Network Basics

Physical Network Topologies

Physical Network Topologies

Network topology is the arrangement of the various nodes of a computer network. Essentially, it is the topological structure of a network and may be depicted **physically** or **logically** which are the two basic categories of network topologies.

The shape of the cabling layout used to link devices is called the **physical topology** of the network. This refers to the *layout of cabling, the locations of nodes*, *the interconnections between the nodes* and *the cabling*. The physical topology of a network is determined by:

- the capabilities of the network access devices and media,
- the level of control or fault tolerance desired,
- the cost associated with cabling or telecommunications circuits.

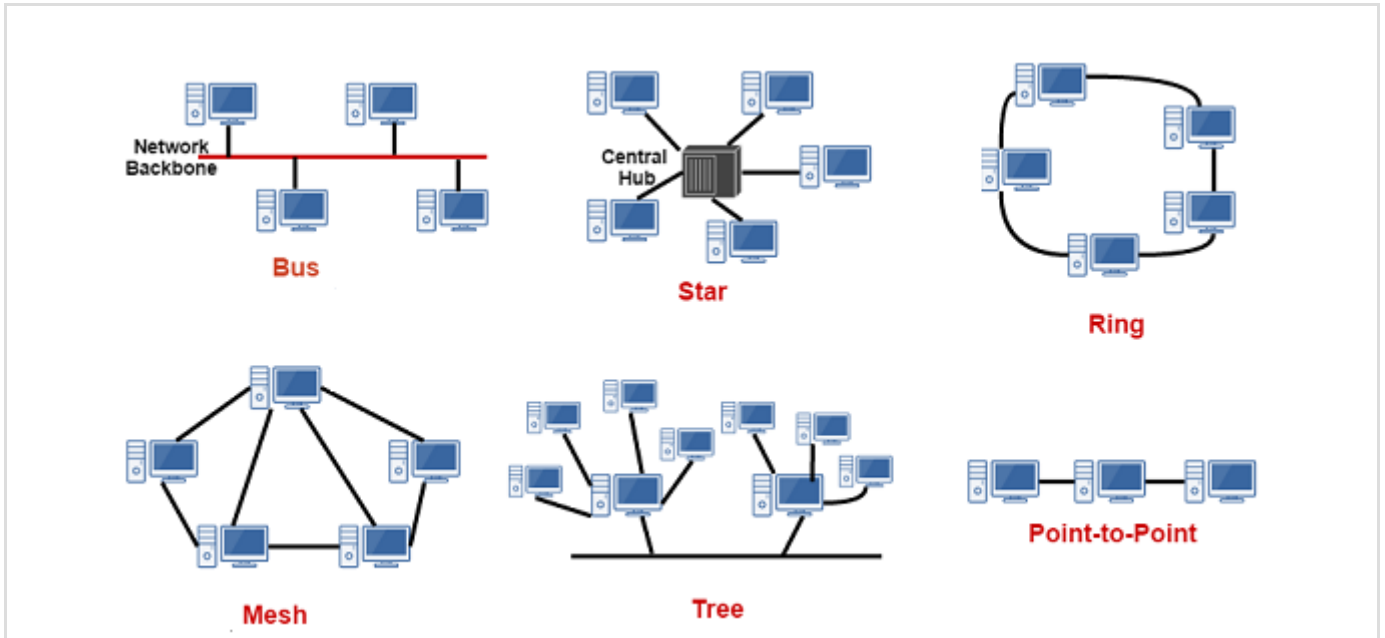
In opposition to the *Physical Topology*, the **logical topology** is the way that the *signals act on the network media*, or the *way that the data passes through the network* from one device to the next without regard to the physical interconnection of the devices.

> **Tip:**
> - A network's logical topology is not necessarily the same as its physical topology.

The logical topologies are generally determined by network protocols as opposed to being determined by the physical layout of cables, wires, and network devices or by the flow of the electrical signals. In many cases, the paths that the electrical signals travel among the nodes may closely match the logical flow of data. That is why, the terms *logical topology* and *signal topology* can be interchangeably used.

Here's a list of the topologies mostly used nowadays:

- Bus
- Star
- Ring
- Mesh
- Tree
- Point-to-point
- Point-to-multipoint
- Hybrid



Physical network topologies

> Q: What do you mean by network topology?
> A: Network topology specifies the layout of a computer network. It shows how devices and cables are connected to each other. Some types of topologies are: Bus, Star, Ring, Mesh, etc.
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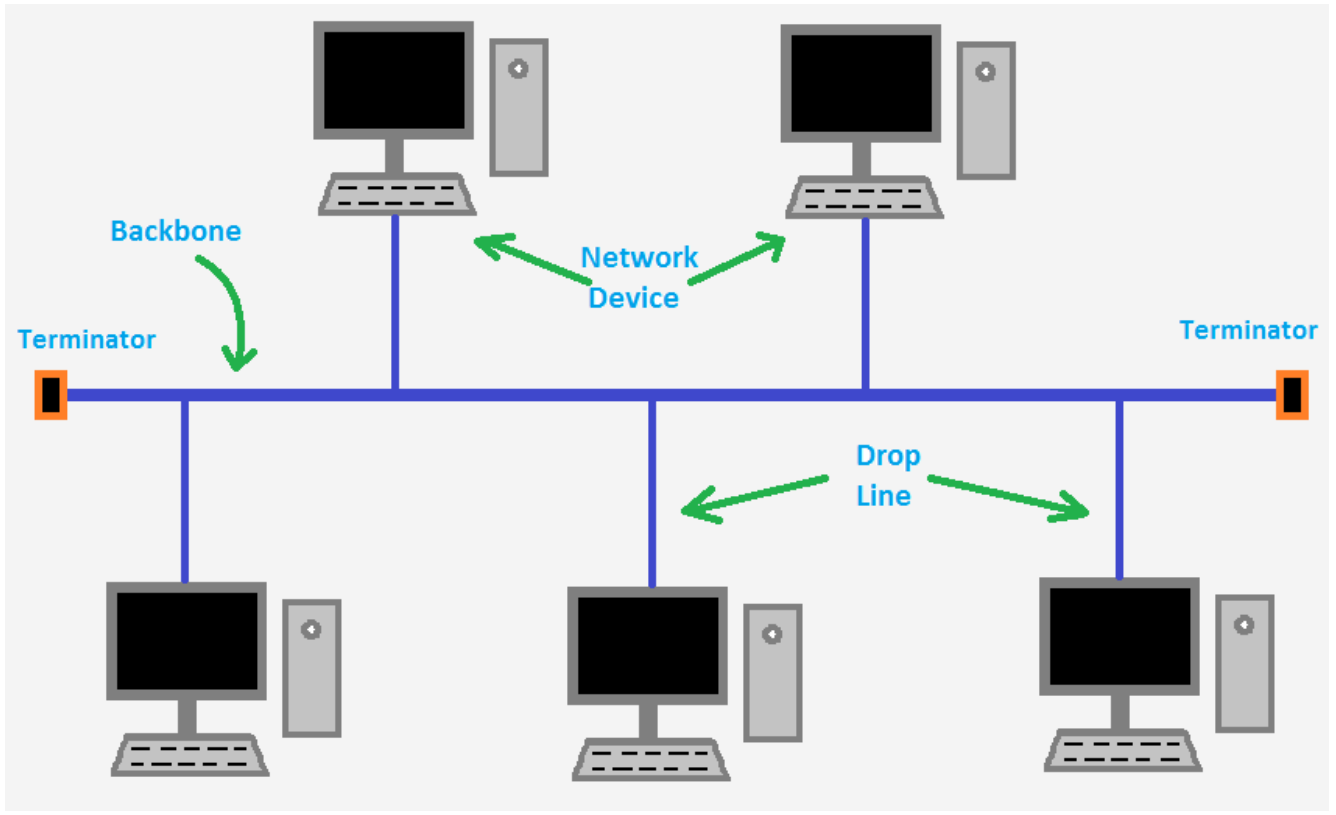
Bus Topology

A bus topology consists of a single cable (the *bus*) with a terminator at each end. All nodes (file server, workstations, and peripherals) are connected to this cable. The signal travels down the bus in both directions from the source and is received by all nodes connected to the cable. The bus is terminated at both ends of the cable to absorb the signal when it has passed all connected devices.



The bus topology

This type of physical bus topology is no longer in widespread use. Bus networks are comparatively difficult to reconfigure (adding or removing nodes can disrupt the whole network), impose limitations on the maximum number of nodes on a segment of cable, and are difficult to troubleshoot (a cable fault could be anywhere on the segment of cable). Perhaps most importantly, a fault anywhere in the cable means that all nodes will be unable to communicate.

The logical bus topology, however, remains the basis of most local networks.

Advantages of bus topology:
1. Easy installation, each cable needs to be connected with the backbone cable.
2. Fewer cables required than mesh and star topology (We'll see these topologies in the following lessons)

Disadvantages of bus topology:
1. Difficult in fault detection

1. Difficulty in fault detection.
2. Not scalable as there is a limit of how many nodes can be connected.

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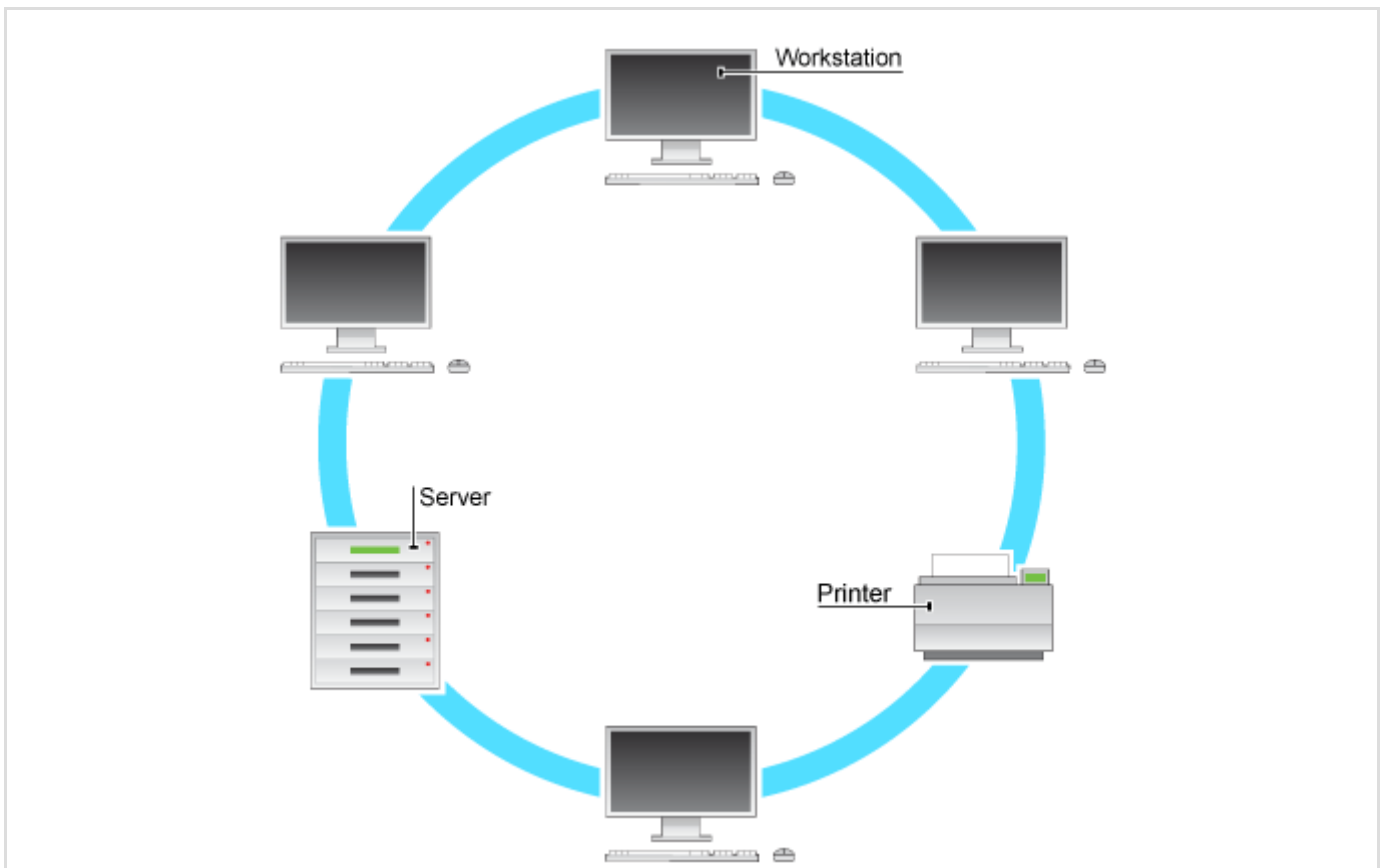
Ring Topology

A network topology is set up in a circular fashion in which data travels around the ring in one direction and each device on the right acts as a repeater to keep the signal strong as it travels. Each device incorporates a receiver for the incoming signal and a transmitter to send the data to the next device in the ring. If a device wants to send data to another device then it sends the data in one direction, if the received data is intended for other devices then it forwards this data until the intended device receives it.



The ring topology

The physical ring topology is no longer used on LANs but it does remain as a feature of many WANs. Two ring systems (dual counter-rotating rings) can be used to provide fault tolerance. These dual rings allow the system to continue to operate if there is a failure in one ring.

Advantages of Ring Topology:
1. Easy to install.
2. Management is easier because to add or remove a device from the topology only requires changing just two links.

Disadvantages of Ring Topology:
1. A link failure can fail the entire network as the signal will not travel ahead due to failure.
2. Data traffic issues, since all the data is circulated in a ring.

> Q: What are some drawbacks of implementing a ring topology?
> A: In case one workstation on the network suffers a malfunction, it can bring down the entire network. Another drawback is that when there are adjustments and reconfigurations needed to be performed on a particular part of the network, the entire network has to be temporarily brought down as well.
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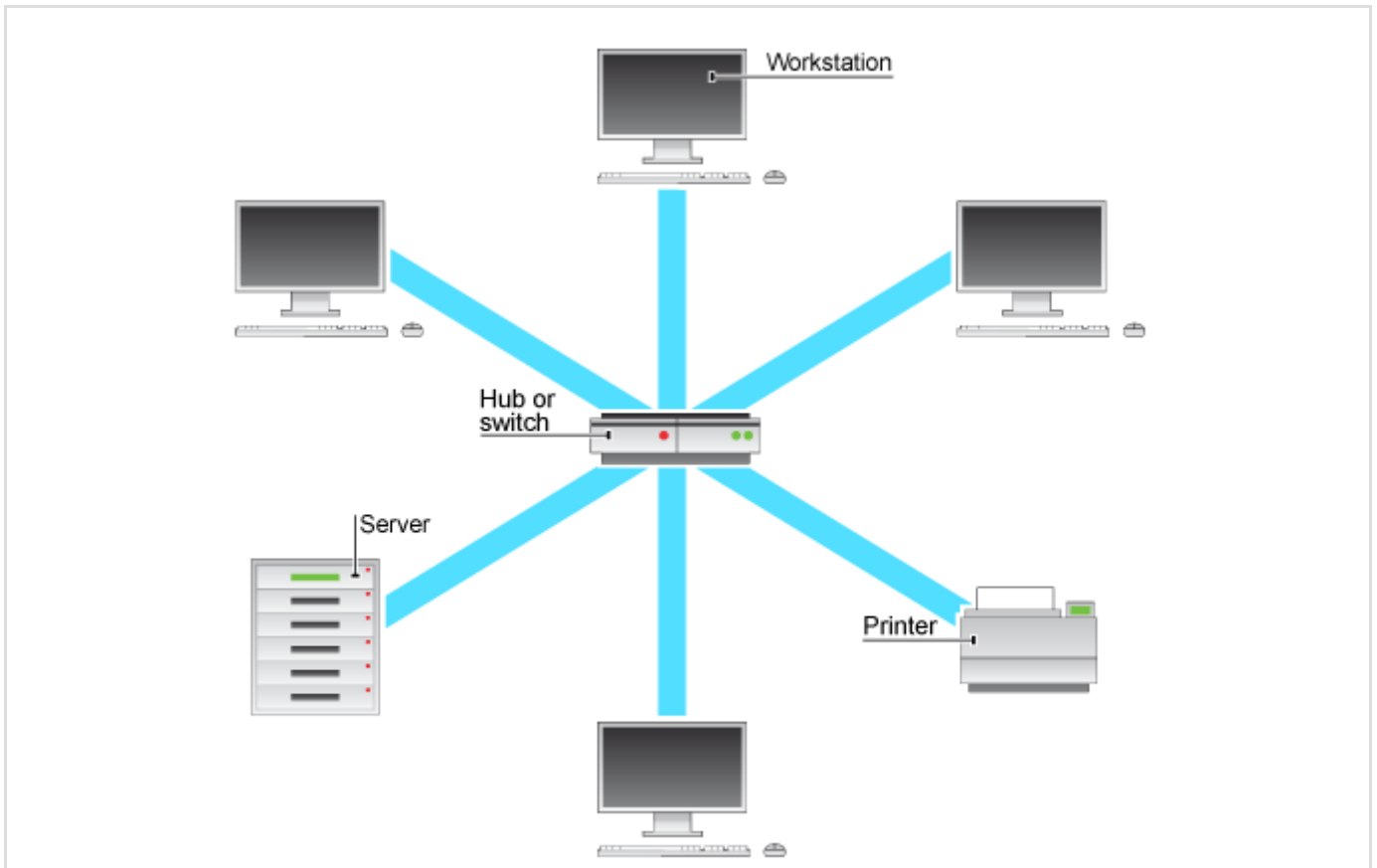
Star Topology

In star topology, every node (computer workstation or any other peripheral) is connected to a central node called **hub** or **switch**. The network does not necessarily have to resemble a star to be classified as a star network, but all of the nodes on the network must be connected to one central device. All traffic that traverses the network passes through the central hub.

The star topology is the most widely used physical topology. It is easy to reconfigure and easy to troubleshoot because all data goes through a central point, which can be used to monitor and manage the network. Faults are automatically isolated to the node (network card), or the hub, switch, or router at the center of the star.



The star topology

Advantages of Star topology:
1. Less expensive because each device only needs one I/O port and needs to be connected with a hub with one link.
2. Easier to install.
3. Less amount of cables required because each device needs to be connected with the hub only.
4. Robust, if one link fails, other links will work just fine.
5. Easy fault detection because the link can be easily identified.

Disadvantages of Star topology:
1. If the central node goes down every node goes down, none of the devices can work without the central node.

2. The central node requires more resources and regular maintenance because it is the central system of star topology.

> Q: Describe star topology
> A: Star topology consists of a central hub that connects the nodes. This is one of the easiest way to setup and maintain.
>
> - Interview Q&A

> Q: What is the disadvantage of a star topology?
> A: One major disadvantage of star topology is that once the central hub or switch damaged, the entire network becomes unusable.
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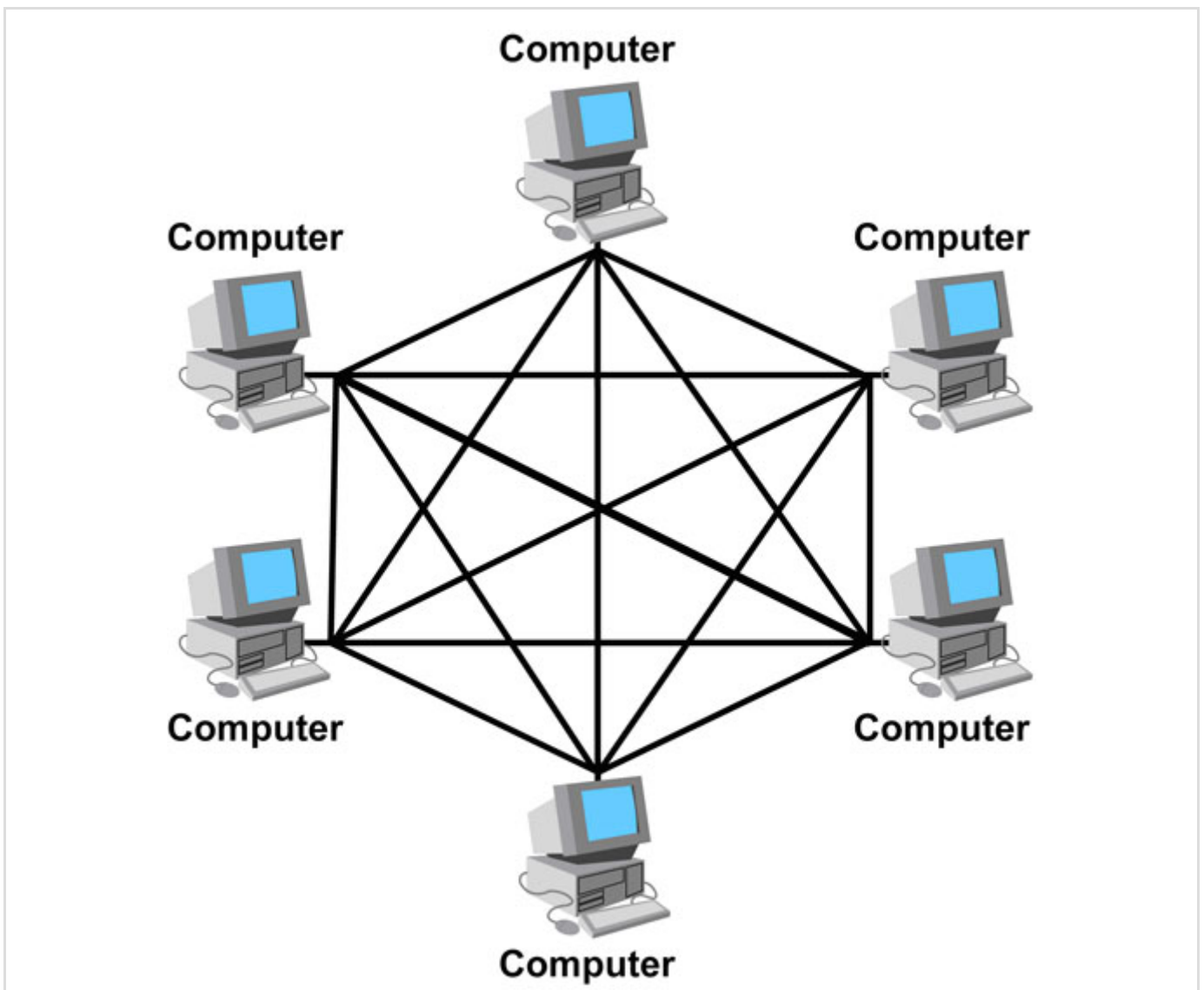
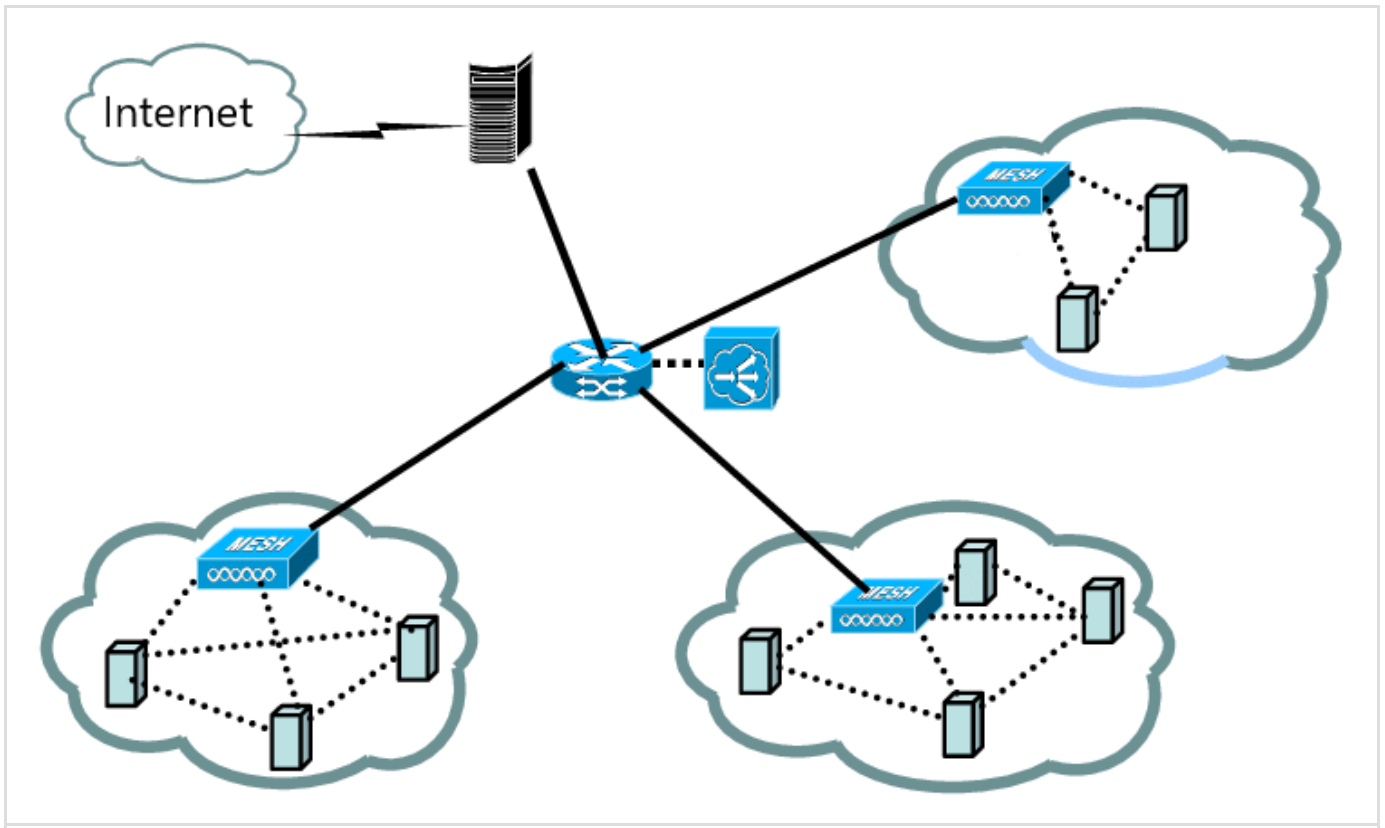
Mesh Topology

Mesh network topologies are commonly used in **WANs**, especially public networks like the Internet. In theory, a mesh network requires that each device has a point-to-point link with every other device on the network (**fully connected**). This approach is normally impractical, however. The number of links required by a full mesh is expressed as n(n-1)/2, where "n" is the number of nodes. For example, a network of just 4 nodes would require 6 links, while a network of 40 nodes would need 780 links!



The mesh topology

Consequently, often a "**hybrid**" approach is used with only the most important devices interconnected in the mesh, perhaps with extra links for fault tolerance and redundancy. In this case, the topology is referred to as a **partial mesh.**



Partial mesh topology

Advantages of Mesh topology:

1. No data traffic issues as there is a dedicated link between two devices which means the link is only available for those two devices.
2. Mesh topology is reliable and robust as a failure of one link doesn't affect the other links and the communication between other devices on the network.
3. Mesh topology is secure because there is a point to point link thus unauthorized access is not possible.
4. Fault detection is easy.

Disadvantages of Mesh topology:

1. The amount of wires required to connect each system is tedious.
2. Since each device needs to be connected with other devices, the number of I/O ports required must be huge.
3. Scalability issues because a device cannot be connected with a large number of devices with a dedicated point to point link.

> Q: What is mesh topology?
> A: Mesh topology is a setup wherein each device is connected directly to every other device on the network. Consequently, it requires that each device has at least two network connections.
>
> - Interview Q&A

> Q: What is one advantage of mesh topology?
> A: In the event that one link fails, there will always be another available. Mesh topology is actually one of the most fault-tolerant network topology.
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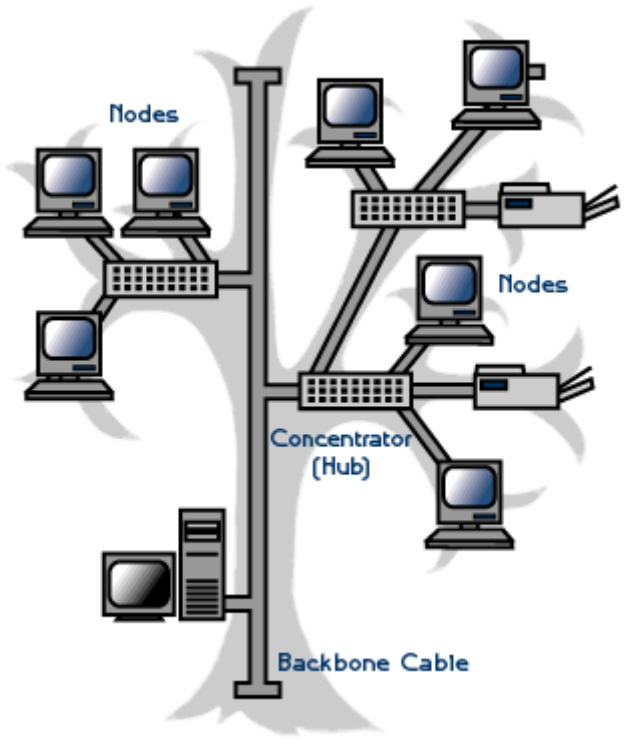
Tree Topology

A tree topology combines characteristics of linear bus and star topologies. It consists of groups of star-configured workstations connected to a linear bus backbone cable. Tree topologies allow for the expansion of an existing network.



The tree topology

Advantages of tree topology:

1. It is scalable. Secondary nodes allow more devices to be connected to a central node.
2. Point to point connection of devices.
3. Having different levels of network makes it more manageable hence easier fault identification and isolation.

Disadvantages of tree topology:

1. Maintenance of the network may be an issue when the network spans a great area.
2. Since it is a variation of bus topology, if the backbone fails, the entire network is down.

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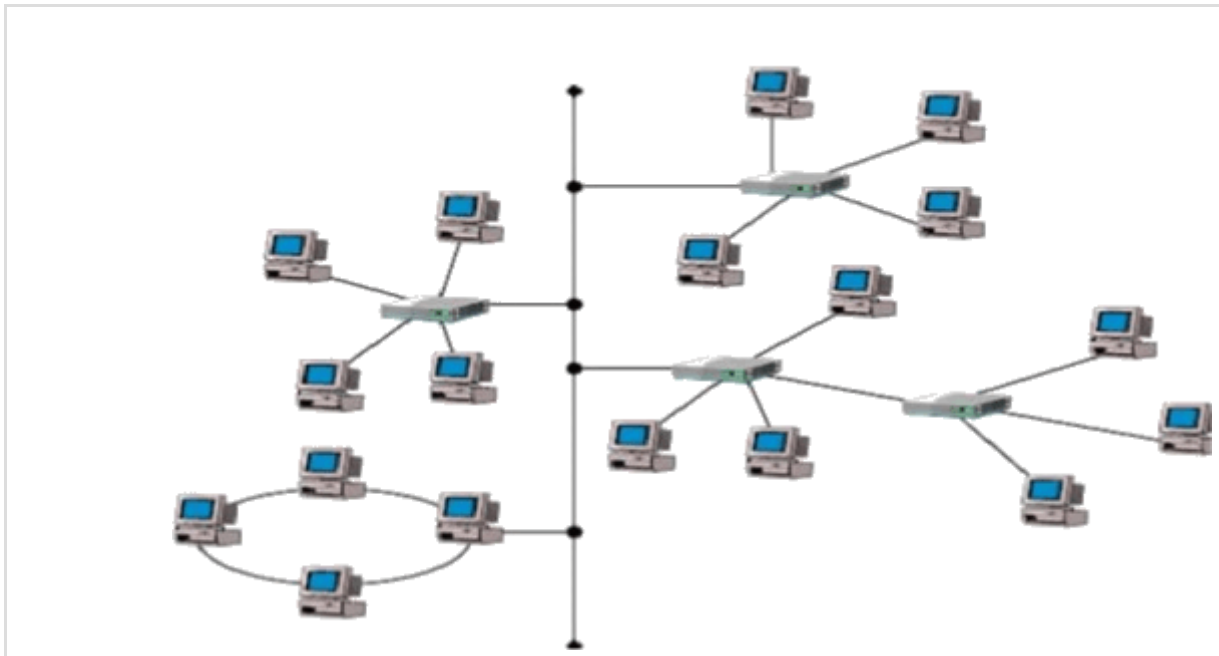
Hybrid Topology

Hybrid topology means just that—a combination of two or more types of physical or logical network topologies working together within the same network.



Hybrid topology

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Point-to-Point Topology

It's the simplest topology where there is a permanent link between two endpoints. These endpoints may be hubs, routers, switches, computers, etc. which give you one communication path. Switched point-to-point topologies are the basic model of conventional telephony.

- Permanent (dedicated)

Easiest to understand, the variations of point-to-point topology, is a point-to-point communications channel that appears, to the user, to be permanently associated with the two endpoints. A children's tin can telephone is one example of a physical dedicated channel.

Within many switched telecommunications systems, it is possible to establish a permanent circuit. One example might be a telephone in the lobby of a public building, which is programmed to ring only the number of a telephone dispatcher. "Nailing down" a switched connection saves the cost of running a physical circuit between the two points. The resources in such a connection can be released when no longer needed.

- Switched

Using circuit-switching or packet-switching technologies, a point-to-point circuit can be set up dynamically and dropped when no longer needed. This is the basic model of conventional telephony.

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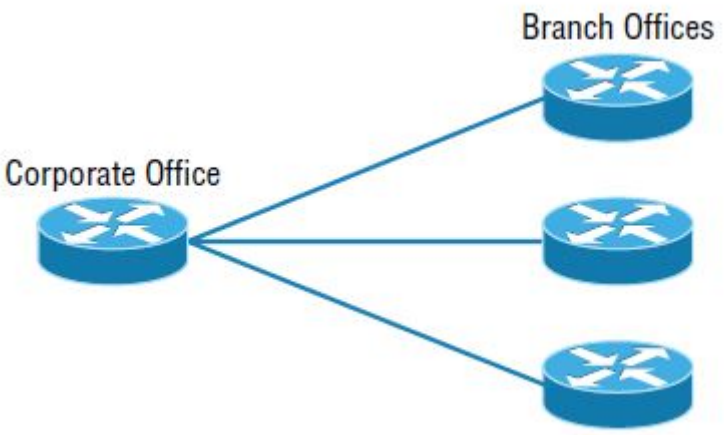
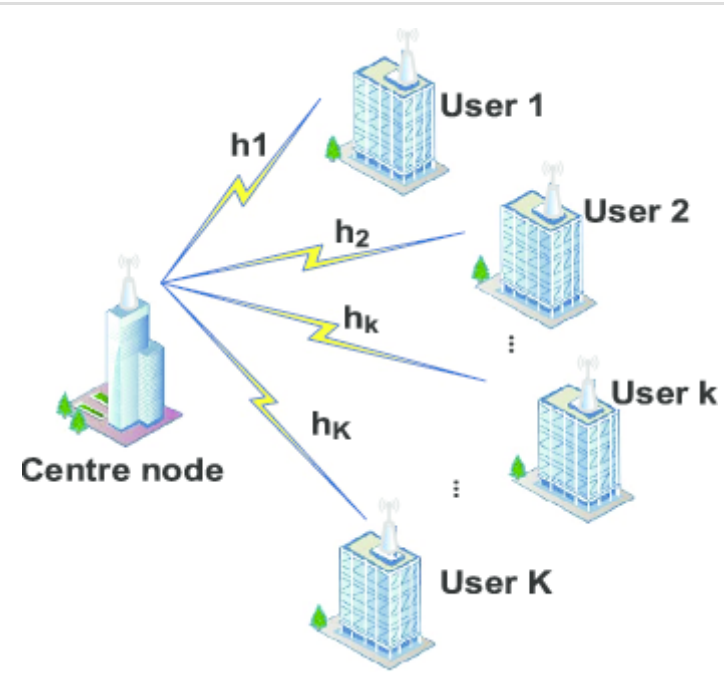
Point-to-Multipoint Topology

A **point-to-multipoint** topology consists of a succession of connections between an *interface* on one router and *multiple destination routers*—one point of connection to multiple points of connection. Each of the routers and every one of their interfaces involved in the point-to-multipoint connection is part of the same network.



Point-to-multipoint topology

The below figure shows another prime example of a point-to-multipoint network: a college or corporate campus.



Point-to-multipoint topology

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