



Computer Networks II

Lecture No. 1

“Introduction ”
“Network Types”

4th Year/ 1st semester

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Computer Network

Mean a collection of autonomous computers interconnected by a single technology. Two computers are said to be interconnected if they are able to exchange information.

The connection need not be via a copper wire; fiber optics, microwaves, infrared, and communication satellites can also be used. Networks come in many sizes, shapes and forms, as we will see later. They are usually connected together to make larger networks, with the **Internet** being the most well-known example of a network of networks.

Goals of Using Networks for Companies

- Resource sharing: equipment, programs, data
- High reliability
 - replicated data
 - hardware
- Saving money
 - mainframe: 10 times faster, but 1000 times more expensive than PC
 - client-server model
- Scalability
 - mainframe: replace a larger one
 - client-server model: add more servers
- Communication medium for separated employees

Networks for People

- Access to remote information
 - e.g.: financial, shopping, customized newspapers, on-line digital library, WWW
- Person-to-person communication
 - email, video conference, newsgroup
- Interactive entertainment
 - VOD, interactive movies or TVs, game playing

Classification of Computer Networks

Computer networks are classified based on various factors. They include:

- **Geographical span** : PAN, LAN , WANetc.
- **Inter-connectivity (Computer Topology)** :Components of a network can be connected to each other differently in some fashion. By connectedness we mean either logically, physically, or both ways.
- **Administration** :From an administrator's point of view, a network can be private network which belongs a single autonomous system and cannot be accessed outside its physical or logical domain. A network can be public, which is accessed by all.
- **Architecture**: Computer networks can be discriminated into various types such as Client-Server, peer-to-peer or hybrid, depending upon its architecture.

TYPES OF COMPUTER NETWORKS

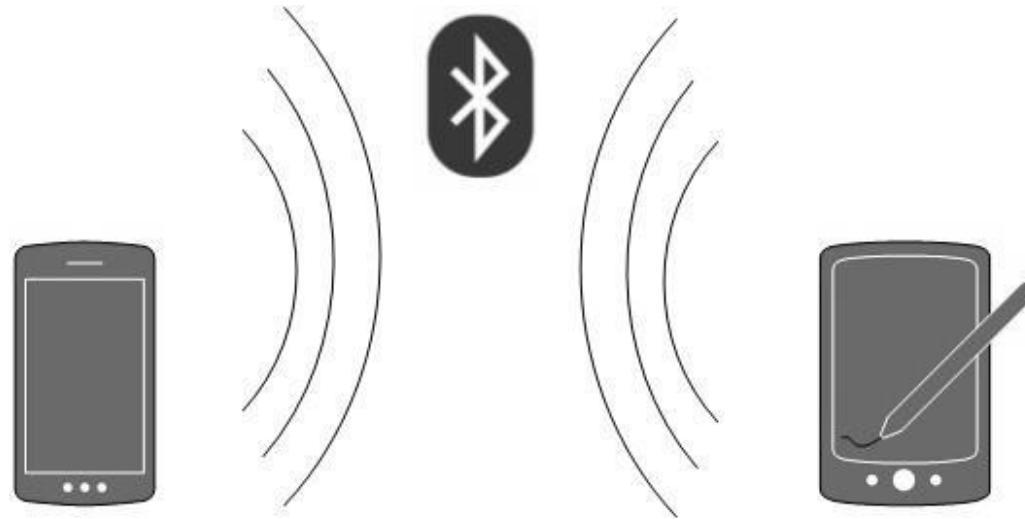
Generally, networks are distinguished based on their geographical span. A network can be as small as distance between your mobile phone and its Bluetooth headphone and as large as the internet itself, covering the whole geographical world

- Personal Area Network
- Local Area Networks
- Metropolitan Area Networks
- Wide Area Networks
- Campus Area Network(CAN)
- Storage Area Network(SAN)
- Virtual Private Networks (VPNs)
- Wireless Networks
- Home Networks
- Internetworks

Interprocessor distance	Processors located in same	Example
1 m	Square meter	Personal area network
10 m	Room	
100 m	Building	Local area network
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	Wide area network
1000 km	Continent	
10,000 km	Planet	The Internet

Personal Area Network

A Personal Area Network (PAN) is smallest network which is very personal to a user. This may include Bluetooth enabled devices or infrared enabled devices. PAN has connectivity range up to 10 meters. PAN may include wireless computer keyboard and mouse, Bluetooth enabled headphones, wireless printers, and TV remotes.



For example, **Piconet** is Bluetooth-enabled Personal Area Network which may contain up to 8 devices connected together in a master-slave fashion.

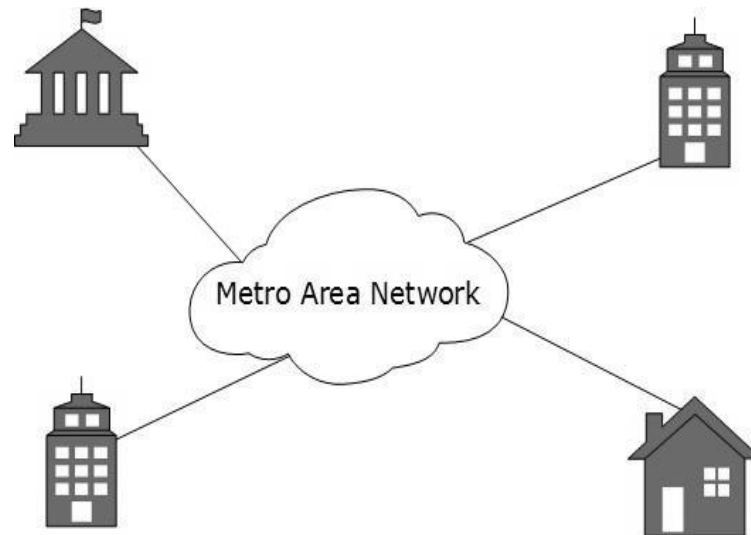
Local Area Network

- A computer network spanned inside a building and operated under single administrative system is generally termed as Local Area Network (LAN). Usually, LAN covers an organization offices, schools, colleges or universities. Number of systems connected in LAN may vary from as least as two to as much as 16 million.
- LAN provides a useful way of sharing the resources between end users. The resources such as printers, file servers, scanners, and internet are easily sharable among computers.

Metropolitan Area Network

The Metropolitan Area Network (MAN) generally expands throughout a city such as cable TV network. It can be in the form of Ethernet, Token-ring, ATM, or Fiber Distributed Data Interface (FDDI).

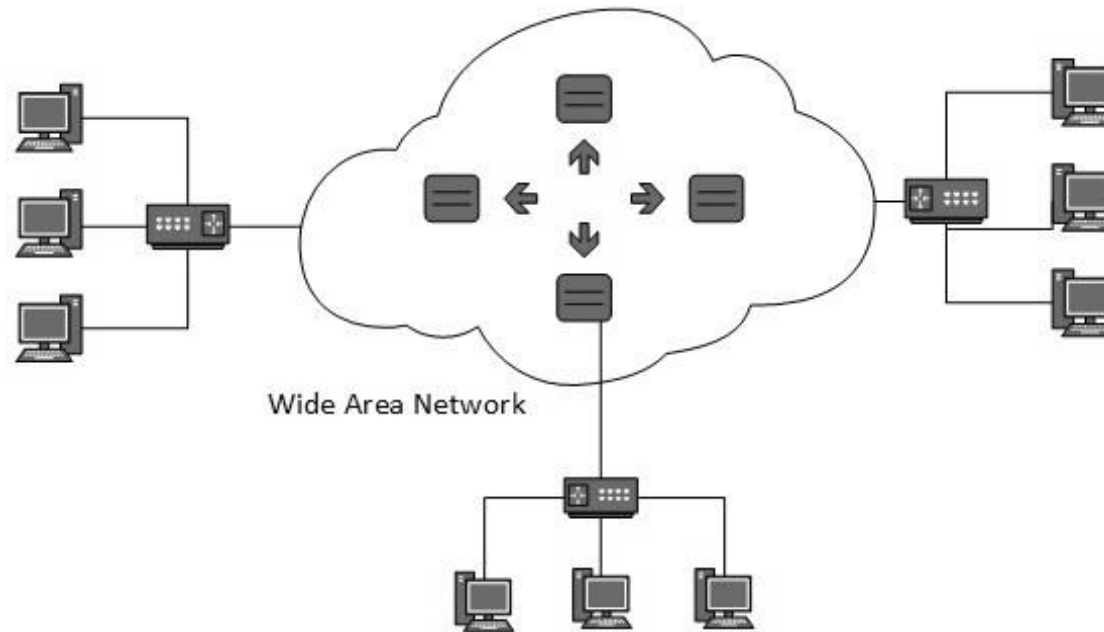
Metro Ethernet is a service which is provided by ISPs. This service enables its users to expand their Local Area Networks. For example, MAN can help an organization to connect all of its offices in a city.



Backbone of MAN is high-capacity and **high-speed fiber optics**. MAN works in between Local Area Network and Wide Area Network. MAN provides uplink for LANs to WANs or internet.

Wide Area Network

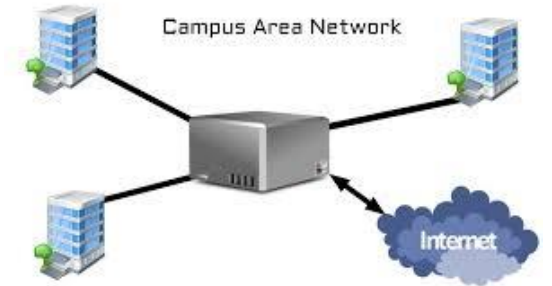
As the name suggests, the Wide Area Network (WAN) covers a wide area which may span across provinces and even a whole country. Generally, telecommunication networks are Wide Area Network. These networks provide connectivity to MANs and LANs. Since they are equipped with very high speed backbone, WANs use very expensive network equipment.



WAN may use advanced technologies such as **Asynchronous Transfer Mode (ATM)**, **Frame Relay**, and **Synchronous Optical Network (SONET)**. WAN may be managed by multiple administration.

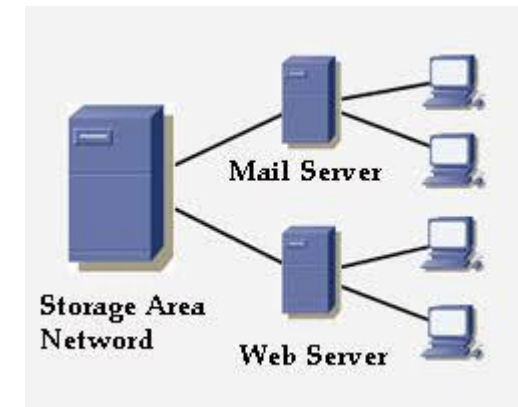
Campus Area Network (CAN)

An area network that connects multiple LANs on a college or school campus. CANs are smaller than MANs.



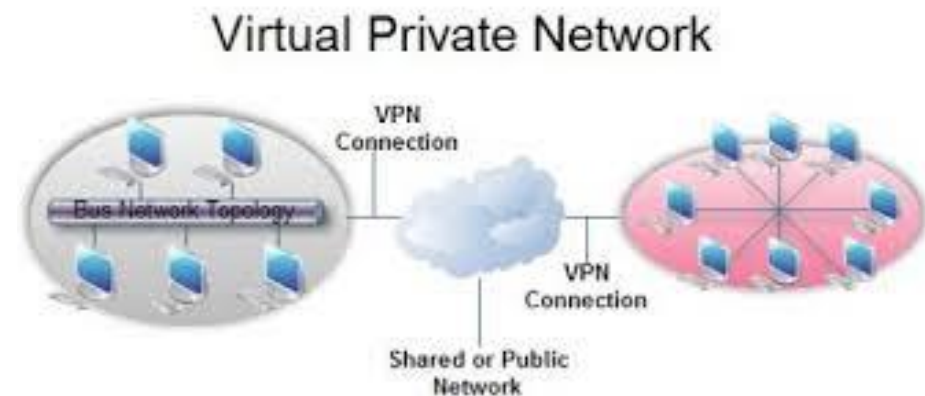
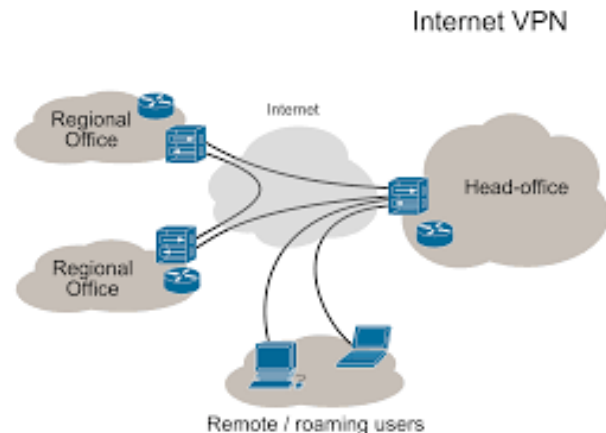
Storage Area Network (SAN)

This is a type of LAN that connects data storage devices to servers by using high-speed data transfer and storage technology. SANs usually support **data backups**, **data replication** (copying and sharing data to improve reliable access to data for network users), and **data clustering** (combining data from multiple sources in order to get a better understanding of something—such as sales statistics or census information).



Virtual Private Networks (VPN)

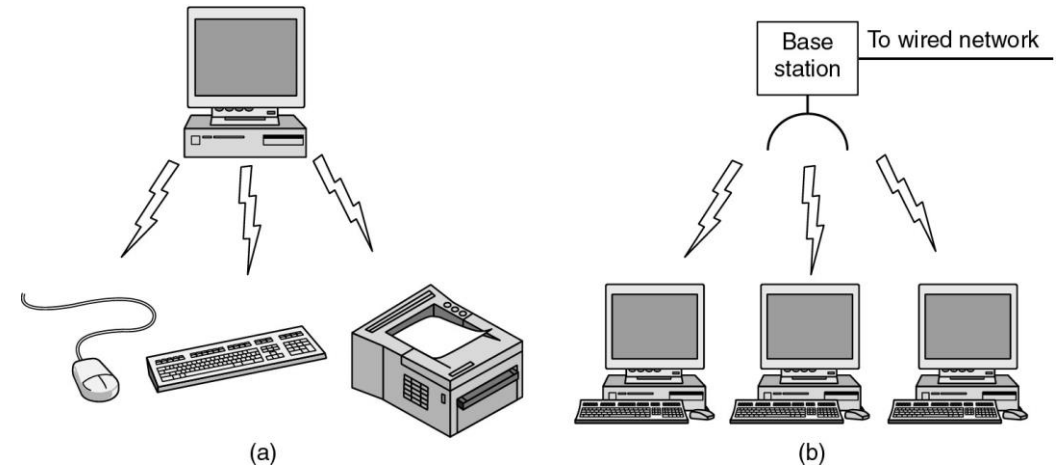
Sometimes networks like the ones described above are connected through the Internet. Doing this allows private network users from all around the world to access the same network without travelling to the physical location of the servers. To keep these networks secure, a technology called Virtual Private Network (VPN) is used. **VPN creates an encrypted connection so that other Internet users are not able to see or access user data or network activity on that VPN.** VPN networks use passwords and other identification methods so that only approved users may access the network.



Wireless Networks

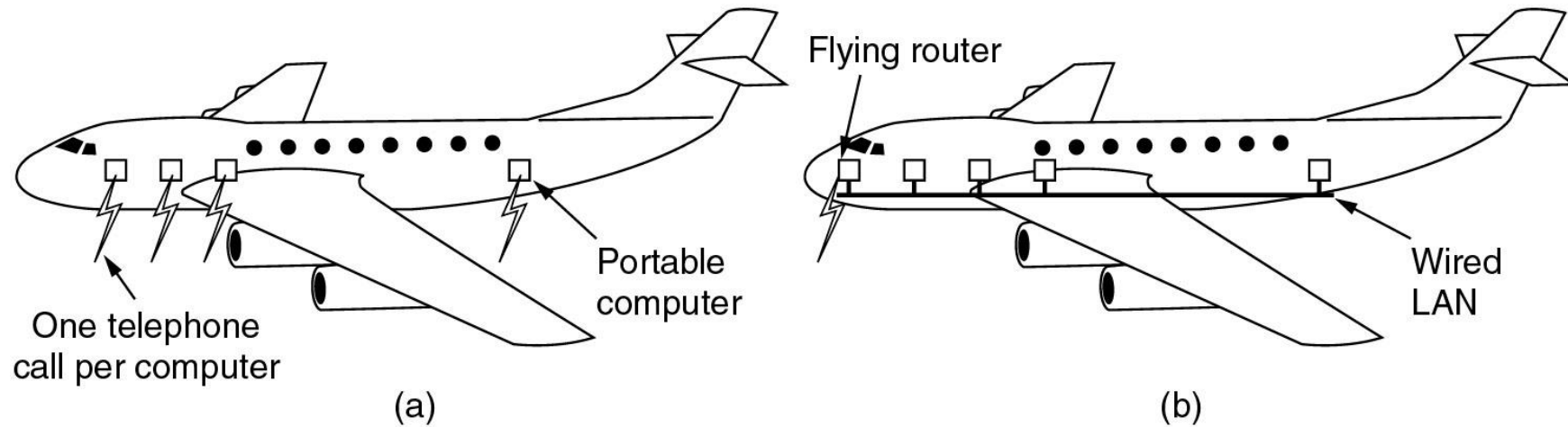
Categories of wireless networks:

- System interconnection
(short-range radio, e.g. Bluetooth)
- Wireless LANs
(802.11a, 802.11b, 802.11g)
- Wireless WANs
(802.16, Cellular telephones, Satellites)
- Wireless sensor networks



- (a) Bluetooth configuration
- (b) Wireless LAN

Wireless Networks



- (a) Individual mobile computers
- (b) A flying LAN

Home Network Categories

- Computers (desktop PC, PDA, shared peripherals)
- Entertainment (TV, DVD, VCR, camera, stereo, MP3)
- Telecomm (telephone, cell phone, intercom, fax)
- Appliances (microwave, fridge, clock, furnace, airco., light)
- Telemetry (utility meter, smoke/burglar alarm, babycam).

Internetwork

A network of networks is called an internetwork, or simply the internet. It is the largest network in existence on this planet. The internet hugely connects all WANs and it can have connection to LANs and Home networks. Internet **uses TCP/IP protocol** suite and uses **IP** as its addressing protocol. Present day, Internet is widely implemented using IPv4. Because of shortage of address spaces, it is gradually migrating from IPv4 to IPv6.

Internet enables its users to share and access enormous amount of information worldwide. It uses WWW, FTP, email services, audio, and video streaming etc. At huge level, internet works on Client-Server model.

Internet uses **very high speed backbone of fiber optics**. To inter-connect various continents, fibers are laid under sea known to us as submarine communication cable.

Internet is widely deployed on World Wide Web services using HTML linked pages and is accessible by client software known as Web Browsers. When a user requests a page using some web browser located on some Web Server anywhere in the world, the Web Server responds with the proper HTML page. The communication delay is very low.

Internetwork

Internet is serving many proposes and is involved in many aspects of life. Some of them are:

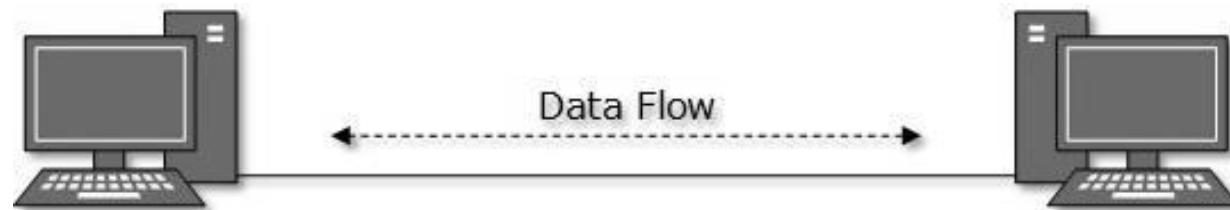
- Web sites
- E-mail
- Instant Messaging
- Blogging
- Social Media
- Marketing
- Networking
- Resource Sharing
- Audio and Video Streaming

Computer network topologies

A Network Topology is the arrangement with which computer systems or network devices are connected to each other. Topologies may define both physical and logical aspect of the network. Both logical and physical topologies could be same or different in a same network

Point-to-Point

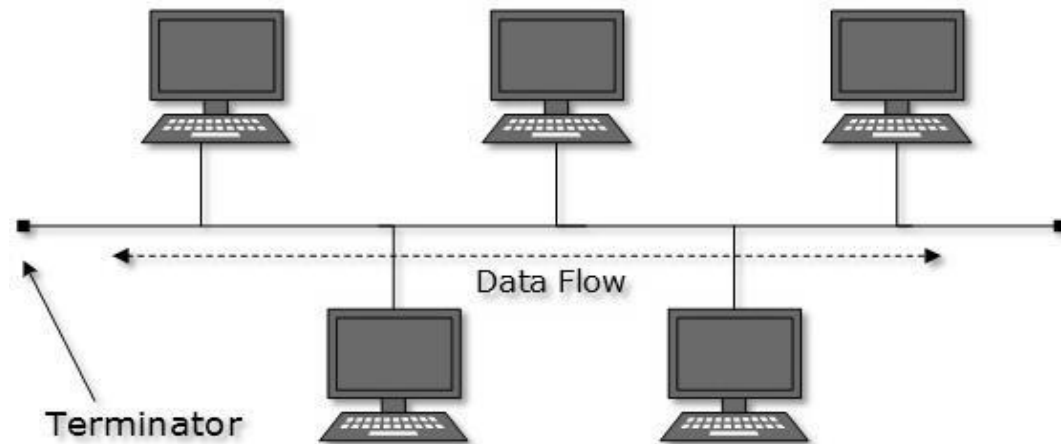
Point-to-point networks contains exactly two hosts such as computer, switches, routers, or servers connected back to back using a single piece of cable. Often, the receiving end of one host is connected to sending end of the other and vice versa.



If the hosts are connected point-to-point logically, then may have multiple intermediate devices. But the end hosts are unaware of underlying network and see each other as if they are connected directly.

Bus Topology

In case of Bus topology, all devices share single communication line or cable. Bus topology may have problem while multiple hosts sending data at the same time. Therefore, Bus topology either uses CSMA/CD technology or recognizes one host as Bus Master to solve the issue. It is one of the simple forms of networking where a failure of a device does not affect the other devices. But failure of the shared communication line can make all other devices stop functioning.

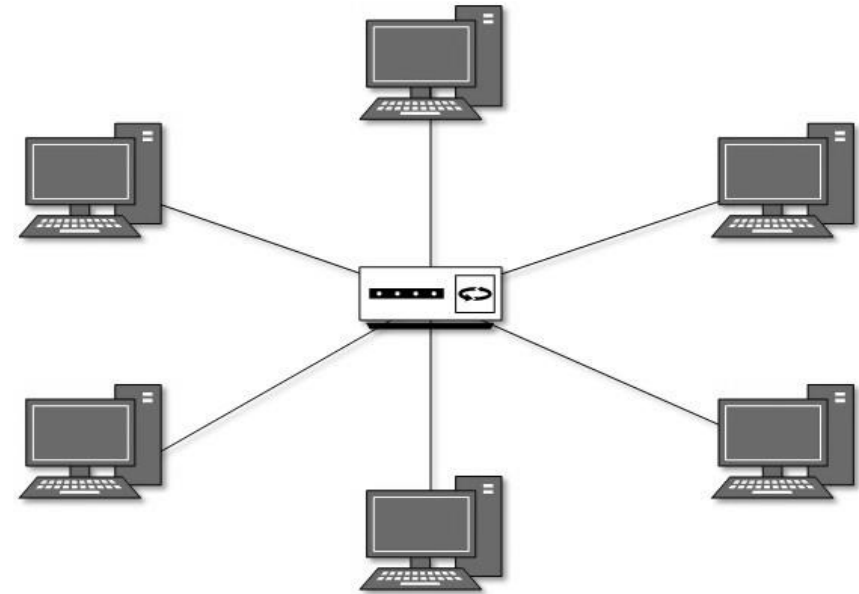


Both ends of the shared channel have line terminator. The data is sent in only one direction and as soon as it reaches the extreme end, the terminator removes the data from the line.

Star Topology

All hosts in Star topology are connected to a central device, known as hub device, using a point-to-point connection. That is, there exists a point to point connection between hosts and hub. The hub device can be any of the following:

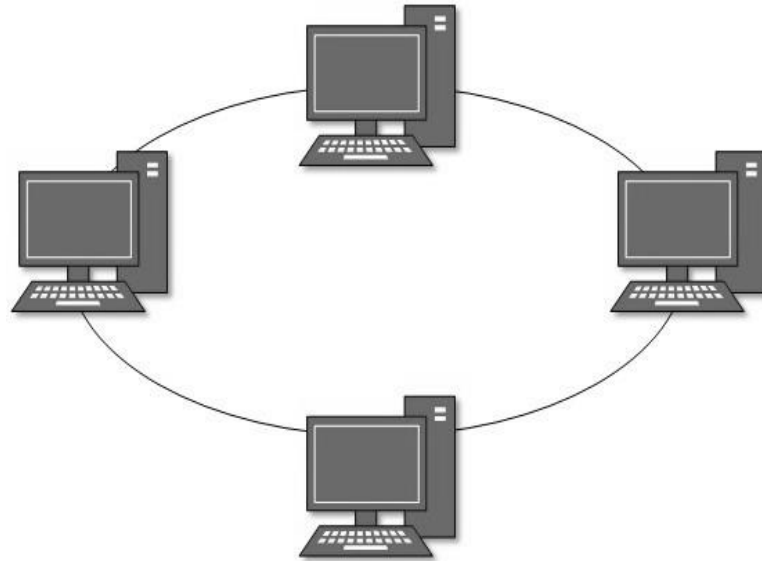
- Layer-1 device such as hub or repeater
- Layer-2 device such as switch or bridge
- Layer-3 device such as router or gateway



As in Bus topology, hub acts as single point of failure. If hub fails, connectivity of all hosts to all other hosts fails. Every communication between hosts takes place through only the hub. Star topology is not expensive as to connect one more host, only one cable is required and configuration is simple.

Ring Topology

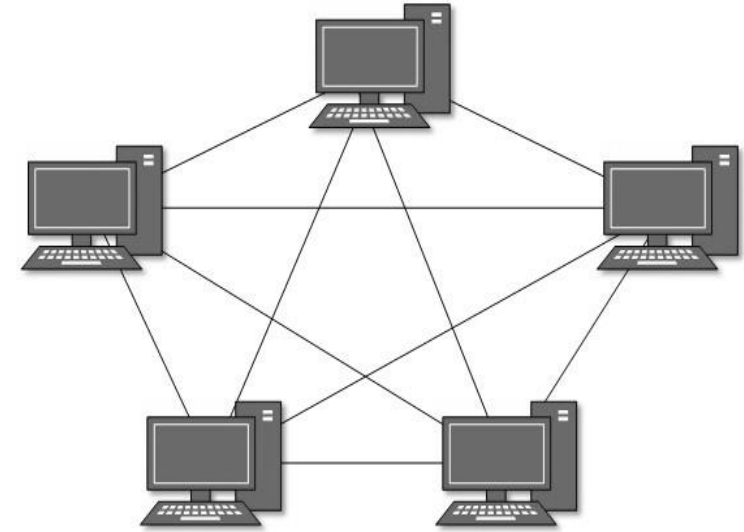
In ring topology, each host machine connects to exactly two other machines, creating a circular network structure. When one host tries to communicate or send message to a host which is not adjacent to it, the data travels through all intermediate hosts. To connect one more host in the existing structure, the administrator may need only one more extra cable.



Failure of any host results in failure of the whole ring. Thus, every connection in the ring is a point of failure. There are methods which employ one more backup ring.

Mesh Topology

In this type of topology, a host is connected to one or multiple hosts. This topology has hosts in point-to-point connection with every other host or may also have hosts which are in point-to-point connection with few hosts only.



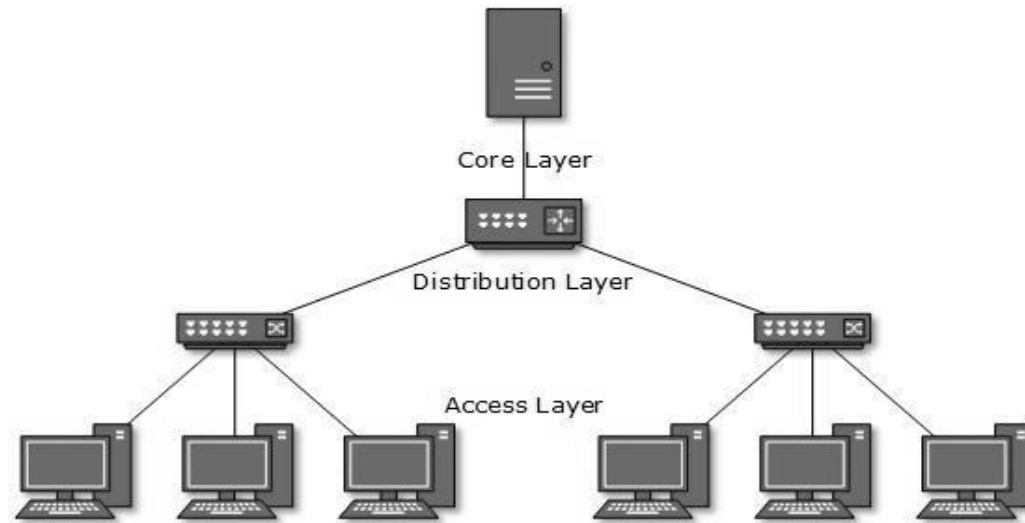
Hosts in Mesh topology also work as relay for other hosts which do not have direct point-to-point links. Mesh technology comes into two types:

- **Full Mesh:** All hosts have a point-to-point connection to every other host in the network. Thus for every new host $n(n-1)/2$ connections are required. It provides the most reliable network structure among all network topologies.
- **Partially Mesh:** Not all hosts have point-to-point connection to every other host. Hosts connect to each other in some arbitrary fashion. This topology exists where we need to provide reliability to some hosts out of all.

Tree Topology

Also known as Hierarchical Topology, this is the most common form of network topology in use presently. This topology imitates as extended Star topology and inherits properties of Bus topology.

This topology divides the network into multiple levels/layers of network. Mainly in LANs, a network is bifurcated into three types of network devices. The lowermost is access-layer where computers are attached. The middle layer is known as distribution layer, which works as mediator between upper layer and lower layer. The highest layer is known as core layer, and is central point of the network, i.e. root of the tree from which all nodes fork.



All neighboring hosts have point-to-point connection between them. Similar to the Bus topology, if the root goes down, then the entire network suffers even though it is not the single point of failure. Every connection serves as point of failure, failing of which divides the network into unreachable segment.

Daisy Chain

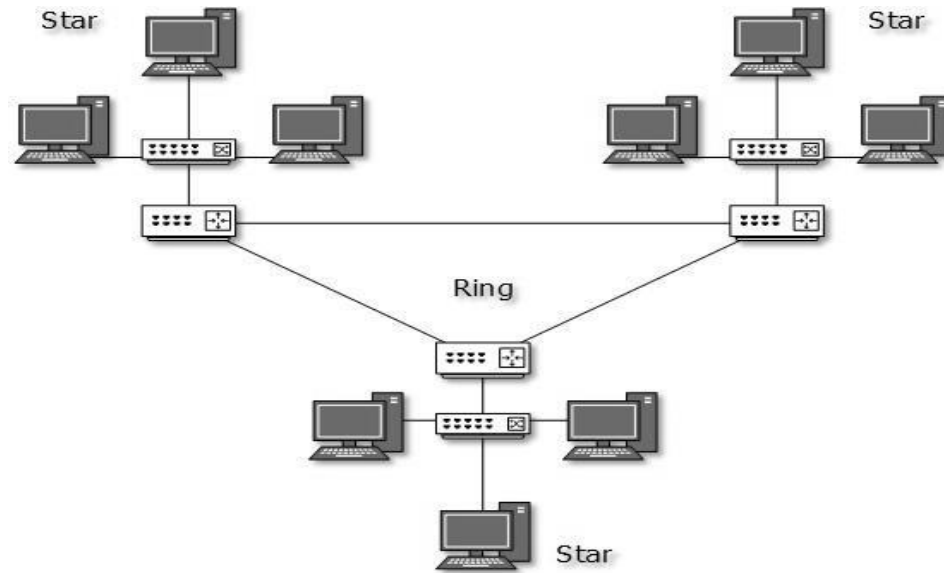
This topology connects all the hosts in a linear fashion. Similar to Ring topology, all hosts are connected to two hosts only, except the end hosts. Means, if the end hosts in daisy chain are connected then it represents Ring topology.



Each link in daisy chain topology represents single point of failure. Every link failure splits the network into two segments. Every intermediate host works as relay for its immediate hosts.

Hybrid Topology

A network structure whose design contains more than one topology is said to be hybrid topology. Hybrid topology inherits merits and demerits of all the incorporating topologies.



The above picture represents an arbitrarily hybrid topology. The combining topologies may contain attributes of **Star, Ring, Bus, and Daisy-chain topologies**. Most WANs are connected by means of Dual-Ring topology and networks connected to them are mostly Star topology networks. Internet is the best example of largest Hybrid topology.

Network Software

- Protocol Hierarchies (Layer structure)
- Design Issues for the Layers
- Connection-Oriented and Connectionless Services
- Service Primitives
- The Relationship of Services to Protocols

Network Applications

Computer systems and peripherals are connected to form a network. They provide numerous advantages:

- Resource sharing such as printers and storage devices
- Exchange of information by means of e-Mails and FTP
- Information sharing by using Web or Internet
- Interaction with other users using dynamic web pages
- IP phones
- Video conferences
- Parallel computing
- Instant messaging

Thank you for listening