

## Basics :

### **Network Devices (Cables, Hub, Repeater, Bridge, Switch, Routers, Gateways, IDS, Firewall, Modem)**

**Network Devices:** Network devices, also known as networking hardware, are physical devices that allow hardware on a computer network to communicate and interact with one another. For example **Cables, Hub, Repeater, Bridge, Switch, Routers, Gateways, IDS, Firewall, Modem** etc.

-> Attenuation : Means signal became less powerful after a certain period of distance t.

-> Cables are used in physical layers as they are pure hardware without any kind of software

### **1). Cables**

An ethernet cable allows the user to connect their devices such as computers, mobile phones, routers, etc, to a Local Area Network (LAN)

- Coaxial Cables
- Twisted Pair Cables
- Fiber optic Cables

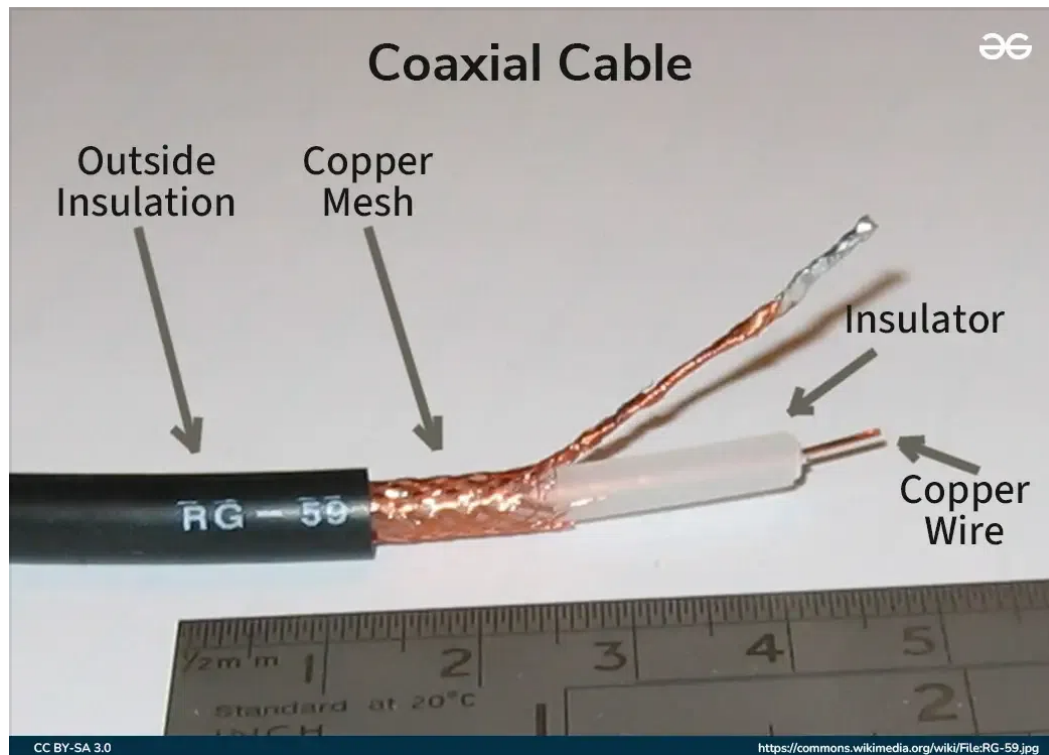
#### **1. Coaxial Cables**

-> 10BaseT -> 10mb/s spread for 100m

-> uses radio frequency signals

-> Used in tv etc

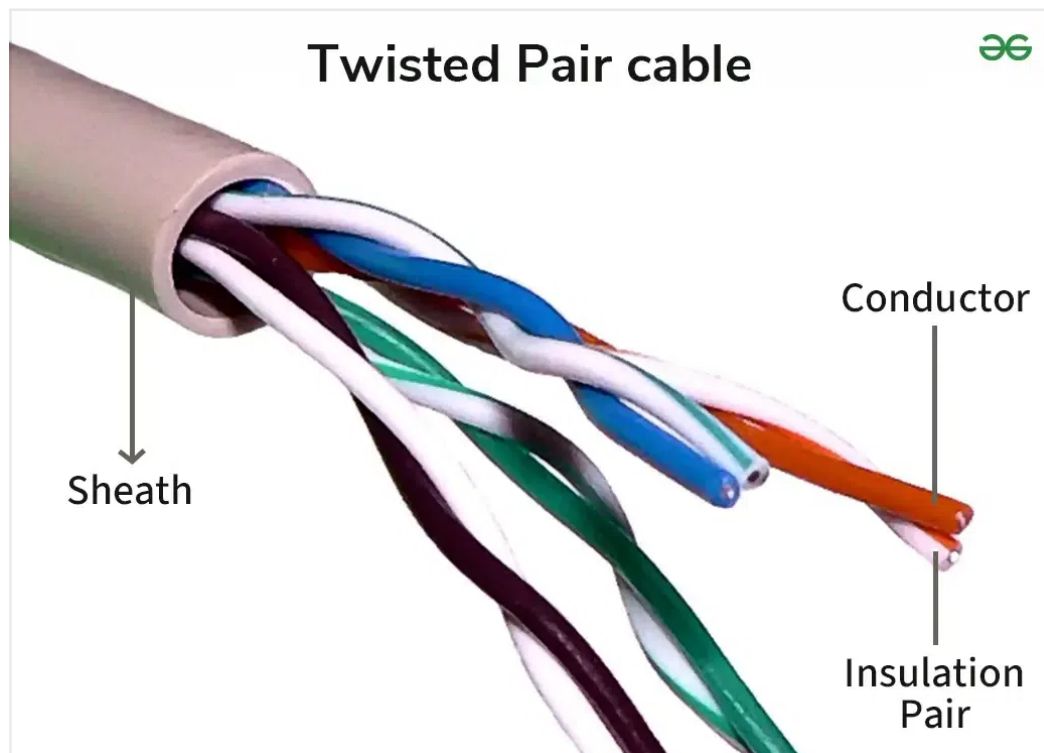
A coaxial cable is used to carry high-frequency **electrical signals** with low losses. It uses 10Base2 and 10Base5 Ethernet variants.



## 2. Twisted Pair Cable

-> 100 Base T - 100mb/s unto 100m

A twisted pair is a copper wire cable in which two insulated copper wires are twisted around each other to reduce interference or crosstalk. It uses 10BASE-T, 100BASE-T, and some other newer ethernet variants. It uses **RJ-45 connectors**.

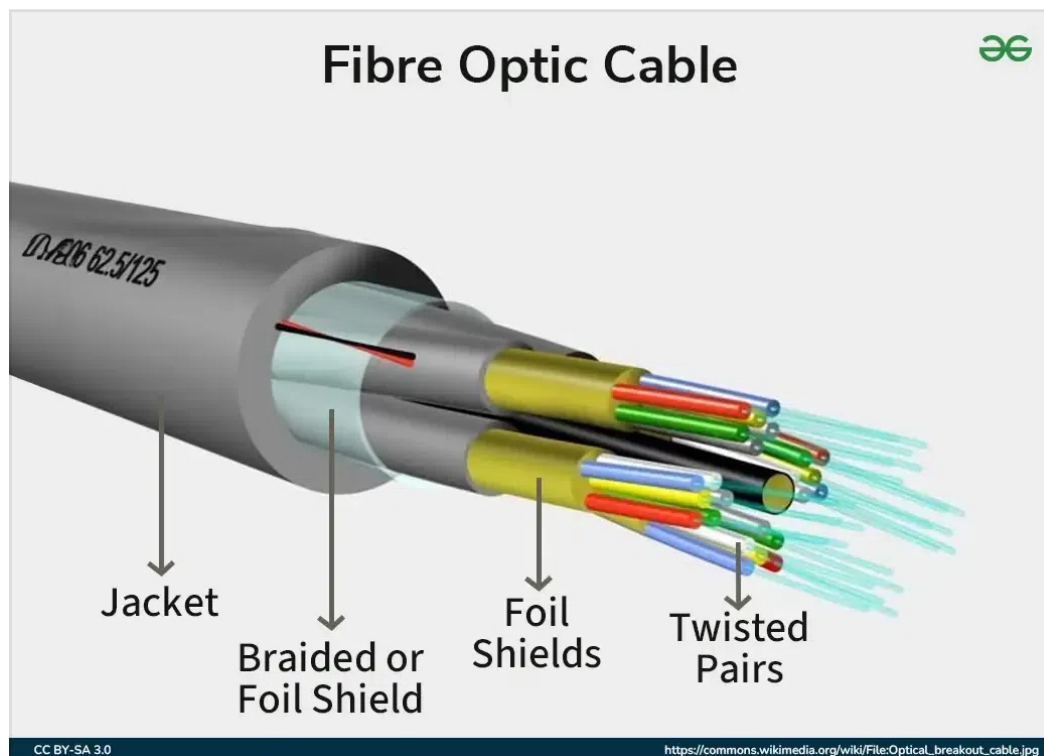


### 3. Fiber Optic Cable

-> 100mb/s speed up to 1000km

-> Uses electric signals for data transfer

Fiber optic cables use optical fibers which are made of glass cores surrounded by several layers of covering material generally made of PVC or Teflon. It transmits data in the form of light signals due to which there are no interference issues in fiber optics. Fiber optics can transmit signals over a very long distance as compared to twisted pairs or coaxial cables. It uses 10BaseF, 100BaseFX, 100BaseBX, 100BaseSX, 1000BaseFx, 1000BaseSX, and 1000BaseBx ethernet variants. Hence, it is capable of carrying information at a great speed.

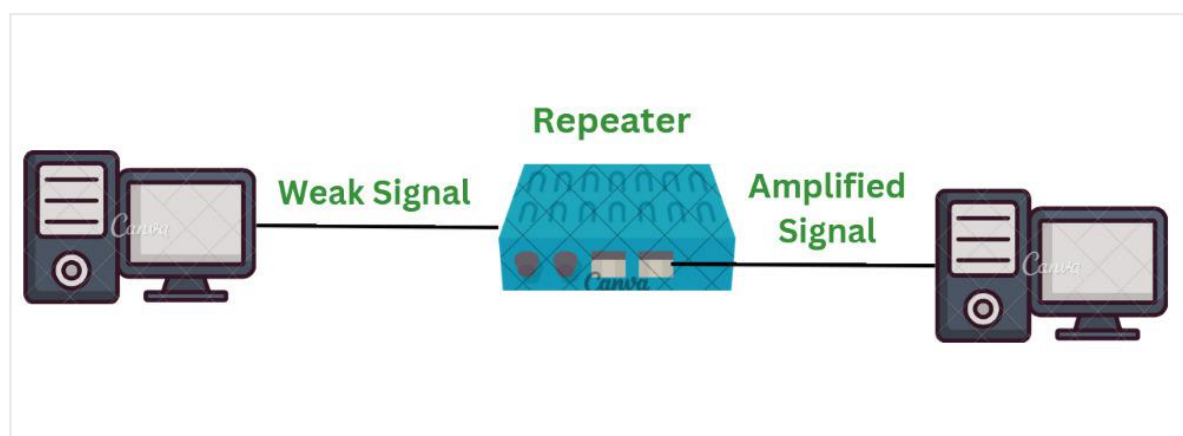


*Fiber Optic Cable*

## 2 ). Repeaters - Used in physical layer, pure hardware

-> It is used to regain the strength of a signal which usually decrease over a distance

-> Amplifier does the same thing but it could double or triple the strength of signal while repeater restore the original strength of signal or we say initial strength.



What is a Repeater?

Repeaters are defined as a networking device that is used to amplify and generate the incoming signal. Repeaters work at the physical layer of the OSI model. The main aim of using a repeater is to increase the networking distance by increasing the strength and quality of signals. The performance of Local Area Networks (LANs).

and [Wide Area Networks \(WANs\)](#) repeaters are used. Using repeaters helps to reduce error, and loss of data and provides with delivery of data at specified locations only. The major advantage of using a repeater is that it provides with transfer of data with more security and over a long distance.

### Features of Repeaters

- Repeater can regenerate the signal without modifying it.
- Repeaters can be used in [analog signals](#) and [digital signals](#).
- Repeaters can extend the range of networks.
- Dynamic networking is supported by repeater.
- Use of Repeaters reduces error and loss of data.
- Power is required for working of repeaters.
- Using repeater can add complexity in the network.
- IT doesn't filter the signals.
- Maximum number of collision could be  $n$ ,  $n$  = number of devices connected to repeater.
- No buffer support
- Its a 2 port device

### 3). Hub - Physical Layers, pure hardware



- Multiple port device
- Provides extra functionality like detecting if any of the port has some connection issues or not.
- Forwarding is also present here
- Also doesn't filter the signals will send to everyone connected.
- Collision possible, maximum collision will be  $n$ .

## Difference Between Network Hub And Switch

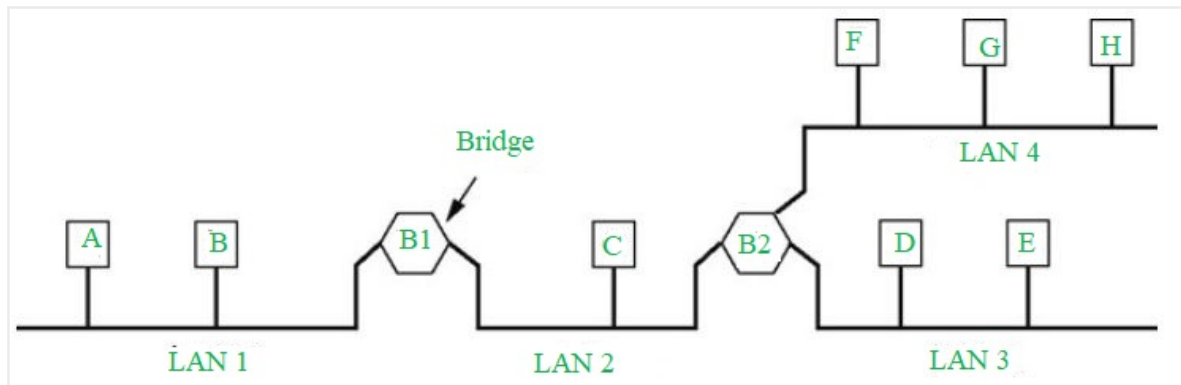
Hub	Switch
It works on the physical layer of the OSI model.	It works on the data link layer of the <a href="#">OSI model</a> .
It performs frame <a href="#">flooding</a> , which includes broadcast, multicast and unicast as well.	It mainly performs broadcasts and performs multicast, and unicast whenever required.
The transmission mode is half-duplex.	The transmission mode is full-duplex.
It cannot perform data filtering.	It can filter data and send the frame to the desired destination.
There is no spanning tree.	A switch may contain more than one spanning tree possible.
It can not store the MAC address of the ports and the destination address of the frame that arrived.	It can store the data in a <a href="#">routing table</a> and it helps in further sending the data.
It is a passive device.	It is an active device.
Hub can operate at a speed of 10Mbps.	The switch can operate at a speed of 10-100Mbps and 1-10 Gbps.

Does a Network Hub Affect Speed?

## 4) Bridge in Computer Network

A bridge in a computer network is a device used to connect multiple LANs together with a larger Local Area Network (LAN). The mechanism of network aggregation is known as bridging. The bridge is a physical or hardware device but operates at the OSI model's data link layer and is also known as a layer of two switches.

The primary responsibility of a switch is to examine the incoming traffic and determine whether to filter or forward it. Basically, a bridge in computer networks is used to divide network connections into sections, now each section has a separate [bandwidth](#) and a separate collision domain. Here bridge is used to improve network performance.



## Types of Bridges

There are three types of bridges in computer networks, which are as follows:

- **Transparent Bridge:** Transparent bridges are invisible to other devices on the network. This bridge doesn't reconfigure the network on the addition or deletion of any station. The prime function of the transparent bridge is to block or forward the data according to the MAC address.
- **Source Routing Bridge:** Source routing bridges were developed and designed by IBM specifically for token ring networks. The frame's entire route is embedded with the data frames by the source station to perform the routing operation so that once the frame is forwarded it must follow a specific defined path/route.
- **Translational Bridge:** Translational bridges convert the received data from one networking system to another. Or it is used to communicate or transmit data between two different types of networking systems. Like if we are sending data from a token ring to an Ethernet cable, the translational cable will be used to connect both the networking system and transmit data.

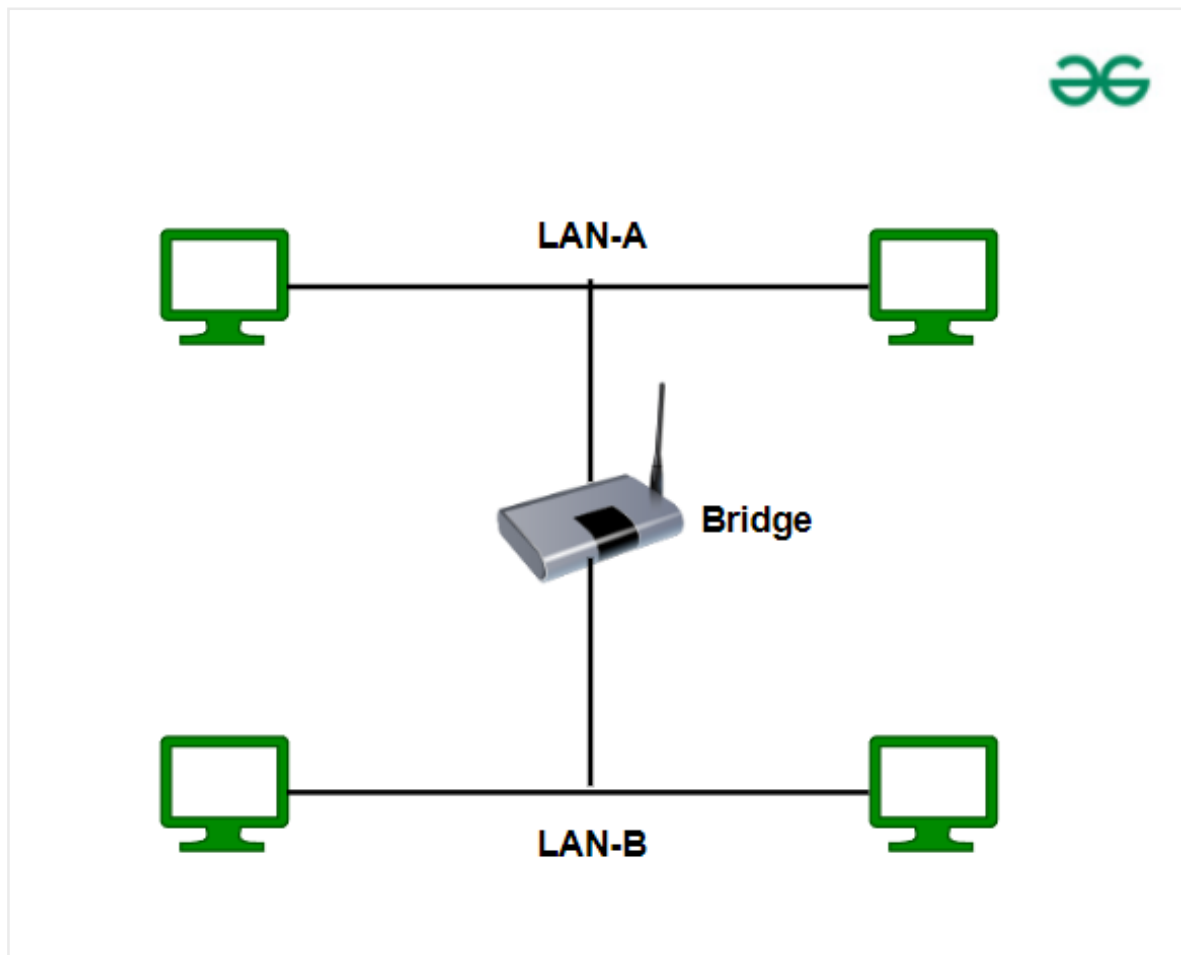
## Working of Bridges

Let's see the step-by-step working of the bridge in computer networks:

- **Receiving Data:** The bridge gets data packets (or frames) from both network segments A and B.
- **Building a Table:** It creates a table of MAC addresses by looking at where the data is coming from to know which device is on which segment.
- **Filtering Data:** If the data from network A is meant for a device also on network A, the bridge stops it from going

further.

- **Forwarding Data:** If the data from network A is meant for a device on network B, the bridge sends it to the correct place on network B.
- **Repeating for Both Sides:** The bridge does the same thing for data coming from network B.



*Working of Bridge*

### Models of Bridge in Computer Networks

There are two main models of bridging in computer network: Local bridging and remote bridging. Let us learn about them in detail.

- **Local Bridging** Local bridging connects LAN switches using local cables. This allows computers on the same **Ethernet** segment, whether they're connected to virtual hubs or physical LANs, to communicate freely. It's used when LANs within the same area need to talk to each other directly at the **link layer**.
- **Remote Bridging** Remote bridging connects two bridges over a **Wide Area Network** (WAN). This model is used when LANs are located in different geographical areas and need to communicate with each other at the link layer.



## Uses of Bridge in Computer Network

- Bridges are used to increase the network capacity as they can integrate multiple LANs together.
- On receiving a data frame, databases use the bridge to decide whether to accept or reject the data.
- In the OSI model, it can be used to transmit the data to multiple nodes of the network.
- Used to broadcast the data even if the MAC address or destination address is unavailable.
- It forwards data packets despite faulty nodes.
- The data packet can be forwarded or discarded by the bridge when the MAC address is available.

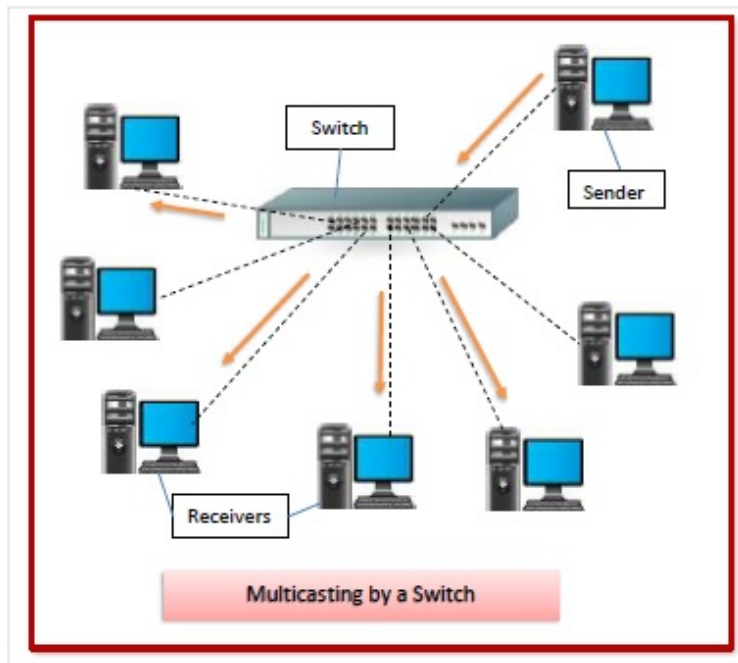
## Functions of Bridges in the Network

- The bridge is used to divide LANs into multiple segments.
- To control the traffic in the network.
- It can interconnect two LANs with a similar protocols.
- It can filter the data based on destination/MAC address.

## 5) Switches in Computer Network?

Switches are networking devices operating at layer 2 or a **data link layer** of the **OSI model**. They connect devices in a network and use packet switching to send, receive or forward data packets or data frames over the network.

A switch has many ports, to which computers are plugged in. When a data frame arrives at any port of a network switch, it examines the destination address, performs necessary checks and sends the frame to the corresponding device(s). It supports unicast, multicast as well as broadcast communications.



## Features of Switches

- A switch operates in the layer 2, i.e. data link layer of the OSI model.
- It is an intelligent network device that can be conceived as a multiport network bridge.
- It uses **MAC addresses** (addresses of medium access control sublayer) to send data packets to selected destination ports.
- It uses **packet switching technique** to receive and forward data packets from the source to the destination device.
- It supports unicast (one-to-one), multicast (one-to-many), and broadcast (one-to-all) communications.
- Transmission mode is full duplex, i.e. communication in the channel occurs in both the directions at the same time. Due to this, collisions do not occur.
- Switches are active devices, equipped with network software and network management capabilities.
- Switches can perform some error checking before forwarding data to the destined port.
  - The number of ports is higher – 24/48.

## 5 ) Routers :

### What is a Router?

The router is a physical or virtual internetworking device that is designed to receive, analyze, and forward data packets between computer networks. A router examines a destination IP address of a

given data packet, and it uses the headers and forwarding tables to decide the best way to transfer the packets. There are some popular companies that develop routers; such are **Cisco, 3Com, HP, Juniper, D-Link, Nortel**, etc. Some important points of routers are given below:

- A router is used in **LAN** (Local Area Network) and **WAN** (Wide Area Network) environments. For example, it is used in **offices** for connectivity, and you can also establish the connection between distant networks such as from **Bhopal** to
- It shares information with other routers in networking.
- It uses the routing protocol to transfer the data across a network.
- Furthermore, it is more **expensive** than other networking devices like switches and hubs.



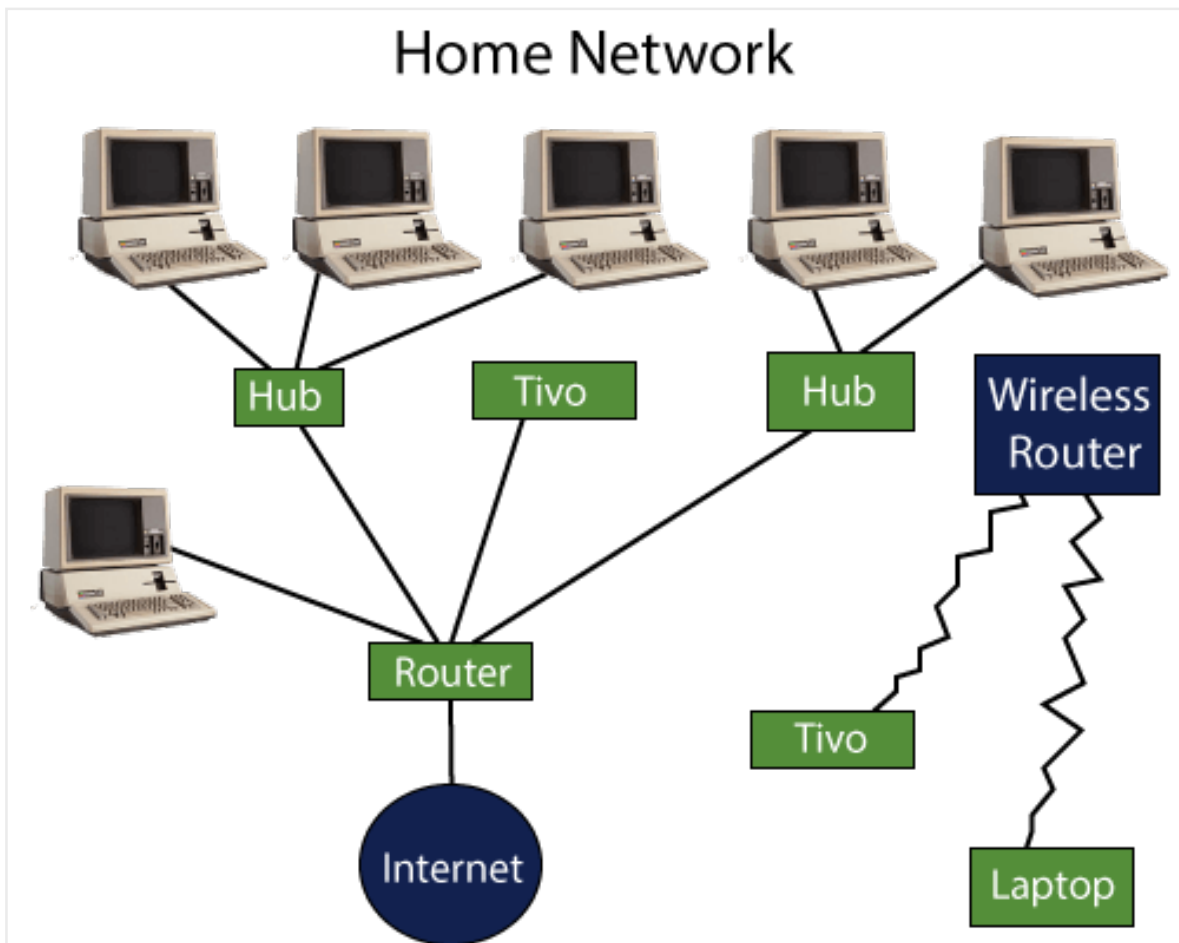
A router works on the **third layer** of the OSI model, and it is based on the IP address of a computer. It uses protocols such as ICMP to communicate between two or more networks. *It is also known as an **intelligent device** as it can calculate the best route to pass the network packets from source to the destination automatically.*

A virtual router is a software function or software-based framework that performs the same functions as a physical router. It may be used to increase the reliability of the network by virtual router redundancy protocol, which is done by configuring a virtual router as a default gateway. A virtual router runs on commodity servers, and it is

packaged with alone or other network functions, like load balancing, firewall packet filtering, and wide area network optimization capabilities.

### Why Routers?

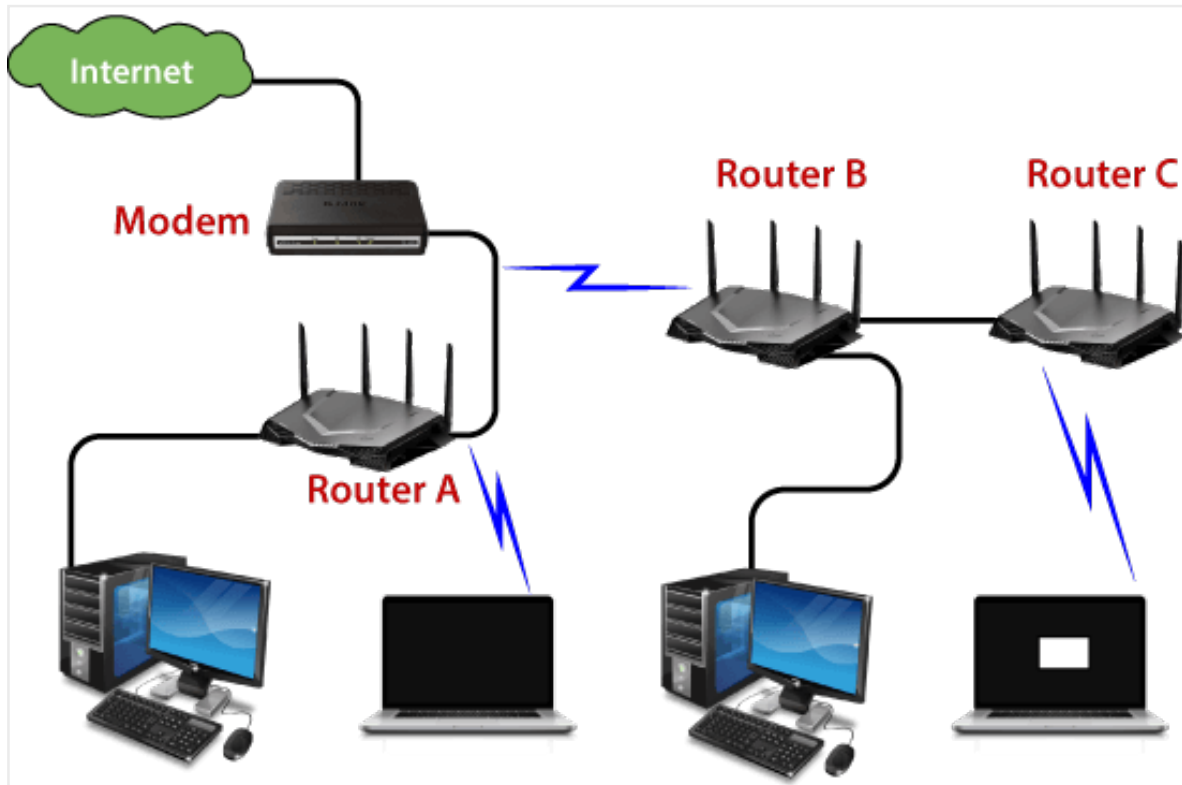
A router is more capable as compared to other network devices, such as a hub, switch, etc., as these devices are only able to execute the basic functions of the network. For example, a hub is a basic networking device that is mainly used to forward the data between connected devices, but it cannot analyze or change anything with the transferring data. On the other hand, the router has the capability to analyze and modify the data while transferring it over a network, and it can send it to another network. For example, generally, routers allow sharing a single network connection between multiple devices.



### How does Router work?

A router analyzes a destination IP address of a given packet header and compares it with the routing table to decide the packet's next path. The list of routing tables provides directions to transfer the data to a particular network destination. They have a set of rules that compute the best path to forward the data to the given IP address. Routers use a **modem** such as a cable, fiber, or DSL modem to allow communication between other devices and the internet. Most of the

routers have several ports to connect different devices to the internet at the same time. It uses the **routing tables** to determine where to send data and from where the traffic is coming.



A routing table mainly defines the default path used by the router. So, it may fail to find the best way to forward the data for a given packet. For example, the office router along a single default path instructs all networks to its internet services provider.

There are two types of tables in the router that are **static and dynamic**. The static routing tables are configured manually, and the dynamic routing tables are updated automatically by dynamic routers based on network activity.

### Features of Router

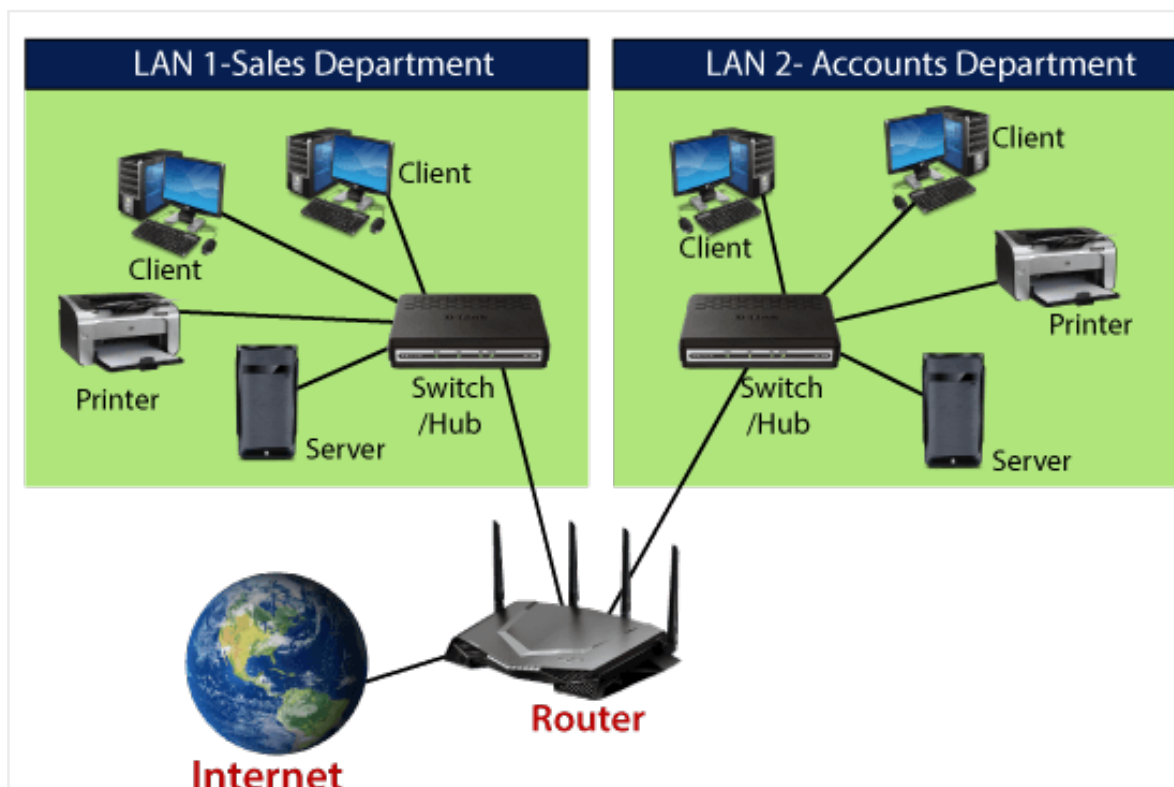
- A router works on the 3rd layer (Network Layer) of the OSI model, and it is able to communicate with its adjacent devices with the help of IP addresses and subnet.
- A router provides high-speed internet connectivity with the different types of ports like gigabit, fast-Ethernet, and STM link port.
- It allows the users to configure the port as per their requirements in the network.
- Routers' main components are central processing unit (CPU), flash memory, RAM, Non-Volatile RAM, console, network, and interface card.
- Routers are capable of routing the traffic in a large networking

- system by considering the sub-network as an intact network.
- Routers filter out the unwanted interference, as well as carry out the data encapsulation and decapsulation process.
  - Routers provide the redundancy as it always works in master and slave mode.
  - It allows the users to connect several LAN and WAN.
  - Furthermore, a router creates various paths to forward the data.

## Applications of Routers

There are various areas where a router is used:

- Routers are used to connect hardware equipment with remote location networks like **BSC, MGW, IN, SGSN**, and other servers.
- It provides support for a fast rate of data transmission because it uses high STM links for connectivity; that's why it is used in both wired or wireless communication.
- Internet service providers widely use routers to send the data from source to destination in the form of e-mail, a web page, image, voice, or a video file. Furthermore, it can send data all over the world with the help of an IP address of the destination.
- Routers offer access restrictions. It can be configured in a way that allows for few users to access the overall data and allows others to access the few data only, which is defined for them.
- Routers are also used by software testers for WAN communications. For example, the software manager of an organization is located in Agra, and its executive is located at a different place like Pune or Bangalore. Then the router provides the executive the method to share his software tools and other applications with the manager with the help of routers by connecting their PCs to the router using WAN architecture.
- In wireless networks, by configuring VPN in routers, it can be used in the client-server model, which allows sharing the internet, video, data, voice, and hardware resources. As shown in the below picture:



- In modern times, routers have the facility of inbuilt USB ports within the hardware. They have enough internal storage capacity. External storage devices can be used with routers to store and share data.
  - Routers are used to set up the operation and maintenance center of an organization, which is known as the NOC center. All equipment at a distant location are connected by routers on optical cable at a central location, which also offer redundancy through the main link and protection link topology.

### Collision Domain vs Broadcast Domain

Device Name	Collision Domain	Broadcast Domain
<u>Repeater</u>	No Change	No Change
<u>Hub</u>	No Change	No Change
<u>Bridge</u>	Reduce	No Change
<u>Switch</u>	Reduce	No Change
<u>Router</u>	Reduce	Reduce