

# Computer Networks - Exp 1

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## Aim

To study different networking devices and different networking topologies

## Networking Devices

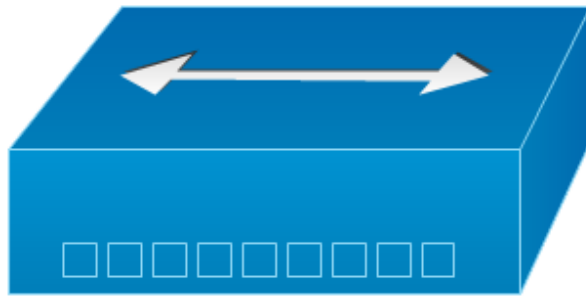
### 1. Hub

A hub is a common connection point, also known as a **network hub**, which is used for connection of devices in a network. It works as a central connection for all the devices that are connected



through a hub. The hub has numerous ports. If a packet reaches one port, it is able to see all the segments of the network due to a packet being copied to the other ports. A network hub has no routing tables or intelligence (unlike a network switch or router), which is used to send information and broadcast all network data across each and every connection.

### Logical Symbol



### Working

Hubs work as a central connection between all network equipment and handle a data type, which is called **frames**. If a frame is received, it is transmitted to the port of the destination computer after amplifying it. A frame is passed to each of its ports in the hub, whether it is destined only for one port. It does not include the way of deciding a frame to which port it should be sent. Therefore, a frame has to transmit to **every port**, which ensures that it will reach its intended destination that generates a lot of traffic on the network and can be caused to damage the network. The hub is slower as compared to standard switch as it is not able to send or receive information at the same time, but a switch is more costly than a hub.

### Advantages of Hub

1. It provides support for different types of Network Media.
2. It can be used by anyone as it is very cheap.
3. The use of a hub does not impact on the network performance.
4. Additionally, it can expand the total distance of the network

### Disadvantages of Hub

1. It has no ability to choose the best path of the network.
2. It does not include mechanisms such as collision detection.
3. It cannot reduce the network traffic as it has no mechanism.
4. It is not able to folder the information as it transmits packets to all the connected segments.

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5. It is not capable of connecting various network architectures like a ring, token, and ethernet, and more.

## Applications

1. Hub is used to create small home networks.
2. It is used for network monitoring.
3. They can be used in organizations to provide connectivity.
4. It can be used to create a device that is available throughout the network.

## 2. Switch

A **network switch** (also called switching hub, bridging hub) is a networking device 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.



## Logical Symbol



## Working

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When the source wants to send the data packet to the destination, the packet first enters the switch and the switch reads its header and finds the **MAC address** of destination to identify the device then it sends the packet out through the appropriate ports that lead to the destination devices. Switch establishes a temporary connection between source and destination for communication and terminates the connection once conversation is done. Also, it offers full bandwidth to network traffic going to and from a device at the same time to reduce collision. Switching techniques are used to decide the best route for data transmission between source and destination.

### Advantages of Switch

1. Switch increases the bandwidth of the network.
2. It reduces the workload on individual PCs as it sends the information to only the device which has been addressed.
3. It increases the overall performance of the network by reducing the traffic on the network.
4. There will be less frame collision as the switch creates the collision domain for each connection.

### Disadvantages of Switch

1. A Switch is more expensive than network bridges.
2. A Switch cannot determine the network connectivity issues easily.
3. Proper designing and configuration of the switch are required to handle multicast packets.

### Applications

In larger networks, switches are often used as a way to offload traffic for analytic purposes. Nowadays, switches are used almost everywhere from **small office/home office (SOHO)** to **major ISPs** (Internet Service Providers). You can use them at your home office or small-sized area as you wish.

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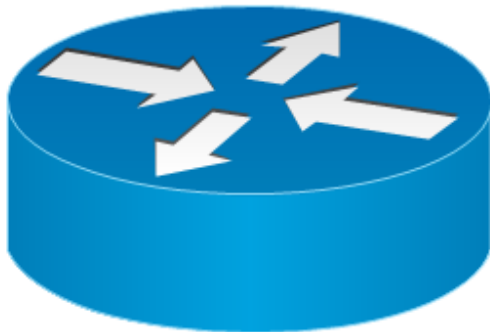
At its most basic, however, it is the simple task for a network switch to quickly and efficiently deliver packets from computer A to computer B, whether the computers are located across the hallway or halfway around the world. Several other devices contribute to this delivery along the way, but the switch is an essential part of the networking architecture.

### 3. Router

Routers are networking devices operating at layer 3 or a **network layer** of the OSI model. They are responsible for receiving, analyzing, and forwarding data packets among the connected computer networks. When a data packet arrives, the router inspects the **destination IP address**, consults its routing tables to decide the optimal route and then transfers the packet along this route.



#### Logical Symbol



#### Working

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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.

### **Advantages of Router**

1. It provides connection between different network architectures such as ethernet & token ring etc.
2. It can choose the best path across the internetwork using dynamic routing algorithms.
3. It can reduce network traffic by creating collision domains and also by creating broadcast domains.
4. It provides sophisticated routing, flow control and traffic isolation.
5. They are configurable which allows network managers to make policy based on routing decisions.

### **Disadvantages of Router**

1. They operate based on routable network protocols.
2. They are expensive compared to other network devices.

3. Dynamic router communications can cause additional network overhead.  
This results in less bandwidth for user data.
4. They are slower as they need to analyze data from layer-1 through layer-3.
5. They require a considerable amount of initial configurations.
6. They are protocol dependent devices which must understand the protocol they are forwarding.

## Applications

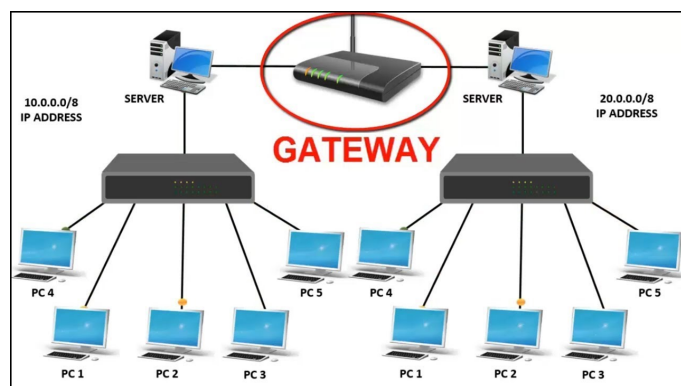
Routers may also be used to connect two or more logical groups of computer devices known as subnets, each with a different network prefix. Routers may provide connectivity within enterprises, between enterprises and the Internet, or between internet service providers' (ISPs') networks.

The largest routers (such as the Cisco CRS-1 or Juniper PTX) interconnect the various ISPs, or may be used in large enterprise networks. Smaller routers usually provide connectivity for typical home and office networks. All sizes of routers may be found inside enterprises. The most powerful routers are usually found in ISPs, academic and research facilities. Large businesses may also need more powerful routers to cope with ever-increasing demands of intranet data traffic.

## 4. Gateway

A gateway is a network node that forms a passage between two networks operating with different transmission protocols. The most common type of gateways, the network gateway operates at layer 3, i.e. network layer of the OSI (open systems

interconnection) model. However, depending upon the functionality, a gateway can operate at any of the seven layers of OSI model. It acts as the entry – exit point for a network since all traffic that flows across the networks should pass through the



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gateway. Only the internal traffic between the nodes of a LAN does not pass through the gateway.

### **Logical Symbol**



### **Working**

It is a state of a network that can get to different networks. Typically, in the intranet, a node or router can go about as a router or the gateway node that interfaces the networks are called gateways. In big companies, the PCs that deal with the traffic between enterprise networks are named gateway nodes. For example, the PCs utilized by Internet service providers to connect fluctuated users at the moment time to the web are gateway nodes.

It very well may be connected to the router since a router precisely thinks about the routing path of data packets that shows up at the gateway, then a switch chooses in the reasonable in and out the way of the gateway for the assigned packet. The gateway is a required trait of courses even though different devices can act well as a gateway.

### **Advantages of Gateway**



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1. It can connect the devices of two different networks having dissimilar structures.
  2. It is an intelligent device with filtering capabilities.
  3. It has control over both collisions as well as a broadcast domain.
  4. It uses a full-duplex mode of communication.
  5. It has the fastest data transmission speed amongst all network connecting devices.
  6. It can perform data translation and protocol conversion of the data packet as per the destination network's need.
  7. It can encapsulate and decapsulate the data packets.
  8. It has improved security than any other network connecting device.

### **Disadvantages of Gateway**

1. It is complex to design and implement.
2. The implementation cost is very high.
3. It requires a special system administration configuration.

### **Applications**

A typical function of a gateway is a gateway to connect from the user's tenant to the normal capacity pool. It is given as a virtual switch devoted to users on repetitive equipment. A gateway server permits clients to approach their hosted webpage without approaching the remainder of the internet. It advances filtered solicitations to end-points however obstructs the wide range of various solicitations. This implies that when a client demands.

An IP gateway alludes to a device on a network that sends nearby network traffic to different networks. The subnet veil number helps characterize the connection between the host (switches, routers, computers, and so on) and the remainder of the network.

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## 5. Repeater

A repeater operates at the physical layer. Its job is to regenerate the signal over the same network before the signal becomes too weak or corrupted so as to extend the length to which the signal can be transmitted over the same network.

An important point to be noted about repeaters is that they do not amplify the signal. When the signal becomes weak, they copy the signal bit by bit and regenerate it at the original strength. It is a 2 port device.



### Logical Symbol



### Working

When an electrical signal is broadcasted through a channel, then it gets attenuated based on the nature of technology. This deploys a limitation depending upon the length of the LAN network. This issue is created by embedding the repeaters at the specific intervals.

Repeater gets to amplify the attenuated signal then retransmits it. Repeaters are getting popular for being incorporated to link between two small LAN and large LAN networks.

### Advantages of Repeater

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1. Repeaters are simple to install and can easily extend the length or the coverage area of networks.
  2. They are cost effective.
  3. Repeaters don't require any processing overhead. The only time they need to be investigated is in case of degradation of performance.
  4. They can connect signals using different types of cables.

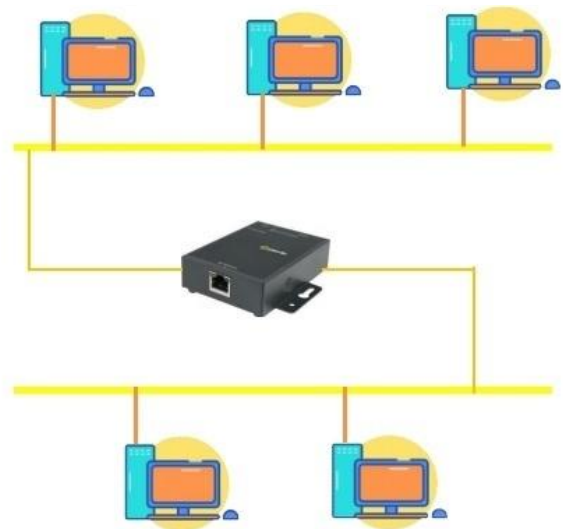
### Disadvantages of Repeater

1. Repeaters cannot connect dissimilar networks.
2. They cannot differentiate between actual signal and noise.
3. They cannot reduce network traffic or congestion.
4. Most networks have limitations upon the number of repeaters that can be deployed.

### Applications

When an electrical signal is transmitted via a channel, it gets attenuated depending upon the nature of the channel or the technology. This poses a limitation upon the length of the LAN or coverage area of cellular networks. This problem is alleviated by installing repeaters at certain intervals.

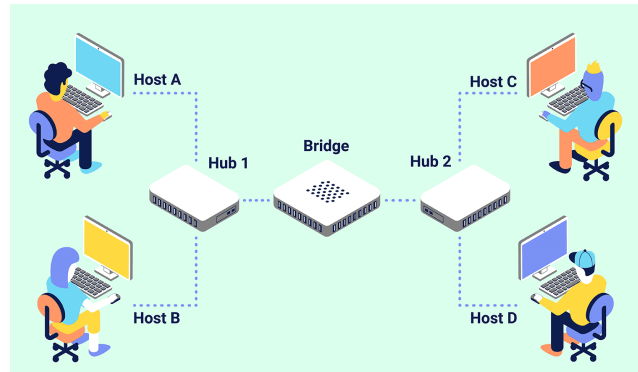
Repeaters amplify the attenuated signal and then retransmits it. Digital repeaters can even reconstruct signals distorted by transmission loss. So, repeaters are popularly incorporated to connect between two LANs thus forming a large single LAN. This is shown in the following diagram



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## 6. Bridge

A bridge is a network device that connects multiple LANs (local area networks) together to form a larger LAN. The process of aggregating networks is called network bridging. A bridge connects the different components so that they appear as parts of a single network. Bridges operate at the data link layer of the OSI model and hence are also referred to as Layer 2 switches.



### Logical Symbol



### Working

A bridge accepts all the packets and amplifies all of them to the other side. The bridges are intelligent devices that allow the passing of only selective packets from them. A bridge only passes those packets addressed from a node in one network to another node in the other network.

### Advantages of Bridge

1. It reduces network traffic with minor segmentation
2. It reduces collisions
3. Bridge connects similar network types with different cabling

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4. Bridge increase the number of attached workstation and network segments
  5. It extends the physical network
  6. Bridges also can reduce network traffic on a segment by subdividing network communications
  7. It connects different architecture

### Disadvantages of Bridge

1. It does not filter broadcasts
2. It is slower compare to repeaters due to the filtering process
3. It is more expensive compared to repeaters
4. Complex network topology, it can pose a problem for transparent bridge
5. A bridge is more expensive than repeaters or hubs'

### Applications

- Bridges are used to divide large busy networks into multiple smaller and interconnected networks to improve performance.
- Bridges also can increase the physical size of a network.
- Bridges are also used to connect a LAN segment through a synchronous modem relation to another LAN segment at a remote area.

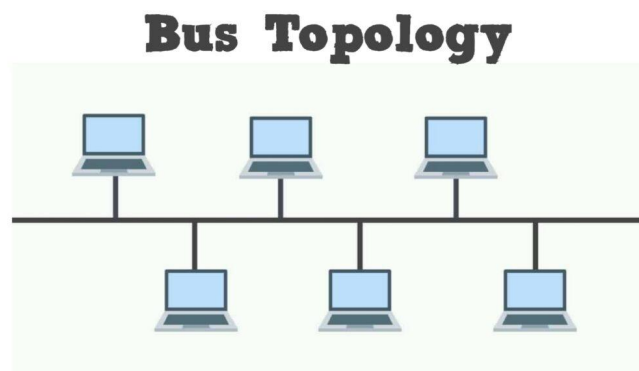
## Topologies

Topology defines the structure of the network of how all the components are interconnected to each other.

Here is the common topologies list:

### 1. Bus

Bus topology is a network type in which every computer and network device is connected to a single cable. It transmits the data from one end to another in a



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single direction. No bi-directional feature is in bus topology. It is a multi-point connection and a non-robust topology because if the backbone fails the topology crashes.

## **Architecture**

Bus topology uses a single cable which connects all the included nodes. The main cable acts as a spine for the entire network. One of the computers in the network acts as the computer server. When it has two endpoints, it is known as a linear bus topology.

## **Advantages of Bus Topology**

1. Works efficiently for small networks
2. Easy and cost-effective to install and add or remove devices
3. Doesn't require as much cabling as alternative topologies
4. If one device fails, other devices are not impacted

## **Disadvantages of Bus Topology**

1. If the cable is damaged, the entire network will fail or be split
2. Difficult to troubleshoot problems
3. Very slow and not ideal for larger networks
4. Requires terminators at both ends of the cable to prevent bouncing signals that cause interference
5. Adding more devices and more network traffic decreases the entire network's performance
6. Low security due to all devices receiving the same signal from the source

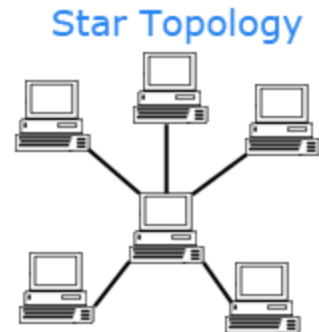
## **Applications**

- Small workgroup local area networks (LANs) whose computers are connected using a thinnet cable.
- Trunk cables connecting hubs or switches of departmental LANs to form a larger LAN.
- Backboning, by joining switches and routers to form campus-wide networks.

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## 2. Star

Star topology is a network topology in which each network component is physically connected to a central node such as a router, hub or switch.



### Architecture

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.

### Advantages of Star Topology

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

### Disadvantages of Star Topology

1. If the concentrator (hub) on which the whole topology relies fails, the whole system will crash down.
2. The cost of installation is high.
3. Performance is based on the single concentrator i.e. hub.

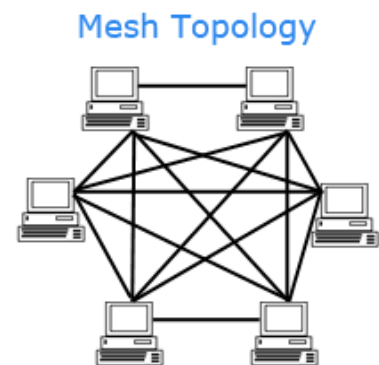
### Applications

- Star topology is used in Local Area Network (LAN)
- High speed LAN often uses the star topology.
- Star topology is often used in homes and offices.

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- Star topology is also used to transmit data along the central hub between the network nodes.
  - By connecting all the systems to the central hubs, star topology can ease the probability of network failure.

### 3. Mesh

In a mesh topology there is no central connection point. Instead, each node is connected to at least one other node and usually to more than one. Each node is capable of sending messages to and receiving messages from other nodes. The nodes act as relays, passing on a message towards its final destination.



#### Architecture

In Mesh Topology, the connections between devices take place randomly. The connected nodes can be computers, switches, hubs, or any other devices. In this topology setup, even if one of the connections goes down, it allows other nodes to be distributed.

Suppose,  $N$  number of devices are connected with each other in a mesh topology, the total number of ports that are required by each device is  $N-1$ . 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  $NC2$ .

#### Advantages of Mesh Topology

1. It is robust.
2. The fault is diagnosed easily. Data is reliable because data is transferred among the devices through dedicated channels or links.
3. Provides security and privacy.

#### Disadvantages of Mesh Topology



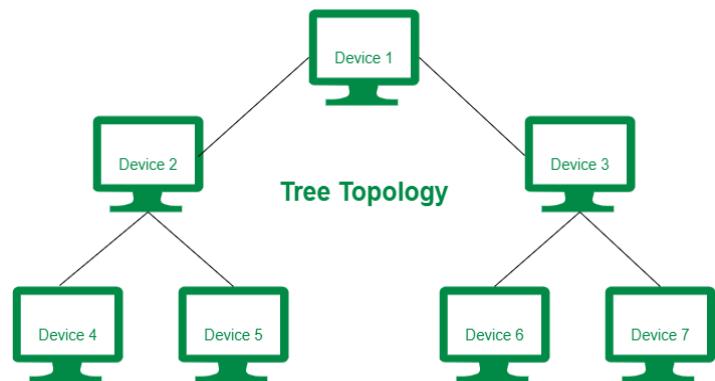
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1. Installation and configuration are difficult.
  2. The cost of cables is high as bulk wiring is required, hence suitable for less number of devices.
  3. The cost of maintenance is high.

## Applications

- **Home monitoring and control:** It's a snap to turn lights off and on or dim them.
- **Building monitoring and control:** Monitoring and controlling lights, HVAC, and other functions in large office buildings, hotels, hospitals, and other structures can yield huge energy savings.
- **Military communications and reconnaissance:** A mesh makes soldier-to-soldier communications more reliable with longer range. Meshes also help tie together and coordinate many weapons and systems in monitoring and managing the battlefield.

## 4. Tree

A tree topology, or star-bus topology, is a hybrid network topology in which star networks are interconnected via bus networks. Tree networks are hierarchical, and each node can have an arbitrary number of child nodes.



## Architecture

In this topology, the various secondary hubs are connected to the central hub which contains the repeater. This data flows from top to bottom i.e. from the central hub to secondary and then to the devices or from bottom to top i.e. devices to the

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secondary hub and then to the central hub. It is a multi-point connection and a non-robust topology because if the backbone fails the topology crashes.

### Advantages of Tree Topology

1. 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.
2. It allows the network to isolate and also prioritize different computers.

### Disadvantages of Tree Topology

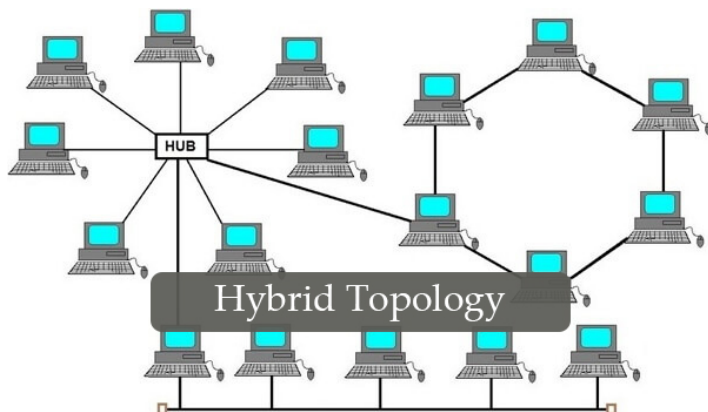
1. If the central hub fails the entire system fails.
2. The cost is high because of cabling.

### Applications

- When you have a multi-story building and wish to establish clusters at each section of the network, you can utilize tree topology.
- If you have departments and sub-departments, you can segregate the whole Tree Network with the help of several switches that makes the entire network easy to maintain and more manageable.

## 5. Hybrid

Hybrid topology is an integration of two or more different topologies to form a resultant topology which has many advantages (as well as disadvantages) of all the constituent basic topologies rather than having characteristics of one specific topology.



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## Architecture

A hybrid cloud network architecture consists of private servers, public cloud virtual servers, and the network that connects them. Public cloud providers typically utilize direct MPLS or Ethernet connections to move data between the client's private cloud and the service provider's public cloud.

## Advantages of Hybrid Topology

1. **Reliability**- Among the networking topologies, the hybrid topology is the most reliable and safe for use. Because of its branching factor, the error detection is very fast in hybrid and for that troubleshooting is very easy.
2. **Effectiveness of Networks**- Since the combination of various topologies makes the hybrid structure more effective, the overall effectiveness is improved greatly that not only enhances the strengths of the networks but also neutralizes the weak networks of different topologies.
3. **Flexibility**- Hybrid topology offers great flexibility in usage since the overall configurations and modifications can be planned and designed according to the requirements of the users and the organizations that optimize the overall resources of the networks.

## Disadvantages of Hybrid Topology

1. It is an expensive type of network.
2. Design of a hybrid network is very complex.
3. There is changing hardware in order to connect topology with another topology.

## Applications

The examples and applications of hybrid topology are increasing rapidly. It has a super-power set up and flexible option and declared as a smart option; hence, the people choose to deploy it in-home or office. A compact is provided for the small-scale industries by this topology, as well as to their subunits. Thus, it is good to use for multi-floor buildings and departments such as an office or home. This

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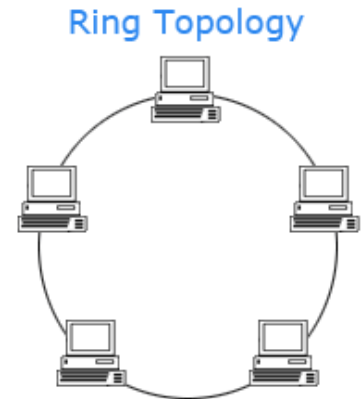
topology is placed to give its maximum efficiency on the basis of the requirements as it provides many benefits.

## 6. Ring

In this topology, it forms a ring connecting devices with exactly two neighboring devices.

### Architecture

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.



One station is known as a monitor station which takes all the responsibility to perform the operations. To transmit the data, the station has to hold the token. After the transmission is done, the token is to be released for other stations to use. When no station is transmitting the data, then the token will circulate in the ring. There are two types of token release techniques: Early token release releases the token just after transmitting the data and Delay token release releases the token after the acknowledgment is received from the receiver.

### Advantages of Ring Topology

1. The possibility of collision is minimum in this type of topology.
2. Cheap to install and expand.

### Disadvantages of Hybrid Topology

1. Troubleshooting is difficult in this topology.
2. The addition of stations in between or removal of stations can disturb the whole topology.
3. Less secure.

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## Applications

- It is used in the Wide Area Network (WAN) and in the Metropolitan Area Network (MAN) is used in vast areas for connecting all the (LAN) it is also used in-ring networks, also the most crucial part in a ring topology.
- Local Area Network (LAN) is used in all computer machines connected to the ring network for the data flow in the unidirectional and bidirectional path.