

Networks

Computer networking is the process of connecting two or more computers with the purpose to share data, provide technical support, and to communicate.

Internet is the technology that is used to connect different computer systems (located in different geographic location).



User connected to a network

Advantages of Networking

- **Facility of Technical Support:** a person sitting in the United States of America provides technical support to a person sitting in a remote part of India.
- **Easy Sharing of Data:** it is very simple to share all formats of digital data from one computer system to another (irrespective of their geographic location).
- **Easy Sharing of Hardware Resource:** with the help of networking, it has now become very simple to share the expensive resources including storage space, processor, fax, etc.
- **Easy Sharing Software:** through the networking system, it is easy to share and install the software from one computer system to another computer system.
- **Easy to Decentralize Data Processing:** decentralising ultimately helps to control, secure, and manage the important data.
- **Easy to Communicate:** with the help of networking, the communication system has now become highly efficient, frugal,

and fast. The different modes of communication are text chatting, video chatting, emails, etc.

Disadvantages of Networks

- Purchasing the network cabling and file servers can be expensive.
- Managing a large network is complicated, requires training and a network manager usually needs to be employed.
- If the file server breaks down the files on the file server become inaccessible. Email might still work if it is on a separate server. The computers can still be used but are isolated.
- Viruses can spread to other computers throughout a computer network.
- There is a danger of hacking, particularly with wide area networks. Security procedures are needed to prevent such abuse, eg a firewall.

Resources

Shared resources, also known as network resources, refer to computer data, information, or hardware devices that can be easily accessed from a remote computer through a network. Successful shared resource access allows users to operate as if the shared resource were on their own computer. The most frequently used shared network environment objects are files, data, multimedia and hardware resources like printers, fax machines and scanners.

Types of Networks

The types are described below

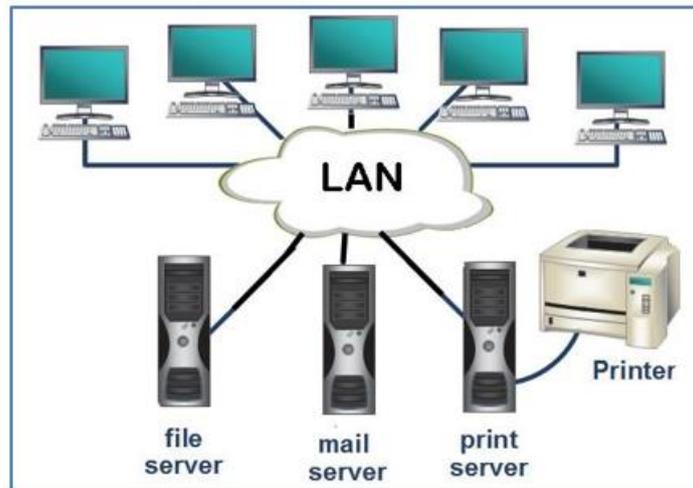
- Local Area Network (LAN)
- Metropolitan Area Network (MAN)
- Wide Area Network (WAN)

Local Area Network

A LAN is a computer network that spans a relatively small area. Most LANs are confined to a single building or group of buildings. However, one LAN can be connected to other LANs over any distance. A system of LANs connected in this way is called a wide-area network (WAN).

Most LANs connect workstations and personal computers. Each node (individual computer) in a LAN has its own CPU with which it executes programs, but it also can access data and devices anywhere on the LAN.

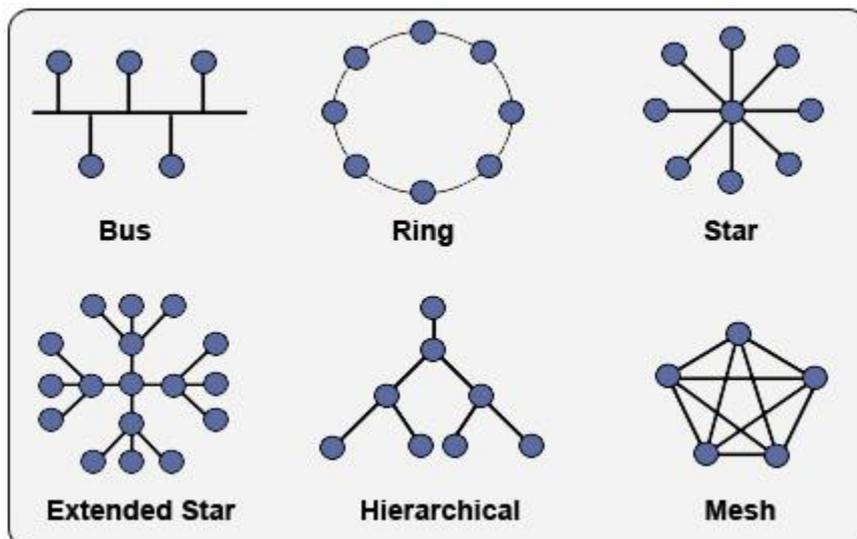
There are many different types of LANs, Ethernets being the most common for PCs. Most Apple Macintosh networks are based on Apple's AppleTalk network system, which is built into Macintosh computers.



Local Area Network

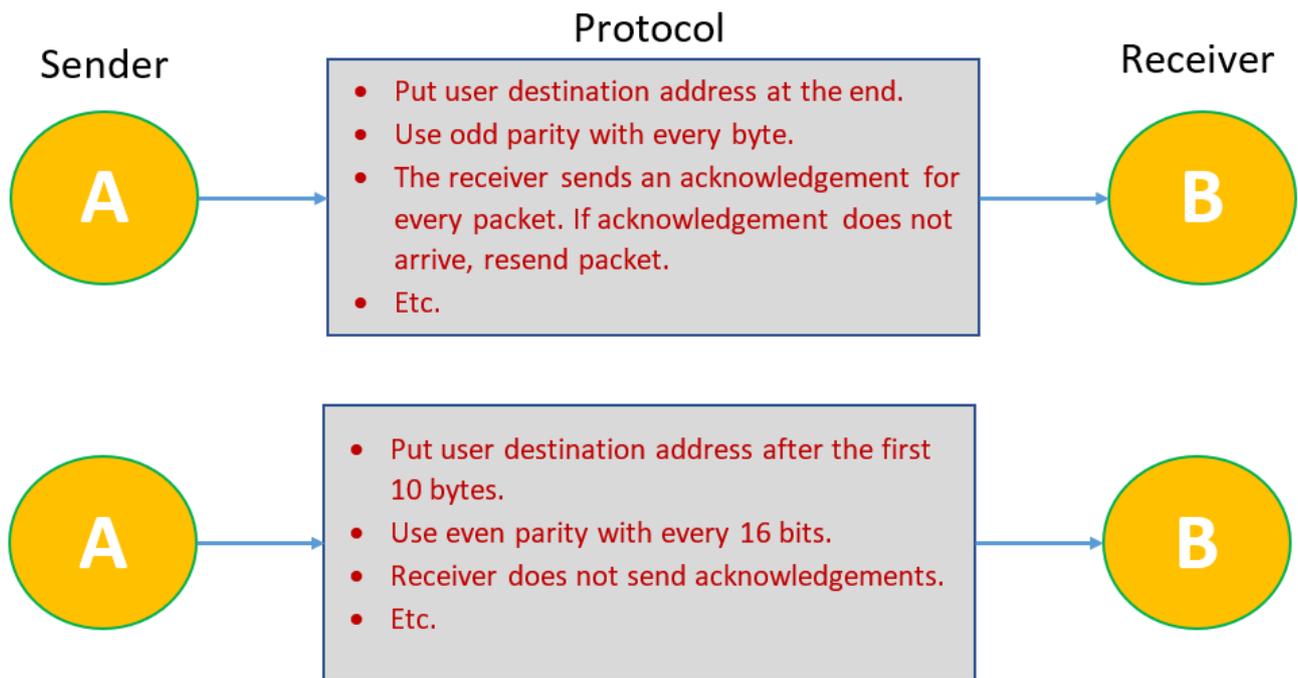
The following characteristics differentiate one LAN from another:

- **Topology:** This refers to the geometric arrangement of devices on the network. For example, devices can be arranged in a ring or in a straight line.



Various topologies

- **Protocols:** These are rules for sending data. The protocols also determine whether the network uses a peer-to-peer or client/server architecture. Peer-to-peer (P2P) is a type of network in which each workstation has equivalent capabilities and responsibilities. This differs from client/server architectures, in which some computers are dedicated to serving the others. Peer-to-peer networks are generally simpler, but they usually do not offer the same performance under heavy loads.



Different protocols

- **Media:** Devices can be connected by twisted-pair wire, coaxial cables, or fibre optic cables. Some networks do without connecting media altogether. The connections are wireless.

Coaxial Cable



Twisted Pair



Fiber Optic



Different cables

LANs are capable of transmitting data at very fast rates, but the distances are limited, and there is also a limit on the number of computers that can be attached to a single LAN.

Wireless LAN

WLANs use high-frequency radio waves and often include an access point to the Internet. A WLAN allows users to move around the coverage area, often a home or small office, while maintaining a network connection.

Every component that connects to a WLAN is considered a station and falls into one of two categories: access points (APs) and clients.

- **Access points or APs** transmit and receive radio frequency signals with devices able to receive transmitted signals; they normally function as routers.
- **Clients**, on the other hand, may include a variety of devices, such as desktop computers, workstations, laptop computers, IP phones and other cell phones and smartphone devices.



One wireless access point and four clients

Metropolitan Area Network

A metropolitan area network (MAN) is a network that interconnects users with computer resources in a geographic area or region larger than that covered by a local area network (LAN) but smaller than the area covered by a wide area network (WAN). A MAN can consist of the interconnection of several local area networks by bridging them with backbone lines. The latter usage is also sometimes referred to as a campus network.

Examples of metropolitan area networks of various sizes can be found in cities. Large universities also sometimes use the term to describe their networks.

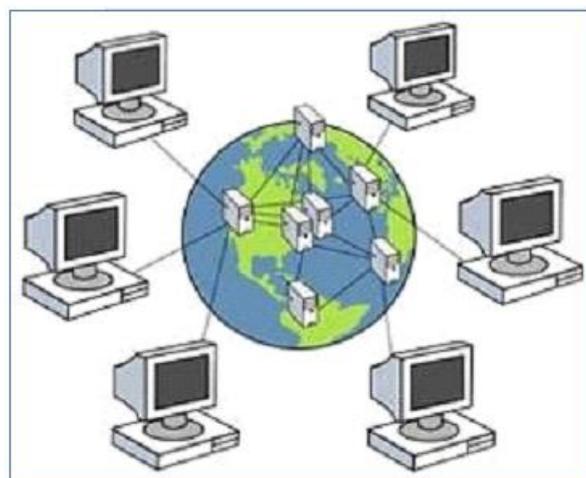


A Metropolitan Area Network

Wide Area Network

A WAN is a computer network that spans a relatively large geographical area. Typically, a WAN consists of two or more local-area networks (LANs).

Computers connected to a wide-area network are often connected through public networks, such as the telephone system. They can also be connected through leased lines or satellites. The largest WAN in existence is the Internet.



Wide Area Network

Microwave Transmission

In the electromagnetic spectrum, waves within the frequencies 1GHz to 300GHz are called microwaves. These waves are also used to carry information.

Features of microwaves:

- Microwaves travel in straight lines, and so the microwave propagation is a line-of-sight propagation. Towers hoisting the stations should be placed so that the curvature of the earth or any other obstacle does not interfere with the communication.
- Since it is unidirectional, it allows multiple receivers in a row to receive the signals without interference.
- Microwaves do not pass through buildings. So, indoor receivers cannot be used effectively.
- Microwaves are often refracted by the atmospheric layers. Thus, the placing of receivers should take this fact into account.

MAC Address

Stands for "Media Access Control Address". A MAC address is a hardware identification number that uniquely identifies each device on a network. The MAC address is manufactured into every network card, such as an Ethernet card or Wi-Fi card, and therefore cannot be changed.

Because there are millions of networkable devices in existence, and each device needs to have a unique MAC address, there must be a very wide range of possible addresses. For this reason, MAC addresses are made up of six two-digit hexadecimal numbers, separated by colons. For example, an Ethernet card may have a MAC address of 00:0d:83:b1:c0:8e. Fortunately, you do not need to know this address, since it is automatically recognized by most networks.

IP Address

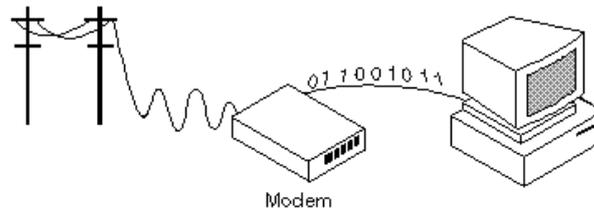
An IP address, or simply an "IP," is a unique address that identifies a device on the Internet or a local network. There are two primary types of IP address formats used today — IPv4 and IPv6.

MAC Address and IP Address are both used to identify a computer on a network or on internet. MAC address is provided by NIC Card's manufacturer and gives the physical address of a computer. IP address

is provided by Internet Service Provider and is called the logical address of a computer connected on a network.

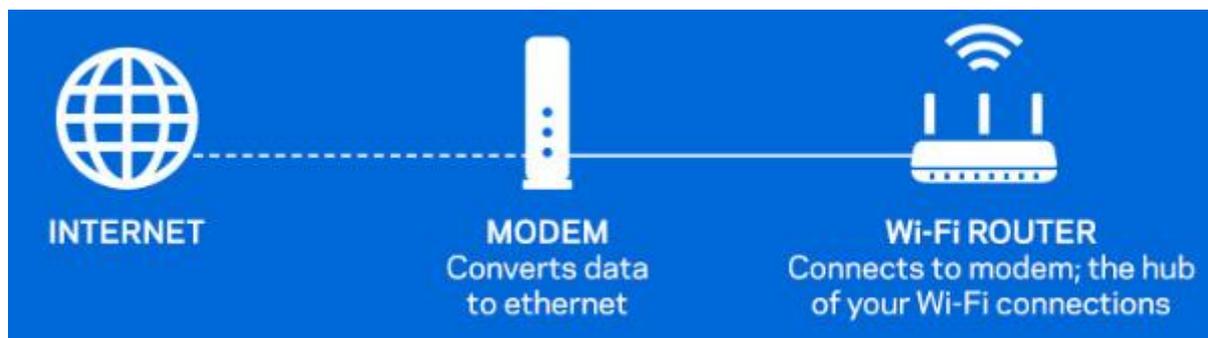
Networking Devices

Modem



Short for modulator-demodulator. A modem is a device or program that enables a computer to transmit data over, for example, telephone or cable lines. Computer information is stored digitally, whereas information transmitted over telephone lines is transmitted in the form of analogue waves. A modem converts between these two forms.

From Wi-Fi router to mobile devices, the components that make up your home network all speak different digital languages, but your modem is the translator. It takes the signals that come from your Internet Service Provider, or ISP, and translates them into an Internet connection for your Wi-Fi router to broadcast.



Download (or downstream) speed denotes how fast data comes into your home when you are doing things like streaming movies from Netflix. Upload (or upstream) speed represents how fast you can send data to Internet services, like when you upload photos to Facebook.

There are several technologies that permit the transmission of data from one place to another. They all use modem. These technologies are explained hereunder.

Cable Modem

- This modem designed to operate over cable TV lines (coaxial cable).
- Provides greater bandwidth than telephone lines.
- Most providers offer service with between 1 Mbps and 16 Mbps (even beyond) bandwidth for downloads, and up to a few Megabits for uploads.
- Always-on connection.

DSL Modems

- xDSL refers collectively to all types of “digital subscriber lines” (DSL).
- The one used in homes is ADSL.
- Provides outstanding speeds. Can transmit a signal via a copper phone line at speeds over 100 Mbps. The average DSL service, however, tends to be around seven to 25 Mbps.
- Use telephone lines.
- DSL service allows the user to talk on the phone while simultaneously accessing the Internet.

Fibre Optic Modem

- The medium of transmission is glass. Data is carried in beams of light.
- Because fiber internet is not affected by deteriorating copper phone lines or hindered by crowded cable lines, it transmits more data farther and faster than DSL or cable. So, getting a fiber-compatible modem will give you the best experience.

Wireless Modem

- Connects directly to a wireless network.
- May be prebuilt into smartphones.
- Range from the size of a cable modem to the size of a credit card or smaller.
- There are several wireless technologies e.g. Bluetooth, Wi-Fi and WiMAX.

Satellite Modem

- Not used much.
- Slow.
- Usually used only in remote locations

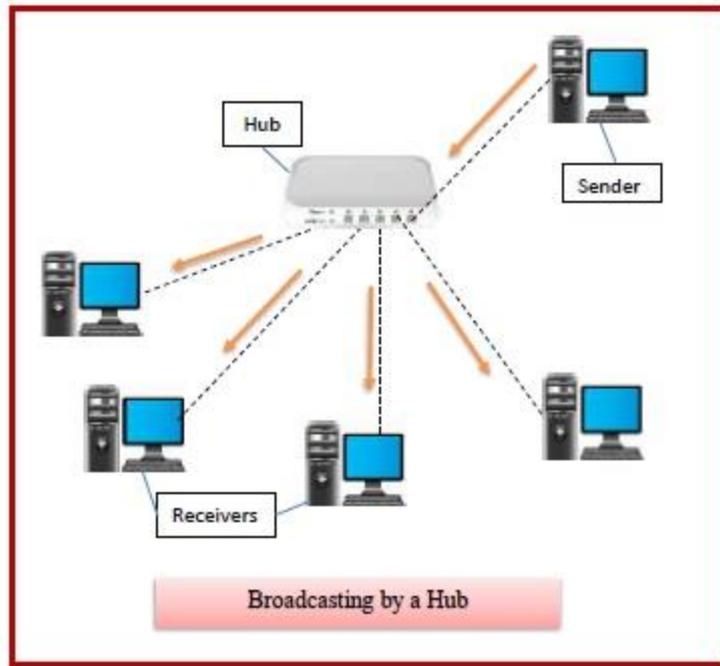
Comparison of ADSL and Cable Networks

- ADSL uses the existing telephone lines for providing data, voice and multimedia services, while cable uses existing cable TV networks to provide similar services.
- Both ADSL and cable networks use fibre optic cables in their backbone. However, in the customer end, cable network uses coaxial cables while ADSL use twisted pairs.
- Cable provide much high-speed connection than ADSL. ADSL provides maximum speed of 200 Mbps, while cable modem can provide speed up to 1.2 Gbps.
- ADSL provides reasonably consistent bandwidth and speed of transmission. However, in case of cable connections, speed depends upon the number of users who are using the cable at a given instance of time.
- ADSL networks are more scalable in nature, as each user has a dedicated connection. If the number of users increases in the system, it does not have much impact on the existing users. On the other hand, cable lines are shared and so if more users are logged on, the performance decreases. This renders the cable system less scalable.
- To avail ADSL services, the distance between the subscriber and the end offices should be within a stipulated range. On the other hand, the distance from the headend of the cable provider and the subscriber does not pose as a hindrance for availing the services.
- The telephone system is more reliable and secure than the cable network system since the former was designed for point - to - point communication while the latter was designed for broadcast services.

Hub

Hubs are networking devices that are used to connect multiple devices in a network. They are generally used to connect computers in a LAN.

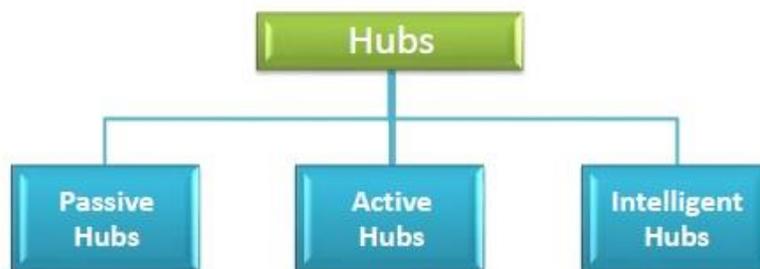
A hub has many ports in it. A computer which intends to be connected to the network is plugged in to one of these ports. When a data frame arrives at a port, it is broadcast to every other port, without considering whether it is destined for a particular destination device or not.



A hub connecting computers in a network

Types of Hubs:

Initially, hubs were passive devices. However, with development of advanced technology, active hubs and intelligent hubs came into use.



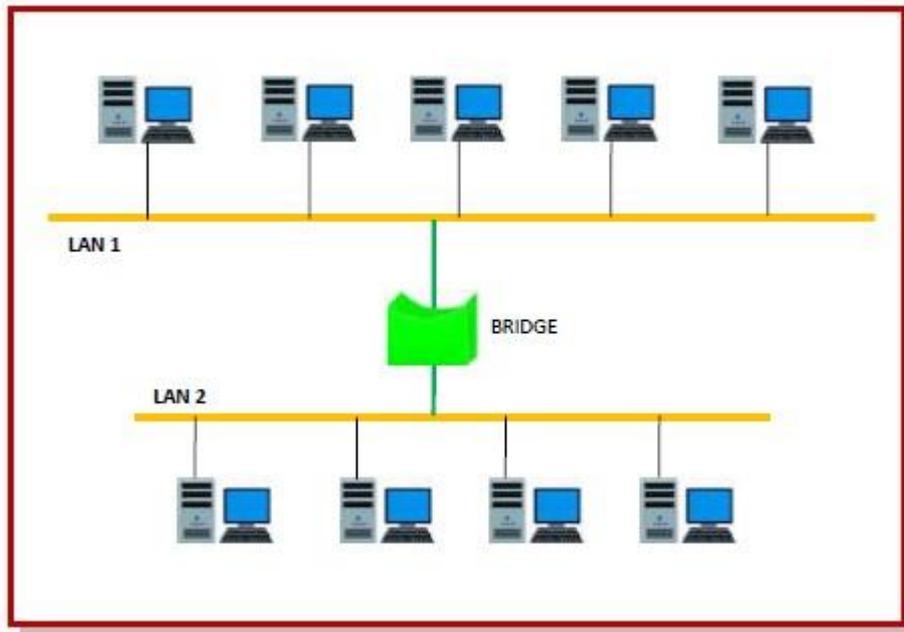
Types of hubs

- **Passive Hubs** – They just receive a message and broadcast it to all the other nodes.
- **Active Hubs** – Active hubs amplify and regenerate the incoming electrical signals before broadcasting them.
- **Intelligent Hubs** – Intelligent hubs are active hubs that provide additional network management facilities. They can perform a variety of functions of more intelligent network devices like network management, switching, providing flexible data rates etc.

Bridge

A bridge is a network device that connects multiple LANs (local area networks) together to form a larger LAN.

The following diagram shows a bridge connecting two LANs.



A bridge connecting two networks

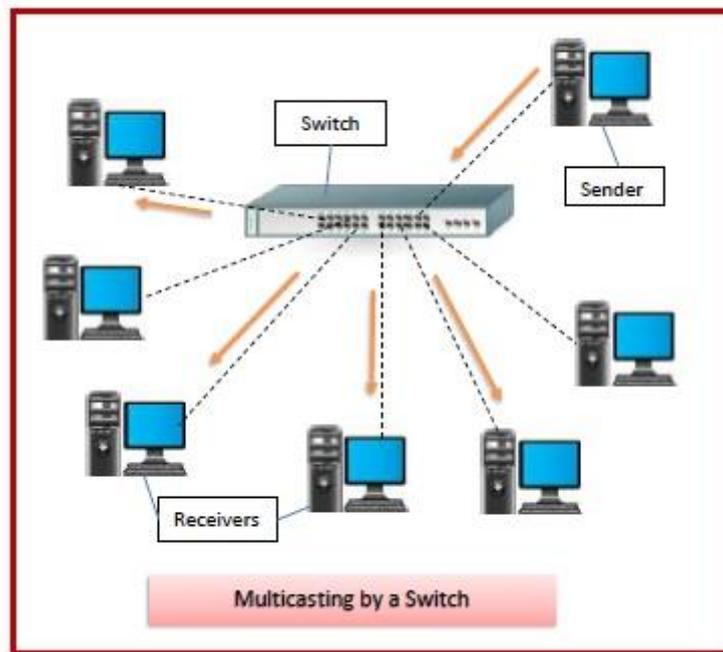
Uses of Bridge

- Bridges connects two or more different LANs that have a similar protocol and provides communication between the devices (nodes) in them.
- Bridges can switch any kind of packets, be it IP packets or AppleTalk packets, from the network layer above. This is because bridges do not examine the payload field of the data frame that arrives, but simply looks at the MAC address for switching.
- Bridges also connect virtual LANs (VLANs) to make a larger VLAN (A VLAN is a group of two or more networks that are connected and appear to be one LAN).
- A wireless bridge is used to connect wireless networks or networks having a wireless segment.

Switch

Switches connect devices in a network. A switch has many ports, to which computers are plugged in. When a data frame arrives at any port

of a network switch, it examines the destination address, performs necessary checks, and sends the frame to the corresponding device(s).



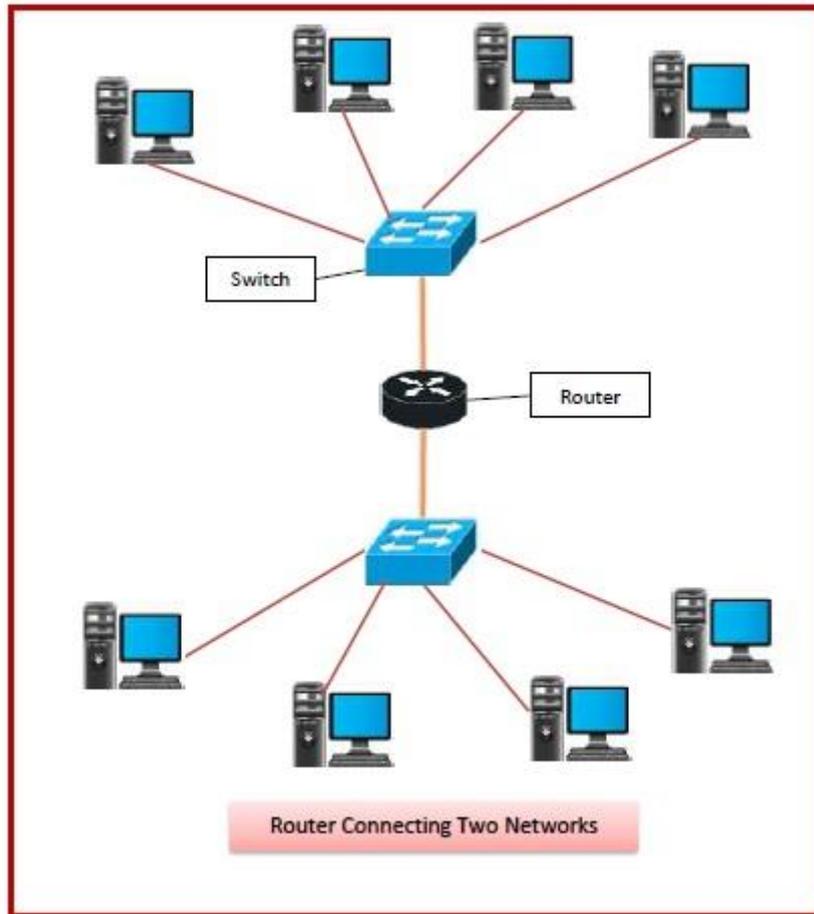
A switch connecting the nodes of a network

Features of Switches

- It is an intelligent network device that can be conceived as a multiport network bridge.
- It uses MAC addresses (addresses of medium access control sublayer) to send data packets to selected destination ports.
- It uses packet switching technique to receive and forward data packets from the source to the destination device.
- It supports unicast (one-to-one), multicast (one-to-many) and broadcast (one-to-all) communications.
- Switches can perform some error checking before forwarding data to the destined port.

Router

Routers are responsible for receiving, analysing, and forwarding data packets among the connected computer networks. When a data packet arrives, the router inspects the destination address, consults its routing tables to decide the optimal route and then transfers the packet along this route.



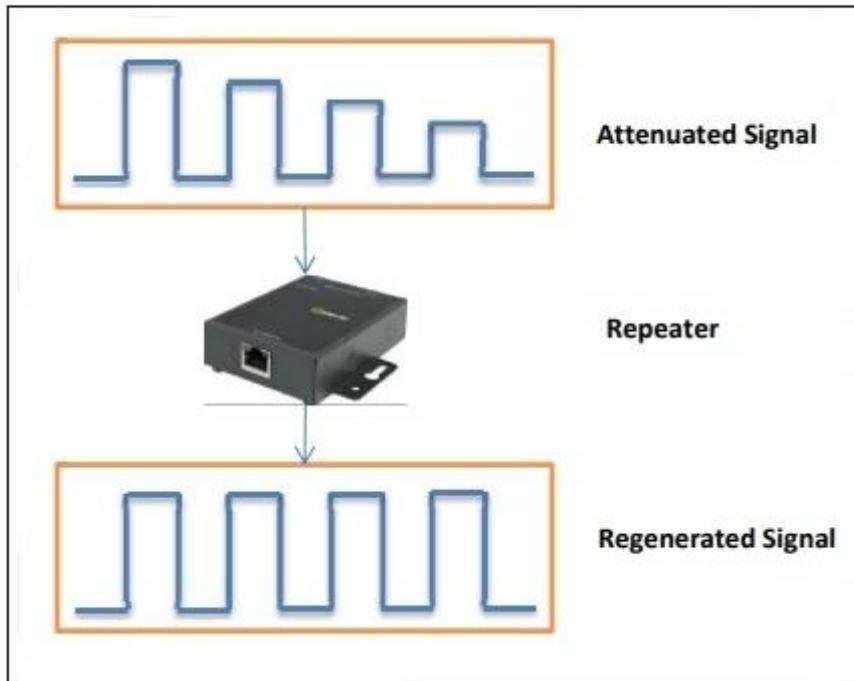
A router directing data packets to the nodes in a network

Features of Routers

- It connects different networks together and sends data packets from one network to another.
- A router can be used both in LANs (Local Area Networks) and WANs (Wide Area Networks).
- Routers have a routing table in it that is refreshed periodically according to the changes in the network. To transmit data packets, it consults the routing table.
- To prepare or refresh the routing table, routers share information among each other.

Repeater

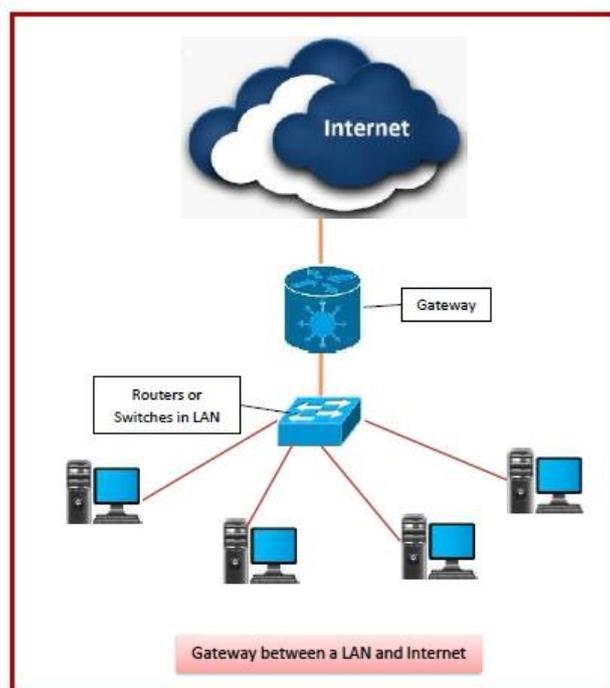
Repeaters amplify or regenerate an incoming signal before retransmitting it. They are incorporated in networks to expand its coverage area. They are also known as signal boosters.



A repeater

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

Gateway



A gateway

A gateway is a network node that forms a passage between two networks operating with different transmission protocols. Only the internal traffic between the nodes of a LAN does not pass through the gateway.

Features of Gateways

- Gateway is located at the boundary of a network and manages all data that inflows or outflows from that network.
- It forms a passage between two different networks operating with different transmission protocols.
- A gateway is generally implemented as a node with multiple NICs (network interface cards) connected to different networks. However, it can also be configured using software.
- It uses packet switching technique to transmit data across the networks.

Examples of Applications Over a Network



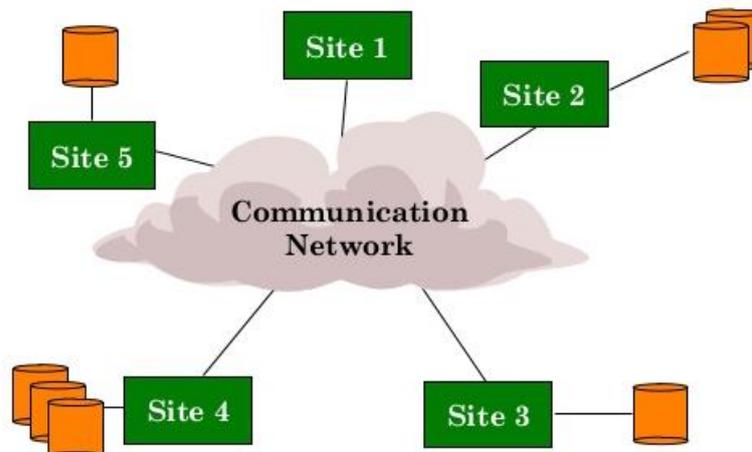
Network applications icons

- Email Programs: They allow users to type messages at their local nodes and then send to someone on the network. It is a fast and easy way of transferring mail from one computer to another.
- World wide web (WWW): It is made of millions of sites that users all over the world can access. It is a part of the Internet and uses hypertext to jump from one site to another (or from a location in a site to another location on the same site). Browsers are used to navigate the WWW.
- File Transfer Protocol (FTP): This application facilitates transfer of files from one computer to another e.g. from a client to a server.
- Terminal Emulation (TELNET): Telnet is used to virtually access a computer and to provide a two-way, collaborative and text-based communication channel between two machines. The user feels like he/she is using the other computer (often a server) directly.

- Groupware: These applications are used work in groups e.g. instance video conferencing and chatting.

Distributed Database

A distributed database is a database that consists of two or more files located in different sites either on the same network or on entirely different networks. Portions of the database are stored in multiple physical locations and processing is distributed among multiple database nodes.



Distributed database

A centralized distributed database management system (DDBMS) integrates data logically so it can be managed as if it were all stored in the same location.

By contrast, a centralized database consists of a single database file located at one site using a single network.
