

COMPUTER NETWORKS

A computer network consists of two or more computers connected so that they can exchange data and programs. When a computer is a member of a network, the programs it runs and the data it uses can be on the hard disk of some other computer on the network. In business and industrial settings, most computers are on a network. The operating system that runs on a networked computer must manage its share of the network (along with managing all its other responsibilities). The operating system is able to find programs and data that are stored on other network computers, and copy them into its own main memory.

Computer Network Properties

- **Scope:** A network architecture should solve so many general problems as possible.
- **Scalability:** A network must work well independently of the number of nodes that compose it.
- **Robustness:** The design of a network should allow it to function correctly, even though there are defective nodes.
- **Self-configuration and Optimization:** A network should have a minimal intervention of the administrator. In turn, you must have a series of parameters that allow the administrator to adjust them to obtain an optimal configuration for some and other networks according to their characteristics.
- **Migration:** If you decide to change networks, migration should not be affected in its properties and operation.
- **Determinism:** Under the same conditions, the network must always work the same.

Computer Network Model

A computer networks communication can be based on centralized, distributed or collaborative computing. Centralized computing involves many workstations or terminals, connected to one central mainframe or other powerful computer. Distributed computing interconnects one or more personal computers and allows various services like Data sharing, hardware sharing resources sharing or network sharing. The collaborative computing is the combination of centralized and distributed computing.

Networks provide the benefits of exchanging information or Data, sharing resources, reducing system costs, increased reliability and flexible working environment. Networking provides the function of back-up, it can also provide a powerful communication medium.

A network can share many types of resources:

- Services, such as printing or scanning.
- Applications, such as databases.
- Storage space on removable devices, such as hard drives or optical drives. Networks can be

used to access information stored on other computers, print documents using shared printers, and synchronize the calendar between your computer and your smartphone.

CLASSIFYING COMPUTER NETWORKS:

Computer Networks Classification can be based on:

- Scale/Physical Size/Range.
- Functional Relationship.
- Network Topology.

Classification According to Scale/Physical Size/Range:

According to their physical size, networks can be:

1. Personal Area Networks (PAN):

PANs are usually wireless, established in an on-demand or ad-hoc fashion when needed to communicate between two or more devices. PANs can be used between devices owned by two different parties, or between two devices owned by one person, such as a PDA and a laptop or mobile phone. These networks are usually characterized as short-range, often limited to 10 meters or less in range.

An example of a PAN technology is Bluetooth wireless networking.

2. Local Area Networks (LAN):

A Local Area Network (LAN) is a relatively small network that is confined to a small geographic area, such as a single office or a building. Laptops, desktops, servers, printers, and other networked devices that make up a LAN are located relatively close to each other.

Local area networks have the following characteristics:

- They are used within small areas (such as in an office building).
- They offer high-speed communication—typically, 10Mbps or faster.
- They provide access for many devices.
- They use LAN-specific equipment such as repeaters, hubs, and network interface cards.

3. Metropolitan Area Networks (MAN):

The term Metropolitan Area Network (MAN) is typically used to describe a network that spans a citywide area or a town. MANs are larger than traditional LANs and predominantly use high-speed media, such as fiber optic cable, for their backbones. The size of a MAN can cover a city whose scope is less than 100km. The best-known example of MAN is cable television networks.

Metropolitan area networks have the following characteristics:

- Sites are dispersed across a city and perhaps the surrounding area as well.
- With the advent of MANs, historically slow connections (56Kbps-1.5Mbps) have given way to communication at hundreds of megabits per second and even gigabit speeds.
- They provide single points of connection between each LAN.
- They use devices such as routers, telephone and *ATM switches*, and microwave antennas.

4. Wide Area Networks (WAN)

A Wide Area Network (WAN) covers a significantly larger geographic area than LANs or MANs. They (WANs) span large geographical areas, often countries or continents. A WAN uses public networks, telephone lines, and leased lines to tie together smaller networks such as LANs and MANs over a geographically dispersed area. Connecting devices in different geographic areas together for information sharing, WANs are an important piece of enterprise networks. Internet is the largest WAN ever established.

Wide area networks have the following characteristics:

- They can cover a very large geographical area—even span the world.
- They usually communicate at slow speeds (compared to LANs).
- Access to the WAN is limited—a LAN usually has only one WAN link that is shared by all devices.
- They use devices such as routers, *modems*, and WAN switches.

There are three categories of wide area networks, namely

- **Enterprise network:** An interconnected version of all the local area networks of a single organization is known as an enterprise network.
- **Global network:** A network formed by combining the networks of several organizations over a wide area.
- **Internet:** A network of networks of broad area category. It is the biggest network in the world. The network components are LANs, WANs, MANs, and millions of autonomous computers of different category. A single authority does not control the network; the local, national authority controls every segment of the Internet.

Classification According to functional relationship:

As software development has improved over the past several decades, so have computers become better at interacting on a network. The way in which computers interact on a network is known as the network architecture. There are three types of network architectures that are the most common and therefore are important for you to understand: peer-to-peer, client-server, and hybrid.

The type of architecture appropriate for an organization depends on several factors, including

- geographical location,
- the number of users,
- any special application needs, and
- The amount of technical support available.

1. Client-server (aka server-based) networks:

Users in this type of networks act as clients of dedicated machines that take the server role.

Although server-based networks can be referred to as client/server, the server is so important to this type of network that NOS vendors, such as Microsoft and Novell, prefer the term "server-based" to emphasize this role. A server is best described as a machine with the sole function of responding to client requests. A server is seldom operated by someone sitting in front of it (and then usually only for installation, configuration, or management tasks); therefore, a server's main role on a network is to be continuously available to handle the many requests for its services that a community of clients can generate.

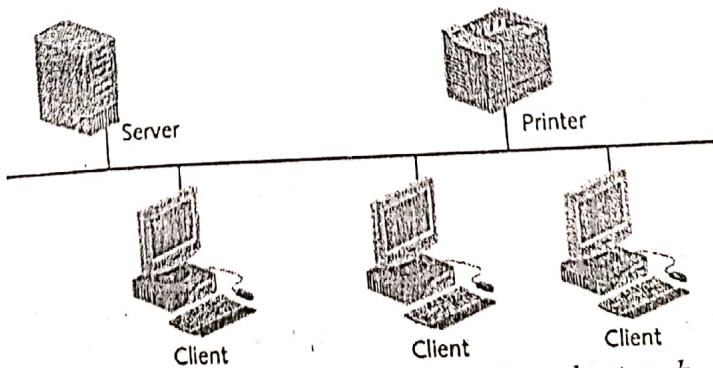


Figure: An example of a server-based network.

Client-server networks, also referred to as *server-based networks*, have the following characteristics:

- They're based on a scalable model that can support small networks of 5 to 10 users, as well as large networks with thousands of users.
- They employ servers—specialized computers that provide services to the client workstations.
- They provide *services* such as printing, file saving, and applications.
- They allow a high level of security based on access permissions.
- They can be centrally managed by a network administrator or a team of network administrators.

There are several types of servers. Some, such as file and e-mail servers, are more common than others, and are found at most companies. Server types include:

File servers Unlike file sharing in a peer network, file servers offer users a central location to save files. Files stored on a file server are secure because they require a user to log in with a unique login name and a unique password.

Print servers As networks grow, so do the printing demands of the users. Print servers help balance the load of printing by allowing users to print simultaneously to the server. The print server stores the print jobs in a print queue—a temporary folder—until the printer is available.

Messaging servers These servers answer requests for mail by clients or route mail messages to appropriate mail servers.

Application servers When there is a heavy demand for an application, an application server improves performance and security by keeping the data and the application on the same computer. Many websites integrate two application servers: a web server and a database server.

Selecting a Client-Server Network

Many companies have more than 10 users and, therefore, will probably be using a client-server network. Planning and selecting the right client-server technology is not easy. As you will see in the next sections, client-server networks can be implemented several ways.

The basic criteria for selecting a client-server network are:

- Files need to be stored centrally.
- Security is important to protect sensitive and valuable data.
- Users will need access to the same application and data.
- A network administrator will be managing the server(s).
- There are more than 10 users.

Note: Make sure that you have considered the advantages and disadvantages before investing in a client-server network.

The advantages of client-server networks include:

- Data is stored centrally and can be easily backed up.
- A high level of security can be implemented at the server.
- Most powerful equipment can be shared.
- Server hardware and software are optimized for performance and reliability on client-server networks.
- Users are relieved of the burden of managing resources.
- The management of user accounts and resources is centralized.

The disadvantages of client-server networks include:

- Planning, design, and management are complicated.
- Managing servers requires dedicated staff.
- Server hardware and software are expensive.

Server-based networks come in three types, based on the following criteria:

- Number of users
- Application needs
- Geographical location

Single-Server Networks

When a company outgrows its peer-to-peer network, it usually adds a server and converts the network into a client-server network. Single-server networks are typically employed by companies with 10 to 50 users, though even small companies may opt for more than one server. A small business might add a second server for special-purpose applications or to make their network more reliable—a single-server strategy is risky because it increases the likelihood of data loss in the event that the server fails.

Single-server networks should be used only if just a few services will be running on the server. A simple single-server network is shown here.

Multi-server Networks

Because servers can provide a variety of functions, it is not uncommon to have several servers working on one network, each providing different services. This type of network, called a *multiserver network*, is typical of networks with 50 to 500 users. Separating services across multiple servers improves performance and reliability. Each server can be optimized to run a service. If one service fails, other servers continue to function normally and can even take up the slack of the malfunctioning server.

Enterprise Networks

As companies grow, so do their networks. Today, companies of all sizes are using networks so employees can communicate and work more efficiently. In some companies, a day's work may involve collaborating with coworkers located in offices around the world. These companies require networks that will support thousands of users who need to access information across the company. These large networks are called *enterprise networks*.

Enterprise networks can be enormous, with thousands of users and possibly hundreds of servers. Each office location may look like a single-or multi-server network, except that each location will be connected to the rest of the corporate WAN.

2. Peer-to-peer.

Computers on a peer-to-peer network can take both a client and a server role (i.e. any computer on a peer-to-peer network can function as a client or a server). Because all computers on this type of network are peers, these networks impose no centralized control over shared resources, such as files or printers. Any user can share resources on his computer with any other user's computer on the same network, however and whenever he chooses. The peer relationship also means that no single computer has any higher priority to access, or increased responsibility to provide, shared resources on the network.

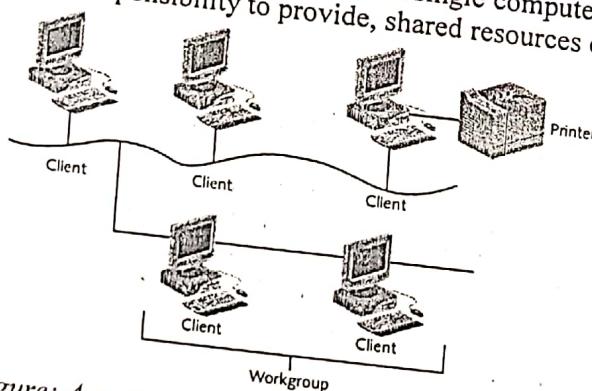


Figure: An example of a typical peer-to-peer network.

Peer-to-Peer Networks

Peer-to-peer networking enables users to share resources, files, and printers in a decentralized way. Specifically, peer-to-peer networks have the following characteristics:

- They allow users to share many resources on their computer, including files and printers.
- They're better for groups of 10 users or fewer.
- They're decentralized—user files are not stored in a central location.
- They allow computers to communicate easily.

3. Hybrid Networks

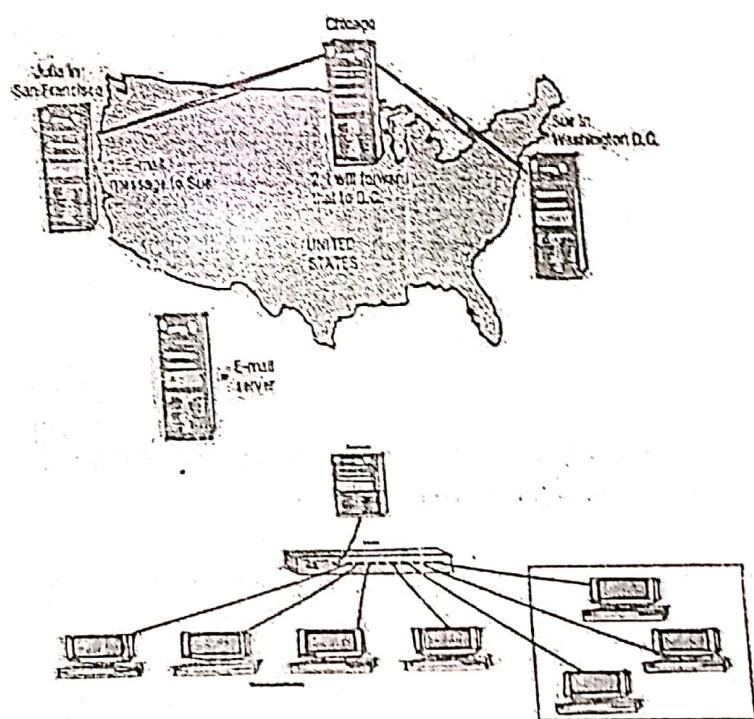
Hybrid networks incorporate the best features of workgroups in peer-to-peer networks with the performance, security, and reliability of server-based networks. Hybrid networks still provide all of the centralized services of servers, but they also allow users to share and manage their own resources within the work-group. After a user in a workgroup logs in to the network, the user doesn't have to have any other interactions with the server while accessing shared files in the workgroup.

The advantages of hybrid networks include:

- Client-server applications are still centrally located and managed.
- Users can assign local access to resources on their computers.
- Workgroups can manage resources without requiring assistance from the network administrator.

The disadvantages of hybrid networks include:

- Network access can become burdensome for the users.
- Users may need to remember multiple passwords.
- Files can be duplicated and changes overwritten between the computer with the shared folder and the server.
- Files saved on the workstation are not backed up.



WHAT IS THE DIFFERENCE BETWEEN LAN, WAN, MAN, CAN, VPN, BAN, NAN, HAN, PAN?

WHAT IS A NETWORK?

In order to understand the difference between the network types, it's important to first understand what a network is. Simply enough, a network is two or more connected computers or other devices, linked for the purpose of communicating or sharing resources. This connection can either be wired or wireless through the use of cables, satellites, radio waves, telephone lines, and infrared light beams. By and large, the most common types of network is a LAN (Local Area Network).

WHAT DIFFERENTIATES ONE KIND OF NETWORK FROM ANOTHER?

For the most part, the differentiating factor in the types of networks is how large of a system it is, or how many devices are included in the network's area, as well as how those devices are connected to one another.

LAN

The most basic and common type of network, a LAN, or local area network, is a network connecting a group of devices in a "local" area, usually within the same building. These connections are generally powered through the use of Ethernet cables, which have length limitations, as the speed of the connection will degrade beyond a certain length.

A WLAN, or wireless LAN, is a subtype of LAN. It uses WiFi to make the LAN wireless through the use of a wireless router.

HAN

A HAN, or home area network, is a network connecting devices within a home. These networks are a type of LAN. All the devices inside the household, including computers, smartphones, game consoles, televisions, and home assistants that are connected to the router are a part of the HAN.

CAN

A CAN, or campus area network, usually comprises several LANs. They cover a campus, connecting several buildings to the main firewall. A university could use a CAN, as could a corporate headquarters.

MAN

Even larger than a CAN, a MAN is a metropolitan area network. These can cover an area as large as a city, linking multiple LANs through a wired backhaul. An example of a MAN would be a citywide WiFi network.

WAN

In contrast to the smaller LAN and HANs, a WAN is a wide area network, covering any distance necessary. The Internet could be considered a WAN that covers the entire Earth.

VPN

A VPN is a virtual private network, or a network of devices that aren't connected through any physical means. The devices connected through a VPN could be anywhere and any distance apart, and are simply connected through the Internet. Many individuals choose to install VPNs on their personal computers, as they offer an extra layer of security and privacy protection.

PAN

A PAN is a personal area network, and devices within a PAN are usually no more than 10 yards apart. Devices connected through Bluetooth technology could be considered part of a PAN, as it is both wireless and devices must be within a close proximity to one another.

BAN

A BAN, or body area network, is an area connected through extremely low-range wireless communication, all within the vicinity of the human body. Devices connected to a BAN could include smartwatches, surgically implanted medical devices, and fitness armbands.

NAN (Near-me Network)

An informal type of network, a NAN is a near-me network, or a network of devices informally connected by their proximity to one another. An example of this could be a business meeting in which various colleagues are sitting at the same conference table, sharing files to one another's devices. They could all be connected to the Internet through different means – cellular, WiFi, or wired connection – but they are a part of the same informal network because they are sharing resources with one another.

Computer Network

During 20th century the most important technology has been the information gathering, its processing and distribution. The computers and communications have been merged together and their merger has had a profound effect on the manner in which computer systems are organized.

The old model in which a single computer used to serve all the computational needs of an organization has been replaced by a new one in which a large number of separate but interconnected computers do the job. Such systems are called as computer networks.

- Two computers are said to be interconnected if they interchange information. The connection between the separate computers can be done via a copper wire, fiber optics, microwaves or communication satellite.
- A printer, computer, or any machine that is capable of communicating on the network is referred to as a device or node.
- We can also say that computer network is an interconnection of various computers to share software, hardware and data through a communication medium between them. The computers connected in a network share files, folders, applications and resources like scanner, web-cams, printers etc.
- The best example of computer network is the Internet.

A computer network is an interconnection of various computers to share software, hardware, resources and data through a communication medium between them.

A Computer Networking is a set of autonomous computers that permits distributed processing of the information and data and increased Communication of resources.

Any Computer Networking communication need a sender, a receiver and a communication medium to transfer signal or Data from sender to the receiver. We need sender, receiver, communication channel, protocols and operating system to establish a computer networking.

A networks model describes the organization of various computers in a network for using resources.

We'll be covering the following topics in this tutorial:

- Computer Network Properties
- Computer Network Model
- Computer Network Classification
- Computer Network topology
- Uses of Computer Networks

Computer Network Properties

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Centralized computing

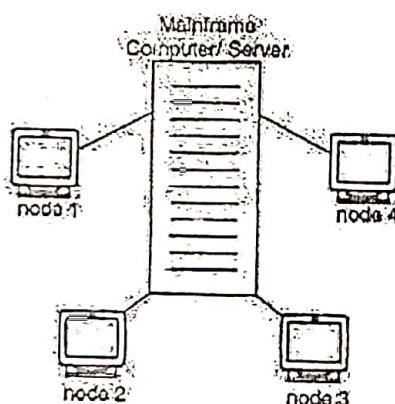
- It is also known as client-server computing.
- In this type of system, multiple computers are joined to one powerful mainframe computer.
- The server or mainframe computer has huge storage and processing capabilities.
- The computers that are connected to the mainframe or server are called Clients or Nodes.
- These nodes are *not* connected to each other; they are only connected to server.

Distributed computing

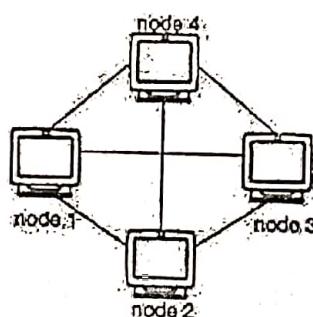
- If one computer can forcibly start, stop or control another the computers are not autonomous. A system with one control unit and many slaves, or a large computer with remote printers and terminals is not called a computer network, it is called a **Distributed System**.
- Distributed computing means that the task is divided among multiple computers.
- Distributed computing interconnects one ore more personal computers or Workstations.
- In distributed computing, the nodes are capable of processing their own data and rely on network for services other than data processing.
- It allows various services like network sharing, hardware sharing and file sharing.

Collaborative computing / Hybrid computing

- It is the combination of centralized and distributed computing



Centralised Computing



(ii) Distributed Computing

- In collaborative computing, the nodes are able to serve the basic needs of their users but they are dependent on some other computers for processing some specific request.

Classification of Computer Networks

A computer network can be classified into different categories. Different criteria are used to classify computer networks. Following are the criteria widely used.

- Geographical spread
- Topology
- Ownership

Classification by Geographical Spread

Based on geographical spread, networks can be classified into the following three categories

- Local Area Network (LAN)
- Metropolitan Area Network (MAN)
- Wide Area Network (WAN)

Local area network (LAN) LAN is a computer network that consists of few or more computers and other communication devices connected in the form of a network within a well-defined area such as a room or a building. A typical example is a college or university computer network. Users in a LAN can share both hardware and sharable software resources. For example, hardware resources include expensive laser printer, plotter, fax machines, modem, etc. Almost all local area networks use a single communication media, as it is restricted to a limited area. All network resources and their management activities are controlled using special system software called Network Operating System (NOS).

Metropolitan area network (MAN) MAN is a network more extensive than a LAN. The name metropolitan is due to the ability to cover a relatively larger area of a city, from a few tens to a maximum of hundred kilometers. Different hardware and transmission media often used in a MAN for efficient transmission of information.

Wide area network (WAN) WAN is a computer network that spans a large geographical area. It uses dedicated or switched connections to link computers in geographically remote locations. Wide area networks are implemented to connect a large number of LANs and MANs. Due to this reason, it is possible to see a large number of heterogeneous components in a wide area network. Different communication media used, and the network spreads across several national boundaries. Computers connected to a WAN often connected to a public network. They can also be connected through leased lines or satellite links. The government or large concerns mostly use WAN because of the considerable investment made to implement them.

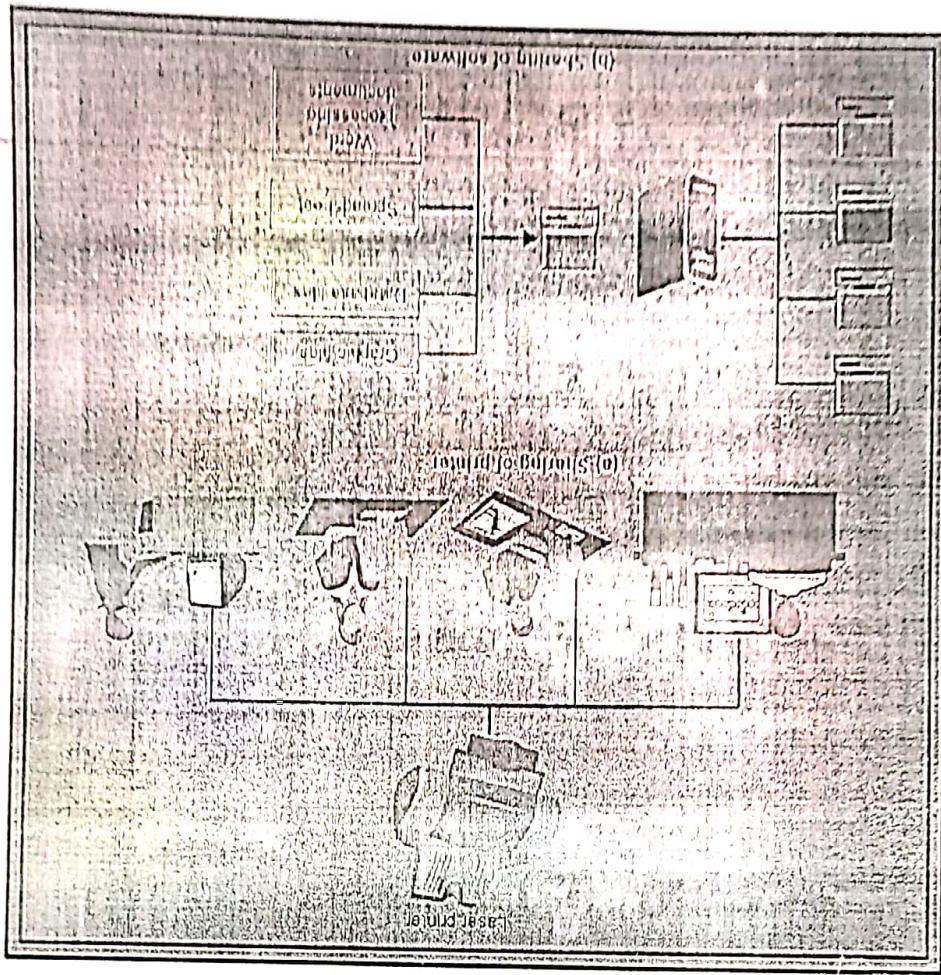
Computer Network Classification

The local area network communication can be constructed by using server based model or peer to peer model. In peer to peer networks, the individual clients share data and resources but no one computer is treated as server.

Networks can be classified into local area Networks, metropolitan area Networks and wide area networks. Local area network is the small network that covers a small area of Network. Metropolitan area networks are created by combining various local area networks. Wide area networks are the biggest networks that provide connectivity across the globe.

Computer Network topology

The physical arrangement of computers in a communication network is called as topology. In star topology, every system on the network is connected to a central controller called Hub and all the data is transmitted through this. Star topology is



- Show in Fig (a) and (b) which shows a printer being shared and different information being shared.

- It allows all programs, equipment and data available to anyone on the network irrespective of the physical location of the resource and the user.

Resource sharing

4. It can provide a powerful communication medium.

3. To save money.

2. For providing high reliability.

1. Resource sharing.

• The computer networks are useful to the organizations in the following ways:

• Even though the computers are located in different locations, the organizations want to keep track of inventories, monitor productivity, do the ordering and billing etc.

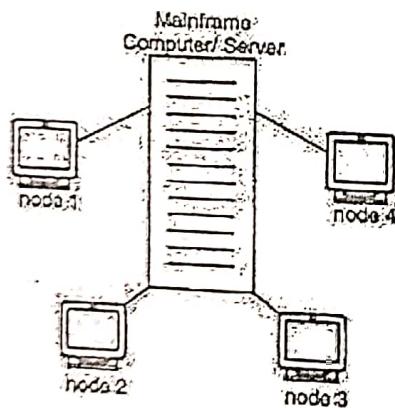
• Many organizations have a large number of computers in operation. These computers may be within the same building, campus, city or different cities.

Distributed computing

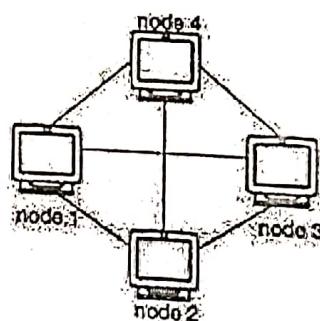
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very easy to install and configure. In bus topology, a single cable acts as a backbone of the communication network and all the nodes or computers are attached to it by using T connectors.

Advantages of Network

The following are the distinct notes in favor of computer network.

- a. The computers, staff and information can be well managed
- b. A network provides the means to exchange data among the computers and to make programs and data available to people
- c. It permits the sharing of the resources of the machine
- d. Networking also provides the function of back-up.
- e. Networking provides a flexible networking environment. Employees can work at home by using through networks ties through networks into the computer at office.

Explain Network Services

1. Network services are the thing that a network can do. The major networking services are
2. **File Services:** This includes file transfer, storage, data migration, file update, synchronization and achieving.
3. **Printing Services:** This service produces shared access to valuable printing devices.
4. **Message Services:** This service facilitates email, voice mails and coordinate object oriented applications.
5. **Application Services:** This services allows to centralize high profile applications to increase performance and scalability
6. **Database Services:** This involves coordination of distributed data and replication.

Network devices connect through various connections:

- **Copper wiring:** uses electrical signals to transmit data between devices.
- **Fiber optic cabling:** uses plastic or glass cable, also called fiber, to transport information as the light emitted.
- **Wireless connection:** uses radio signals, infrared (laser) technology, or satellite transmissions.

Uses of Computer Networks

The computer networks are playing an important role in providing services to large organizations as well as to the individual common man.

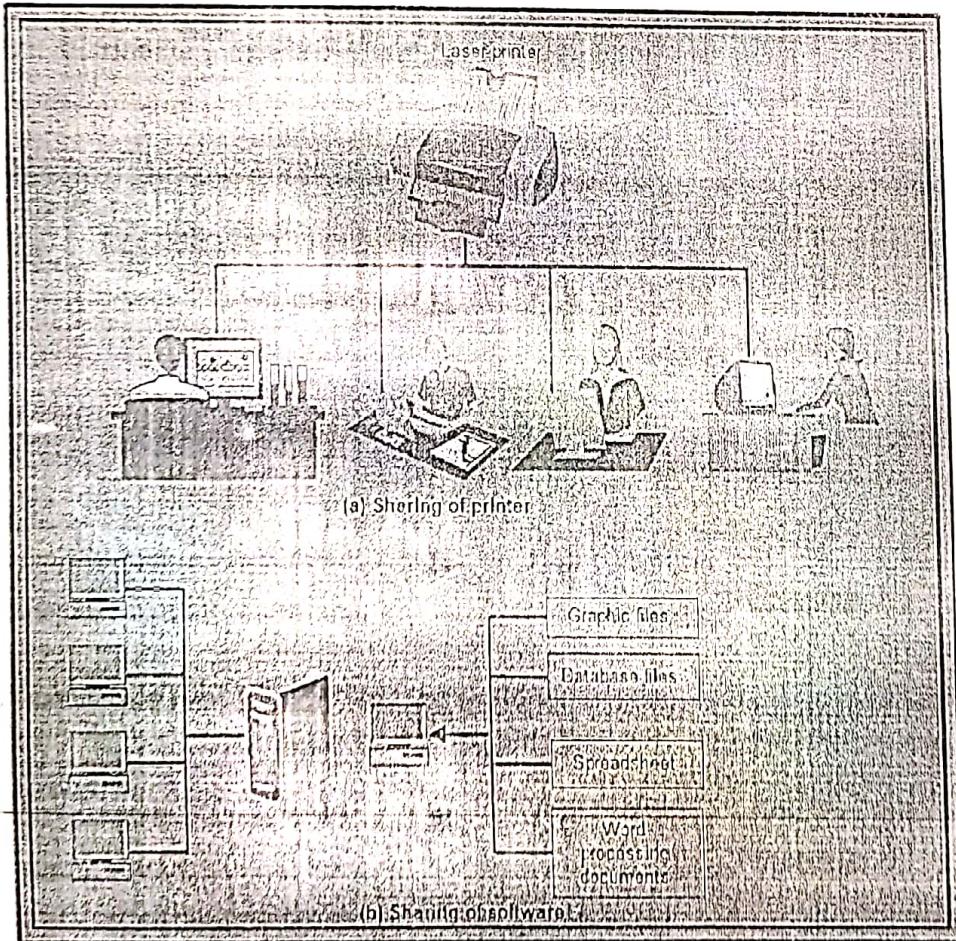
Service Provided by the Network for Companies:

• Reliability due to
it provides high reliability
could be replicated
due to hardware failure
• The

- Many organizations have a large number of computers in operation. These computers may be within the same building, campus, city or different cities.
- Even though the computers are located in different locations, the organizations want to keep track of inventories, monitor productivity, do the ordering and billing etc.
- The computer networks are useful to the organizations in the following ways:
 1. Resource sharing.
 2. For providing high reliability.
 3. To save money.
 4. It can provide a powerful communication medium.

Resource sharing

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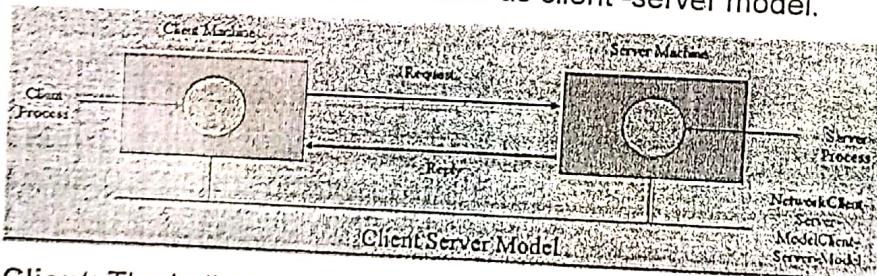


High reliability due to alternative sources of data

- It provides high reliability by having alternative sources of data. For e.g. all files could be replicated on more than one machines; so if one of them is unavailable due to hardware failure or any other reason, the other copies can be used.
- The aspect of high reliability is very important for military, banking, air traffic control, nuclear reactor safety and many other applications where continuous operations is a must even if there are hardware or software failures.

Money saving

- Computer networking is an important financial aspect for organizations because it saves money.
- Organizations can use separate personal computer one per user instead of using mainframe computer which are expensive.
- The organizations can use the work-group model (peer to peer), in which all the PCs are networked together and each one can have the access to the other for communicating or sharing purpose.
- The organization, if it wants security for its operation it can go in for the domain model in which there is a server and clients. All the clients can communicate and access data through the server.
- The whole arrangement is called as client -server model.



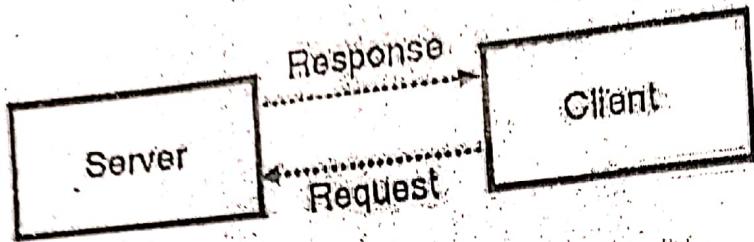
Client: The individual workstations in the network are called as clients.

Server

The central computer which is more powerful than the clients and which allows the clients to access its software and database is called as the server.

- Server computers typically are more powerful than client computers or are optimized to function as servers.

Communication in client-server configuration:



Client/server communication

- The client places a request on the server machine when he wants an access to the centralized resources.
- The server responds to this request and sends the signal accordingly to the client.
- The software run at the client computer is called as client program. This software configures the computer to act as a client.
- Similarly, the software run on the server computer IS called as server program. It configures a computer to act as a server.

Communication medium

- A computer network provides a powerful communication medium among widely separated employees.
- Using network, it is easy for two or more employees, who are separated by geographical locations to work on a report, document or R and D simultaneously i.e. on line.

Networking benefits

The benefits of networking on computers and other devices include low costs and higher productivity. Thanks to networks, resource scan be shared, which reduces data duplication and corruption.

Fewer peripherals are needed.

Every computer on the network does not need its printer, scanner, or backup device. It is possible to configure several printers in a central location and share them among network users. All network users send print jobs to a central print server that manages print requests. The print server can distribute print jobs among the various printers, or it can queue jobs that require a particular printer.

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Individual users of the network do not need to manage their data and devices. An administrator can control the data, devices, and permissions of network users. Creating backup copies of the data is more comfortable because of the data stored in a central location.

Resources are conserved

It is possible to distribute data processing among many computers to prevent a computer from being overloaded with processing tasks.

Transmission media

Transmission media is a pathway that carries the information from sender to receiver. We use different types of cables or waves to transmit data. Data is transmitted normally through electrical or electromagnetic signals.

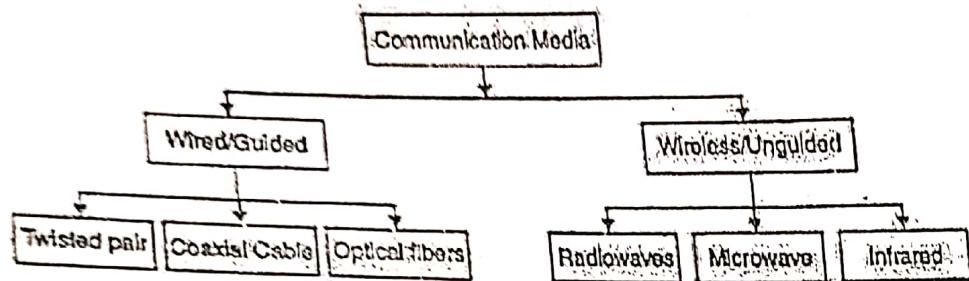
An electrical signal is in the form of current. An electromagnetic signal is series of electromagnetic energy pulses at various frequencies. These signals can be transmitted through copper wires, optical fibers, atmosphere, water and vacuum. Different Medias have different properties like bandwidth, delay, cost and ease of installation and maintenance. Transmission media is also called Communication channel.

Types of Transmission Media

Transmission media is broadly classified into two groups.

Wired or Guided Media or Bound Transmission Media: Bound transmission media are the cables that are tangible or have physical existence and are limited by the physical geography. Popular bound transmission media in use are twisted pair cable, co-axial cable and fiber optical cable. Each of them has its own characteristics like transmission speed, effect of noise, physical appearance, cost etc.

Wireless or Unguided Media or Unbound Transmission Media: Unbound transmission media are the ways of transmitting data without using any cables. These media are not bounded by physical geography. This type of transmission is called **Wireless communication**. Nowadays wireless communication is becoming popular. Wireless LANs are being installed in office and college campuses. This transmission uses Microwave, Radio wave, Infra red are some of popular unbound transmission media.



Classification According to Topology
The term components of network considered the network is considered on a network

Classification According to network topologies:

The term "topology" refers to the basic physical layout of a network and the way in which network components communicate with each other. The arrangement of cabling in a network is considered the network's *physical topology* whereas the path that data travels between computers on a network is considered the network's *logical topology*.

NETWORK TOPOLOGIES

The type of physical topology you choose for your network will affect how devices on your network communicate. Some of the factors to consider are:

- Cost
- Scalability
- Bandwidth capacity
- Ease of installation
- Ease of troubleshooting

Bus Topology

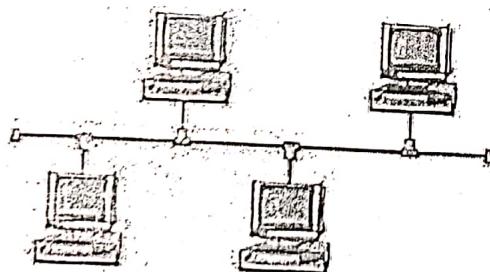
A physical *bus topology* looks a lot like a bus line going through a city. The devices are connected by a single cable, which runs throughout the network. The main cable segment must end with a *terminator* that absorbs the signal when it reaches the end of the line. Without a *terminator*, the electrical signal that represents the data would reach the end of the copper wire and bounce back, causing errors on the network.

bus topology

A physical topology that utilizes a single main cable to which devices are attached.

terminator

A device used to terminate the ends of the main cable in networks implementing a physical bus topology and using Thinnet cabling.



The advantages of a bus topology are:

- Bus networks, Thinnet in particular, are inexpensive to install.
- You can easily add more workstations.
- Bus networks use less cable than other physical topologies.
- The bus topology works well for small networks (2–10 devices).

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The disadvantages of a bus topology are:

- It's no longer a recommended option for new installations.
- If the backbone breaks, the network is down.
- Only a limited number of devices can be included.
- It's difficult to isolate where a problem may be.
- Sharing the same cable means slower access time.

Ring Topology

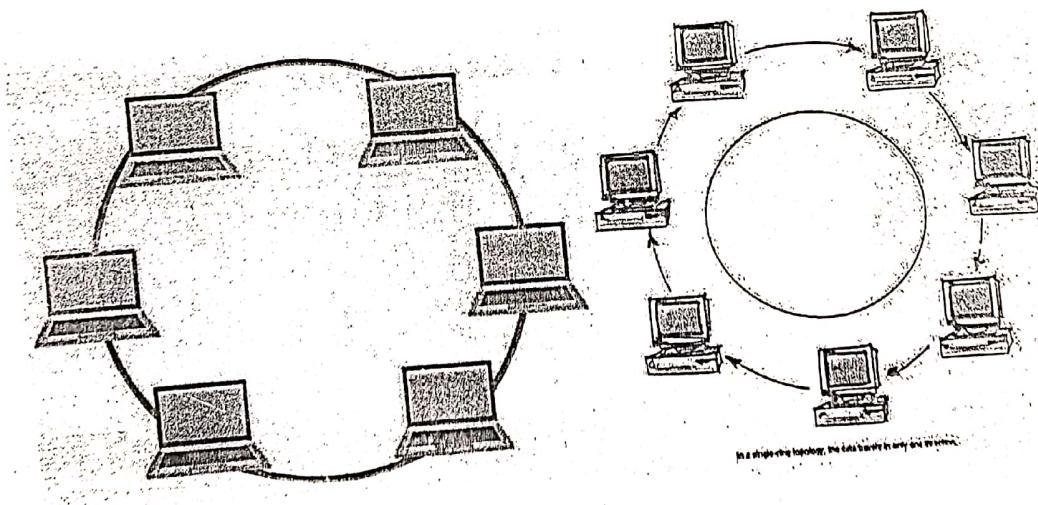
As its name implies, a ring topology is a topology in which the stations are connected in the form of a ring or circle (physical ring), in which the data flows in a circle, from station to station (logical ring), or a combination of both. It has no beginning or end that needs to be terminated. This allows every device to have an equal advantage accessing the media.

ring topology A physical topology in which all devices are connected in a circle, providing equal access to the network media.

There are two kinds of ring topologies:

- Single ring
- Dual ring

When the first ring networks were installed, they used a single-ring topology, as shown in the following illustration. In a single-ring network, a single cable is shared by all the devices, and the data travels in one direction like a merry-go-round. Each device waits its turn and then transmits. When the data reaches its destination, another device can transmit.



The advantages of a ring topology are:

- Data packets can travel at greater speeds.
- There are no collisions.
- It is easier to locate problems with devices and cable.
- No terminators are needed.

The disadvantages of a ring topology are:

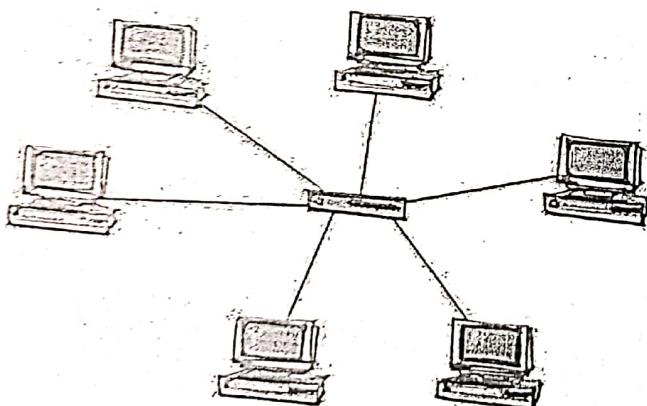
- A ring network requires more cable than a bus network.
- A break in the cable will bring many types of ring networks down.
- When you add devices to the ring, all devices are suspended from using the network.
- It's not as common as the bus topology, so there's not as much equipment available.

Star Topology

A physical star topology is installed in the shape of a star, like spokes in a bicycle wheel. As you can see in the following illustration, a star topology is made up of a central connection point, a hub, where the cable segments meet. Each device in a star network is connected to the central hub with its own cable. Although this does require more media, it has many advantages over both the bus and ring topologies.

star topology

A physical topology that connects networking devices to a central hub.



The advantages of a star topology are:

- It's easy to add more devices as your network expands.
- The failure of one cable or one cable break will not bring down the entire network.
- The hub provides centralized management.
- It's easy to find device and cable problems.
- A star network can be upgraded to faster network transmission speeds.
- It's the most common topology, so many equipment options are available.

The disadvantages of a star topology are:

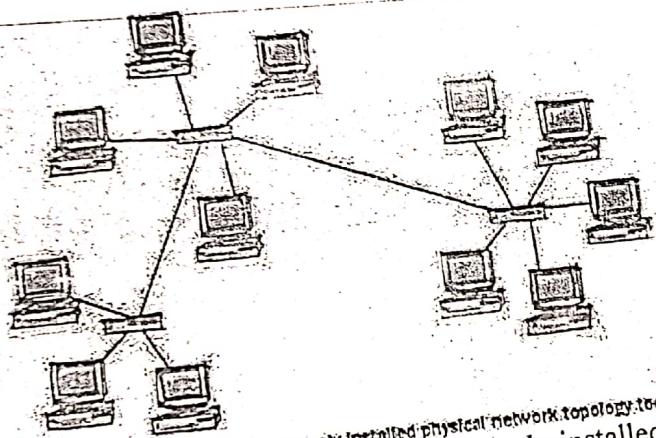
- A star network requires more media than a ring or bus network.
- The failure of the central hub can bring down the entire network.
- The costs of installation and equipment are higher than for most bus networks.
- A finite number of switch ports limits the network's size.

Extended Star Topology

If a star network is expanded to include an additional hub connected to the main hub, as shown in the following illustration, it is called an extended star topology.

extended star topology

A physical topology that connects additional hubs to a central star topology to add devices.



The star network is the most commonly installed physical network topology today.
Note The star network is the most commonly installed physical network topology today.

Mesh Topology

A mesh topology is a point-to-point connection where nodes are interconnected. In this form of topology, data is transmitted via two methods: routing and flooding. Routing is where nodes use routing logic to work out the shortest distance to the packet's destination. In contrast, flooding is where data is sent to all nodes within the network. Flooding doesn't require any form of routing logic to work.

There are two forms of mesh topology: partial mesh topology and full mesh topology. With partial mesh topology, most nodes are interconnected but there are a few which are only

connected to two or three other nodes. A full mesh topology is where every node is interconnected.

The advantages of a mesh topology are:

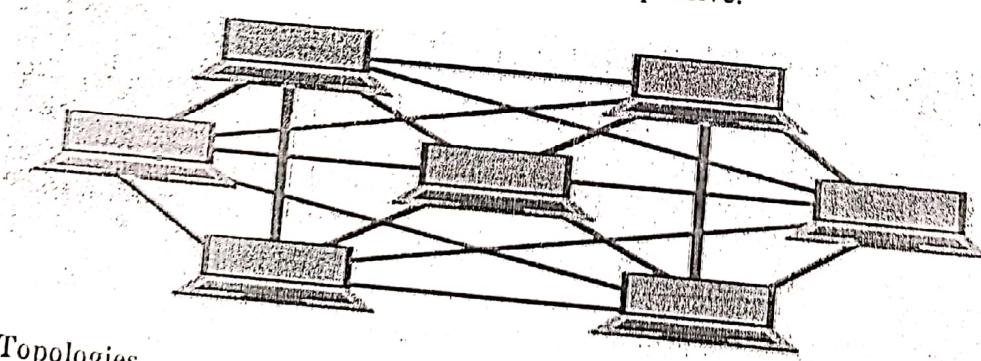
- A mesh network offers improved fault tolerance if part of the system goes down.
- High speeds data transfers
- Durable network that isn't dependent on any one node
- Very secure
- Suitable for high-value networks for small to middle-sized networks
- Easy to identify faulty equipment

Mesh topologies are used first and foremost because they are reliable. The interconnectivity of nodes makes them extremely resistant to failures. There is no single machine failure that could bring down the entire network. The absence of a single point of failure is one of the reasons why this is a popular topology choice. This setup is also secure from being compromised.

The disadvantages of a mesh topology are:

- It's expensive and difficult to install a mesh network.
- A mesh network is difficult to manage.
- A mesh network is also difficult to troubleshoot.
- Requires a very large amount of cable
- Can be difficult to secure all the cable
- Takes a long time to set up
- Requires meticulous planning
- There is a limit to the number of cables each computer can accommodate

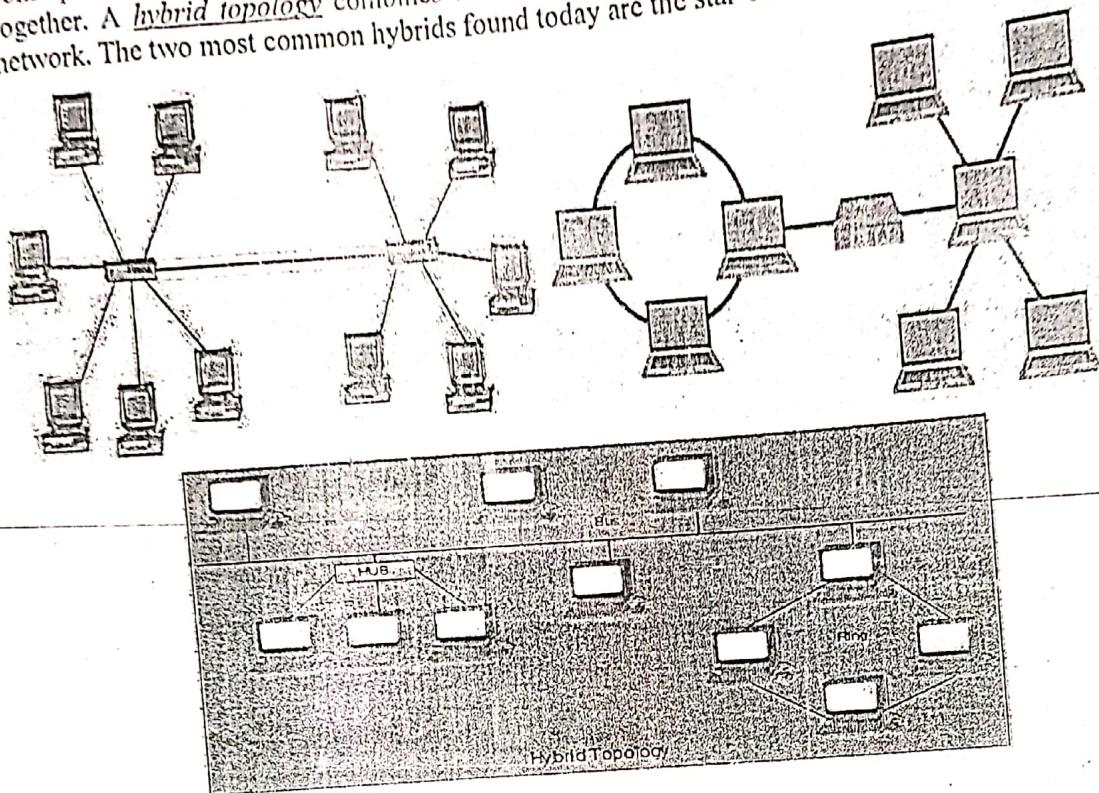
However, mesh topologies are far from perfect. They require an immense amount of configuration once they are deployed. The topological layout is more complex than many other topologies and this is reflected by how long it takes to set up. You'll need to accommodate a whole host of new wiring which can add up to be quite expensive.



Hybrid Topologies

When a topology is composed of two or more different topologies it is referred to as a hybrid topology. Hybrid topologies are most-commonly encountered in larger enterprises where

individual departments have network topologies that different from another topology in the organization. Connecting these topologies together will result in a hybrid topology. As a consequence, the capabilities and vulnerabilities depend on the types of topology that are tied together. A hybrid topology combines two or more different physical topologies in a single network. The two most common hybrids found today are the star-bus and star-ring topologies.



The advantages of a mesh topology are:

- Very flexible
- Suitable for middle-sized and large organizations
- Infinitely extendible
- Adaptable to optimize equipment use

There are many reasons why hybrid topologies are used but they all have one thing in common: flexibility. There are few constraints on the network structure that a hybrid topology cannot accommodate, and you can incorporate multiple topologies into one hybrid setup. As a consequence, hybrid topologies are very scalable. The scalability of hybrid setups makes them well-suited to larger networks.

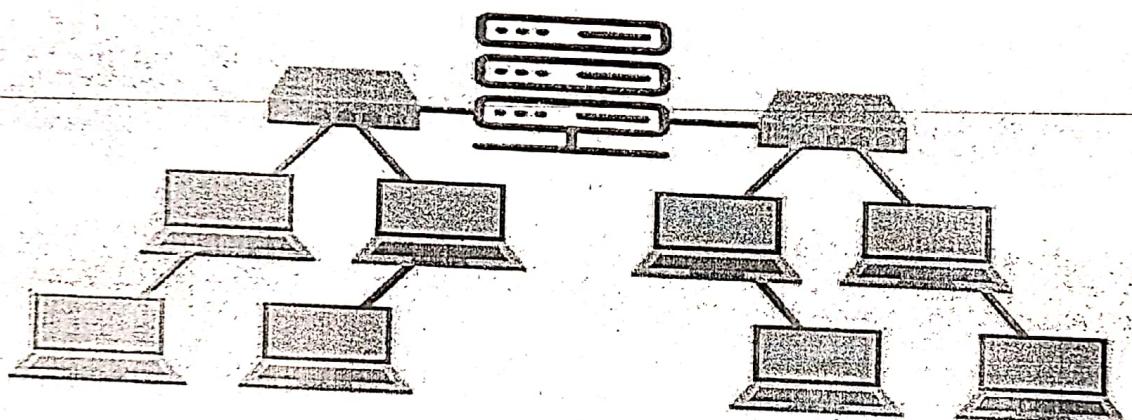
The disadvantages of a mesh topology are:

- Requires professional management
- Needs monitoring software
- Equipment costs are high

Unfortunately, hybrid topologies can be quite complex, depending on the topologies that you decide to use. Each topology that is part of your hybrid topology will have to be managed according to its unique network requirements. This makes administrators' jobs more difficult because they are going to have to attempt to manage multiple topologies rather than a single one. In addition, setting up a hybrid topology can end up being quite costly.

Tree Topology

A hierarchical layout that links together groups of nodes. Creates parent-child dependencies between root nodes and regular nodes. This layout can be vulnerable to failure if a root node has a problem. This topology is complicated and difficult to manage and it uses a lot of cable.



The advantages of a tree topology are:

- Blends bus and star topologies
- Easy to manage
- Easy to expand
- Suitable for middle-sized businesses

The disadvantages of a mesh topology are:

- The network is dependent on the health of the root node. If the root node fails then all of its subtrees become partitioned
- Requires networking expertise. Maintaining the network system is not simple either because the more nodes you add, the more difficult it becomes to manage the network
- Involves a lot of cable. Cables are required to connect every device throughout the hierarchy which makes the network layout more complex when compared to a simpler topology.
- Larger implementations require monitoring software
- Can get expensive

Network Devices

Networking devices are fundamental to the interconnection and communication that takes place within a network, each device has different role. While some devices are specific to LANs, others can function at both the LAN and WAN levels. As technology advances, more and more devices provide services at multiple layers of the OSI model. In this part, you will learn about the types of devices you can use to connect and expand your network and the OSI layers where those devices function.

Device Selection Factors

To meet user requirements, a LAN needs to be planned and designed. Planning ensures that all requirements, cost factors and deployment options are given due consideration. When selecting a device for a particular LAN, there are a number of factors that need to be considered. These factors include, but are not limited to:

- Cost
- Speed and Types of Ports/Interfaces
- Expandability
- Manageability
- Additional Features and Services

Devices

- ❖ Network Interface Cards
- ❖ Repeaters
- ❖ Hubs
- ❖ Access Points
- ❖ Wireless Bridges
- ❖ Switches
- ❖ Routers
- ❖ Brouters
- ❖ Gateways

Comparing Networking Devices

Device	Advantages	Disadvantages
Repeater	Can connect different types of media; can extend the distance a network can reach; does not increase network traffic; Cost effective and simple to connect	Extends the collision domain; cannot filter information; cannot connect different network architectures; only a limited number can be used within a network
Hub	Cheap; can connect segments using different media types	Extends the collision domain; cannot filter information; passes along all packets to all connected segments

Device	Advantages	Disadvantages
Access point	Relatively cheap for use with a small number of wireless devices; does not require a physical connection for users to access network resource	Reduced security; distance limitations; can be affected by interference or structures
Bridge	Limits the collision domain; can extend network distances; can filter packets based on their MAC addresses and ease congestion; can connect different types of media; some can connect different types of network architectures	Broadcast packets cannot be filtered; more expensive than a repeater; slower than a repeater due to processing the addresses and filtering packets
Wireless bridge	Allows the wireless connection of multiple wired LAN segments; can provide services to wireless clients	More expensive than an access point; if large amounts of throughput are needed, it can be expensive
Switch	Limits the collision domain; can provide bridging to multiple segments of a network; can be configured to limit broadcast domains through the use of virtual LANs	More expensive than a hub or a bridge; configuration of additional functions can be complex
Brouter	Limits the collision domain; can provide the services of bridges and routers in one device	More expensive than a bridge
Router	Limits the collision domain; can function in the LAN or WAN environment; can connect networks using different media and architectures; can determine the best path for a packet to reach another network; can filter broadcasts	Expensive; must be used with routable protocols; must be configured by an administrator; can be difficult to configure; slower than a bridge due to increased processing and routing updates sent between routers
Gateway	Can connect different network systems using different protocols, addresses, and applications	Can be difficult to install and configure; additional overhead for processing data slows network performance

ISSUES TO NOTE:

- ❖ Type of network device
- ❖ OSI layer in which they function
- ❖ Functions of the network device
- ❖ Factors to consider when selecting a specific network device
- ❖ Advantages of a specific network device
- ❖ Disadvantages of a specific network device
- ❖ Network media associated in a specific network device

Unshielded Twisted Pair
The standard plastic connector for RJ-45 to be used follows a standard goes with each

NETWORK MEDIA

A network's transmission media is a long-term investment. Unlike computer equipment, which is often replaced every two to five years, a company may use the same networking media for 10 or 15 years. Thus, choosing the correct media is crucial to having a functioning network.

There are many types of media that can be used to carry transmissions across a network to allow end devices to communicate. Common types include copper, glass, and air. Each type of transmission media has characteristics that will affect the network's performance.

Copper Media

Copper cable is the oldest form of networking media. It was implemented in the first IBM mainframe networks using shielded twisted pair. Today, several types of copper media are available that provide different data transmission rates and serve different types of networks. These include coaxial cable, shielded twisted pair, and unshielded twisted pair.

What is Network Cabling?

Cable is the medium through which information usually moves from one network device to another. There are several types of cable which are commonly used with LANs. In some cases, a network will utilize only one type of cable, other networks will use a variety of cable types. The type of cable chosen for a network is related to the network's topology, protocol, and size. Understanding the characteristics of different types of cable and how they relate to other aspects of a network is necessary for the development of a successful network.

The following sections discuss the types of cables used in networks and other related topics.

- Unshielded Twisted Pair (UTP) Cable
- Shielded Twisted Pair (STP) Cable
- Coaxial Cable
- Fiber Optic Cable
- Cable Installation Guides

Twisted pair cabling comes in two varieties: shielded and unshielded. Unshielded twisted pair (UTP) is the most popular and is generally the best option for school networks (See fig. 1).

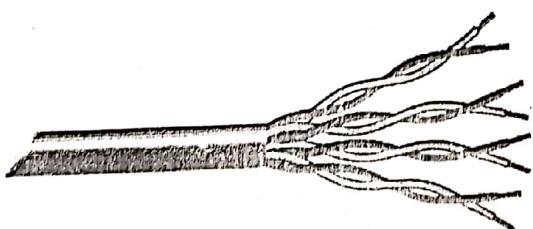


Fig.1. Unshielded twisted pair

Unshielded Twisted Pair Connector

The standard connector for unshielded twisted pair cabling is an RJ-45 connector. This is a plastic connector that looks like a large telephone-style connector (See fig. 2). A slot allows the RJ-45 to be inserted only one way. RJ stands for Registered Jack, implying that the connector follows a standard borrowed from the telephone industry. This standard designates which wire goes with each pin inside the connector.

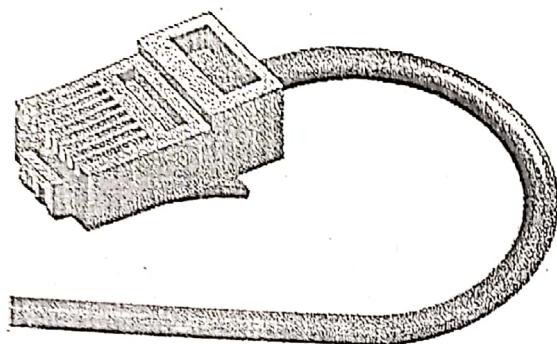


Fig. 2. RJ-45 connector

Shielded Twisted Pair (STP) Cable

Although UTP cable is the least expensive cable, it may be susceptible to radio and electrical frequency interference (it should not be too close to electric motors, fluorescent lights, etc.). If you must place cable in environments with lots of potential interference, or if you must place cable in extremely sensitive environments that may be susceptible to the electrical current in the UTP, shielded twisted pair may be the solution. Shielded cables can also help to extend the maximum distance of the cables.

Coaxial Cable

Coaxial cabling has a single copper conductor at its center. A plastic layer provides insulation between the center conductor and a braided metal shield (See fig. 3). The metal shield helps to block any outside interference from fluorescent lights, motors, and other computers.



Fig. 3. Coaxial cable

Fiber Optic Cable

Fiber optic cabling consists of a center glass core surrounded by several layers of protective materials (See fig. 4). It transmits light rather than electronic signals eliminating the problem of electrical interference. This makes it ideal for certain environments that contain a large amount

of electrical interference. It has also made it the standard for connecting networks between buildings, due to its immunity to the effects of moisture and lighting.



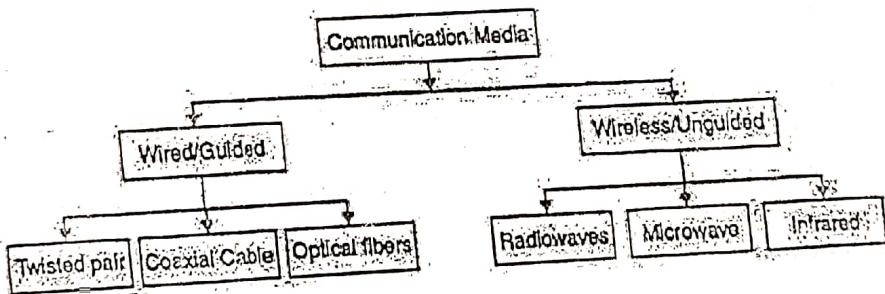
Fig. 4. Fiber optic cable

There are two common types of fiber cables -- single mode and multimode. Multimode cable has a larger diameter; however, both cables provide high bandwidth at high speeds. Single mode can provide more distance, but it is more expensive.

Installing Cable - Some Guidelines

When running cable, it is best to follow a few simple rules:

- Always use more cable than you need. Leave plenty of slack.
- Test every part of a network as you install it. Even if it is brand new, it may have problems that will be difficult to isolate later.
- Stay at least 3 feet away from fluorescent light boxes and other sources of electrical interference.
- If it is necessary to run cable across the floor, cover the cable with cable protectors.
- Label both ends of each cable.
- Use cable ties (not tape) to keep cables in the same location together.



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