What is a computer network?

A computer network is a group of interconnected nodes or computing devices that exchange data and resources with each other. A network connection between these devices can be established using cable or wireless media.

Once a connection is established, communication protocols -- such as TCP/IP , Simple Mail Transfer Protocol and Hypertext Transfer Protocol -- are used to exchange data between the networked devices.

A computer network can be as small as two laptops connected through an Ethernet cable or as complex as the internet, which is a global system of computer networks

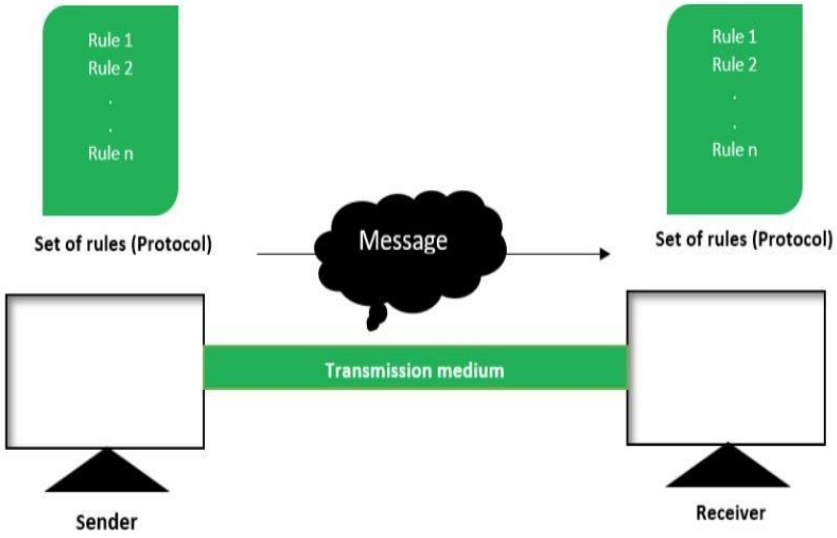
Computer Network Goals

a. **Connectivity:** The main goal of computer networking is to link devices and enable smooth communication and data exchange between them**.**
b. **Resource sharing:** By allowing linked devices to share hardware, software, and data resources, networking maximizes resource usage and load sharing.
c. **Data transfer:** Computer networking seeks to make it possible to send data, files, and information securely and effectively across networks, assuring dependable data transmission.
d. **Scalability:** Scalability is made possible through networking, allowing networks to grow and accommodate more users and devices as organizational demands change.
e. Reduce Cost .
f. If a machine goes down, another can take over.

Data Communication System Components :

There are mainly five components of a data communication system:

- Message
- Sender
- Receiver
- Transmission Medium
- Set of rules (Protocol)



Message

This is most useful asset of a data communication system. The message simply refers to data or piece of information which is to be communicated. A message could be in any form, it may be in form of a text file, an audio file, a video file, etc.

Sender

To transfer message from source to destination, someone must be there who will play role of a source. Sender plays part of a source in data communication system. It is simple a device that sends data message. The device could be in form of a computer, mobile, telephone, laptop, video camera, or a workstation, etc.

Receiver

It is destination where finally message sent by source has arrived. It is a device that receives message. Same as sender, receiver can also be in form of a computer, telephone mobile, workstation,

TransmissionMedium

In entire process of data communication, there must be something which could act as a bridge between sender and receiver, Transmission medium plays that part. It is physical path by which data or message travels from sender to receiver. Transmission medium could be guided (with wires) or unguided (without wires), for example, twisted pair cable, fiber optic cable, radio waves, microwaves, etc.

Set of rules (Protocol)

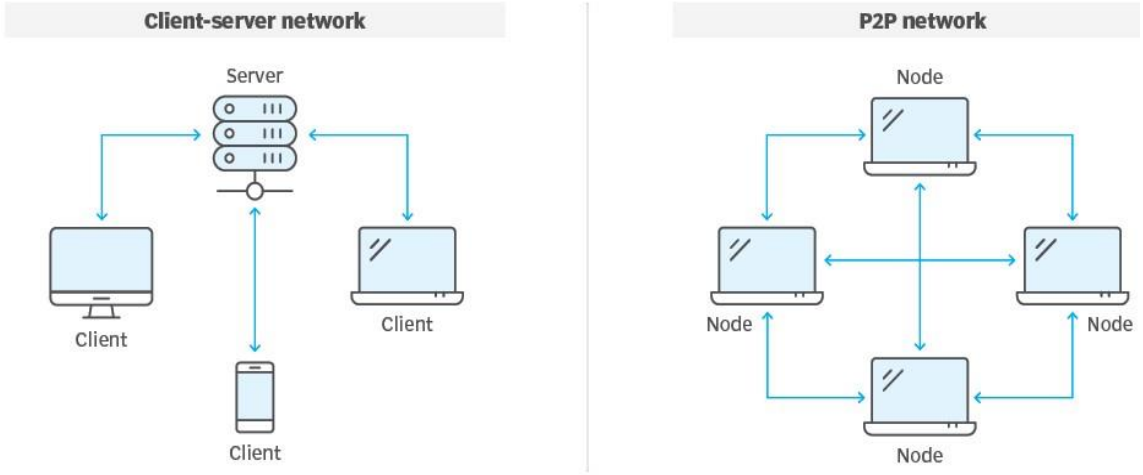
These are defined as protocol. In simple terms, the protocol is a set of rules that govern data communication. If two different devices are connected but there is no protocol among them, there would not be any kind of communication between those two devices. Thus the protocol is necessary for data communication to take place.

The following are the two most common computer network architectures:

Client-server. This model consists of many clients -- or nodes -- where at least one network node acts as the central server. The clients in this model don't share resources, but request the central server, as all the resources are installed on it.

Peer-to-peer (P2P). Each connected device on this network behaves as the client, as well as the server, and enjoys similar privileges. The resources of each peer are shared among the entire network, including memory, processing power and printing. Many companies use the P2P architecture to host memory-intensive applications, such as three-dimensional rendering, across multiple network devices.

Client-server vs. P2P



Types of Network Topology

The arrangement of a network that comprises nodes and connecting lines via sender and receiver is referred to as **Network Topology**.

The various network topologies are: Point to Point Topology

Mesh Topology

Star Topology

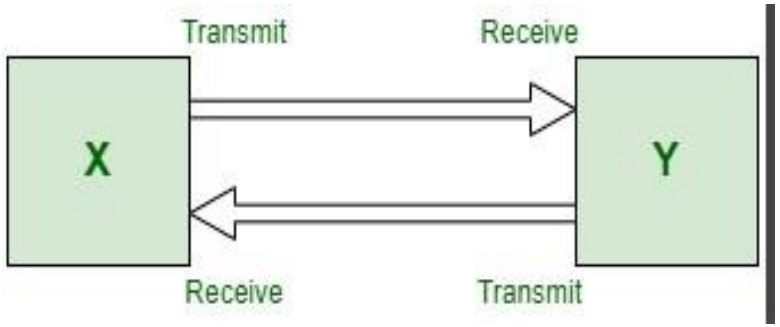
Bus Topology

Ring Topology

Tree Topology

Hybrid Topology

Point to point link : This is the kind of topology that relies upon two functions i.e. Transmit and Receive. It is a type of communication network between two communication nodes where
there is one transmitter and on the other end, there is the receiver. It is a kind of communication medium which have two endpoints or end nodes. They provide high bandwidth



In a **mesh topology**, every device is connected to another device via a particular channel. In Mesh Topology the protocols used are AHCP (Ad Hoc Configuration Protocols), DHCP (Dynamic Host Configuration Protocol), etc

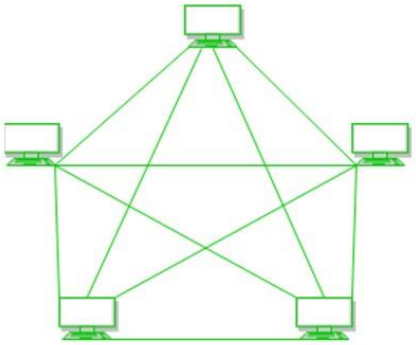


Figure Every device is connected to another via dedicated channels. These channels are known as links.

Suppose, the N number of devices are connected with each other in a mesh topology, the total number of ports that are required by each device is N-1. In Figure 1, there are 5 devices connected to each other, hence the total number of ports required by each device is 4. The total number of ports required = N * (N-1).

Suppose, N number of devices are connected with each other in a mesh topology, then the total number of dedicated links required to connect them is ${}^{N}C_{2}$ i.e. N(N-1)/2. In Figure 1, there are 5 devices connected to each other, hence the total number of links required is 5*4/2 = 10.

Advantages of Mesh Topology

1. Communication is very fast between the nodes.
2. Mesh Topology is robust.
3. The fault is diagnosed easily. Data is reliable because data is transferred among the devices through dedicated channels or links.
4. Provides security and privacy.

Drawbacks of Mesh Topology

1. Installation and configuration are difficult.
2. The cost of cables is high as bulk wiring is required, hence suitable for less number of devices.
3. The cost of maintenance is high.

In **Star Topology** all the devices are connected to a single hub through a cable. This hub is the central node and all other nodes are connected to the central node. The hub can be passive in nature i.e., not an intelligent hub such as broadcasting devices, at the same time the hub can be intelligent known as an active hub. Active hubs have repeaters in them. Coaxial cables or RJ-45 cables are used to connect the computers. In Star Topology, many popular Ethernet LAN protocols are used as CD(Collision Detection), CSMA (Carrier Sense Multiple Access), etc.

Advantages of Star Topology

If N devices are connected to each other in a star topology, then the number of cables required to connect them is N. So, it is easy to set up.

Each device requires only 1 port i.e. to connect to the hub, therefore the total number of ports required is N.

It is Robust. If one link fails only that link will affect and not other than that.

Easy to fault identification and fault isolation.

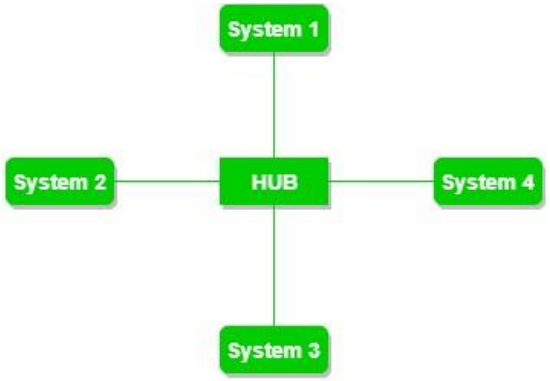
Star topology is cost-effective as it uses inexpensive coaxial cable.

Drawbacks of Star Topology

If the concentrator (hub) on which the whole topology relies fails, the whole system will crash down.

The cost of installation is high.

Performance is based on the single concentrator i.e. hub.



Bus Topology is a network type in which every computer and network device is connected to a single cable. It is bi-directional. It is a multi-point connection and a non-robust topology because if the backbone fails the topology crashes. In Bus Topology, various MAC (Media Access Control) protocols are followed by LAN Ehernet connections like TDMA, Pure Aloha, CDMA, Slotted Aloha, etc.

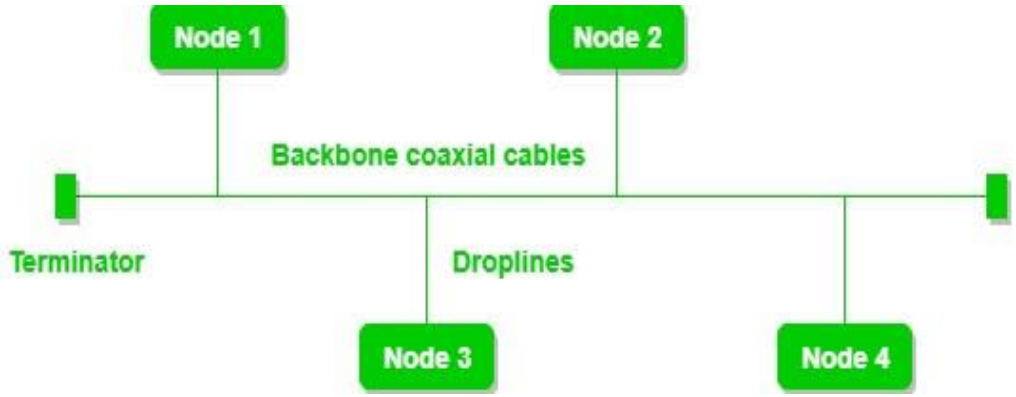


Figure : A bus topology with shared backbone cable. The nodes are connected to the channel via drop lines.

Advantages of Bus Topology

If N devices are connected to each other in a bus topology, then the number of cables required to connect them is 1, known as backbone cable, and N drop lines are required. Coaxial or twisted pair cables are mainly used in bus-based networks that support up to 10 Mbps.

The cost of the cable is less compared to other topologies, but it is used to build small networks.

CSMA is the most common method for this type of topology.

Drawbacks of Bus Topology

•A bus topology is quite simpler, but still, it requires a lot of cabling.

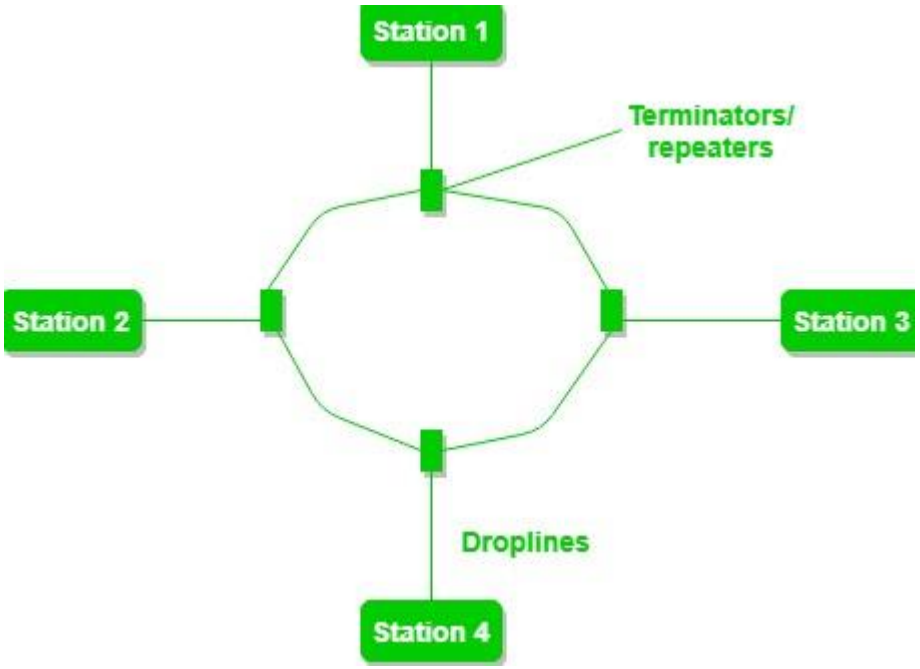
•If the common cable fails, then the whole system will crash down.

•Adding new devices to the network would slow down networks.

•Security is very low.

In a Ring Topology it forms a ring connecting devices with exactly two neighboring devices. A number of repeaters are used for Ring topology with a large number of nodes, because if someone wants to send some data to the last node in the ring topology with

100 nodes, then the data will have to pass through 99 nodes to reach the 100th node. Hence to prevent data loss repeaters are used in the network.
The data flows in one direction, i.e. it is unidirectional, but it can be made bidirectional by having 2 connections between each Network Node, it is called Dual Ring Topology. In-Ring Topology, the Token Ring Passing protocol is used by the workstations to transmit the data.



Advantages of Ring Topology

The data transmission is high-speed.

The possibility of collision is minimum in this type of topology.

Cheap to install and expand.

It is less costly than a star topology.

Drawbacks of Ring Topology

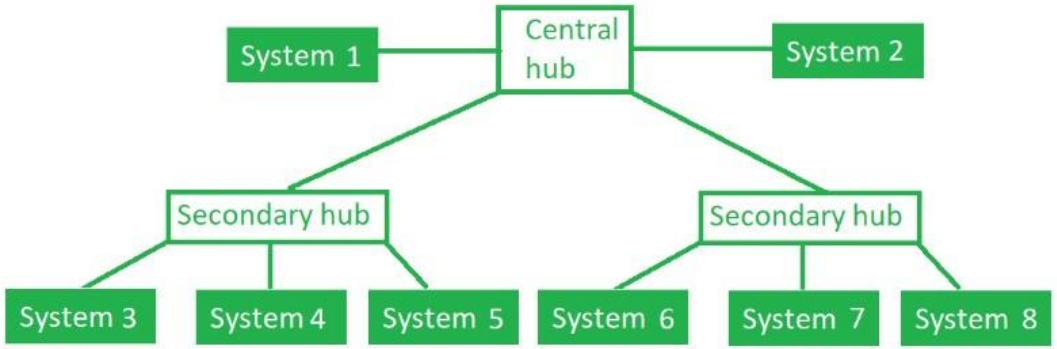
The failure of a single node in the network can cause the entire network to fail.

Troubleshooting is difficult in this topology.

The addition of stations in between or the removal of stations can disturb the whole topology.

Less secure.

This topology is the variation of the Star topology. This topology has a hierarchical flow of data. In Tree Topologyprotocols like SAC (Standard Automatic Configuration) are used.



Advantages of Tree Topology

It allows more devices to be attached to a single central hub thus it decreases the distance that is traveled by the signal to come to the devices.

It allows the network to get isolated and also prioritize from different computers.

We can add **new devices to the existing network.**

Error detection and **error correction** are very easy in a tree topology.

Drawbacks of Tree Topology

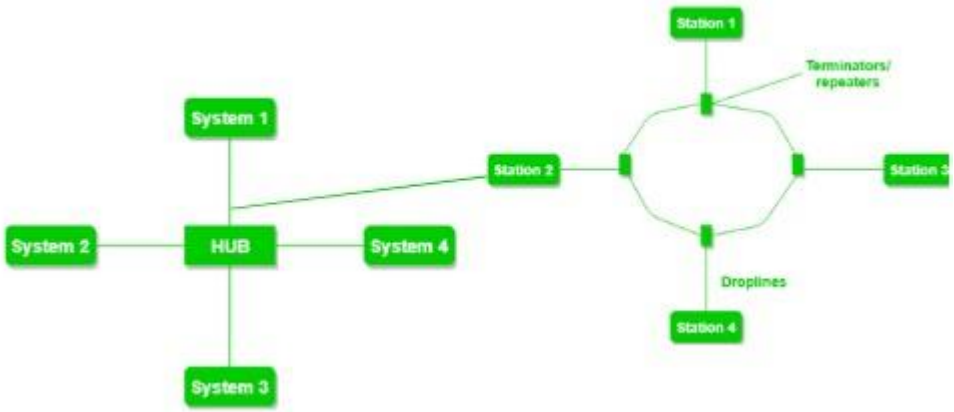
If the central hub gets fails the entire system fails.

The cost is high because of the cabling.

If new devices are added, it becomes difficult to reconfigure.

Hybrid Topology

This topological technology is the combination of all the various types of topologies we have studied above. Hybrid Topology is used when the nodes are free to take any form. It means these can be individuals such as Ring or Star topology or can be a combination of various types of topologies seen above. Each individual topology uses the protocol that has been discussed earlier.



Types of Computer Networks

There are mainly Four types of Computer Networks

•Personal Area Network (PAN)

•Local Area Network (LAN)

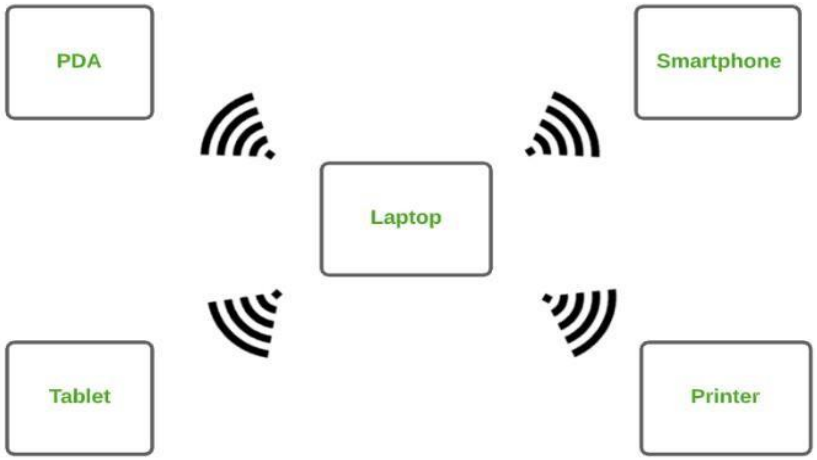
•Metropolitan Area Network (MAN)

•Wide Area Network (WAN)

Personal Area Network (PAN)

PAN is the most basic type of computer network. This network is restrained to a single person, that is, communication between the computer devices is centered only on an individual's workspace. PAN offers a network range of 1 to 100 meters from person to device providing communication. Its transmission speed is very high with very easy maintenance and very low cost.

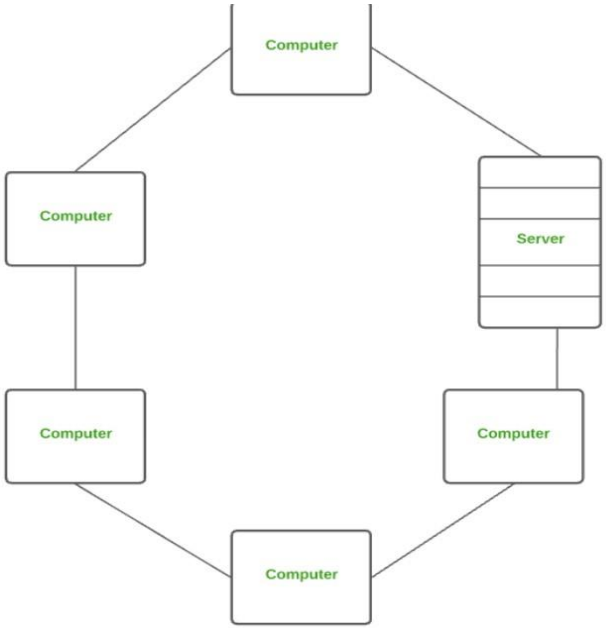
This uses Bluetooth**,** and Zigbee as technology.



Local Area Network (LAN)

LAN is the most frequently used network. A LAN is a computer network that connects computers through a common communication path, contained within a limited area, that is, locally. A LAN encompasses two or more computers connected over a server. The two important technologies involved in this network are **Ethernet and Wi-fi**. It ranges up to 2km & transmission speed is very high with easy maintenance and low cost.

Examples of LAN are networking in a home, school, library, laboratory, college, office, etc.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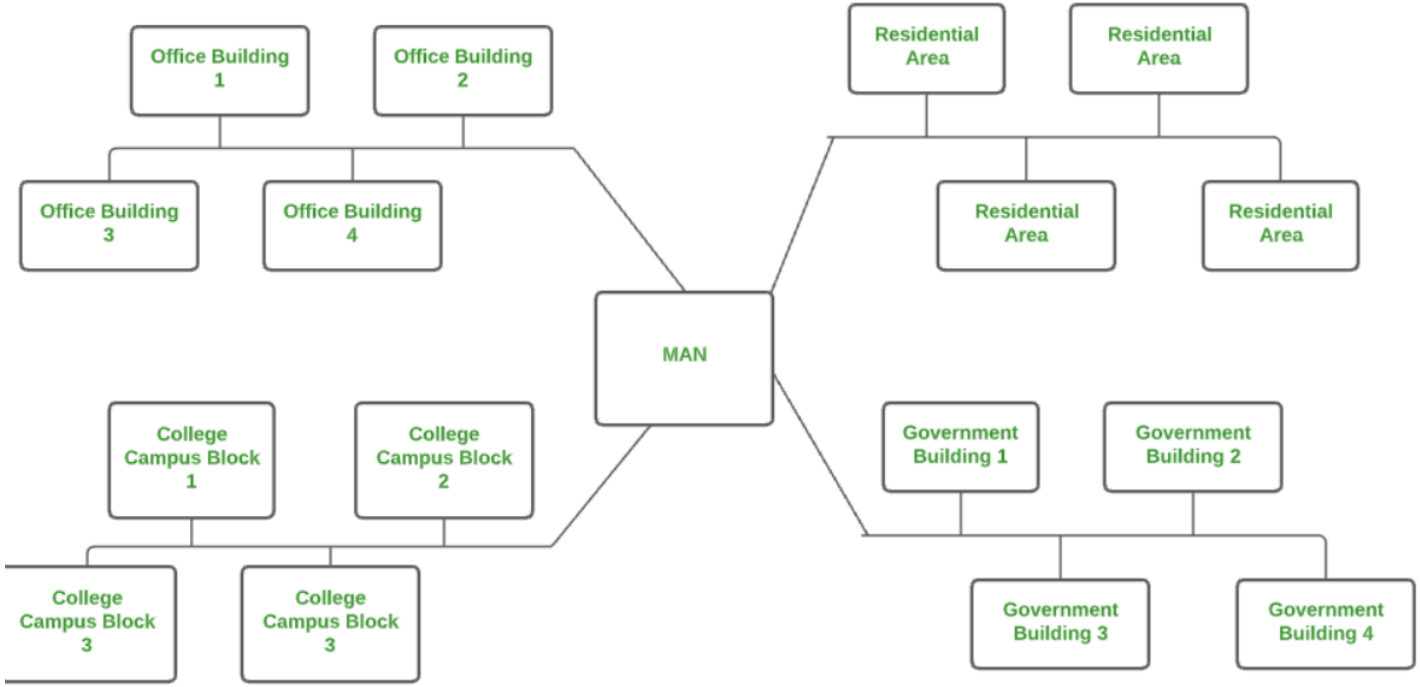


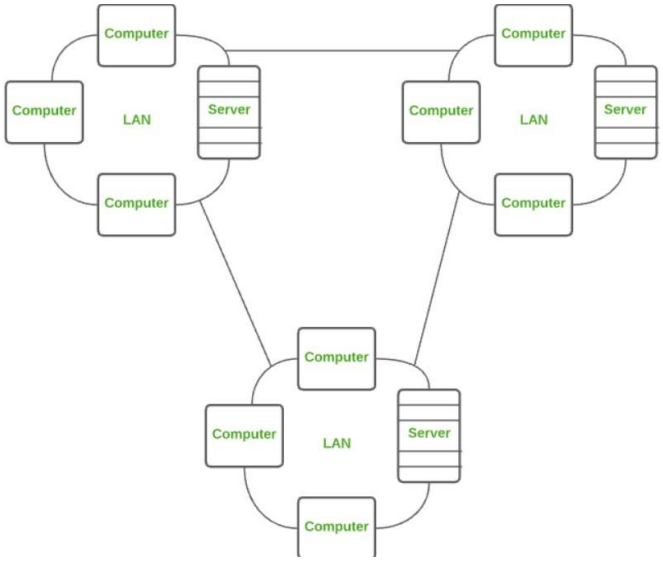
Metropolitan Area Network (MAN)

A MAN is larger than a LAN but smaller than a WAN. This is the type of computer network that connects computers over a geographical istance through a shared communication path over a city, town, or metropolitan area. Its range from 5km to 50km. Its transmission speed is average. It is difficult to maintain and it comes with a high cost.

Wide Area Network (WAN)

WAN is a type of computer network that connects computers over a large geographical distance through a shared communication path. It is not restrained to a single location but extends over many locations. WAN can also be defined as a group of local area networks that communicate with each other with a range above 50km.

Its transmission speed is very low and it comes with very high maintenance and very high cost. The most common example of WAN is the Internet.

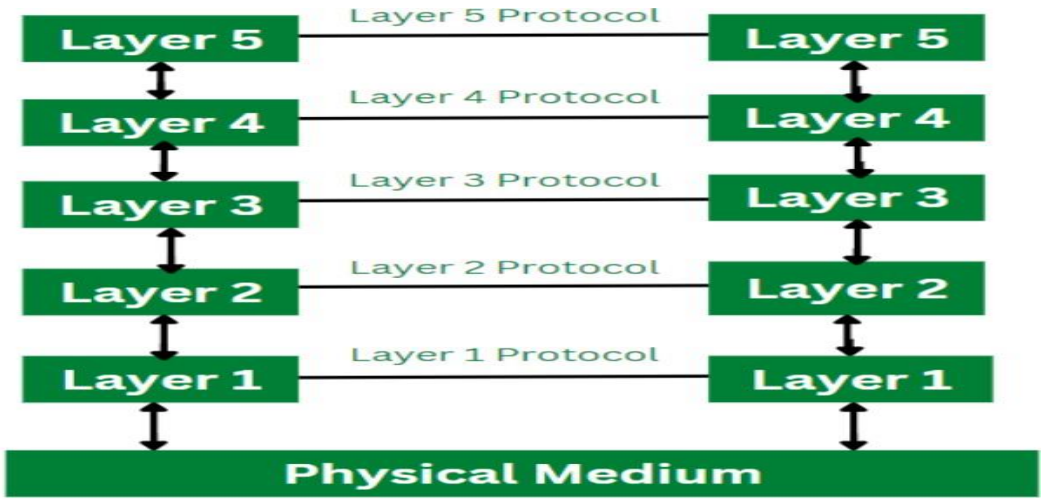


Comparison between Different Computer Networks

Parameters	**PAN**	**LAN**	**CAN**	**MAN**	**WAN**
Full Name	Personal Area Network	Local Area Network	Campus Area Network	Metropolitan Area Network	Wide Area Network
Technology	Bluetooth, IrDA,Zigbee	Ethernet & Wifi	Ethernet	FDDI, CDDi. ATM	Leased Line, Dial-Up
Range	1-100 m	Upto 2km	1 – 5 km	5-50 km	Above 50 km
Transmission Speed	Very High	Very High	High	Average	Low
Ownership	Private	Private	Private	Private or Public	Private or Public
Maintenance	Very Easy	Easy	Moderate	Difficult	Very Difficult
Cost	Very Low	Low	Moderate	High	Very High

Layered Architecture

Every network consists of a specific number of functions, layers, and tasks to perform. Layered Architecture in a computer network is defined as a model where a whole network process is divided into various smaller sub-tasks. These divided subtasks are then assigned to a specific layer to perform only the dedicated tasks. A single layer performs only s specific type of task. To run the application and provide all types of services to clients a lower layer adds its services to the higher layer present above it. Therefore layered architecture provides interactions between the sub-systems. If any type of modification is done in one layer it does not affect the next layer.



As shown in the above diagram, there are five different layers. Therefore it is a five-layered architecture. Each layer performs a dedicated task. The lower level data for example from layer 1 data is transferred to layer 2. Below all the layers Physical Medium is present. The physical medium is responsible for the actual communication to take place. For the transfer of data and communication layered architecture provides with a clean cut interface.