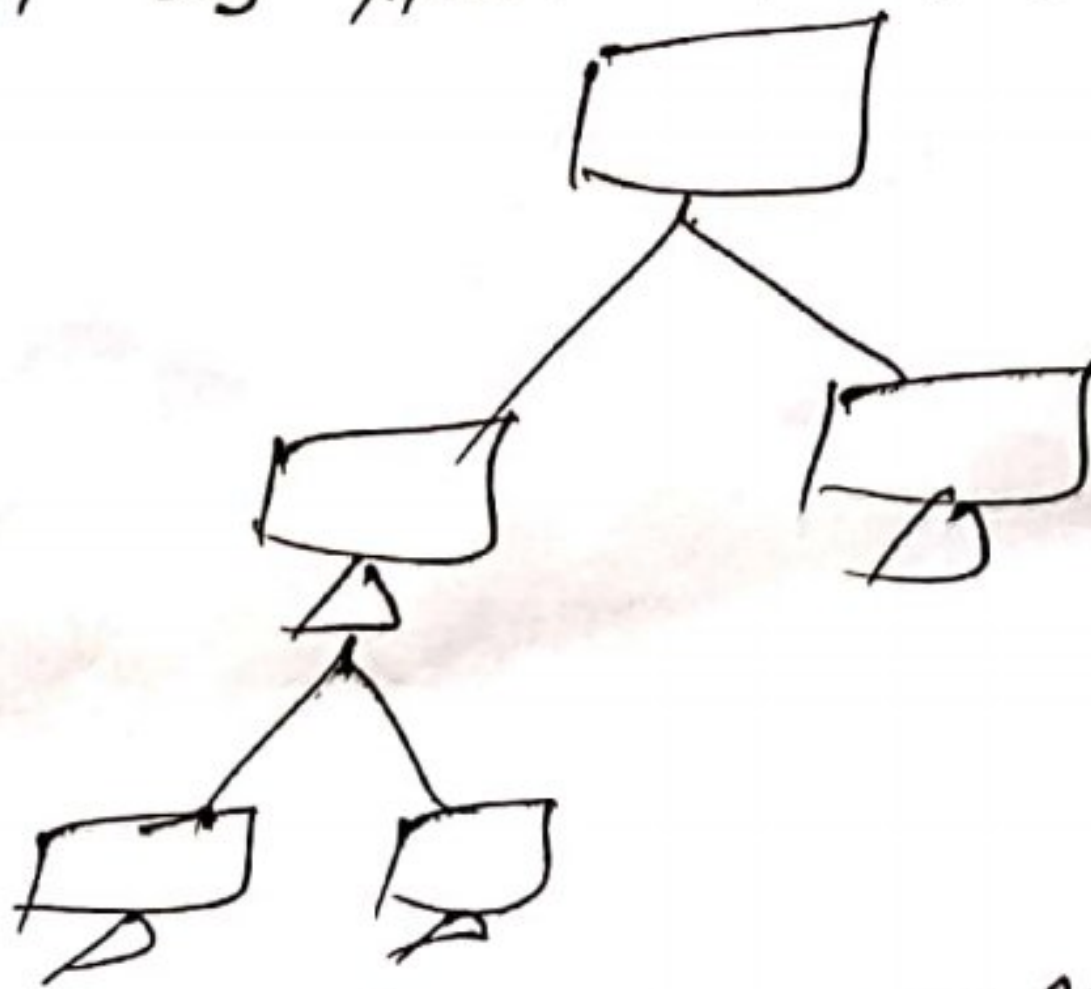


fig: Tree topology

(Application Layer)

Domain Name System (DNS)

DNS is a service that translates the domain name into IP addresses. DNS is for mapping of Host Name to IP address. Domains are unique.

- All system communicate using IP addresses
- Numbers are difficult to remember for human beings than name.
- Internet is very large there are millions of computers and servers
- Therefore, DNS is introduced to convert the domain name of the websites to their numerical IP address.

for eg

157.240.20.35 is the ip address of facebook.com.

for humans, its easy to remember facebook.com rather than remembering the IP addresses.

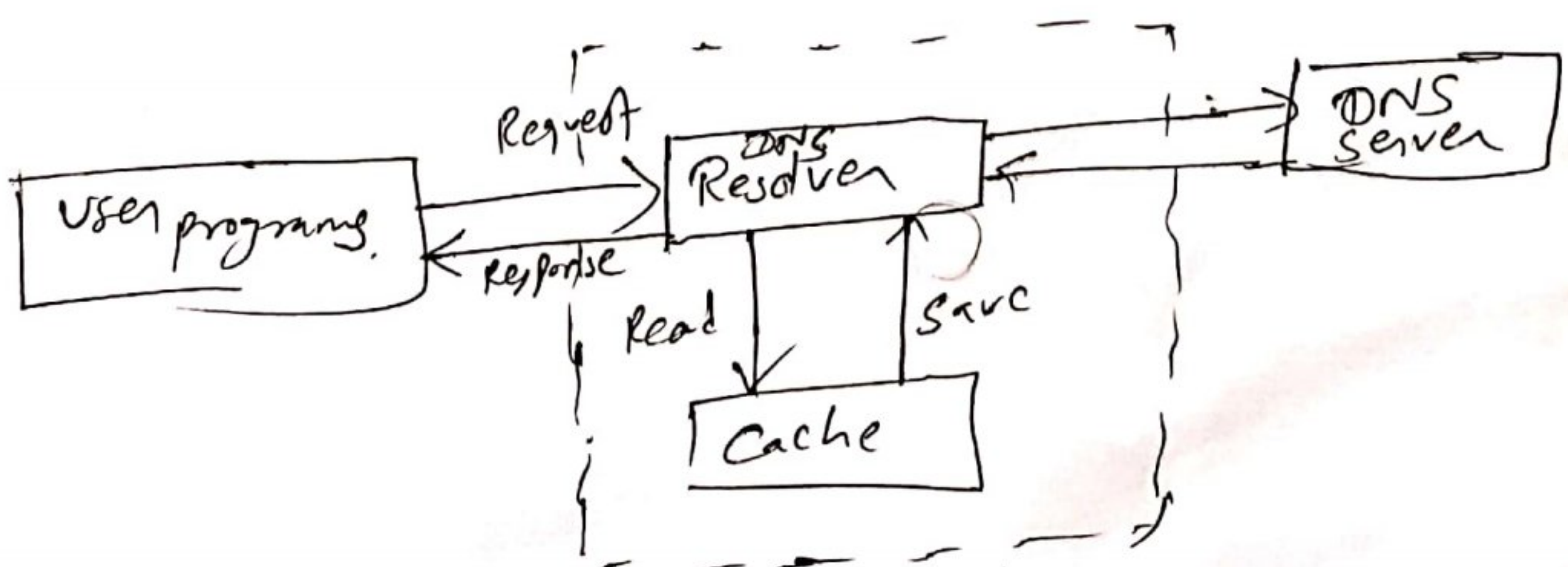


Fig: working of DNS Client