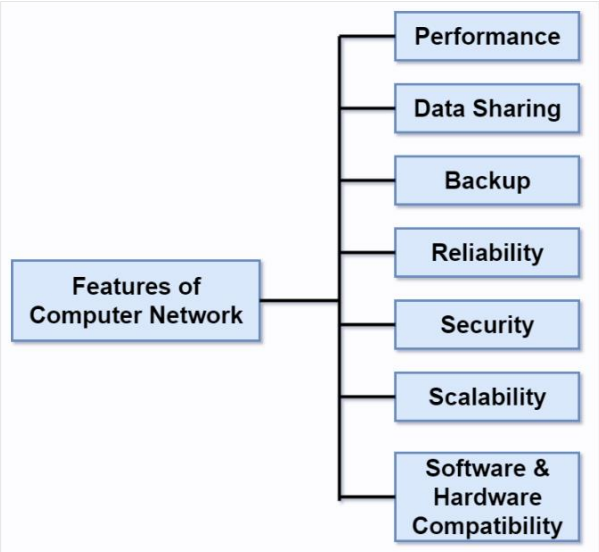
- **Performance:** Performance of a computer network is measured in terms of response time. The response time of transmitted and received data from one device to another should be minimal.
- **Data Sharing:** One of the reasons why we use a computer network is to share the data between different systems.
- **Backup:** A computer network must have a central server to keep the backup of all the shared data over a network in order to recover the data faster in case of failures.
- **Reliability:** There should not be any failure in the network or if it occurs the recovery from failure should be fast.
- **Security:** A computer network should be secure so that the data exchanged over a network should be safe from unauthorized access. Also, the transmitted data should be received without any loss.
- **Scalability:** A computer network should be scalable means adding new devices to the already existing computer network should always be possible. For example, a company runs 100 computers on a network for their 100 employees, let's say they hire another 100 employees and want to add new 100 computers to the already existing LAN then, in that case, the network should allow this.
- **Software and hardware compatibility:** A computer network must not limit all the computers to use the same software and hardware, instead, it should allow us to use different software and hardware configurations in the network without introducing any compatibility issues.

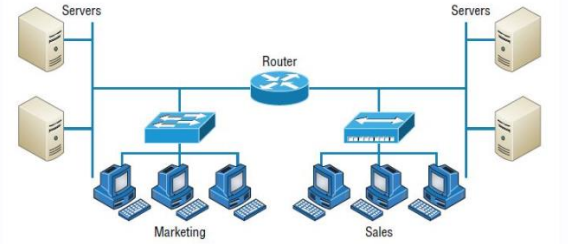


Features of networks

> Q: What is a Computer Network?
> A: A computer network is a connection network between two or more nodes using Physical Media Links viz., cable or wireless to exchange data over pre-configured services and Protocols. A computer network is a collective result of – Electrical Engineering, Computer Science, Telecommunication, Computer Engineering and Information Technology involving their theoretical as well as practical aspects into action. The most widely used Computer Network of Today is the Internet which supports the World Wide Web (WWW).
>
> — - Interview Q&A

What's a Network?

Local Area Network (LAN)



A network with two LANs

> Q: Explain what is LAN?
> A: A LAN or Local Area Network is the network between devices that are located within a small physical location. It can be either wireless or wired. One LAN differs from another based on the following factors:
> **Topology:** The arrangement of nodes within the network
> **Protocol:** Refer to the rules for the transfer of data
> **Media:** These devices can be connected using optic fibers, twisted-pair wires, etc
>
> - Interview Q&A

Common Network Components

Node, Stations, and Hosts: A **node** is any device that can communicate on the network via one or more network interfaces. The term **node** can be used to describe *endpoint devices*, such as *computers, laptops, servers, IP phones, smartphones, or printers*, and *connecting or forwarding devices*, such as *switches* and *routers*. A **node** on a wireless network is often called as a *station*.

The term **host** is often used in *TCP/IP networking* to mean an *end system device*, such as a *computer*, with a unique address on the network.

Workstations: Workstation is a client **machine** used to deploy an **application** or **server**. They are usually powerful **computers** that have more than one central processing unit (CPU) and whose resources are available to other users on the network when needed. Workstations are often equipped with systems for end-users to use daily. Don't confuse workstations with client machines. Client machines can be workstations but not always. Technically speaking, they are different. A client machine is any device on the network like a printer or other hosts from a server or powerful workstation.

Servers: Servers are also powerful **computers**. They get their name because they truly are "at the service" of the network and run specialized software known as the network operating system to maintain and control the network. In a good design, they optimize the network's performance. Servers are highly specialized and handle important labor-intensive jobs. A single server can't do many jobs, that's why, in order to get better performance, a single task is often assigned to a dedicated server. Here's a list of common dedicated servers:

- **File Server** - Stores and dispenses files
- **Mail Server** - The network's post office; handles email functions
- **Print Server** - Manages printers on the network
- **Web Server** - Manages web-based activities by running Hypertext Transfer Protocol (HTTP) for storing web content and accessing web pages
- **Fax Server** - The "memo maker" that sends and receives paperless faxes over the network
- **Application Server** - Manages network applications
- **Telephony Server** - Handles the call center and call routing and can be thought of as a sophisticated network answering machine
- **Proxy Server** - Handles tasks in the place of other machines on the network, particularly an internet connection.

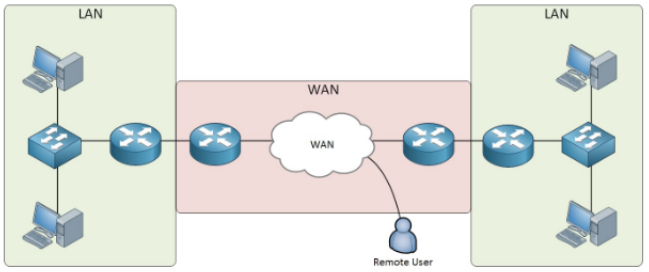
> Q: What do you mean by a Node?
> A: The intersection point in a network is called as a Node. Nodes can send or receive data/ information within a network. For example, if two computers are connected to form a network, there are 2 nodes in that network. Similarly, in case of adding more computers, there will be more nodes and so on. It is not necessary for a node to be a computer, it can be any communication device such as a printer, servers, modems, etc..
>
> - Interview Q&A

What's a Network?

Wide Area Network (WAN)

Our own networks are called **LANs** (Local Area Network). We own and operate these networks. It's called a **"local"** area network since all devices that make up the LAN are close to each other. Perhaps in one building or a few buildings close to each other (called a **campus**).

When we need access to other remote networks, or give others access to our LAN, we need a **WAN (Wide Area Network)**. As the name implies, WANs cover *large geographical areas*. This could be a network between two cities or as large as the **Internet**.



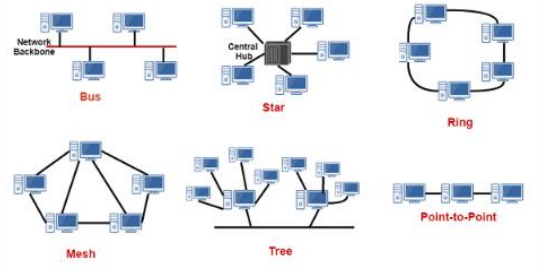
On the **LAN**, the dominant protocol that we use is **Ethernet**. For **WAN**, there are dozens of technologies and protocols we can choose from.

Below is the list of some differences between WAN and LANs:

- WANs usually need a router.
- WANs span larger geographic areas and/or can link disparate locations.
- WANs are usually slower.
- We can choose when and how long we connect to a WAN. A LAN is all or nothing—our workstation is connected to it either permanently or not at all.
- WANs can utilize either private or public data transport media such as phone lines.

We get the word Internet from the term internetwork. An internetwork is a type of LAN and/or WAN that connects a bunch of networks or intranets. In an internetwork, hosts still use hardware addresses to communicate with other hosts on the same LAN. However, they use logical addresses (IP addresses) to communicate with hosts on a different LAN (the other side of the router). And routers are the devices that make this possible. Each connection into a router is a different logical network.

> Q: What is WAN?
> A: WAN stands for Wide Area Network. It is an interconnection of computers and devices that are geographically dispersed. It connects networks that are located in different regions and countries.
>
> - Interview Q&A

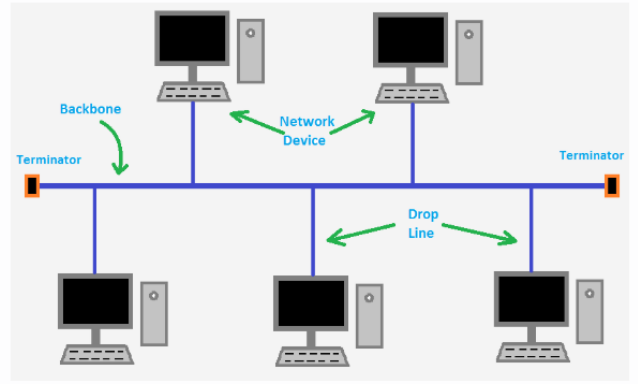


Physical network topologies

> 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.

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.



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.

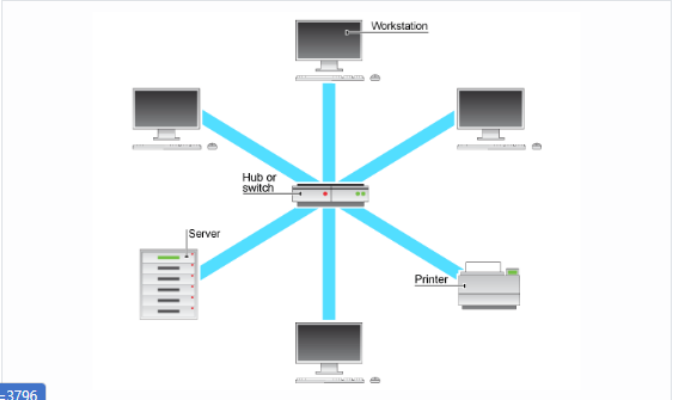
Advantages of bus topology:
1. Easy installation, each cable needs to be connected with backbone cable.
2. Fewer cables required than mesh and star topology

Disadvantages of bus topology:
1. Difficultly in fault detection.
2. Not scalable as there is a limit of how many nodes you can connect with backbone cable.

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 media, node (network card), or the hub, switch, or router at the center of the star.



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:

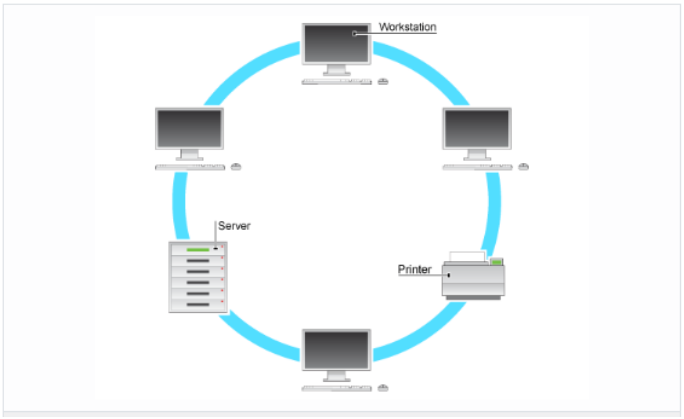
1. If the hub goes down every node goes down, none of the devices can work without the hub.
2. Hub requires more resources and regular maintenance because it is the central system of star topology.

> 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.
>
> - Interview Q&A

Ring Topology

A network topology that 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 on 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 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 to change just two links.

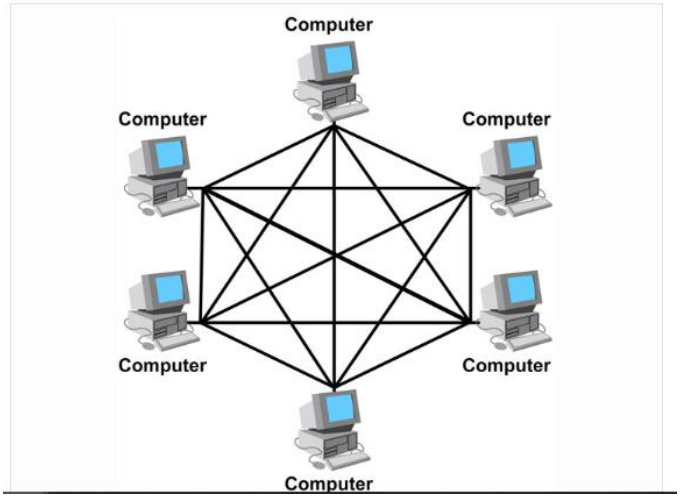
Disadvantages of Ring Topology:

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.

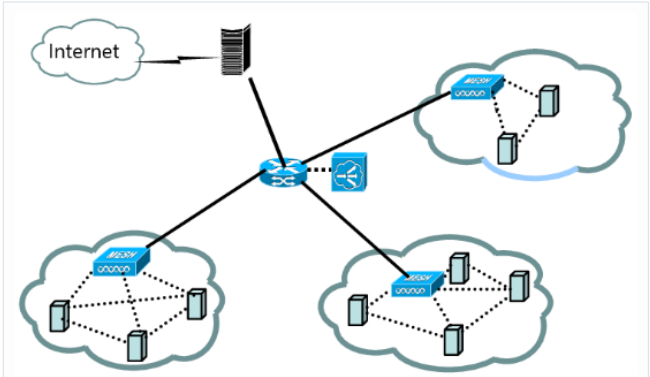
> Q: What are some drawbacks of implementing a ring topology?
> A: In case one workstation on the network suffers a malfunction, it can bring down the entire network. Another drawback is that when there are adjustments and reconfigurations needed to be performed on a particular part of the network, the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

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!



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:

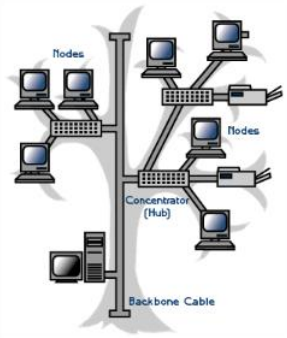
1. The amount of wires required to connected each system is tedious.
2. Since each device needs to be connected with other devices, a number of I/O ports required must be huge.
3. Scalability issues because a device cannot be connected with a large number of devices with a dedicated point to point link.

> 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.
>
> - Interview Q&A

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.



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.

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. The value of a permanent point-to-point network is unimpeded communications between the two endpoints.

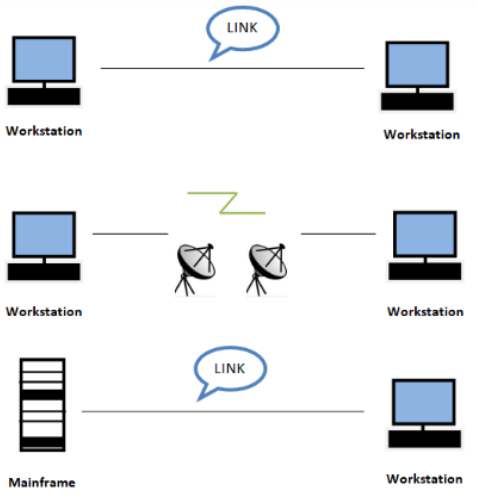
- **Permanent (dedicated)**

Easiest to understand, of 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**

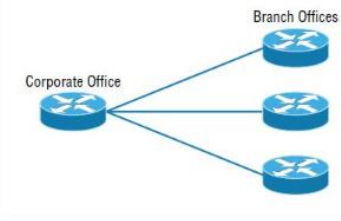
Using circuit-switching or packet-switching technologies, a point-to-point circuit can be set up dynamically and dropped when no longer needed. This is the basic model of conventional telephony.



Point-to-point topologies

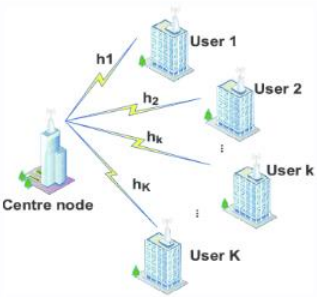
Point-to-Multipoint Topology

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

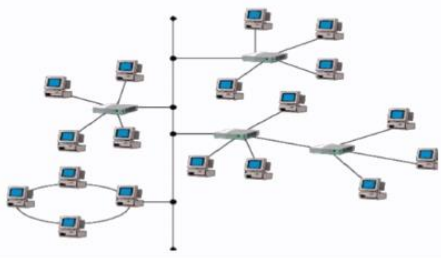
The below figure shows another prime example of a point-to-multipoint network: a college or corporate campus.



Point-to-multipoint topology

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