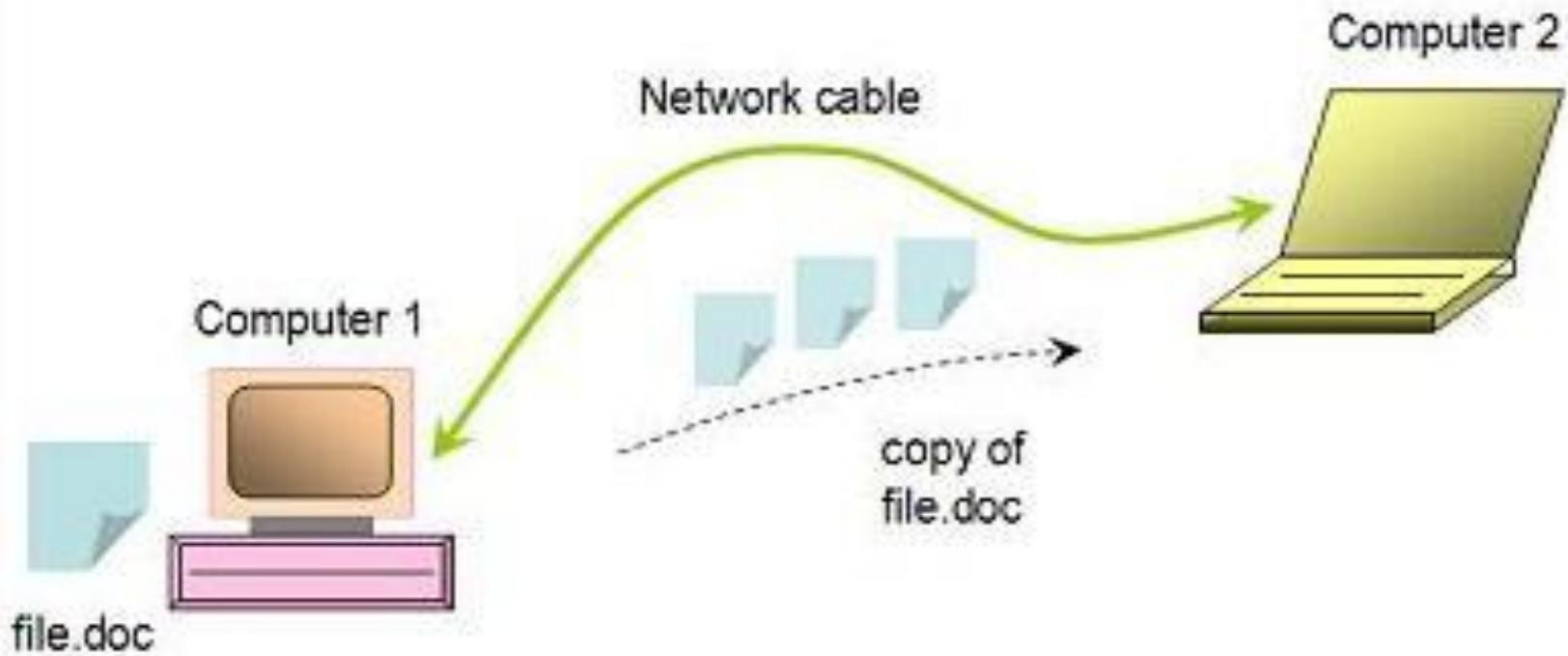


Networking

Topics Covered

1. Introduction to Networks
2. Data Communication Terminologies
3. Transmission Media
4. Network Devices
5. Network Topologies and types
6. Communication Protocols
7. Internetworking Concepts
8. Network security concepts and Terms

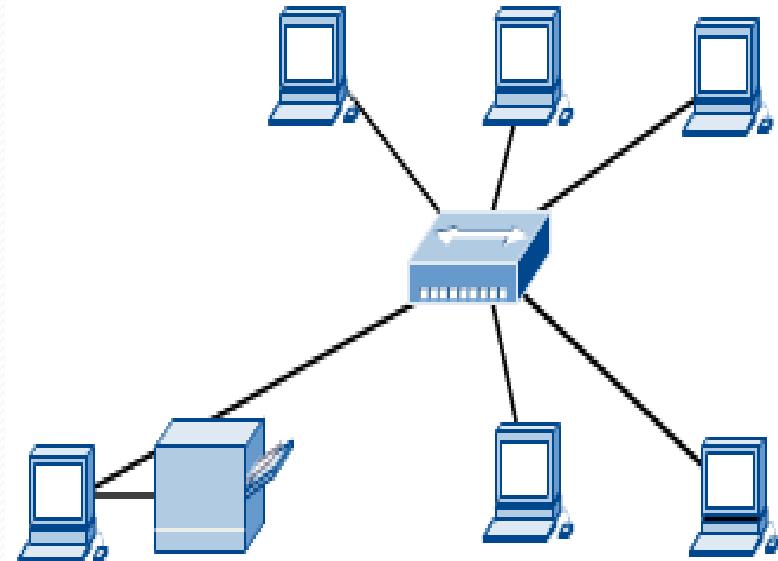
Welcome to the world of Networking



Computer Networks

■ Computer network connects two or more autonomous computers.

■ The computers can be located anywhere.



Applications of Networks

■ Resource Sharing

- Hardware (computing resources, disks, printers)
- Software (application software)

■ Information Sharing

- Easy accessibility from anywhere (files, databases)
- Search Capability (WWW)

■ Communication

- Email
- Message broadcast

■ Remote computing

■ Distributed processing (GRID Computing)

Disadvantages of NETWORK

- The system are more sophisticated and complex to run. This can add to costs and you may need specialist staff to run the network.
- If s/w and files are held centrally, it may be impossible to carry out any work if the central server fails.
- If networks are badly managed services can becomes unusable and productivity falls.
- File security is more important especially if connected to WAN.

Evolution of NETWORK

ARPANET, NSFnet, Internet

ARPANET (*Advanced Research Projects Agency NETwork*): In 1969, ARPANET was started to connect computers at US defense & different universities.

NSFnet (*National Science Foundation Network*) : In 1980 NSFnet was started to make a high-capacity network to be used strictly for academic and engineering research.

Internet : In 1990 the internetworking of ARPANET , NSFnet and other private networks resulted into Internet.

Gateway & Backbone Network

A **Gateway** is a device that connects dissimilar networks.

A **Backbone** is central interconnecting structure that connects one or more networks just like the trunk of a tree or the spine of a human being

Internet Functioning

The internet works at all is that every computer connected to it uses the same set of rules for communication is called ***Protocol.***

The communication protocol used by internet is **TCP/IP.**

The TCP (Transmission Control Protocol) part is responsible dividing the files/massage into packet on the source computer. It is also responsible for reassembling the received packet at the destination computer.

The IP (Internet Protocol) part is responsible for handling the address of destination computer so that each packet is routed to its proper destination.

Interspace

The future of internet is said to be in Interspace.

Interspace is a client/server software program that allows multiple users to communicate online with real-time audio, video and text chat in dynamic 3D environments.

Data Communication Terminologies

Nodes: the term nodes refers to the computers that are attached to a network and are seeking to share the resources of the network.

A computer becomes a workstation of a network as soon as it is attached to a network.

Data Communication Terminologies

Server: A computer that facilitates the sharing of data, s/w and h/w resources on the network is termed as a Server.

Servers can be of two Types:

- Non-dedicated
- Dedicated

NIU (Network Interface Unit) : A network interface unit is an interpreter that helps establish communication between the server and workstation.

MAC address : The MAC address refers to the physical address assigned by NIC manufacturer. MAC address is 6 Byte Hexadecimal Address

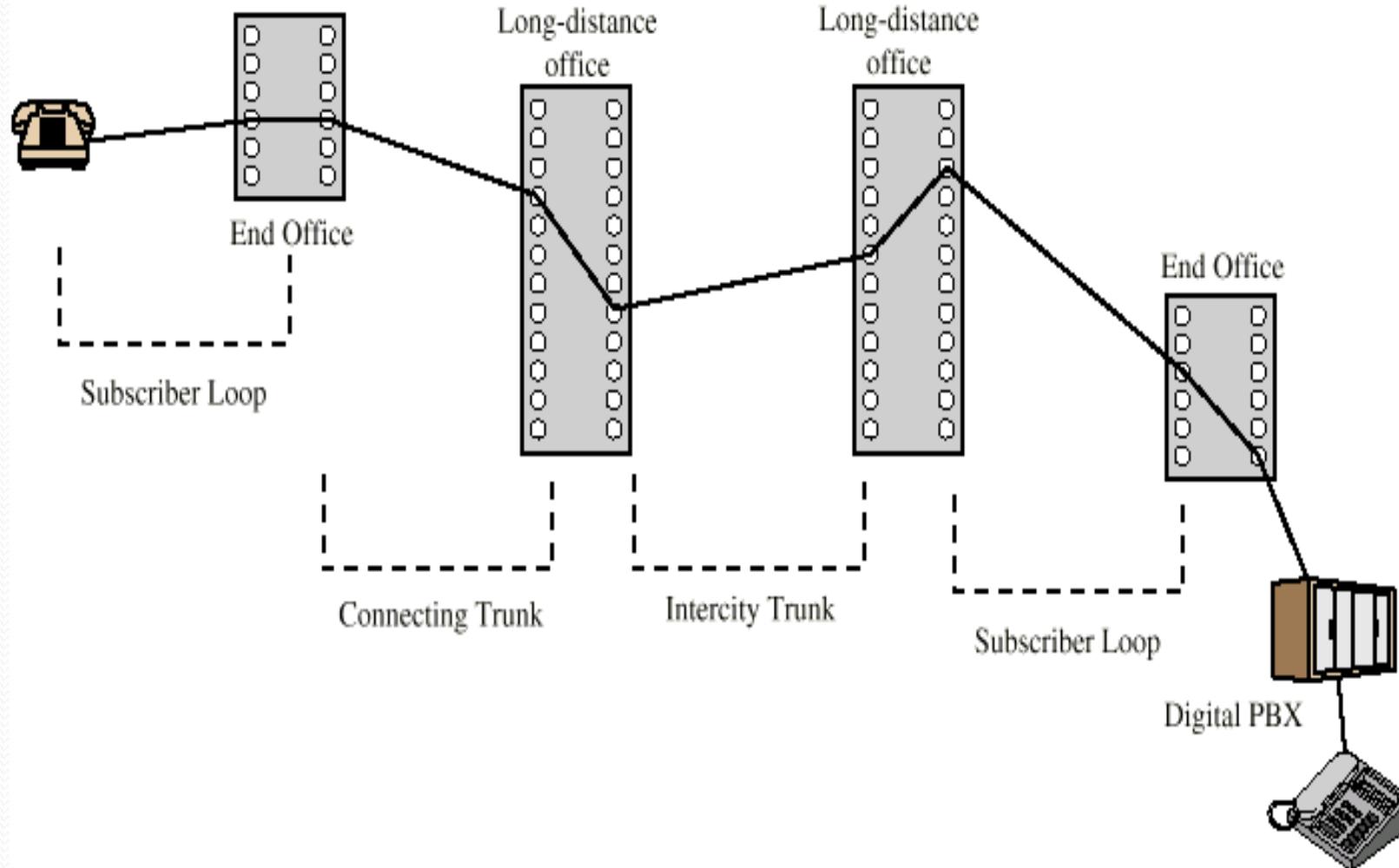
Switching Data

Data units must be switched through the various intermediate devices until they are delivered to their destination

Switching Techniques are used for transmitting data across networks.

Circuit Switching : 1st the complete physical connection between two computers is established and then data are transmitted from source computer to the destination computer.

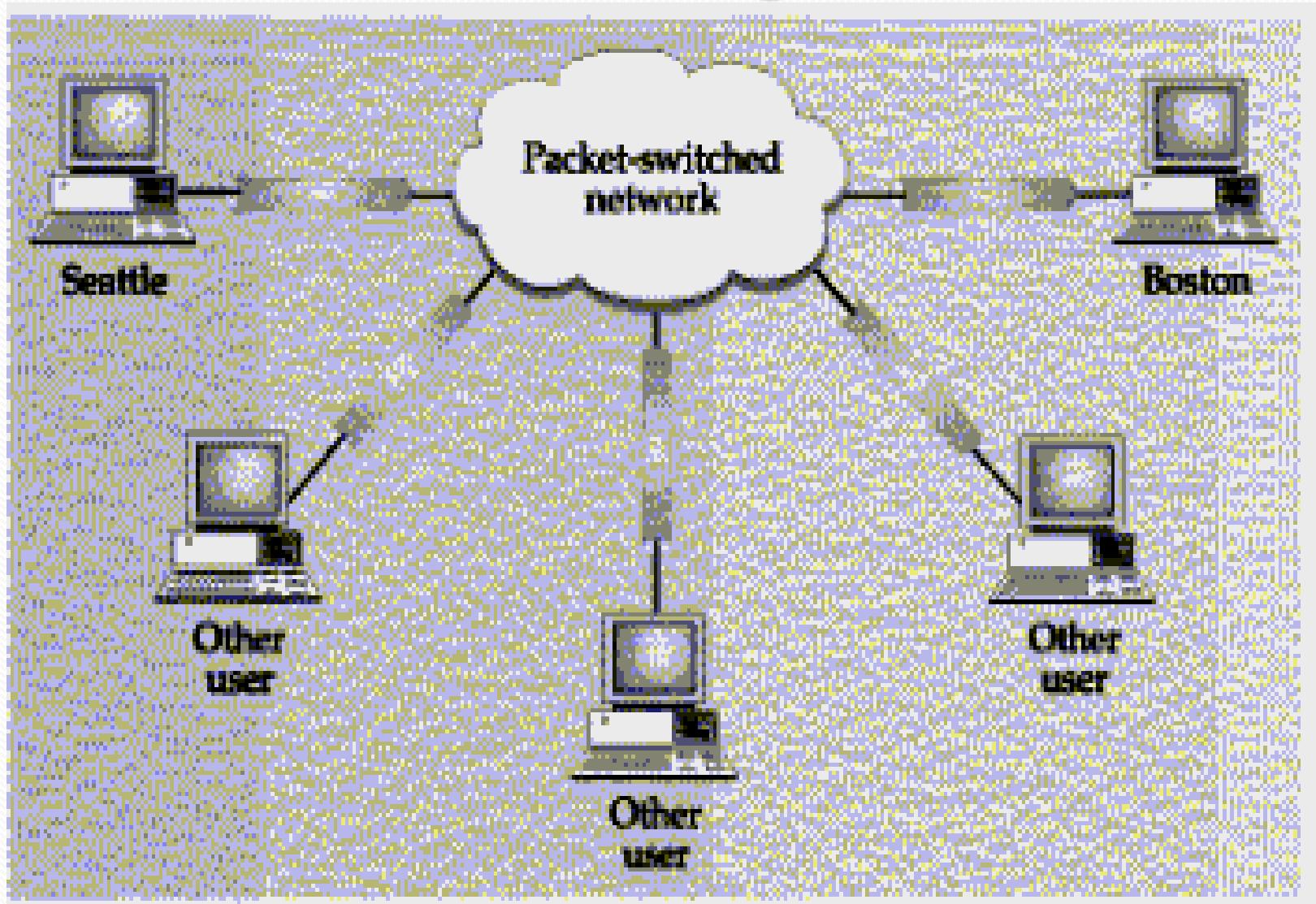
Circuit Switching



Message Switching: the source computer sends data or the message to the switching office first, which stores the data in its buffers. It then looks for free link to another switching office and then send the data to this office. This process is continued until the data are delivered to the destination computers.

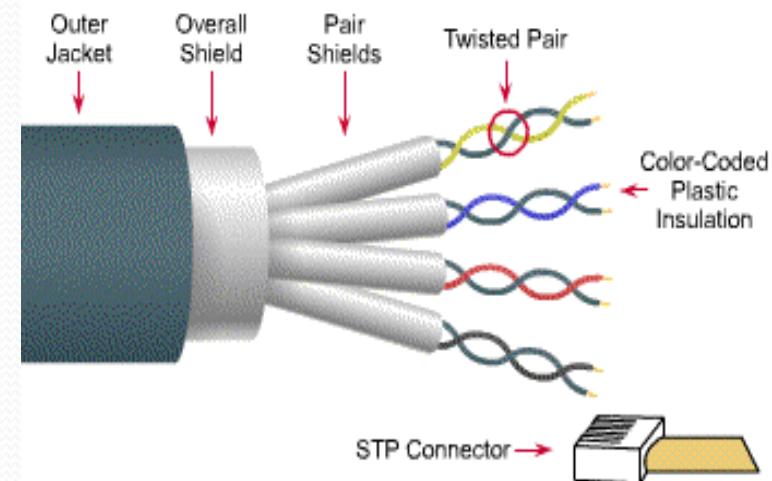
Packet Switching: With message switching, there is no limit on block size, in contrast, packet switching places a tight upper limit on block size. A fixed size of packet which can be transmitted across the network is specified. Packets are stored in main memory whereas in message switching the data are stored on the disk. This improves the performance as the access time is reduced, thus the throughput of the network is improved.

Packet Switching



Networking Media

- Networking media can be defined simply as the means by which signals (data) are sent from one computer to another (either by cable or wireless means).



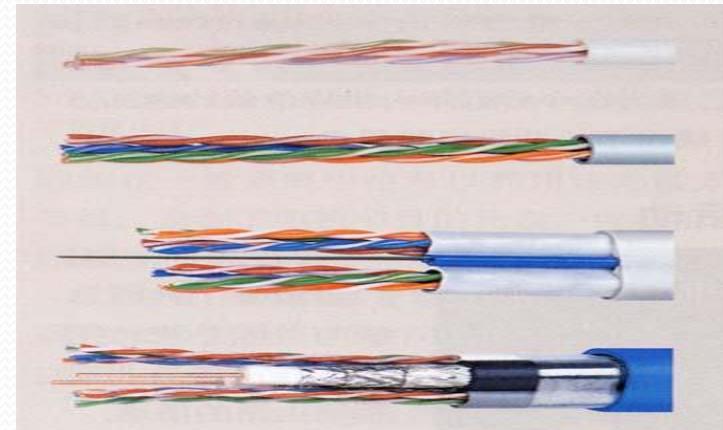
- Speed and throughput: 10-100 Mbps
- Cost per node: Moderately expensive
- Media and connector size: Medium to Large
- Maximum cable length: 100m (short)

Guided Media

Transmission media or communication channels meant that the ‘connecting cables’ or ‘connection media’.

1. Twisted Pair Cable
2. Coaxial Cable
3. Optical Fibers

Twisted Pair Cable



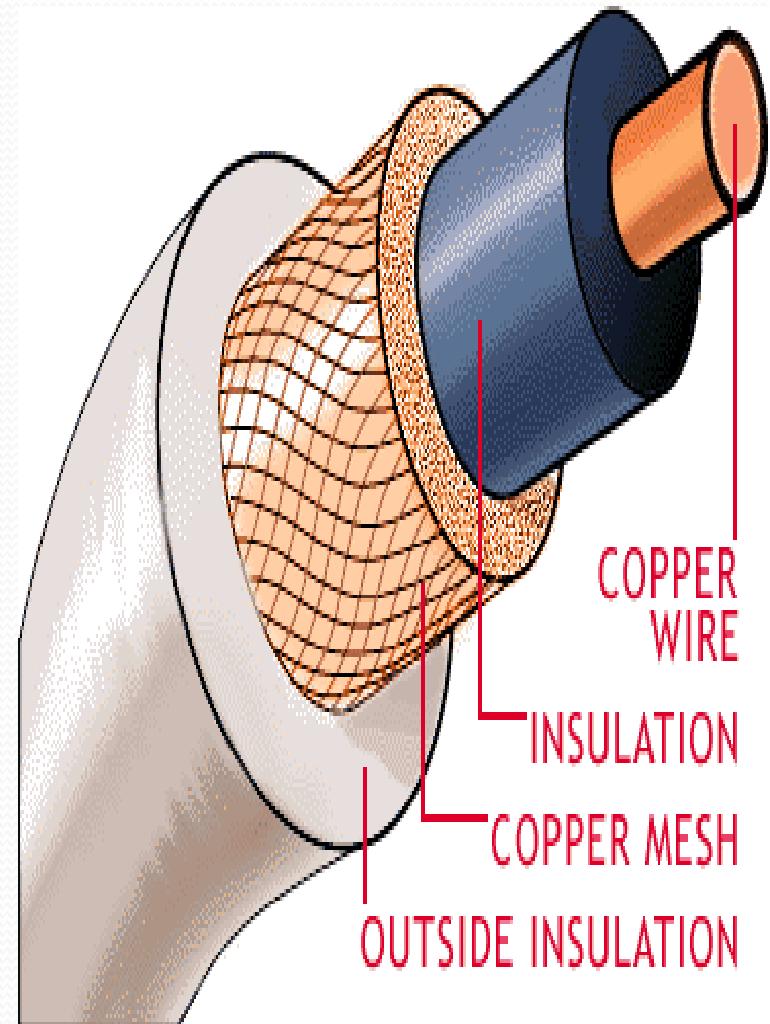
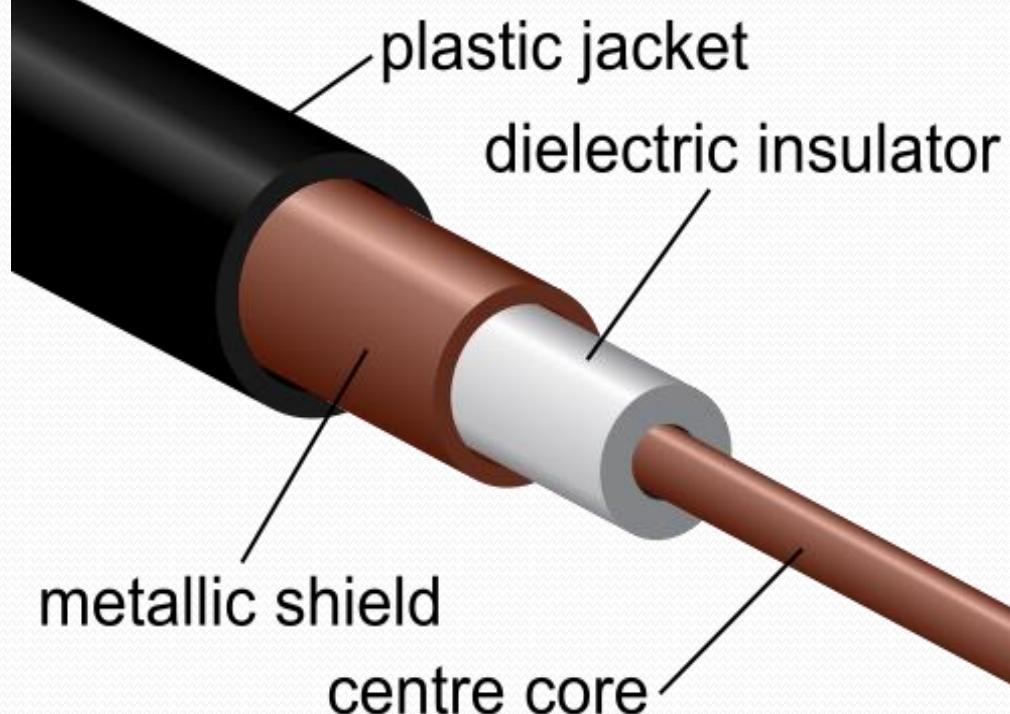
Advantages

- It is simple
- Easy to install and maintain
- Physically Flexible
- Low weight
- Easily connected
- Inexpensive

Disadvantages

- High attenuation, it cannot carry a signal over long distances without the use of repeaters.
- Low bandwidth capabilities, unsuitable for broadband app.
- Supports maximum data rates 1Mbps without conditioning and 10 Mbps with conditioning.

Coaxial Cable



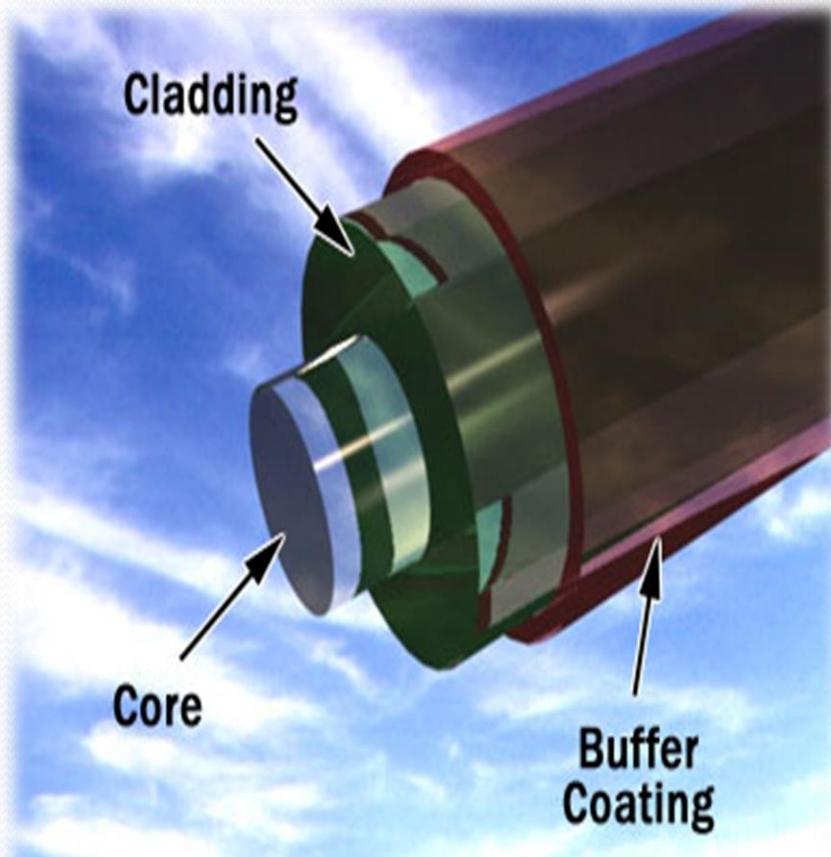
Advantages

- Better than twisted pair cable.
- Used as shared cable network
- Used for broadband transmission.
- Higher bandwidth upto 400 MBPS

Disadvantages

- Expensive
- Not compatible with twisted pair.

Optical Fiber Cable



©2001 How Stuff Works

Advantages

- Immune to electrical and magnetic interference.
- Highly suitable for harsh industrial environments.
- Secure transmission and very high transmission capacity.
- Used for broadband transmission.

Disadvantages

- Installation problem.
- Connecting two fibers together is a difficult process.
- Because of noise immunity, they are virtually impossible to tap.
- Light can reach the receiver out of phase.
- Connection losses are common problem
- Difficult to solder
- Most expensive.

Unguided media-Microwave

Microwave signals are used to transmit data without the use of cables. It consists of a transmitter, receiver and atmosphere.

Advantages

- Cheaper
- Offers freedom from land acquisition rights
- Ease of communication over difficult terrain
- Ability to communicate over oceans.

Disadvantages

- Insecure communication
- Susceptible to weather effects.
- Bandwidth allocation is extremely limited
- Cost of design, implementation and maintenance



RADIO WAVE:-Transmission making use of radio frequency is termed as radio-wave transmission.

Advantages

- It offers mobility
- Cheaper
- Offers freedom from land acquisition rights
- Ease of communication over difficult terrain

Disadvantages

- Insecure communication
- Susceptible to weather effects.



Satellite communication is special case of microwave relay system. Satellite communication use the synchronous satellite to relay the radio signal transmitted from ground station.

Advantages

- Area coverage through satellite is quite large.
- The laying and maintenance is easy and inexpensive.
- Heavy usage of intercontinental traffic makes it commercial attractive.

Disadvantages

- Technological limitation preventing the deployment of large, high gain antennas on the satellite platform.
- Over-crowding
- High investment and insurance cost associated with significant probability of failure.
- High atmospheric losses.



Data Communication Terminologies

- Channel-It is the medium used to carry information or data from one point to another.
- Baud-It is the measurement for the information carrying capacity of a communication channel. It is synonymous with bps(bits per second).
- Bandwidth-It refers to the difference between the highest and lowest frequencies of a transmission channel.
- Data Transfer Rate- The speed of data transfer from one channel to another.

Data rate measured in bits (not bytes) per seconds

Kbps (Kilobits per seconds)

125 chars/sec

Mbps (Megabits per seconds)

1,250 chars/sec

Gbps (Gigabits per seconds)

12,500 chars/sec

Network Devices

1. Modem :

Modem is a computer peripheral that allows you to connect and communicate with other computers via telephone lines

External Modem



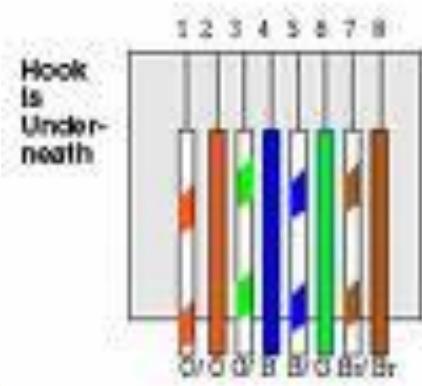
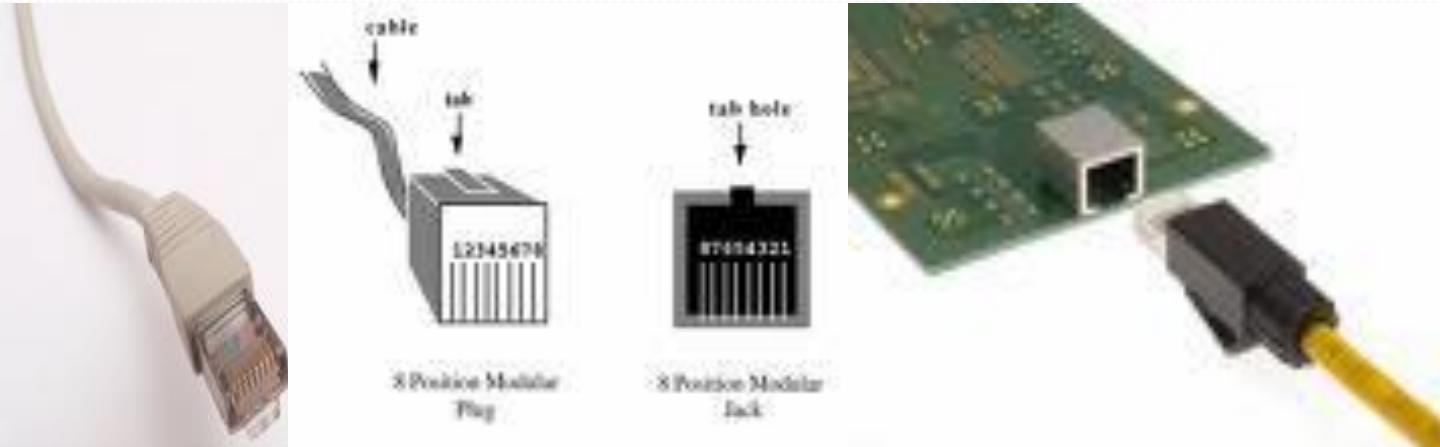
External Modem



2. RJ-45 :

RJ-45 is short of registered jack-45. RJ-45 is an eight-wire connector, which is commonly used to connect computers on the LAN especially Ethernets.

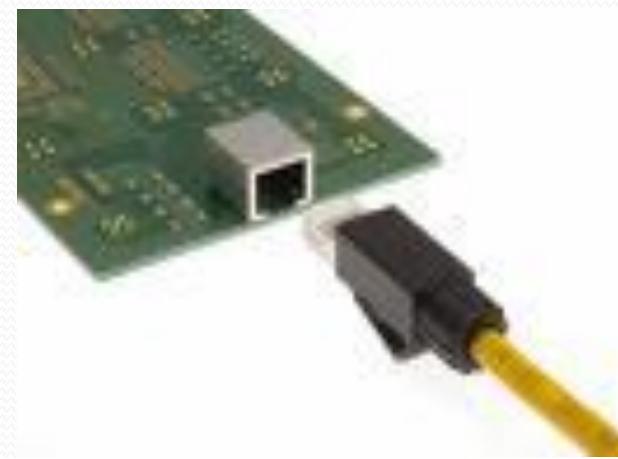
(Ethernet is a LAN architecture developed by Xerox Corp along with DEC and Intel.)



3. Ethernet Card :

Ethernet is a LAN architecture developed by Xerox Corp along with DEC and Intel.

The computers that are part of Ethernet, have to install a special card called Ethernet card.

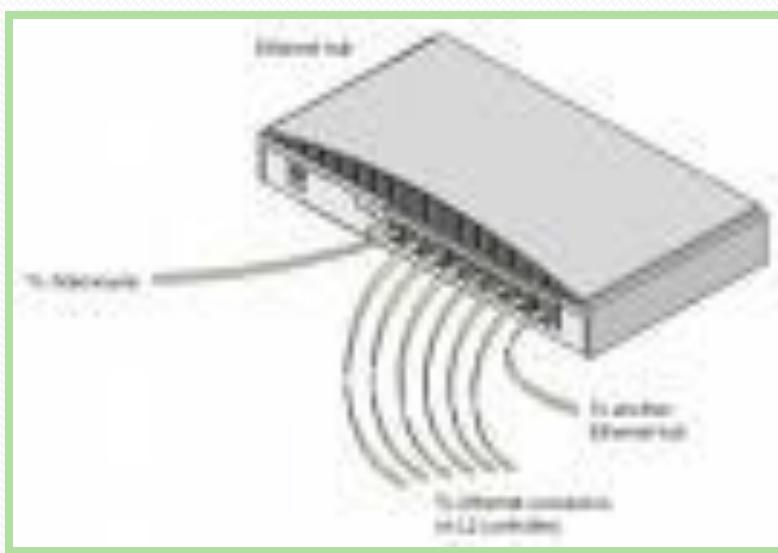


4.HUB :

A hub is a hardware device used to connect several computers together.

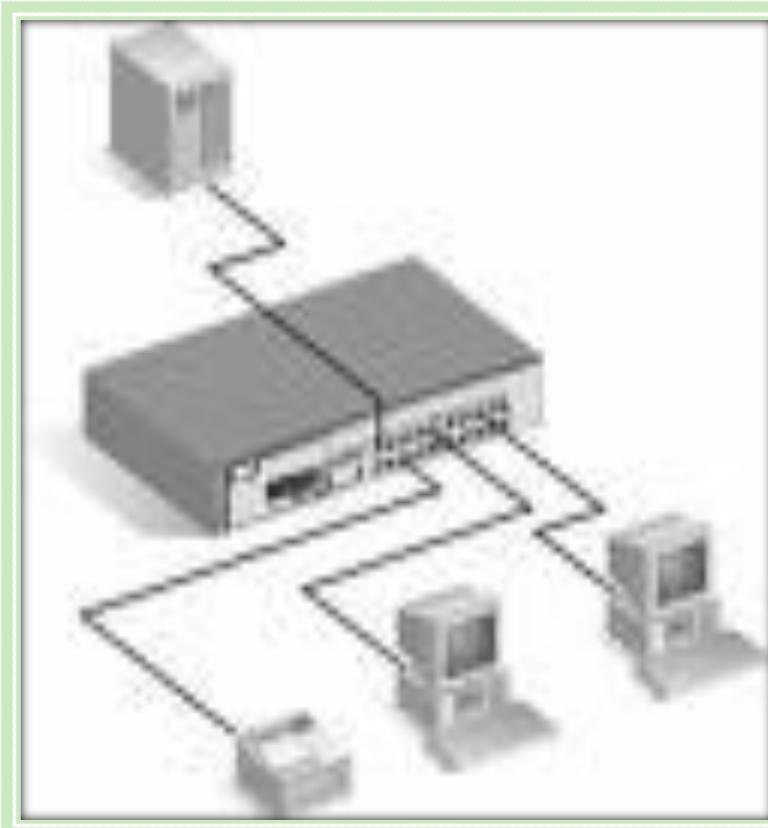
Active : electrically amplify the signal as it moves from one connected device to another .

Passive : allow the signal to pass from one computer to another without any change.



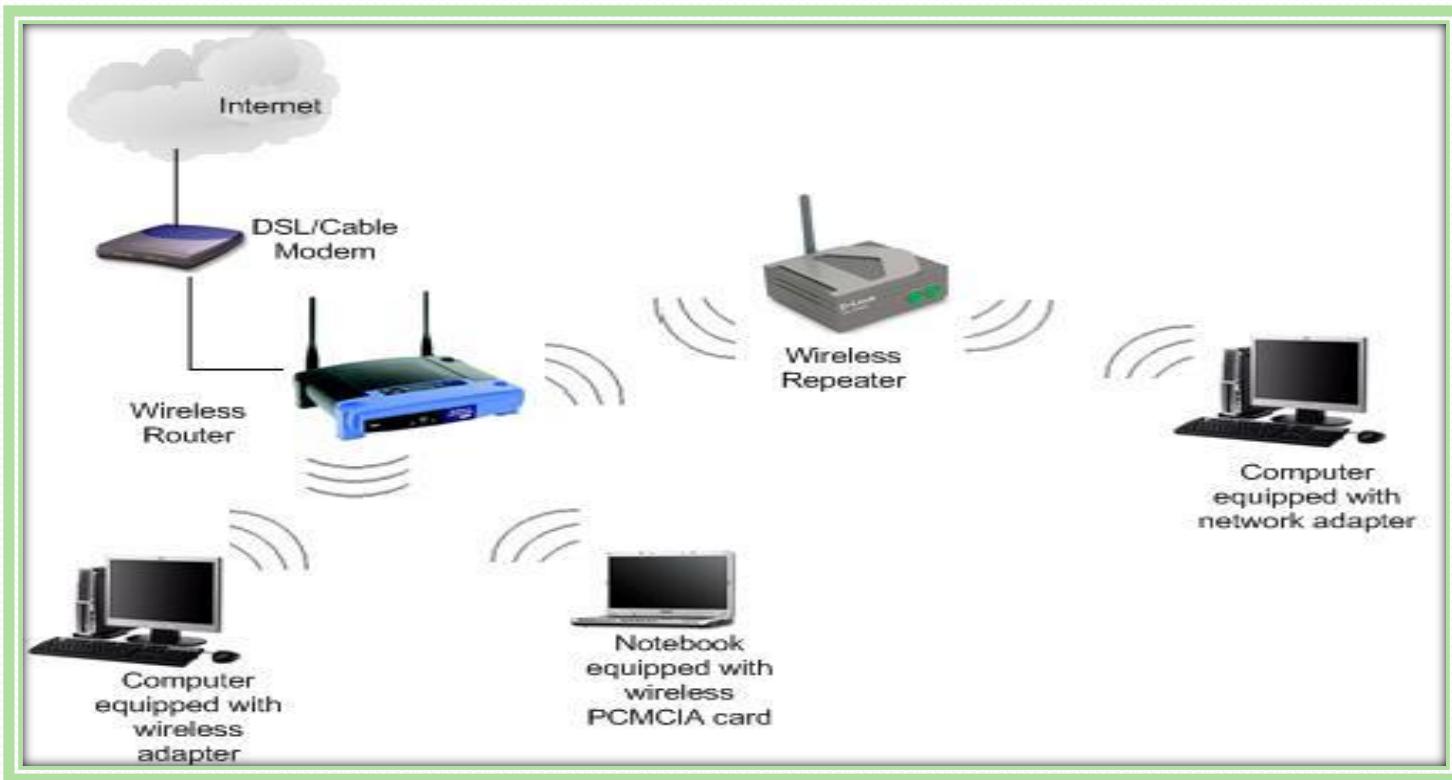
Switch :

A switch is a device that is used to segment networks into different sub-networks called subnets or LAN segments.



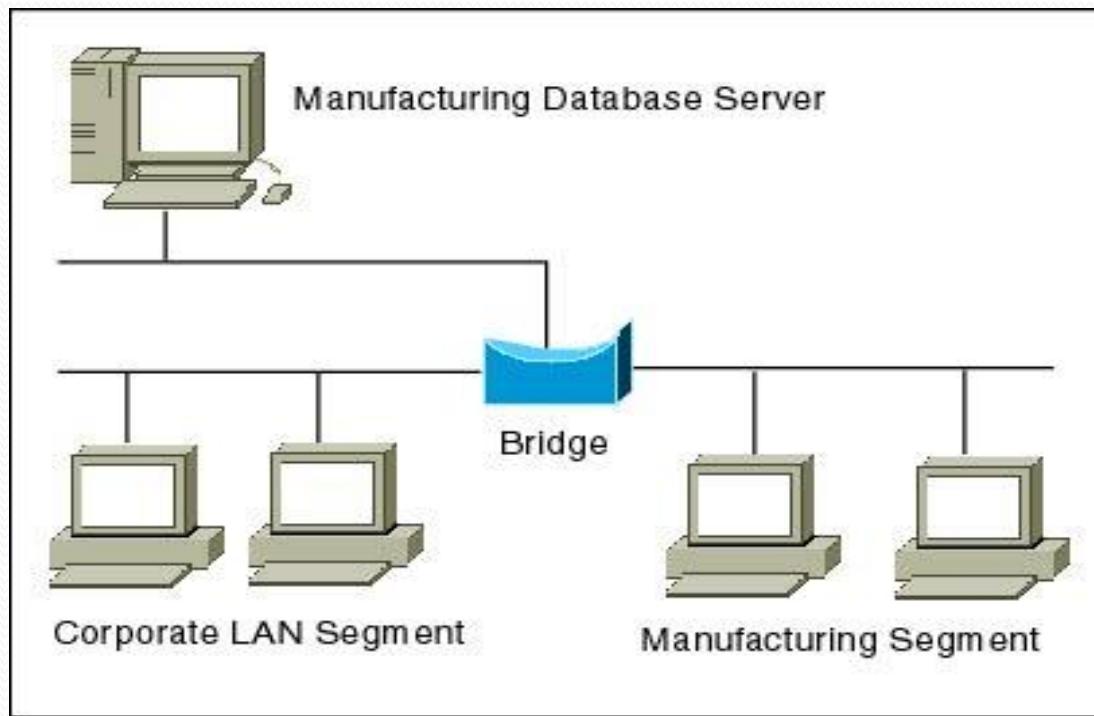
Repeater :

A repeater is a network device that amplifies and restores signals for long-distance transmission.



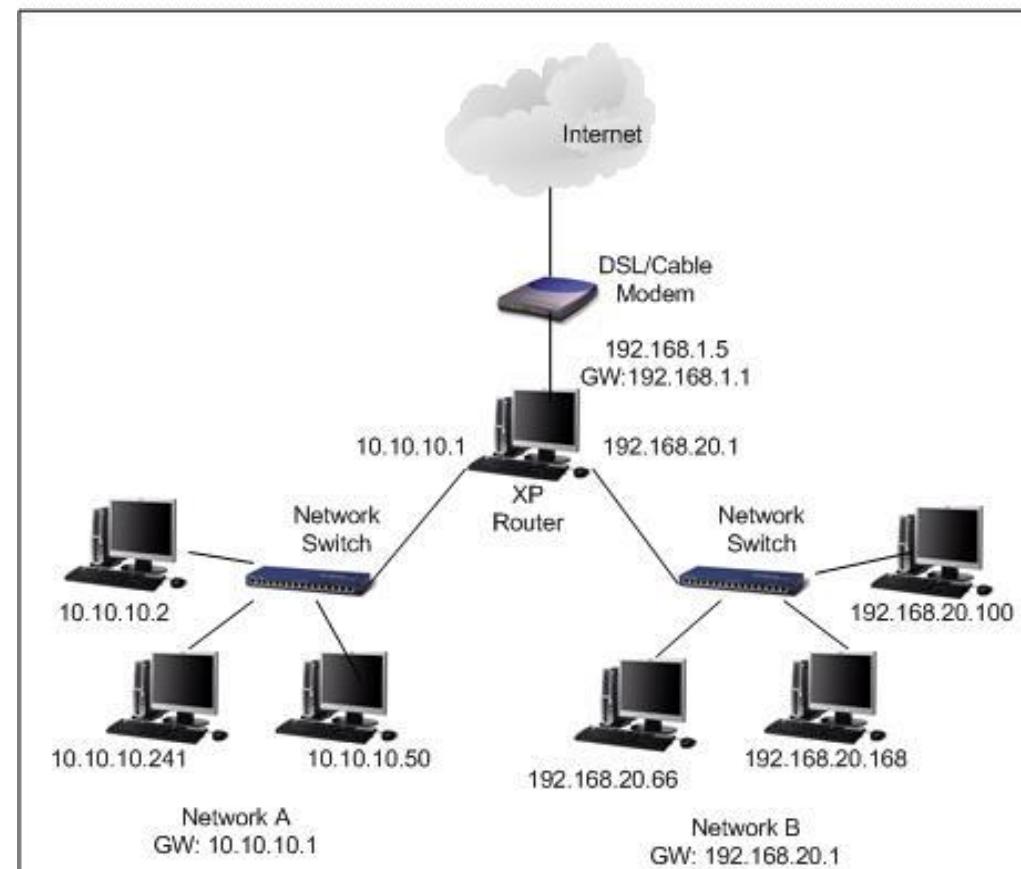
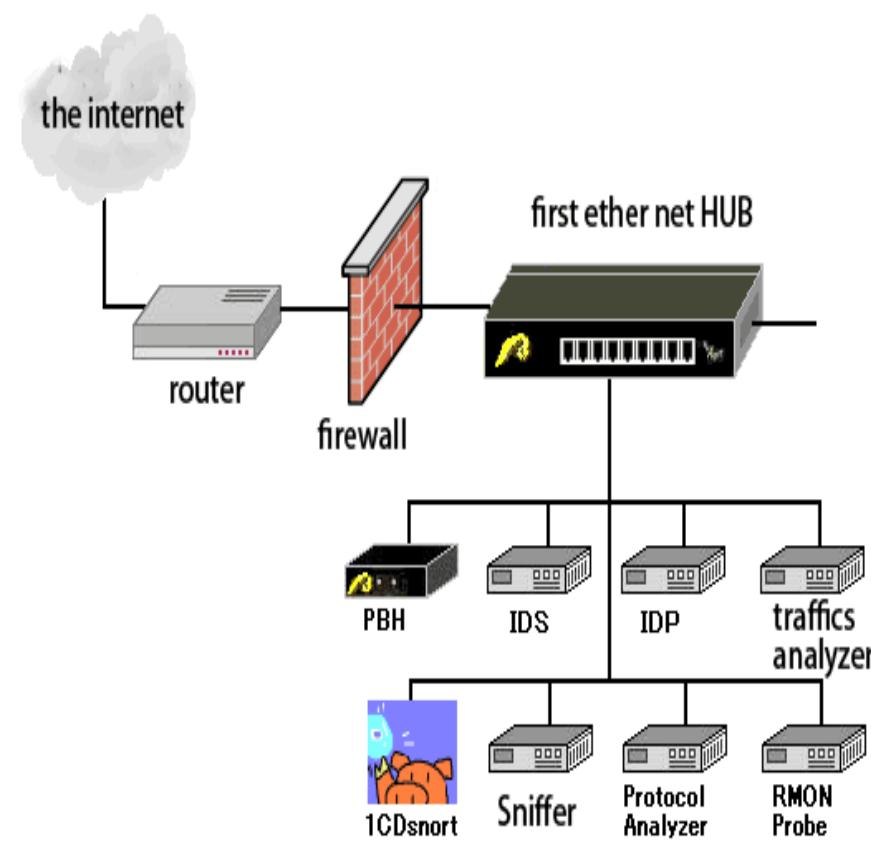
Bridge :

A bridge is a network device that establishes an intelligent connection between two local networks with the same standard but with different types of cables.



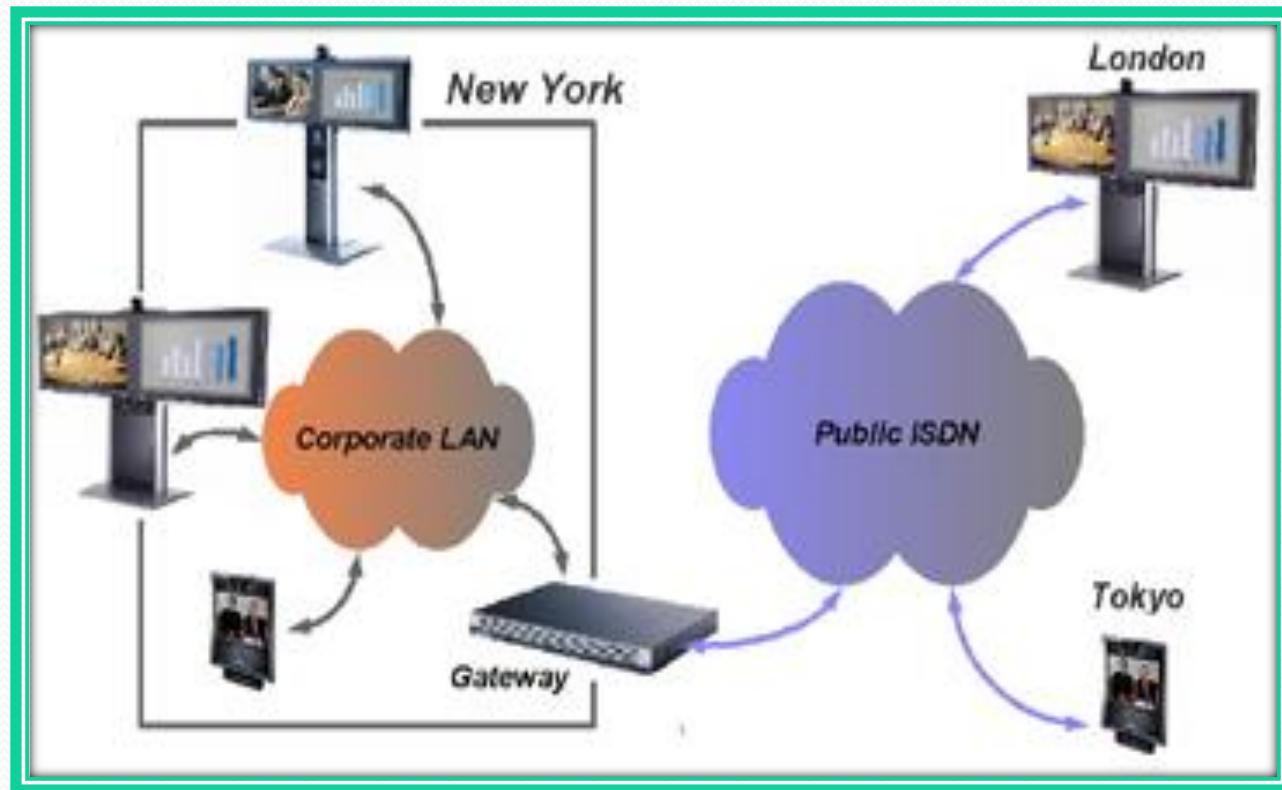
Router :

A Router is a network device that is used to separate different segments in a network to improve performance and reliability. A router works like a bridge but can handle different protocols.



Gateway :

A Gateway is a network device that connects dissimilar networks. It establishes an intelligent connection between a local networks and external networks with completely different structure .



NETWORK TOPOLOGIES

The pattern of interconnection of nodes in a network is called the **Topology**.

The selection of a topology depends on

1. **Cost.** For a network to be cost effective, one would try to minimize installation cost.
2. **Flexibility.** the topology should allow for easy reconfiguration of the network. This involves moving existing nodes and adding new ones.
3. **Reliability..** The topology chosen for the network can help by allowing the location of the fault to be detected and to provide some means of isolating it.

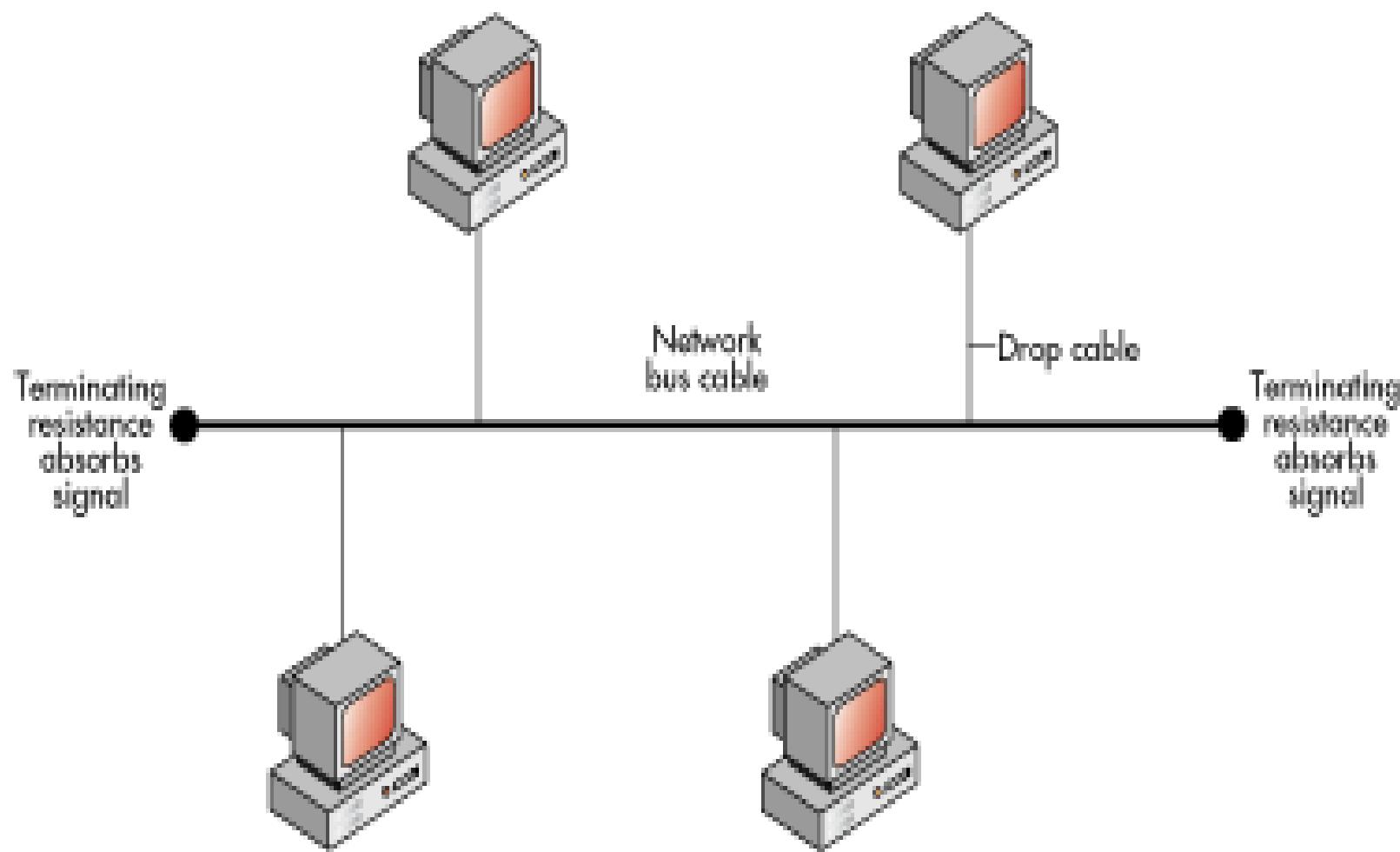
TYPES OF NETWORK TOPOLOGY

Network topologies are categorized into the following basic types :

- 1. Bus,**
- 2. Ring**
- 3. Star**
- 4. Tree**
- 5. Mesh**

More complex networks can be built as hybrids of two or more of the above basic topologies.

BUS TOPOLOGY



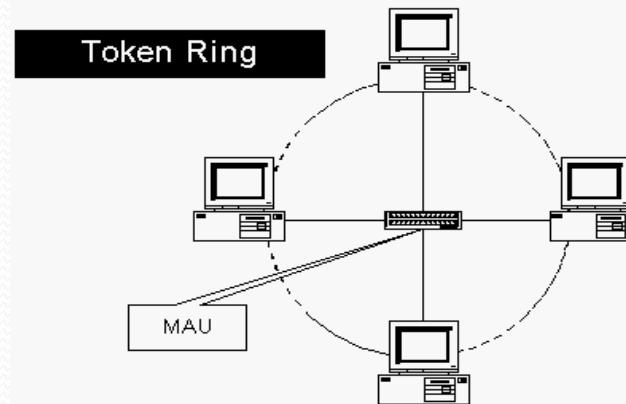
Bus Topology

- A **bus topology** connects each computer (node) to a single segment trunk.
 - A ‘**trunk**’ is a communication line, typically coax cable, that is referred to as the ‘**bus**.’ The signal travels from one end of the bus to the other.
 - A **terminator** is required at each end to absorb the signal so it does not reflect back across the bus.
- In a bus topology, signals are broadcast to all stations. Each computer checks the address on the signal (data frame) as it passes along the bus. If the signal’s address matches that of the computer, the computer processes the signal. If the address doesn’t match, the computer takes no action and the signal travels on down the bus.
- Only one computer can ‘talk’ on a network at a time. A media access method (protocol) called **CSMA/CD** is used to handle the collisions that occur when two signals are placed on the wire at the same time.
- The bus topology is **passive**. In other words, the computers on the bus simply ‘listen’ for a signal; they are not responsible for moving the signal along.
- A bus topology is normally implemented with coaxial cable.

Bus Topology

- ***Advantages*** of bus topology:
 - Easy to implement and extend
 - Well suited for temporary networks that must be set up in a hurry
 - Typically the cheapest topology to implement
 - Failure of one station does not affect others
- ***Disadvantages*** of bus topology:
 - Difficult to administer/troubleshoot
 - Limited cable length and number of stations
 - A cable break can disable the entire network; no redundancy
 - Maintenance costs may be higher in the long run
 - Performance degrades as additional computers are added

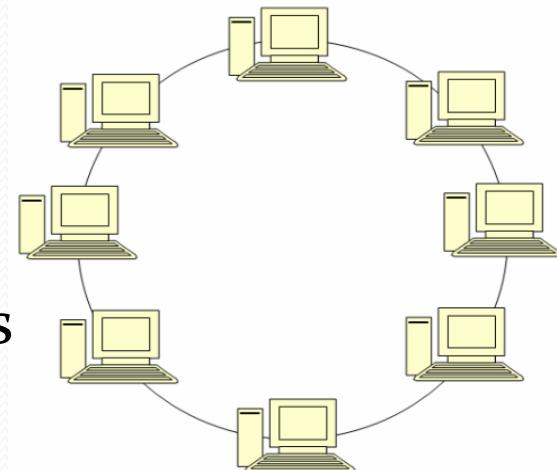
RING TOPOLOGY



Ring topology is one of the old ways of building computer network design and it is pretty much obsolete. FDDI, SONET or Token Ring technologies are used to build ring technology. It is not widely popular in terms of usability but incase if you find it any where it will mostly be in schools or office buildings. In ring network topology computers and other networking devices are attached to each other in such a way that they have devices adjacent to each other (Left and right side). All messages are traveled in the same directory either clockwise or anticlockwise. In case of failure of any device or cable the whole network will be down and communication will not be possible.

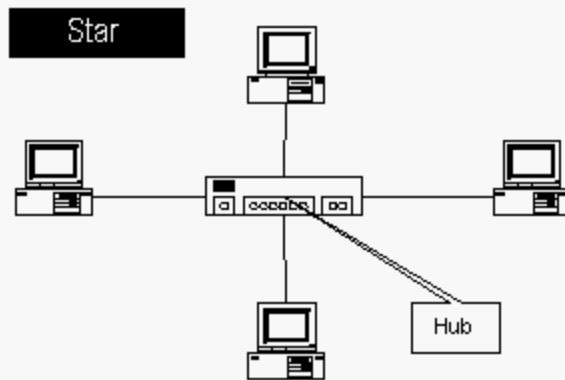
Ring Topology

- In contrast to the ‘passive’ topology of the bus, the ring employs an ‘*active*’ topology. Each station repeats or ‘boosts’ the signal before passing it on to the next station.
- Rings are normally implemented using twisted pair or fiber-optic cable
- ***Advantages*** of ring topology:
 - Growth of system has minimal impact on performance
 - All stations have equal access
- ***Disadvantages*** of ring topology:
 - Most expensive topology
 - Failure of one computer may impact others
 - Complex



Some networks implement a Logical Ring Topology

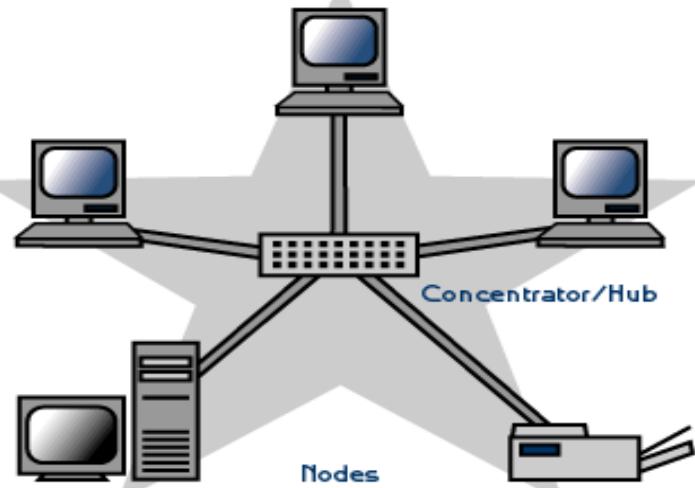
Star Topology



- All of the stations in a ***star topology*** are connected to a central unit called a ***hub***.
 - The hub offers a common connection for all stations on the network. Each station has its own direct cable connection to the ***hub***. In most cases, this means more cable is required than for a bus topology. However, this makes adding or moving computers a relatively easy task; simply plug them into a cable outlet on the wall.
- If a cable is cut, it only affects the computer that was attached to it. This eliminates the single point of failure problem associated with the bus topology. (Unless, of course, the hub itself goes down.)
- Star topologies are normally implemented using twisted pair cable, specifically unshielded twisted pair (UTP). The star topology is probably the most common form of network topology currently in use.

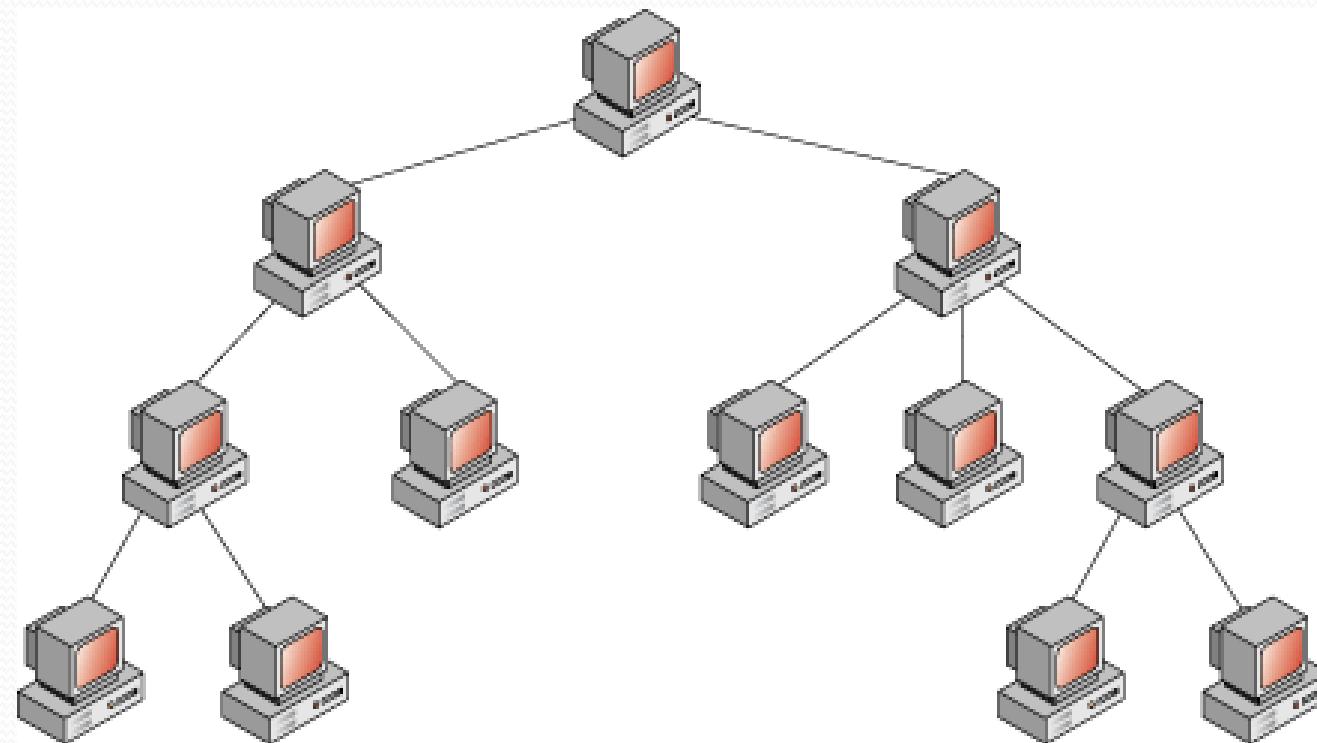
Star Topology

- ***Advantages*** of star topology:
 - Easy to add new stations
 - Easy to monitor and troubleshoot
 - Can accommodate different wiring
- ***Disadvantages*** of star topology:
 - Failure of hub cripples attached stations
 - More cable required (more expensive to wire a building for networking)



TREE TOPOLOGY

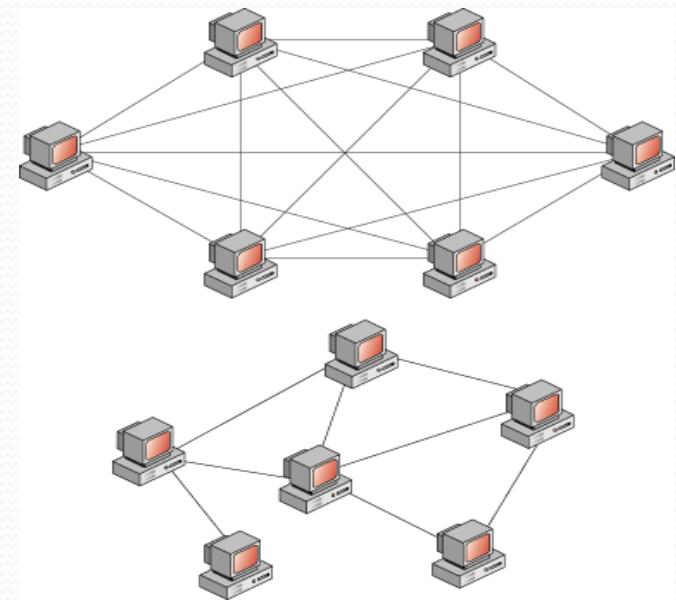
Tree topology is basically the mixture of many Star topology designs connected together using bus topology. Devices like Hub can be directly connected to Tree bus and each hub performs as root of a tree of the network devices. Tree topology is very dynamic in nature and it holds potential of expandability of networks far better than other topologies like Bus and Star.



MESH TOPOLOGY:-

In this topology, each node is connected to more than one node to provide an alternative route in the case the host is either down or too busy. It is an extension to *P-P* network.

The mesh topology is excellent for long distance networking because it provides extensive back-up, rerouting and pass-through capabilities.



The mesh topology is commonly used in large internetworking environments with stars, rings, and buses attached to each node. This is also ideal for distributed networks.

GRAPH TOPOLOGY

In this topology, nodes are connected together in an arbitrary fashion. A link may or may not connect two or more nodes. There may be multiple links also. It is not necessary that all the nodes are connected. But if a path can be established in two-nodes via one or more links, it is called a connected graph.

LAN (Local Area Network)

- A network of computers that are in the same physical location, such as home or building
- Usually connected using Ethernet
 - A standard on how computers communicate over a shared media (cable)

Old: BNC connector for coaxial cable New: RJ45 for twisted pair cable



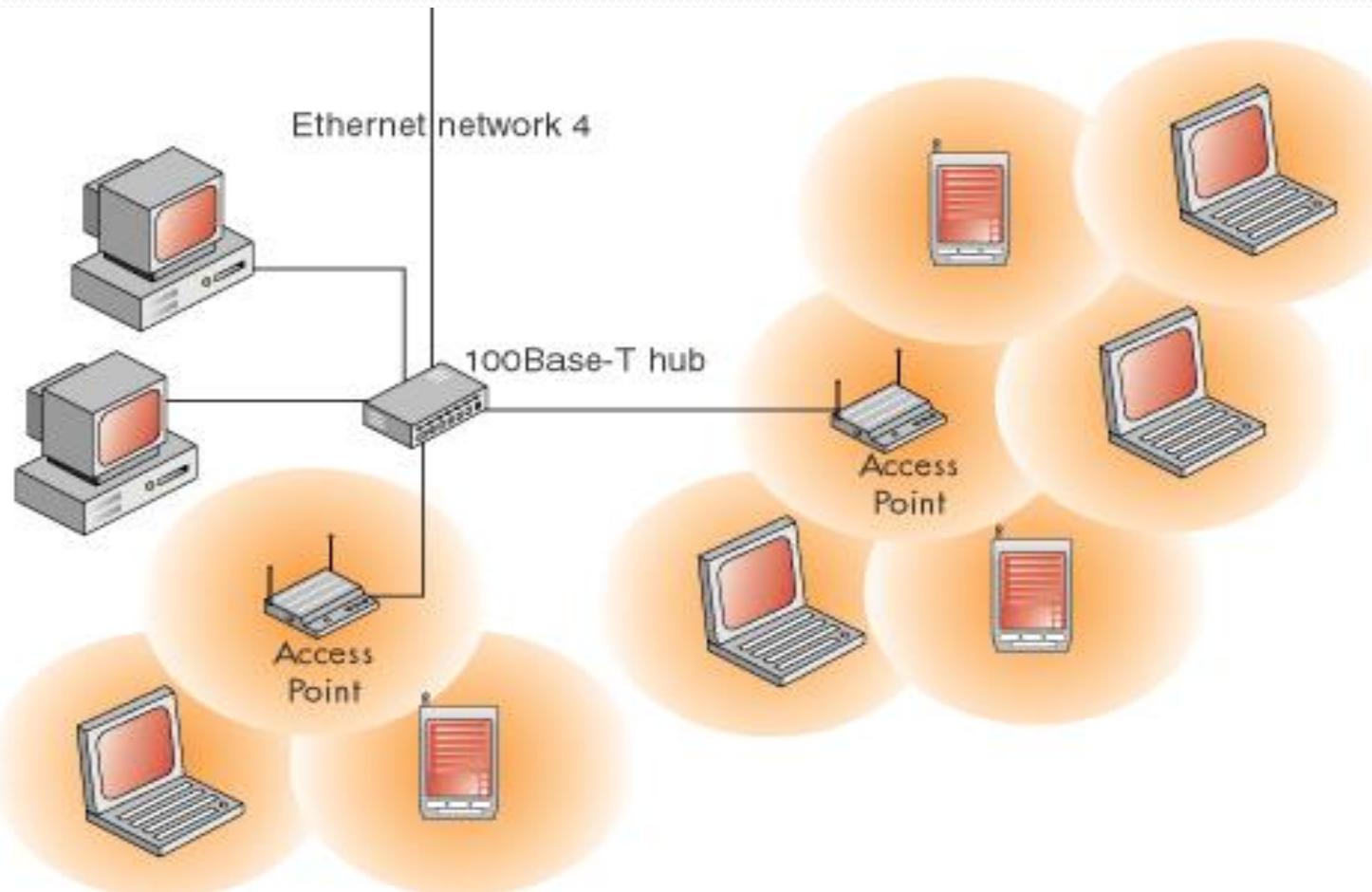
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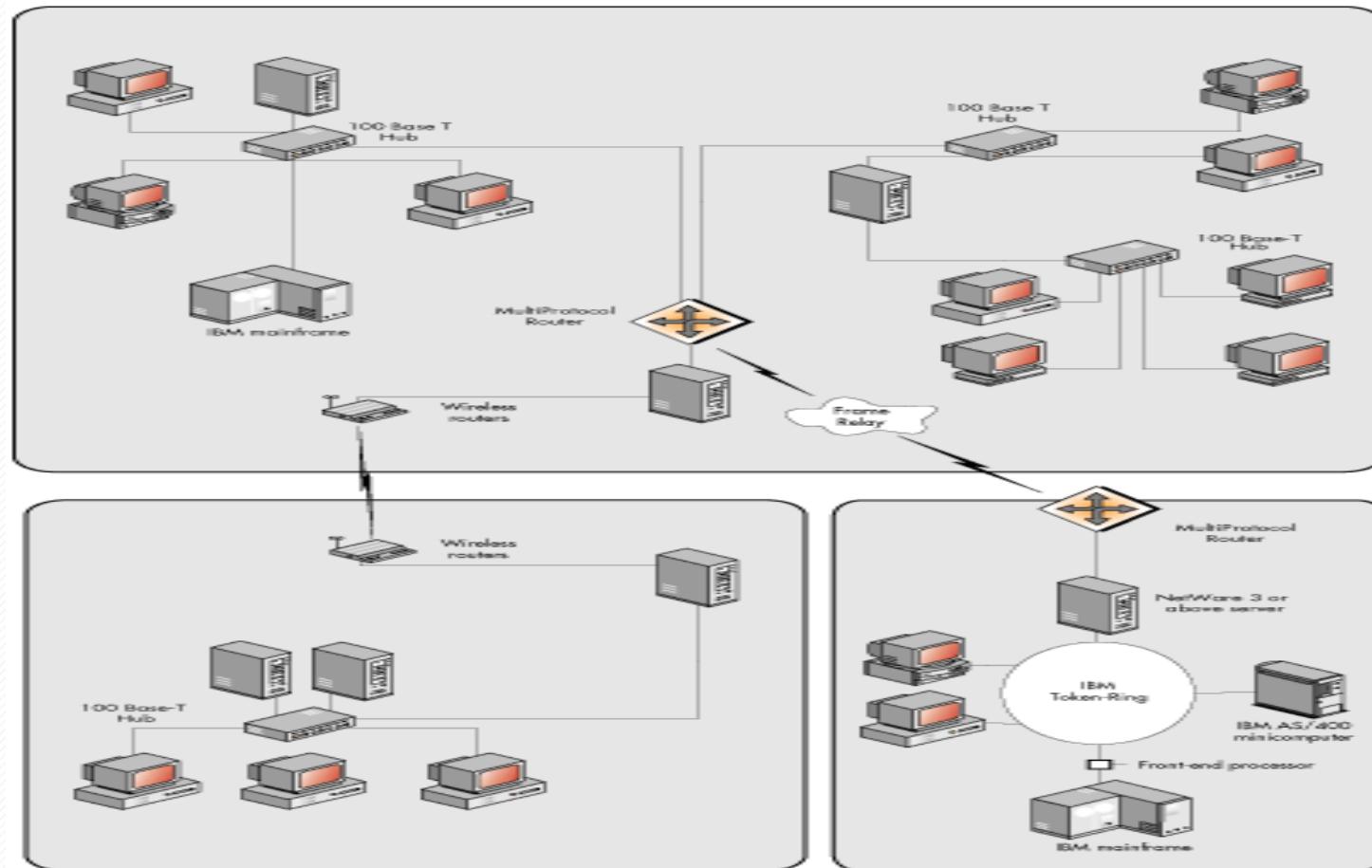
LAN

LAN: Local Area Network



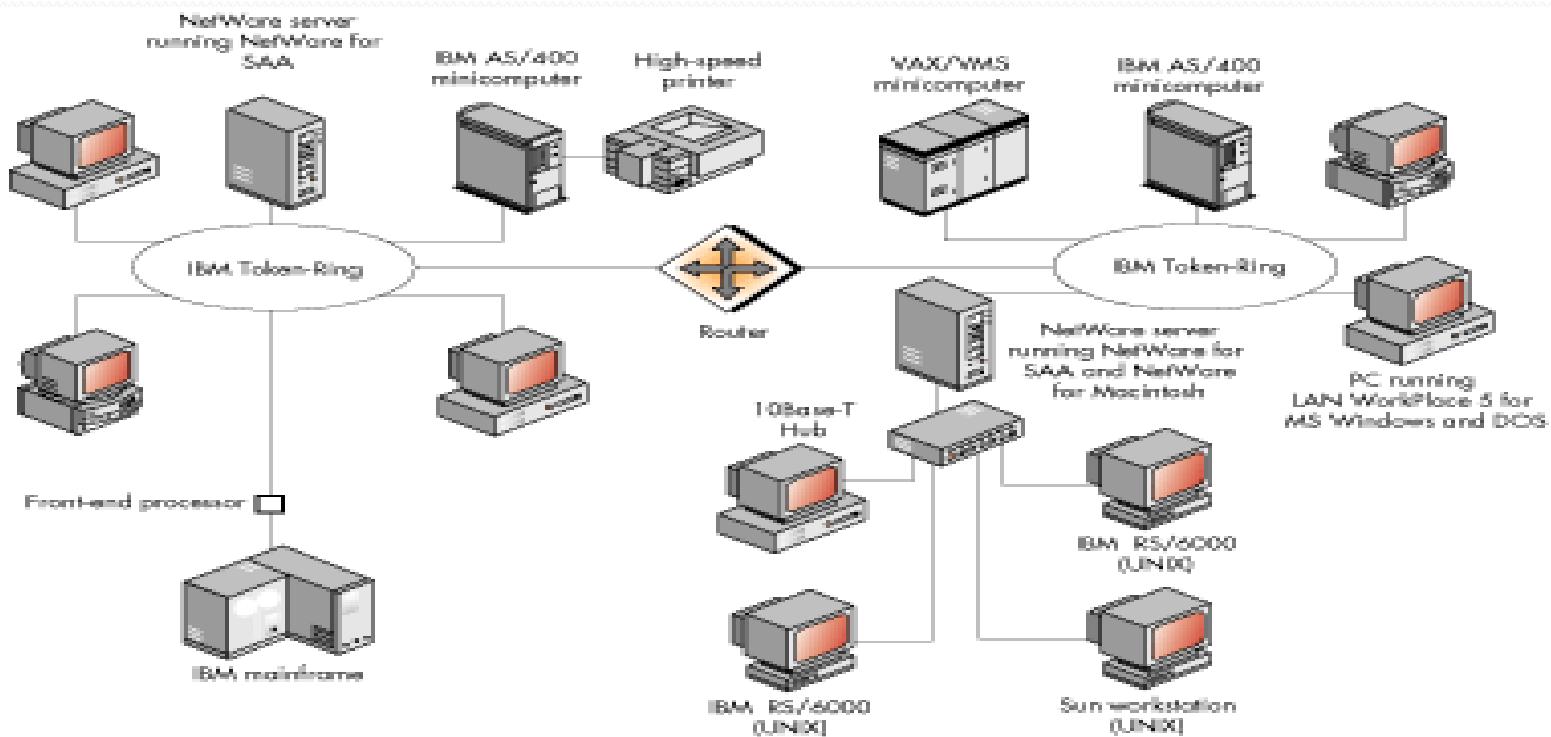
WAN: Wide Area Network

A **Wide Area Network** (WAN) is a network that covers a broad area (i.e., any telecommunications network that links across metropolitan, regional, or national boundaries) using private or public network transports.



MAN: Metropolitan Area Network

A **metropolitan area network (MAN)** is a computer network that usually spans a city or a large campus. A MAN usually interconnects a number of local area networks (LANs) using a high-capacity backbone technology, such as fiber-optical links, and provides up-link services to wide area networks (or WAN) and the Internet.



Communication Protocols

Protocol:- A protocols means the rules that are applicable for a network. Protocol defines standardized formats for data packets, techniques for detecting and correcting errors and so on.

It is a formal description of message formats and the rules that two or more machines must follow to exchange those message.

Communication Protocols

HTTP (Hypertext Transfer Protocol) :

Hypertext Transfer Protocol (HTTP) is an application-level protocol for distributed, collaborative, hypermedia information systems. Its use for retrieving inter-linked resources, called hypertext documents, led to the establishment of the World Wide Web in 1990 by English physicist Tim Berners-Lee.

FTP (File Transfer Protocol) :

File Transfer Protocol (FTP) is a standard network protocol used to exchange and manipulate files over a TCP/IP based network, such as the Internet. FTP is built on a client-server architecture and utilizes separate control and data connections between the client and server applications.

TCP/IP (Transmission Control Protocol / Internet Protocol) :

TCP and IP were developed by a Department of Defense (DOD) research project to connect a number different networks designed by different vendors into a network of networks (the "Internet")

The IP component provides routing from the department to the enterprise network, then to regional networks, and finally to the global Internet.

As with all other communications protocol, TCP/IP is composed of layers:

Communication Protocols

TCP/IP (Transmission Control Protocol / Internet Protocol) :

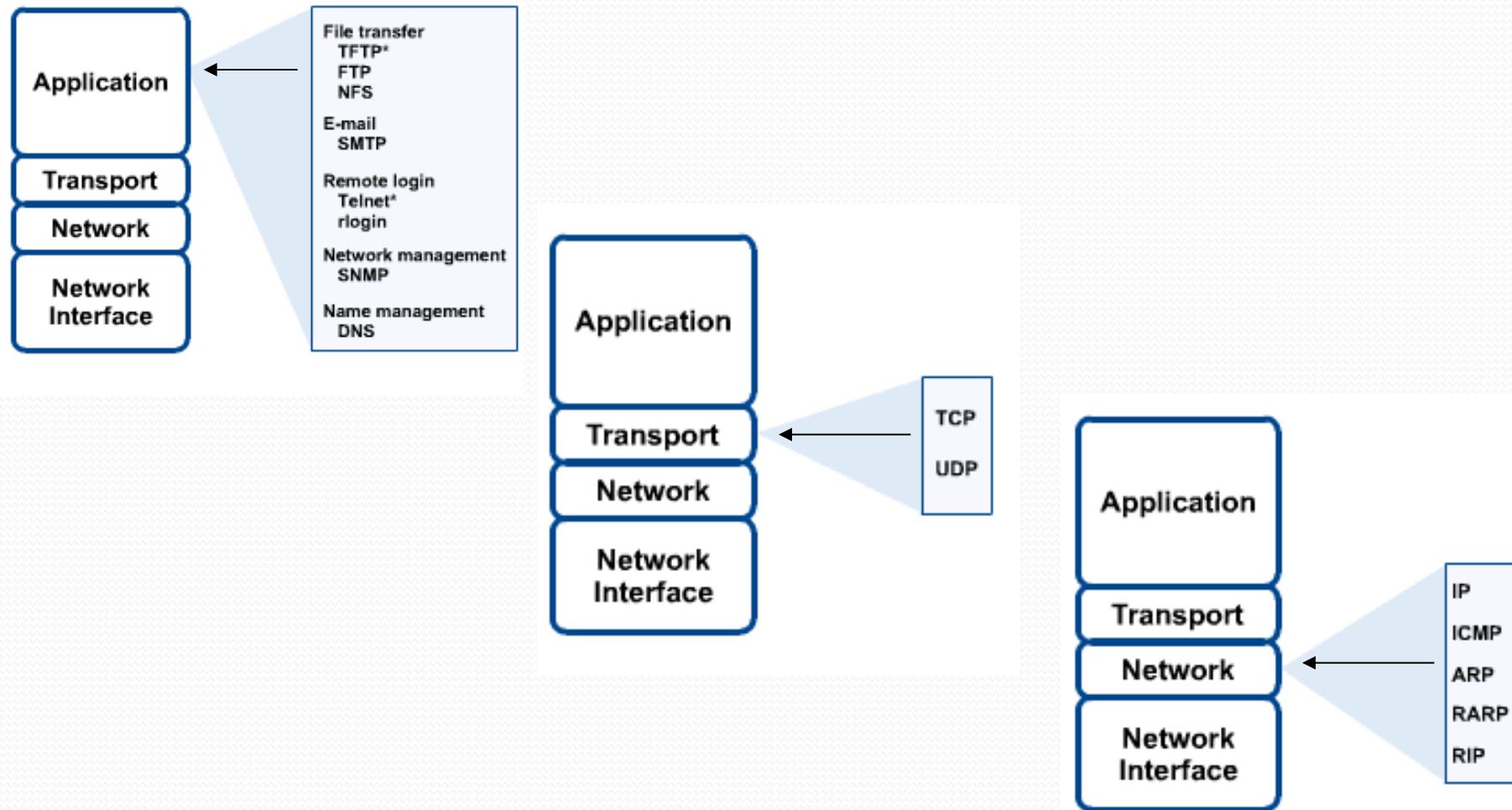
As with all other communications protocol, TCP/IP is composed of layers:

IP - is responsible for moving packet of data from node to node. IP forwards each packet based on a four byte destination address (the IP number). The Internet authorities assign ranges of numbers to different organizations. The organizations assign groups of their numbers to departments. IP operates on gateway machines that move data from department to organization to region and then around the world.

TCP - is responsible for verifying the correct delivery of data from client to server. Data can be lost in the intermediate network. TCP adds support to detect errors or lost data and to trigger retransmission until the data is correctly and completely received.

Sockets - is a name given to the package of subroutines that provide access to TCP/IP on most systems.

Networking Protocol: TCP/IP



Communication Protocols

SLIP/PPP (Serial line internet Protocol / Point to Point Protocol) :

SLIP/PPP - Serial Line Internet Protocol/Point to Point Protocol.
Lets you connect your computer system to the Internet itself, rather than logging on through an Internet access provider's host computer and issuing commands through a shell. SLIP/PPP connections lets you communicate directly with other computers on the network using TCP/IP connections.

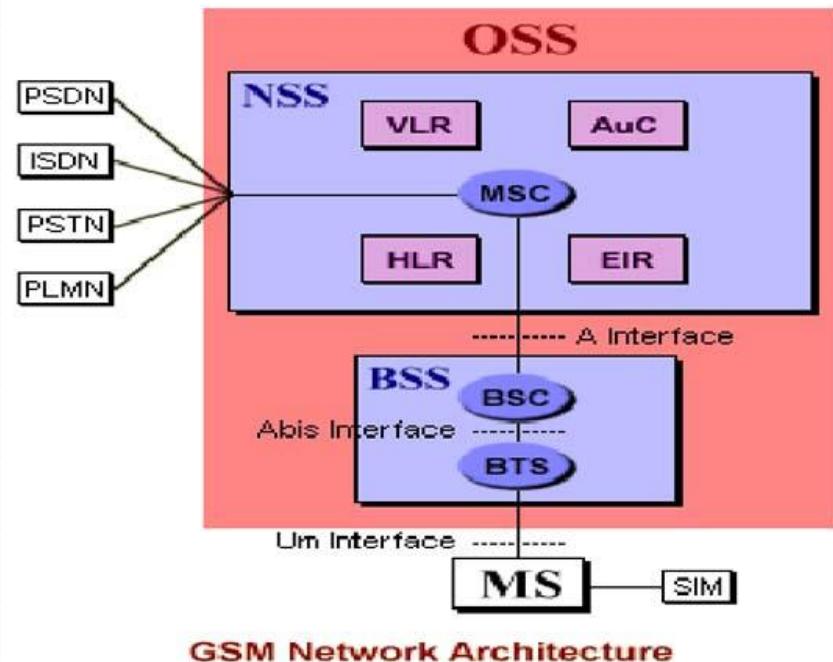
Wireless/Mobile Computing

Wireless communication is simply data communication without the use of cables

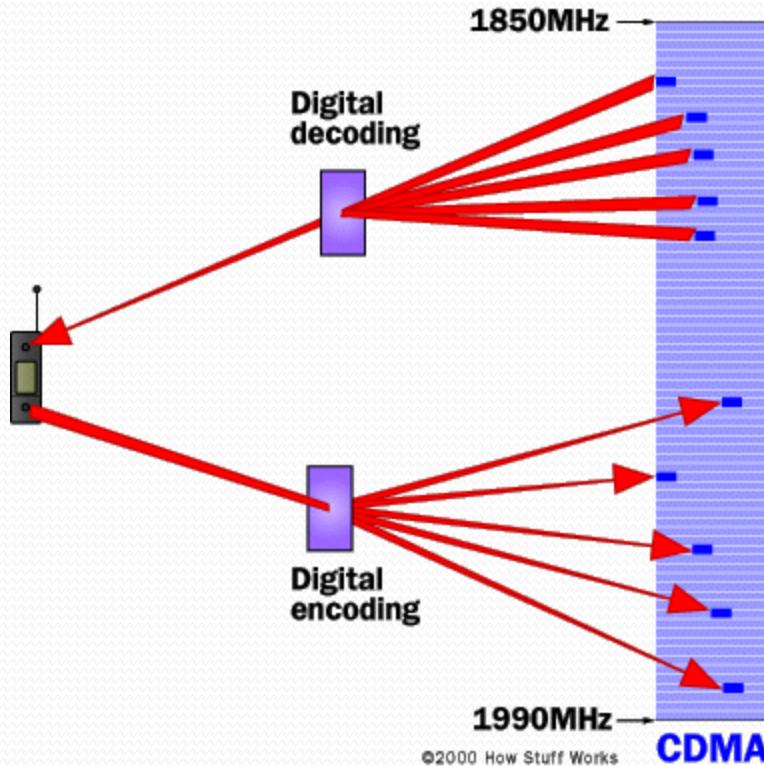
Mobile computing means that the computing device is not continuously connected to the base or central network.

GSM (Global System for Mobile communications)

- GSM (Global System for Mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services.



CDMA (Code Division Multiple Access)



- It uses a spread-spectrum technique where data is sent in small pieces over a number of discrete frequencies available for use.

WLL (Wireless in Local Loop)

- It is a system that connects subscribers to the public switched telephone network (PSTN) using radio signals as a substitute for other connecting media.



3G (Third Generation)



broadband, packet-based transmission of text, digitized voice, video and multimedia at data rates up to 2 megabits per second (Mbps), offering a consistent set of services to mobile computer and phone users

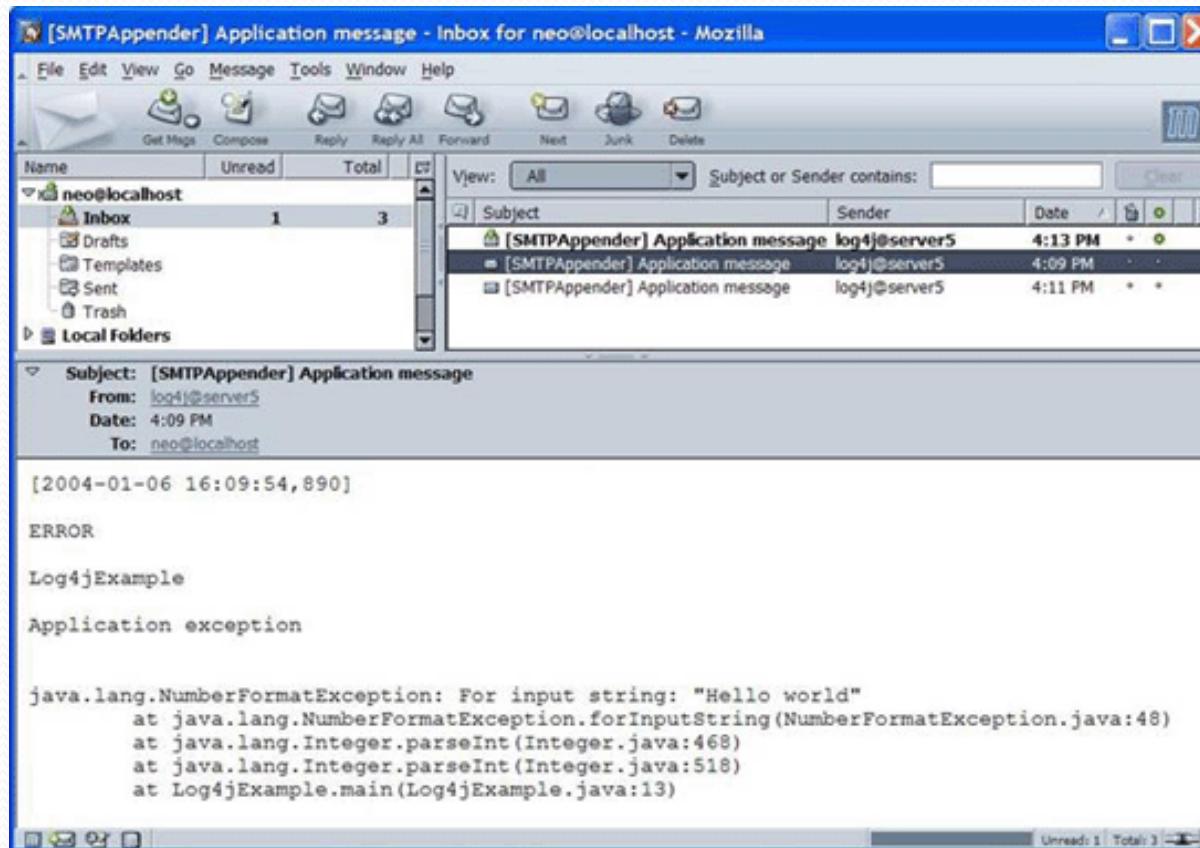
SMS (Short Message Service)

- It is the transmission of short text messages to and from a mobile phone, fax machine and/or IP address.

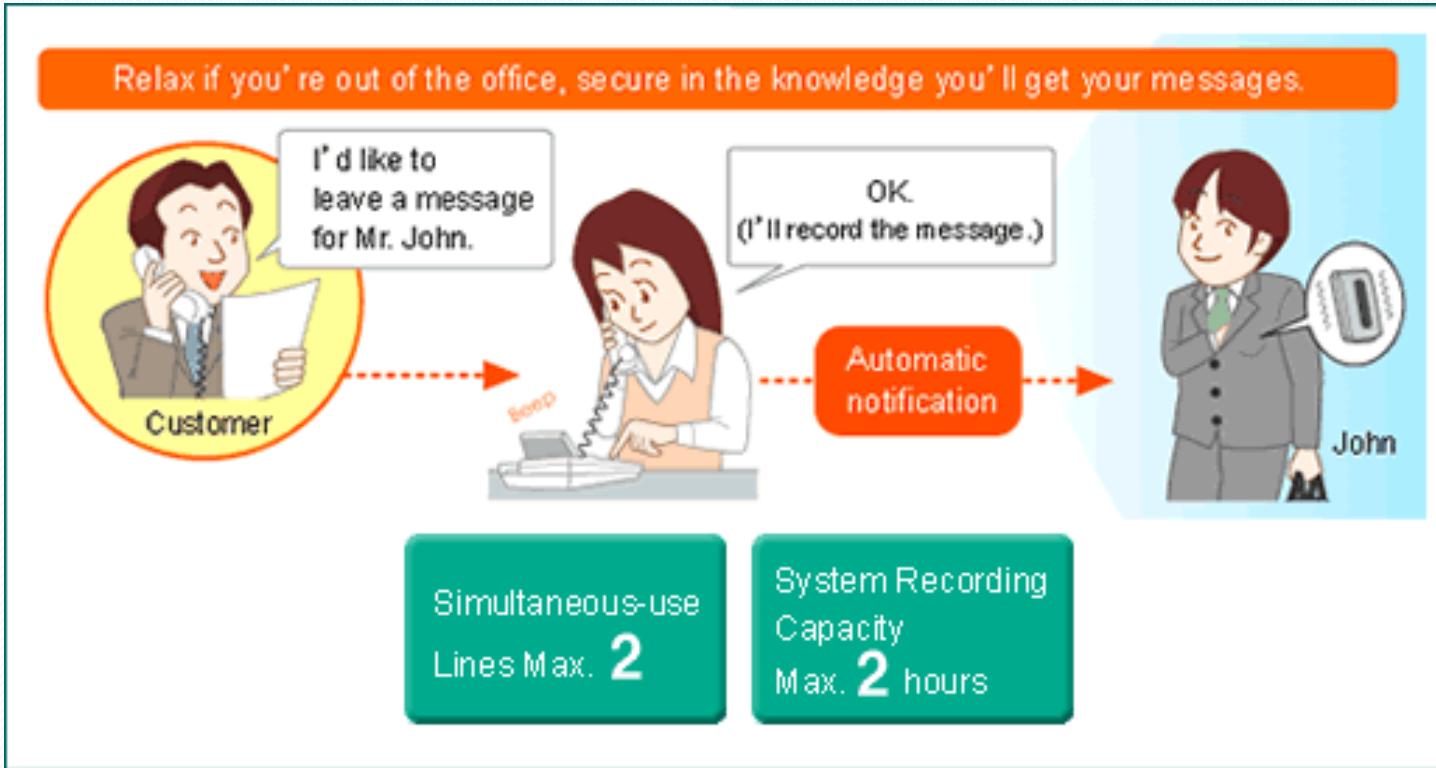


Email (Electronic Mail)

- Electronic Mail is sending and receiving messages by computer.



Voice Mail



- It refers to e-mail systems that support audio.

Chat

- Online textual talk in real time is called chatting.



Video Conferencing

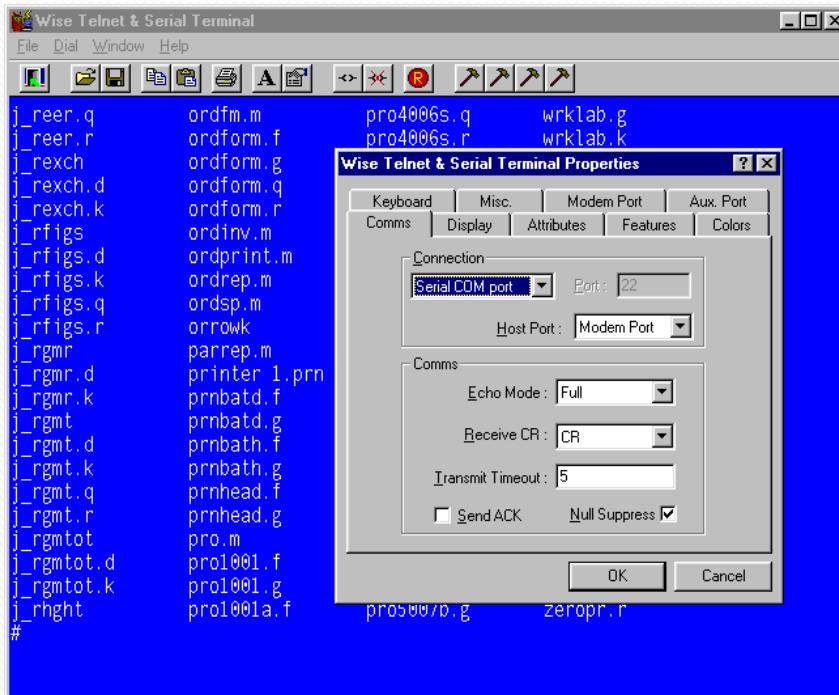


- It is a two-way videophone conversation among multiple participants.

WWW (World Wide Web)

- It is a set of protocols that allows you to access any document on the net through a naming system based on URL's.
- It is a small part of internet.
- WWW Attributes:-
 1. User-friendly
 2. Hypertext and Hyperlink
 3. Interactive
 4. Frames

Telnet



- Telnet is an internet utility that lets you onto remote computer systems.
- We can use Telnet to connect to thousands of catalogs at libraries around the world.

Web Browser and Web server

- A Web browser is a WWW client that navigates through the WWW and displays web pages. e.g. Internet Explorer, Netscape Navigator.
- A Web server is a WWW server that responds to the requests made by web browsers.

Web sites and Web addresses

- A location on a net server is called a web site.
- Each web site has a unique address called URL (Uniform Resource Locator).

URL and Domain Names

- A URL specifies the distinct address for each resource on the internet.
- An internet address which is character based is called a domain name.

Web hosting

- It is a means of hosting web-server application on a computer system through which electronic content on the internet is readily available to any web browser client.
- Categories of web hosting
 - Free Hosting
 - Virtual or Shared Hosting
 - Dedicated Hosting
 - Co-location Hosting

HTML (Hypertext Markup Language)

- It is a document layout and hyperlink-specification language.
- It tells the browser how to display the contents of a hypertext document.
- It also tells how to make a document interactive through special hyperlinks.
- It provides many layout commands, called tags that let us control the presentation of information on a web page.

XML (EXtensible Markup Language)

- It is a markup language for documents containing structured information (both content and some indication of what role that content plays). The XML specification defines a standard to add markup to documents.

DHTML (Dynamic HTML)

- It is a combination of HTML, style sheets and scripts that allows documents to be animated.
- It allows a web page to change after it's loaded into the browser- there doesn't have to be any communication with the web server for an update.

10. Web Scripting

- The process of creating and embedding scripts in a web page is known as web-scripting.
- A script is a list of commands that are embedded in a web page normally and are interpreted and executed by a certain program or scripting engine.
- Types of Web Scripting:
 - Client Side Scripting
 - Server Side Scripting

Network Security Issues

Physical Security holes: When individuals gain unauthorized physical access to a computer and tamper with files.

Software Security holes: When badly written programs or privileged software are compromised into doing things that they shouldn't be doing.

Protection Methods

- Authorization- e.g. username
- Authentication- e.g. password
- Encrypted smart card
- Biometric systems- e.g. fingerprint matching
- Firewall- e.g. Packet filter, Application gateway, Circuit-level gateway, Proxy server

Important terms

- Cookies
- Hackers
- Crackers
- Cyber law
- India's IT Act
- Cyber Crime

Hackers & Crackers

- Hackers: interested in gaining knowledge about computer systems & using this for playful pranks
- Crackers: malicious programmers who break into secure systems for the purpose of stealing or corrupting data

Cyber Law & India's IT Act

- Cyber law: Refers to all the legal and regulatory aspects of Internet & the World Wide Web
- India's IT Act: In India the cyber laws are contained in the IT Act 2000. Aims to provide legal infrastructure for e-commerce in India by governing transactions through internet and other electronic medium

Cyber Crime

An unlawful act where in a computer is either a tool or a target or both. classified as:

- Tampering with computer source documents
- Hacking
- Publishing of obscene information in electronic form
- Child Pornography
- Accessing protected system
- Breach of confidentiality & privacy