

Computer Networks

Lecture 01

Introduction to Computer Networks and the Internet

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Lecture

01

LEARNING OUTCOMES

- Understand the meaning of network.
- Recognize the different types of network.
- Understand the network topologies.
- Recognize the different types of network devices and their functions.
- Understand the Internet evolution.
- Define network protocols.
- Understand the different types of Internet connection and their properties.

What is Computer Networks?



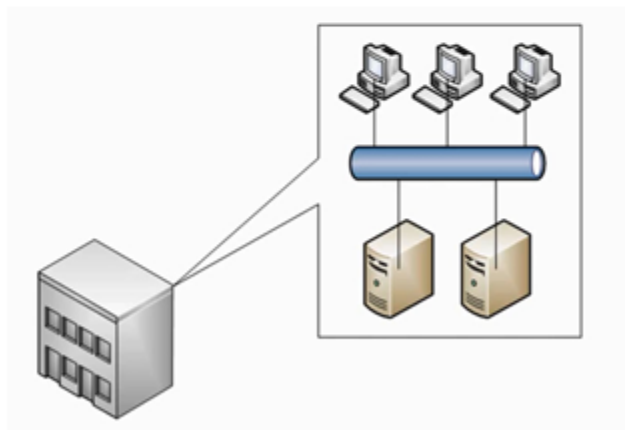
A collection of computers, servers, mainframes, network devices, or other devices connected to one another allowing for data to be shared and used.

Personal Area Network (PAN):

PAN is a computer network organized around an individual person within a single building. This could be inside a small office or residence. A typical PAN would include one or more computers, telephones, peripheral devices, video game consoles and other personal entertainment devices.

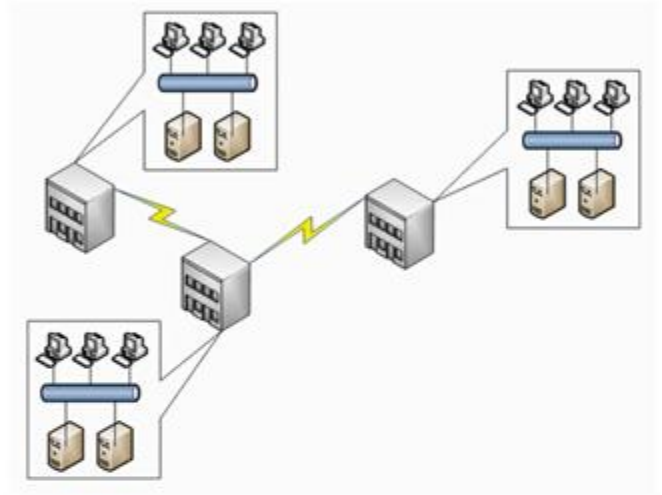
**Local Area Network (LAN):**

LAN is a computer network that connects servers and personal computers within the same building.

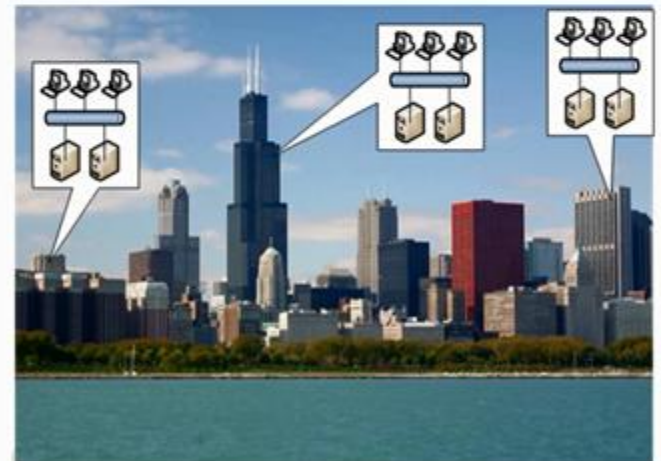


Campus Area Network (CAN):

CAN is a group of LANs that connects (more than one building) within the same property.

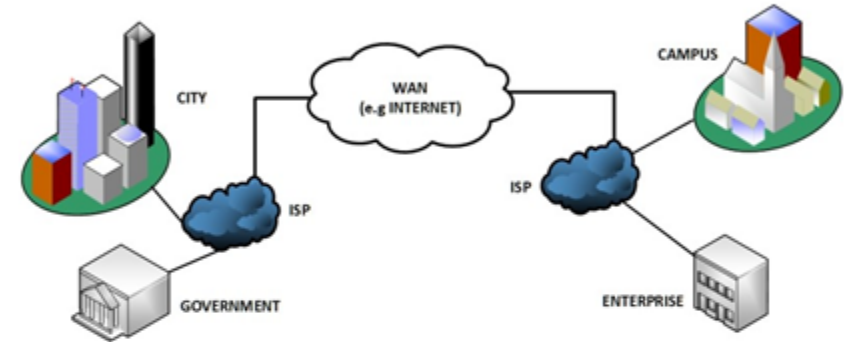
**Metropolitan Area Network (MAN):**

MAN is a group of LANs or CANs that connects buildings in multiple properties but within the same city (Metropolitan).

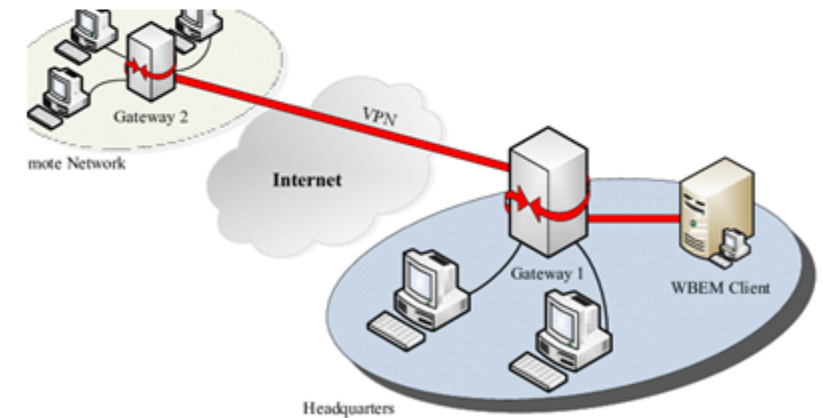


Wide Area Network (WAN):

WAN is a LANs, CANs, or MANs that connects all within the same country or countries.

**Virtual Private Network (VPN):**

VPN allows a secure connection to the WAN, thus protecting your data and device from attack.

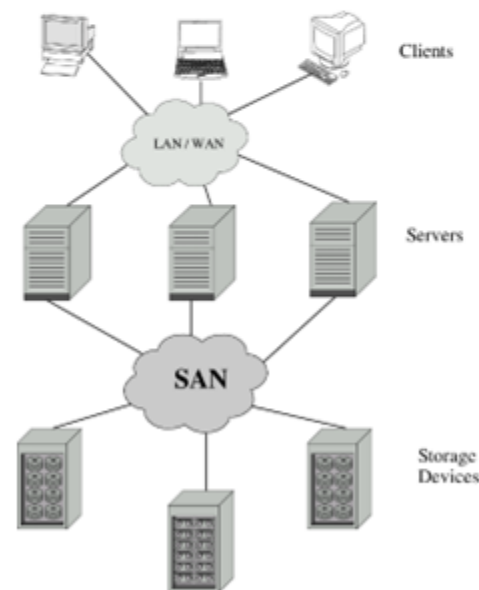


Enterprise Private Network (EPN):

EPN is a computer network that is entirely controlled by one organization, and it is used to connect multiple locations.

Storage Area Network (SAN):

SAN is a dedicated network of storage devices used to provide a pool of shared storage that multiple computers and servers can access. Storing data in centralized shared storage architecture allows organizations to manage storage and apply consistent policies for security, data protection, and disaster recovery.



What is a network topology?

Networks topology is the shape of a local area network (LAN) or other communications system, or in other words, the ways of connecting computers.



Fully Connected Network Topology



Star Network Topology



Mesh Network Topology



Common Bus Topology



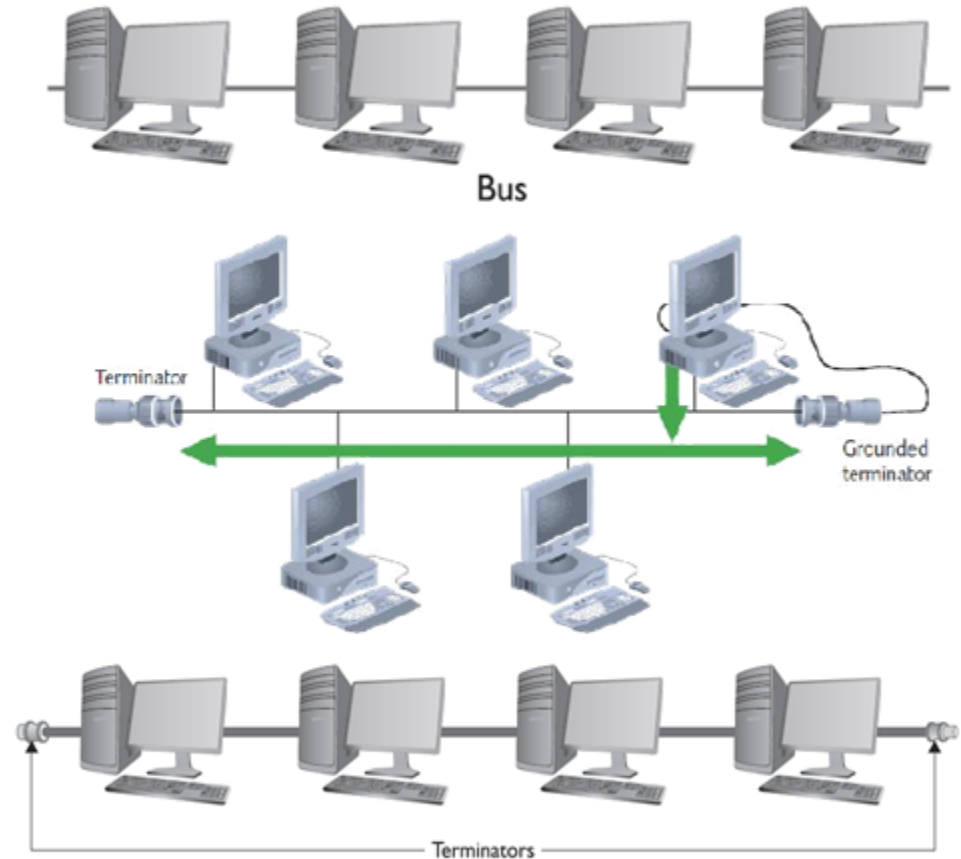
Ring Network Topology

Bus topology:

All computers are connected to a single wire (the bus) that has two endpoints.

A single break to the cable would take down the entire network. The broken ends on a bus topology network do not have the necessary termination, which causes reflection between computers that are still connected.

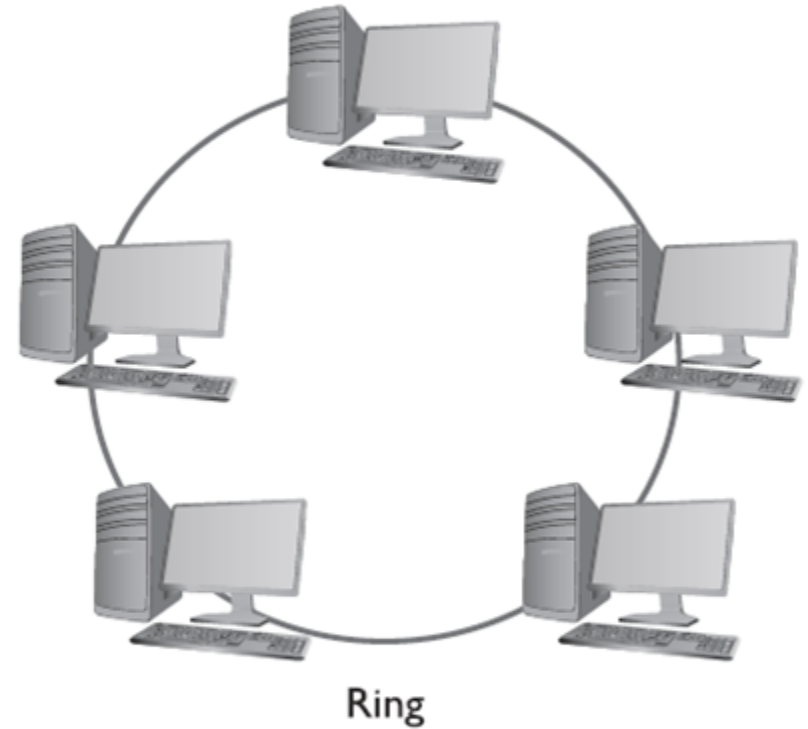
Terminators should be used at each end of a bus segment to prevent a signal from bouncing.



Ring topology:

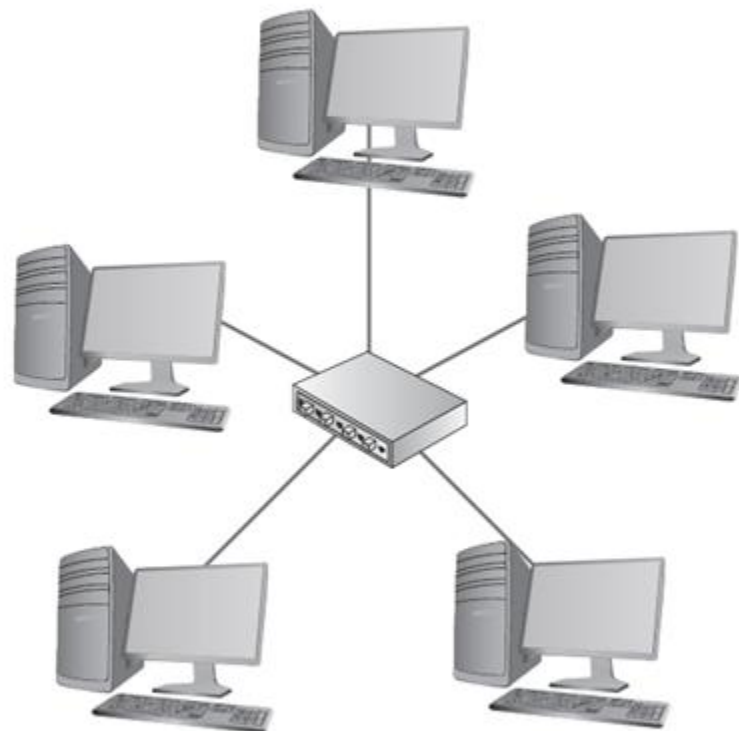
All computers are connected on the network with a ring of cable.

Data is passed around the ring from computer to another in the same direction, with no end to the cable, ring networks require no termination. A break in a ring topology network breaks the circuit, stopping the data flow.

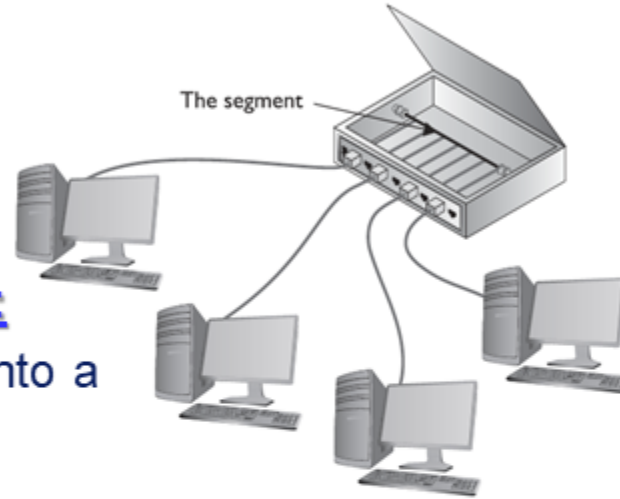


Star topology:

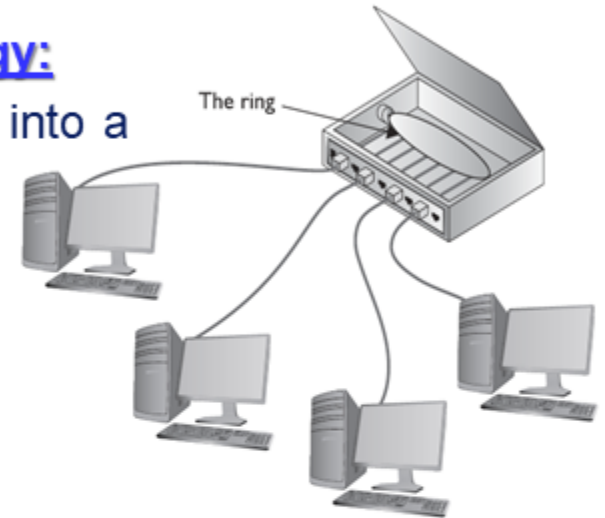
All computers are connected through a central control unit. A single break to a cable would only take down communication to one computer. A central control unit failure would take down the entire network.



- **Star-Bus topology:**
Shrinking the bus into a small box.



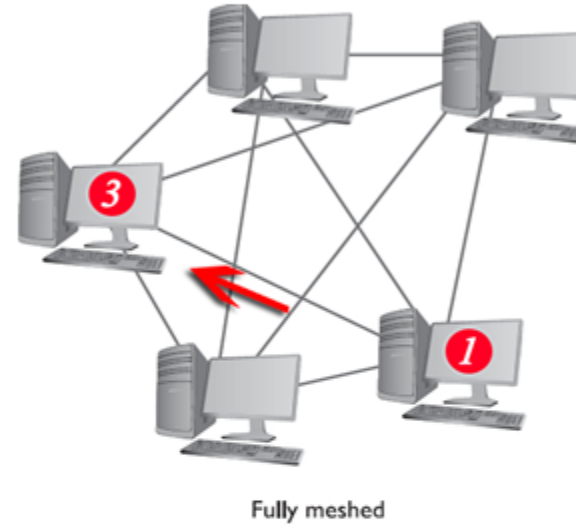
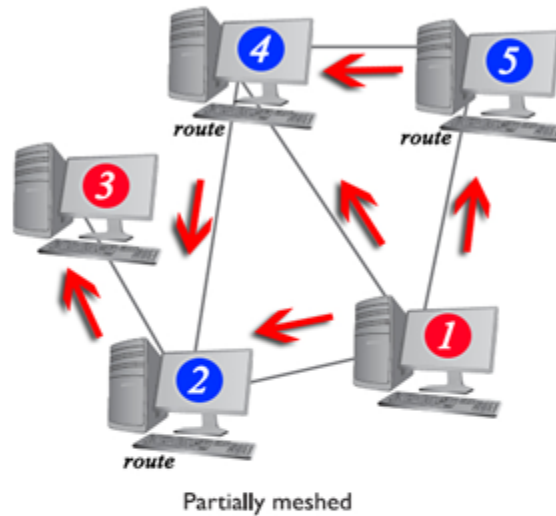
- **Star-Ring topology:**
Shrinking the ring into a small box.



Hybrid topology:

Any form of networking technology that combines a physical topology with a signaling topology is called a hybrid topology.

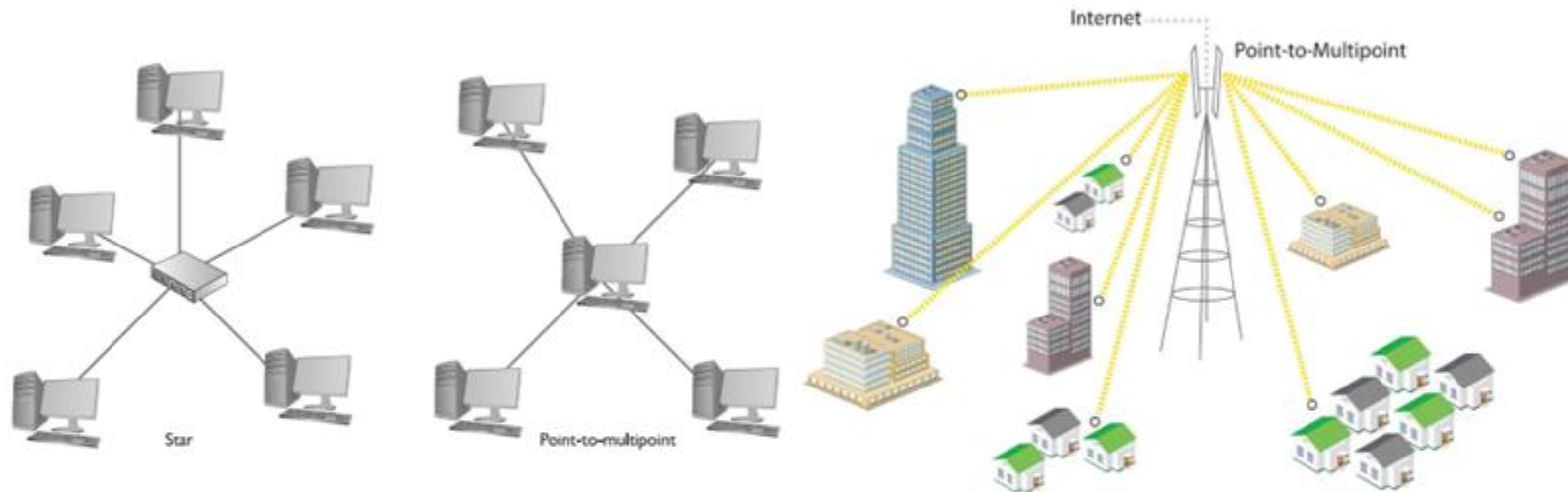
There are only two hybrid topologies, **star-ring topology**, and **star-bus topology**.



Mesh topology :

All computers are connected to all other computers. If all computers are directly connected to other computers without any routes between them, this called a fully meshed topology network. if every computer connects to every other computer via two or more routes, this called a partially meshed topology network.

Network Topologies



Point-to-Multipoint topology:

A single system acts as a common source through which all members of the **Point-to-Multipoint** network converse. The **Point-to-Multipoint** topology is physically similar to the star topology, but the difference is that a point-to-multipoint topology requires an intelligent device in the center.



Point-to-Point topology:

Two computers connect directly together with no need for a central device of any kind. Point-to-Point topology implemented in both wired and wireless networks.

**Modem:**

Used in dial-up connections over standard analog telephone lines. It can be internal or external device.

**Network Interface Card (NIC):**

Used to connect system to physical network media. It can be integrated into the system motherboard or as expansion card. Also, it can be wired or wireless NIC.

An overview of Hexadecimal numeral system:

Hexadecimal system consists of ten numbers (0,1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F), where A=10, B=11, C=12, D=13, E=14 and F=15, Thus:

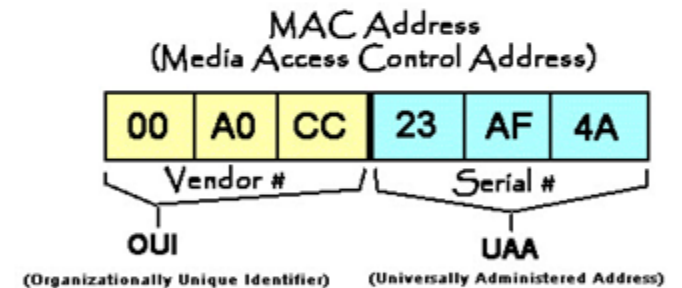
Digits: 0,1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, **Base:** Sixteen (16), since there are sixteen digits to represent this numeral system.

Weight= (Base)^{order}, **Values=** (The number that exist in this position) X (Weight of this position).

Hexadecimal	7	D	E
Order	2	1	0
Weight	$(16^2) = 256$	$(16^1) = 16$	$(16^0) = 1$
Values	$7 \times 256 = 1792$	$13 \times 16 = 208$	$14 \times 1 = 14$

The decimal value of this hexadecimal number equals the summation of all values for each position within this number set $(7DE)_{16} = 1792 + 208 + 14 = (2014)_{10}$

- Inside every **NIC**, burned onto some type of **ROM** chip, is special firmware containing a unique identifier with a **48-bit value** called the **Media Access Control** address, or **MAC** address.
- **MAC** address is **12 hexadecimal characters**. Because each hex character represents 4 bits, it takes 12 hex characters to represent 48 bits (6 Byte).
- The **MAC** address E0-69-95-90-8B-C3, The first six digits, E0-69-95; represent the number of the NIC manufacturer, no other manufacturer may use them. The last six digits, 90-8B-C3, are the manufacturer's unique serial number for that **NIC**.

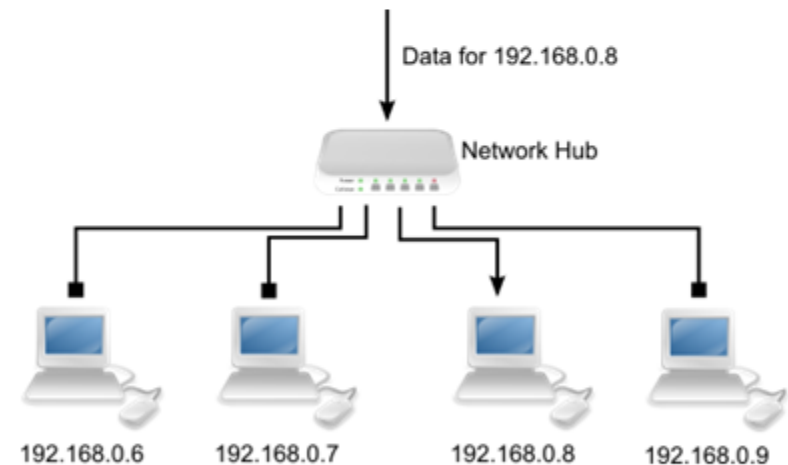


Repeater:

It deals with attenuation issues. It takes the signal in one port and transmitted out the other.

**HUB:**

It is a multi-port repeater. It takes the signal in one port and transmitted out to all other ports.

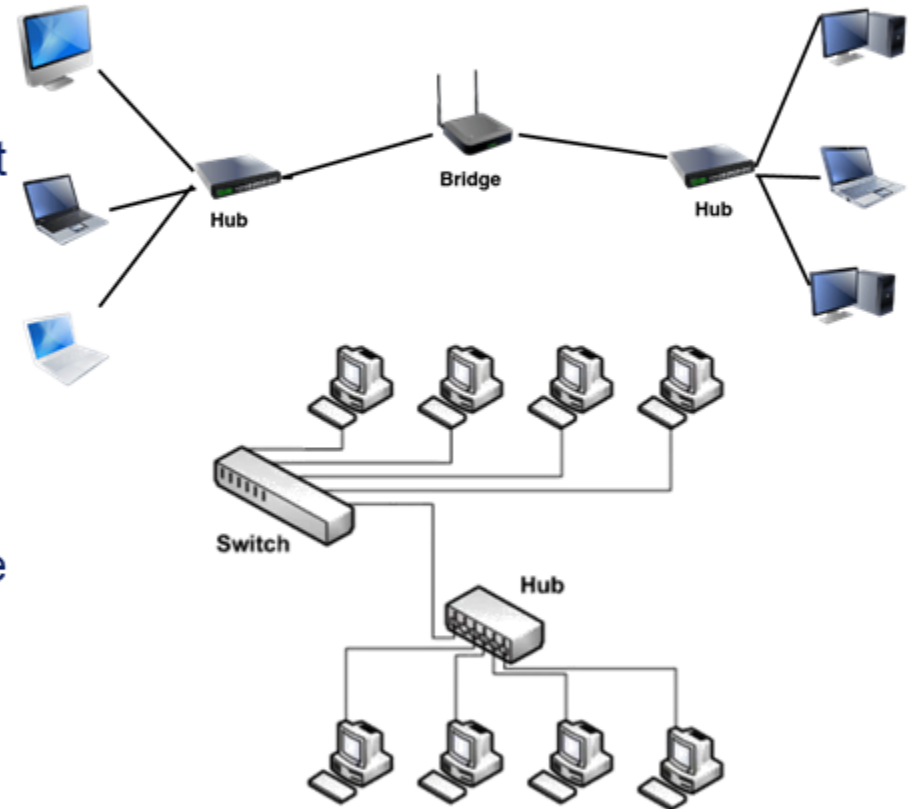


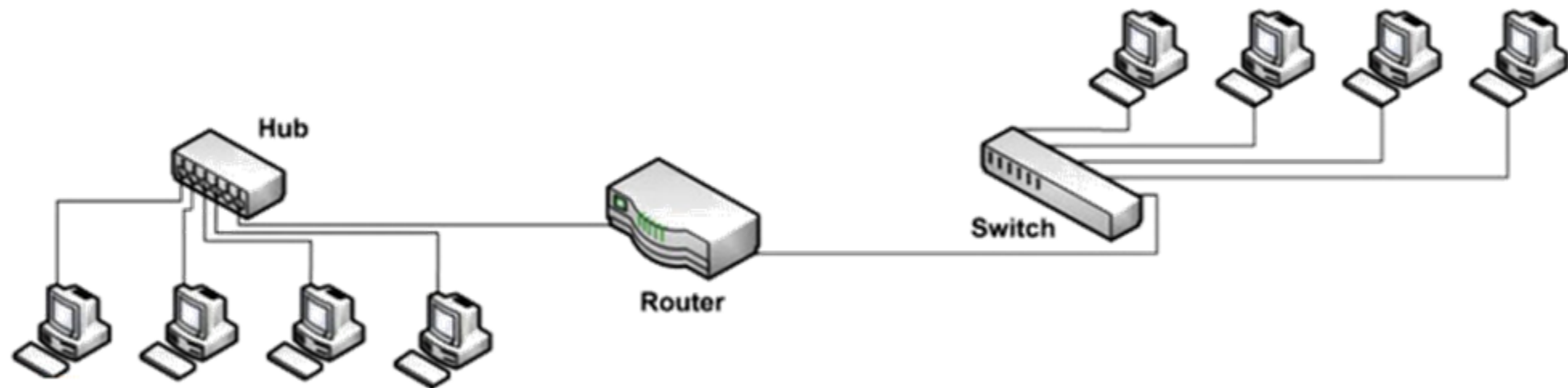
Bridge:

It connects two systems, or two segments of the same LAN that use the same protocol.

Switch:

It is basically a multi-port bridge that can connect more than one system to each other.

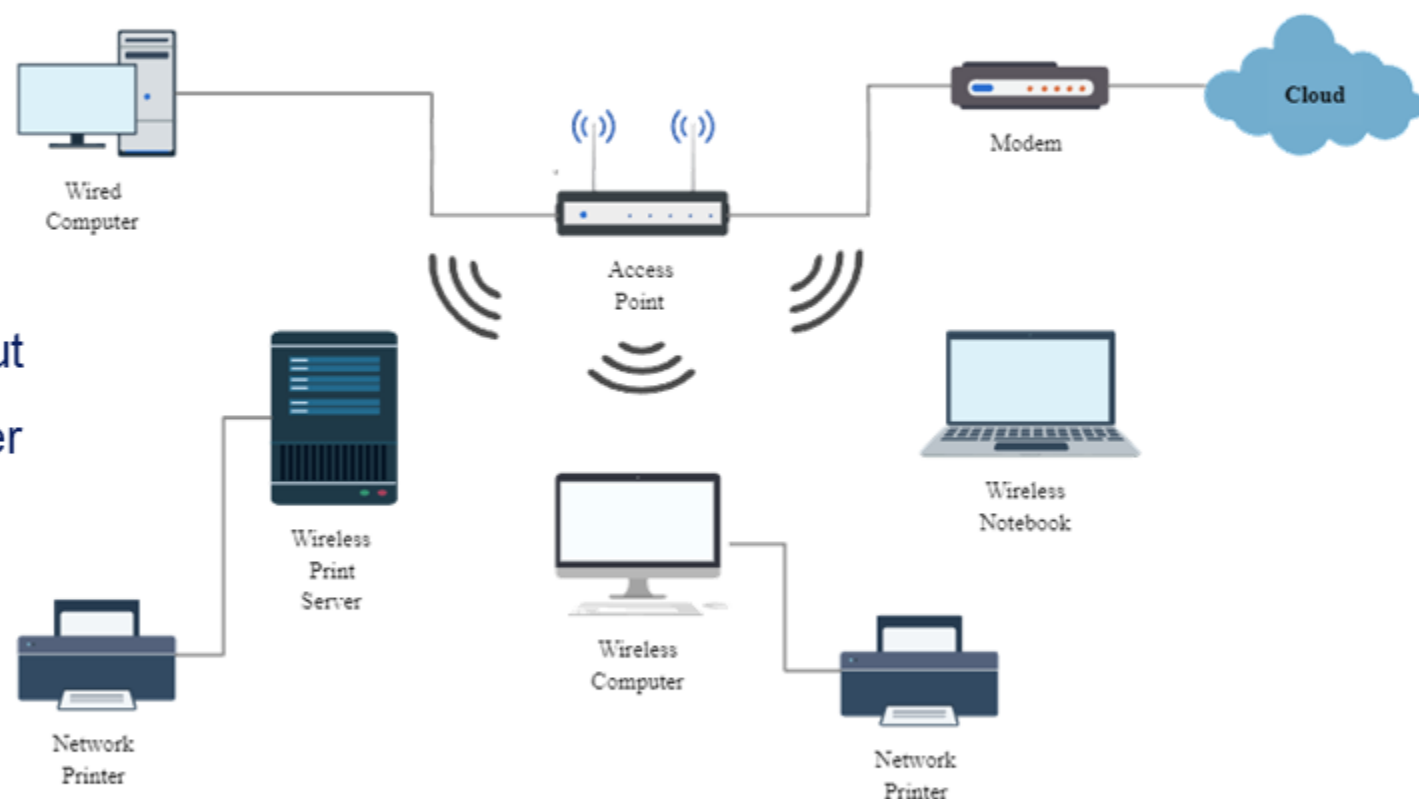


**Router:**

It can connect two or more different networks to each other

Wireless access point:

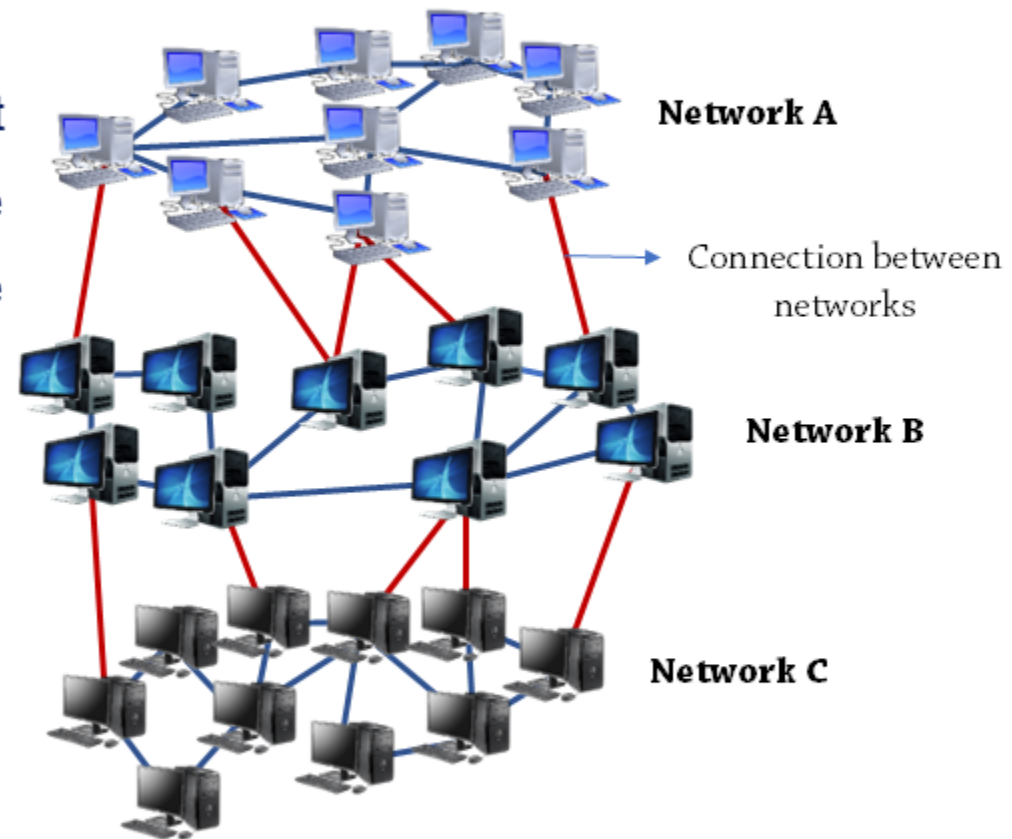
It is basically the same thing as HUB, but the connection is made via airwaves rather than cable.



What is the Internet?

The Internet is a worldwide collection of separate, but interconnected, networks accessed daily by millions of people using a variety of devices to obtain information, disseminate information, access entertainment.

The Internet (Capital "I") is a specific name given to the communication network comprised of hundreds of thousands of inter-connected networks.



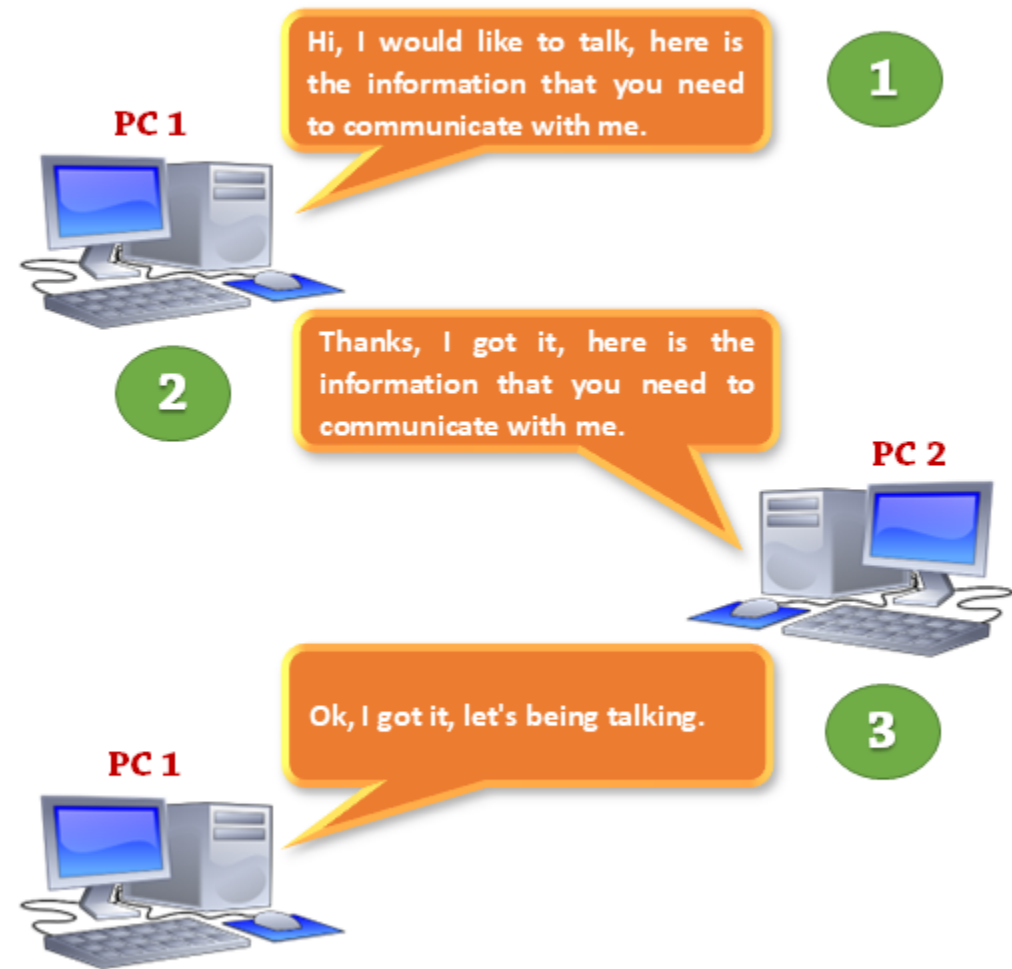
What is the Internet?

The roots of the Internet began with an experimental project called **ARPANET** stands for (A**dvanced** R**esearch** P**rojects** A**gency** N**etwork**) created by The U.S. Department of Defense in 1969 associated with Massachusetts Institute of Technology (MIT), after the Russian's launched *Sputnik*, the first satellite.



What is the Internet?

In 1974 *Bob Kahn* and *Vint Cerf* invented the **T**ransmission **C**ontrol **P**rotocol (**TCP**) which moves data on the modern Internet which became the **standard networking protocol** on the ARPANET.



What is a Protocol?

A protocol is a set of rules and instructions used for transmitting data between two devices. The protocol determines the following:

- The type of error checking to be used.
- Data compression method, if any.
- How the sending device will indicate that it has finished sending a message.
- How the receiving device will indicate that it has received a message.

What is a Port?

A port is a location where information is sent through. For example, http connection uses port no. 80.

Examples of protocols:

- Transmission Control Protocol (TCP): One to One connection, Connection-Oriented, and segment sequencing, and Reliable communication, acknowledgement.
- User Datagram Protocol (UDP): Connectionless, No acknowledgement, and Unreliable communication, and no sequencing.
- Hyper Text Transfer Protocol (HTTP): HTTP is used to transfer web pages from web server to client web browser.
- File Transfer Protocol (FTP): used to download a file from a server using the Internet or to upload a file to a server.

What is the Internet?



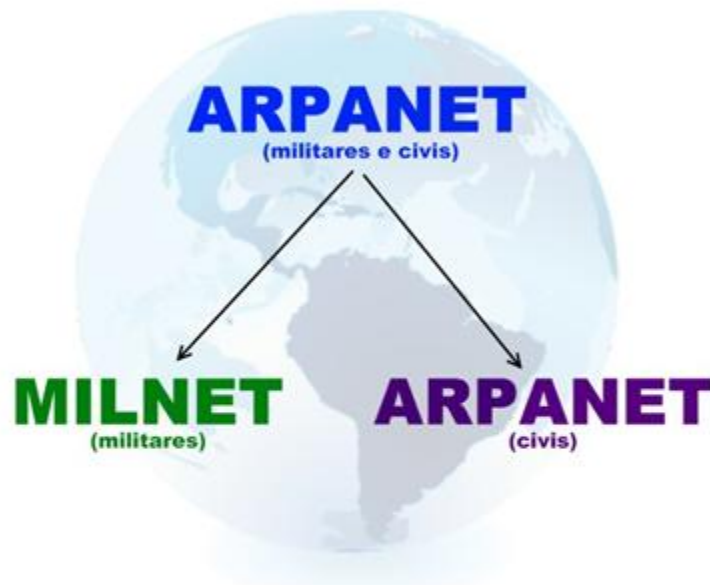
In 1971 *Ray Tomlinson* developed the first email programs called **SNDMSG** and **READMAIL** .

What is the Internet?



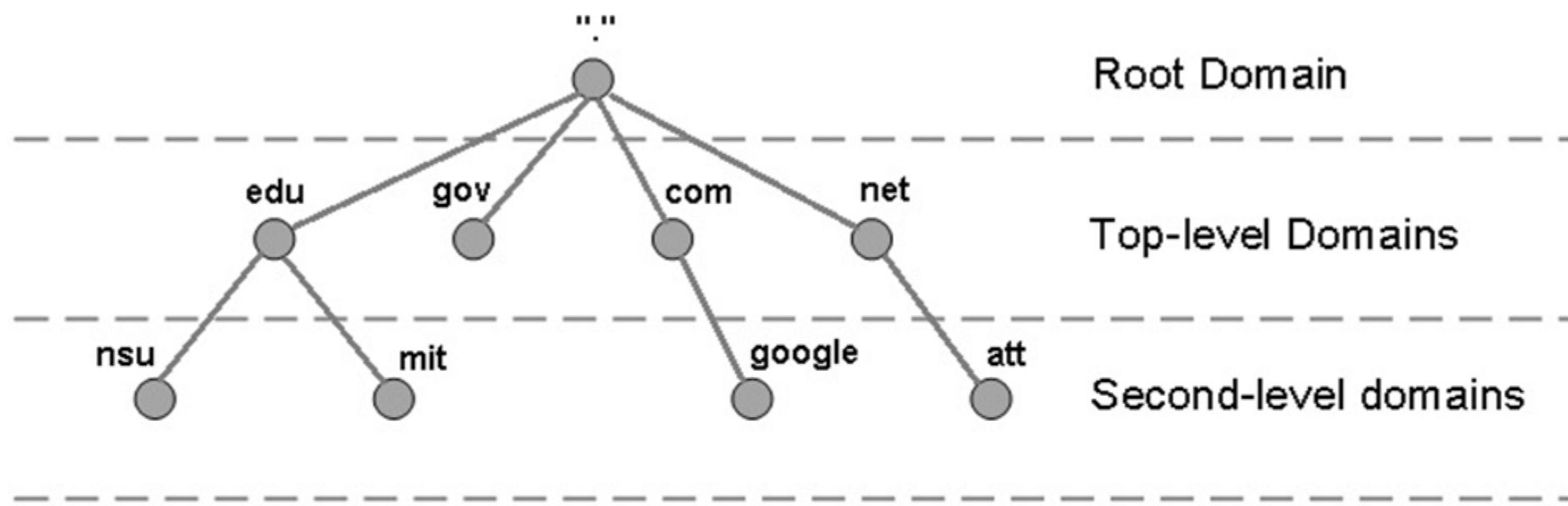
1973-1975: *Robert Metcalfe* develops a system which replaces radio transmission of network data with a cable that provides a larger amount of bandwidth, enabling the transfer of millions of bits of data per second in comparison with the thousands of bits per second when using a radio channel transmission. This system is originally known as the Alto Aloha network, but which was later known as **Ethernet**.

What is the Internet?



1982-1983: **ARPANET** is split into two separate entities: **MILNET** to serve the needs of national defense and the military community and **ARPANET** which is primarily utilized by academics and researchers. This is the first step toward the commercialization of the Internet.

What is the Internet?



In 1984: computer scientists (*Paul Mockapetris, Jon Postel, and Craig Partridge*) begin to consider new methods of naming and addressing users and networks. The **Domain Name System (DNS)**, first defined to divide Internet names between host names (x.com) and usernames (user@x.com).

What is the Internet?

1988: Internet Assigned Numbers Authority (IANA) established to distribute IP number to Internet users.

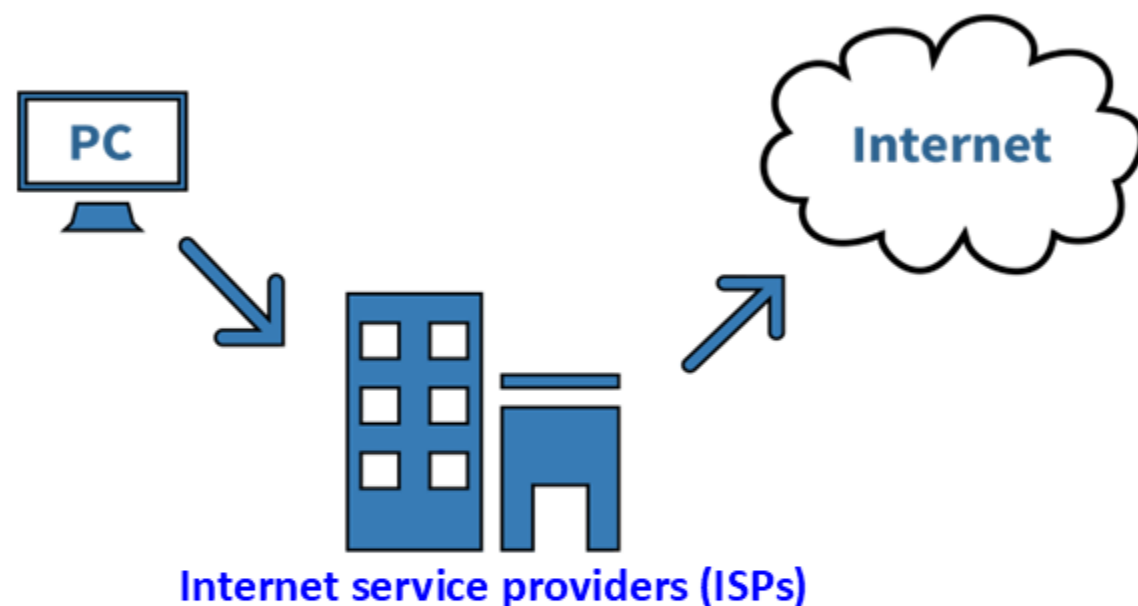


Internet Assigned Numbers Authority

In 1998: Internet Corporation for Assigned Names and Numbers (ICANN) which is responsible for coordinating the management of the technical elements of the DNS to ensure universal resolvability so that all users of the Internet can find all valid addresses.



ICANN is the institution which runs IANA.

**Internet service providers (ISPs):**

ISPs are businesses or other organizations that provide Internet access to others. In 1990 the first Internet service provider (ISP) was "World.Std.com".

Dial-up connection:

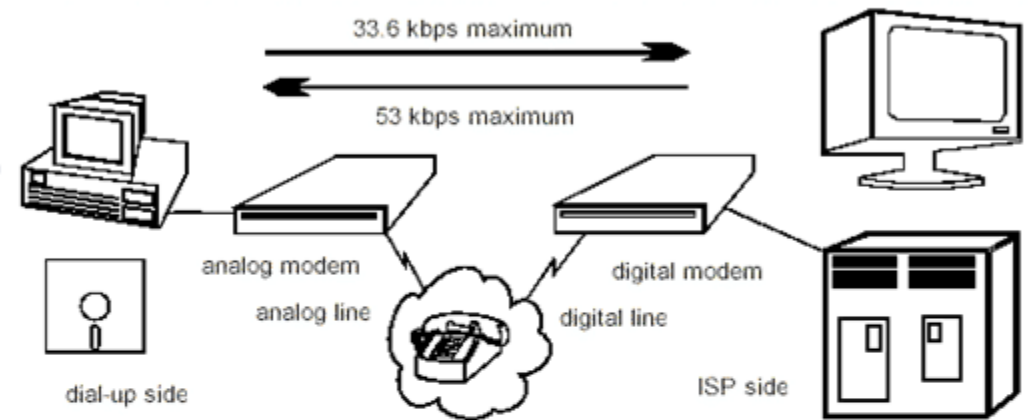
This type of connection uses dial-up modem connected to a standard telephone jack with regular telephone cabling.

Advantages:

It is including inexpensive hardware, ease of setup and use, and widespread availability.

Disadvantages:

It is slow connection speed (a maximum of 56 Kbps) and cannot make or receive phone calls while connecting to the Internet.



Cable connection:

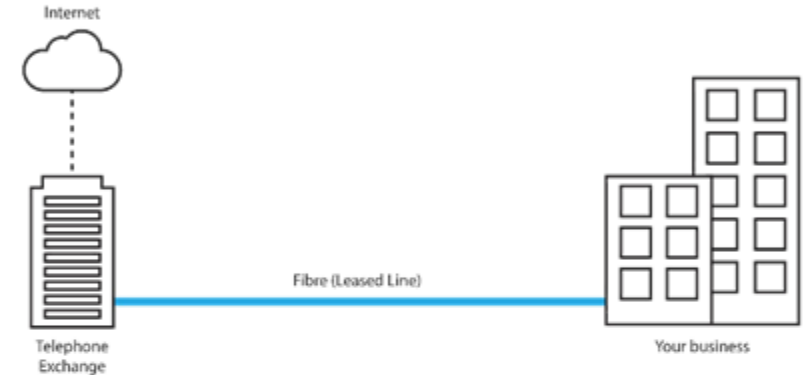
A Cable is a dedicated connection between the user's premises and the local exchange. It is fixed bandwidth and offers identical upload and download speeds up to 100 Mbps and requires a cable modem.

Advantages:

Faster download and upload speed, it does not require any phone service to operate.

Disadvantages:

During peak hours, the data transfer speed gets low, and it is a bit expensive.



Broadband over Fiber (BoF):

Fast direct connection available to homes and businesses in areas where there is fiber-optic cabling available. download speeds for BoF service typically range between 15 Mbps and 150 Mbps.

Advantages:

Extremely High Bandwidth. The volume of data that fiber optic cables transmit per unit time is far greater than copper cables, enables signals can be transmitted to a longer distance than copper cables, and resistance to Electromagnetic Interference.

Disadvantages:

Optical fiber cables are made of glass, which lends to they are more fragile than electrical wires, Difficult to Install, and as transmission distance getting longer, light will be attenuated and dispersed.

DSL/ADSL connection:

DSL (Digital Subscriber Line) and ADSL (Asymmetric Digital Subscriber Line) Internet access is a type of direct connection that transmits via standard telephone lines. DSL/ADSL modem is available only to users who are relatively close (within 5 kilometers) to a telephone switching station (Central).

Advantages:

Deliver download speed up to 100 Mbps, widely used since it depends on telephone landline, and reasonable cost depend on required speed.

Disadvantages:

Slow speed at peak times, the quality of the copper cables can affect the performance of the DSL/ADSL, and the quality of the service is dependent on the distance from a telephone switching station (Central).

Satellite :

Satellite Internet access uses a direct connection, but it is slower and more expensive than **leased line** or **DSL/ADSL** access (around 10 Mbps). It requires a satellite modem, and a transceiver satellite dish mounted outside the home or building .

Advantages:

It has a higher availability rate than DSL or cable, easily used in areas where other internet options are not available.

Disadvantages:

It is difficult to troubleshoot the system, it delivers poor quality internet during bad weather conditions, and it suffer from Latency which is a delay in service caused by the amount of time it takes to transfer a signal to and from a satellite.

Mobile Internet :

It used with smartphones and media tablets to keep them connected to the Internet via a cellular network. The speed of mobile wireless depends on the cellular standard being used, 3G networks have speeds between 1 and 4 Mbps; 4G networks are often between 3 and 15 Mbps and sometimes more.

Advantages:

Using internet while moving from one place to the other, and it does not need any extra hardware or software to connect to the Internet.

Disadvantages:

weak mobile network signal leads to poor connection, and extra cost for data plane provided by mobile network provider.

