COMPUTER NETWORKS

Computer Network - A computer network is an interconnected collection of autonomous computers and devices to exchange information or share resources.

Advantages of Computer Network-

1. Resource sharing : We can share hardware devices, softwares as well as data on a network.

2. Communication Medium : Network can provide communication between different computers attached to a network.

3. Reduced Cost : Sharing of resources helps in reducing hardware and software cost

4. Centralized Control: We can centrally control the computers attached to a network.

5. Central storage of data: We can save data of entire network on single computer. It helps in removing duplication of data as well as maintaining integrity of data.

Disadvantages of Computer Network-

1. Cost of setup and maintenance
2. Threat to data security

Evolution of Networking-

1. **ARPANET (Advanced Research Project Agency Network)-** It was the first network that came into existence in 1969. It was designed and named by ARPA (Advanced Research Project Agency) and US Department of Defense (DoD). It connected different universities and US DoD for sharing of data.
2. **NSFNET (National Science Federation Network)-** In 1980s NSFNET created a network that was more capable than ARPANET. Its main aim was to use network only for academic research.
3. **Internet-** Internet came into existence in 1990s. It stands for interconnected networks. It is interconnection of computers all over the world. It has evolved from ARPANET.
   Network of networks make the internet.

Concept of Communication-

The term “Data Communication” comprises two words: Data and Communication. Data can be any text, image, audio, video, and multimedia files. Communication is an act of sending or receiving data. Thus, data communication refers to the exchange of data between two or more networked or connected devices. These devices must be capable of sending and receiving data over a communication medium.

Components of Data Communication:

Message – it information to be communicated

Sender – The device which send the message

Receiver – The device which receive the message

Transmission media – It is physical path by which message travel from sender to receiver

Protocol – It is a set of rules that governs data communication. Actually it is an agreement between the sender and receiver regarding various communication parameters.

Bandwidth- Bandwidth is defined as the amount of information that can be transferred through a single channel per unit time.

For analog channels, bandwidth is measured as **Hz** (Hertz), **KHz** (Kilo Hertz) ,**MHz**(Mega Hertz)

For digital channels, bandwidth (**Data transfer Rate**) is measured as **bps** (Bits per second), **Kbps** (Kilo Bits per second) , **Mbps(**Mega Bits per second), **Gbps**(Giga Bits per second), **Tbps**(Tera Bits per second).

IP Address- An IP address is a unique address that identifies a device on the internet or a local network. IP stands for "Internet Protocol," which is the set of rules governing the format of data sent via the internet or local network.

It consists of 4 bytes (IPv4) decimal number (between 0 to 255) separated by ‘.’ (Period). E.g. 192.168.23.34

Switching Techniques- Switching is the technique of transmitting information from one device/network to another.

It is of two types: Circuit switching and Packet Switching.

Circuit Switching- In circuit switching, a dedicated path is established before sending data from sender to receiver and entire communication is carried out the same path.

Packet Switching – In packet switching, a message is broken into a number of parts called packets which are sent independently from sender to receiver and reassembled at the destination.

Circuit Switching	Packet Switching
A dedicated path is established	No dedicated path is established
Entire message follow same path	Each packet travels independently to each other

Transmission Media- Communication media or transmission media is a media through which data or signal is transferred between two communication devices i.e. from one system to another system, through wires or without wires.

It is of two types - guided media and unguided media

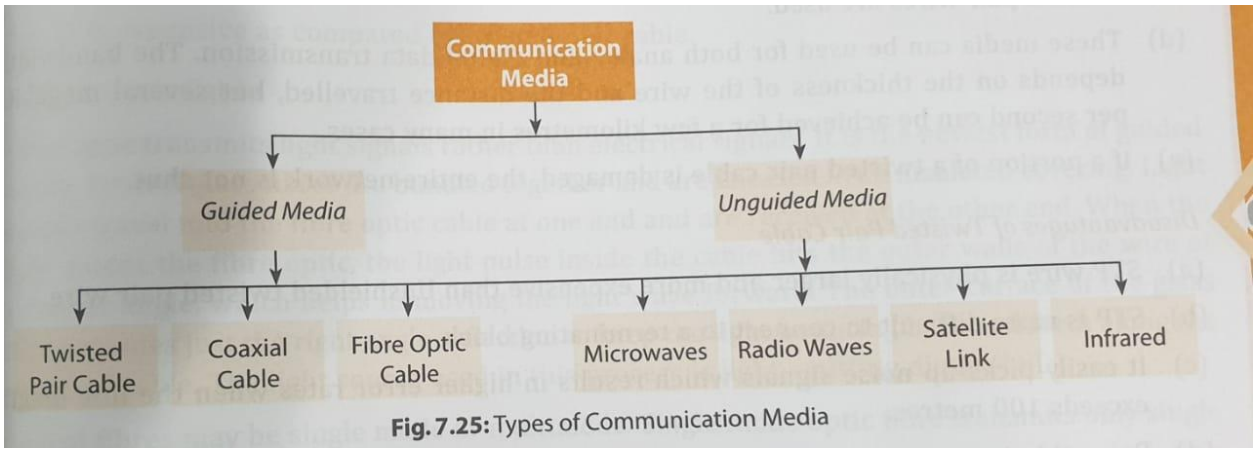


Fig. 7.25: Types of Communication Media

Guided Media/Wired Media - If the data is sent across the network through wires, it is called guided media. Various types of guided media are as follows-

1. **Twisted Pair Cable -** A twisted pair cable is a collection of four pair of insulated wires wrapped together. They are preferably used for local area network.

   It is of two types - STP (Shielded Twisted Pair) and UTP (Unshielded Twisted Pair)

   STP are covered in metal foil. This makes them indifferent to noise and crosstalk.

UTP cables has seven categories. They are connected by RJ-45 connectors.

Advantages -

- They are very cheap.
- They have very less weight.
- They are flexible.
- It is easy to install and maintain twisted pair cable.

Disadvantages -

- It is suitable for short distance communication.
- It has low bandwidth.
- Susceptible to noise and interference.

2. **Coaxial Cable -** Coaxial cabling has a single copper conductor at its center, and a plastic layer that provides insulation between the center conductor and a braided metal shield.

   Advantages -

   - It is suitable for cable TV transmission.
   - It provides high bandwidth so it is suitable for long distance communication.
   - It is suitable for broadband transmission.
   - The cost of a coaxial cable is less.
   - Highly resistant to physical damage.
   - The transmission rate is high.
   - It is less susceptible to noise interference compared to twisted pair.

   Disadvantages -

   - It is expensive to install.
   - Cost maintenance is also high.
   - Less flexible

3. **Optical Fiber Cable -** Optical fiber cable is make of glass or glass like material. It can transmit information in the form of light waves.

   Advantages -

   - It is free from electromagnetic interference.

- It provides high speed for long distance communication
- Immune to cross-talk

Disadvantages -

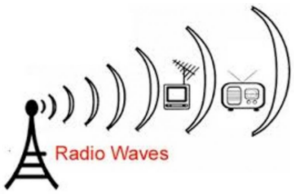
- It is very expensive.
- It is not compatible with other cables.

Unguided Media/Wireless Media: Wireless communication channels are used to transmit information without using cables.

1. **Radio Waves:** Radio waves communication uses continuous sine waves to transmit information from one point to another. It needs two components:

   Transmitter: To transmit information.

   Receiver: To receive information transmitted by transmitter.



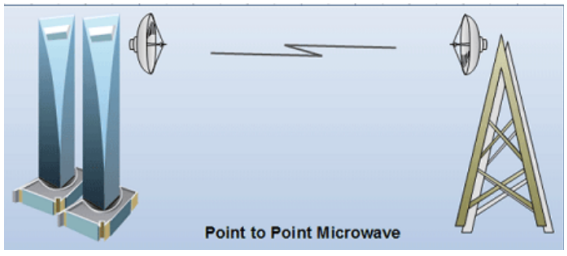
   Advantages:

   - It is easy to install and maintain.
   - It is suitable for hilly areas as well as oceans.
   - It is omnidirectional and can travel in any direction.

   Disadvantages:

   - It is insecure.
   - It is badly affected by the weather.

2. **Micro Waves:** Microwaves are direct line of sight transmission in which parabolic antennas are placed in front of each other.



Advantages:

- It is easy to install and maintain.
- It is suitable for hilly areas as well as oceans.
- It is omnidirectional and can travel in any direction.

Disadvantages:

- It is insecure.
- It is badly affected by the weather.
- It cannot penetrate obstacles.

3. **Infra-red Waves:** Infrared is direct line of sight transmission within a short distance (5 meters).

   Advantages

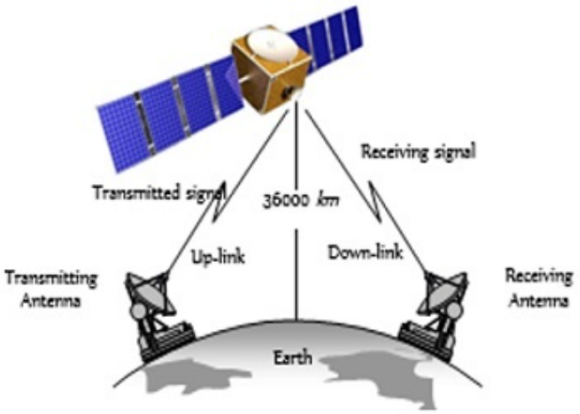
   - It is cheap way of communication
   - It is secure medium of transmitting data

   Disadvantages

   - It can't cross walls and solid objects.
   - It is not suitable for long distance communication.

4. **Satellite Communication:** In satellite communication, an artificial satellite is placed in geostationary orbit at around 36,000 Kms above the surface of earth.

   A satellite contains a Trans-Receiver antenna to receive, generate and redirect signals.



Advantages

- It covers a very large area.
- It provides secure transmission.

Disadvantages

- It is very expensive.
- Installation is very complex.

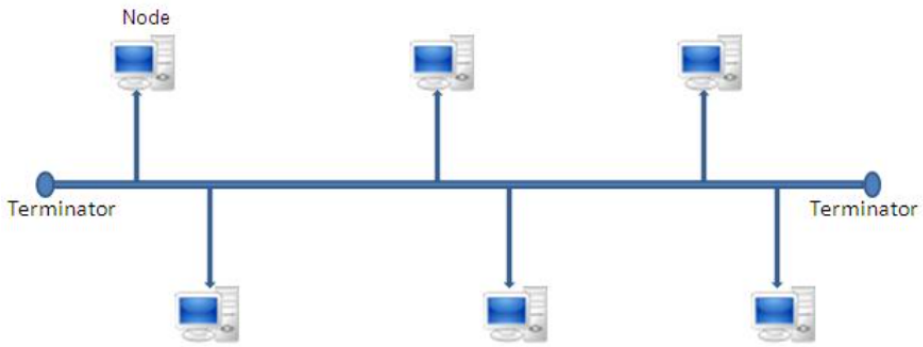
Types of Computer Networks

LAN	MAN	WAN	PAN
1. It stands for Local Area Network	1. It stands for Metropolitan Area Network	1. It stands for Wide Area Network	1. It stands for Personal Area Network
2. It is a network within a small area such as building.	2. It is a network within a city.	2. It is a network across cities, countries and continents.	2. It is a network within a very small area upto 10 meters.
3. Twisted pair cable is preferably used for communication.	3. Coaxial cable is preferably used for communication..	3. Optical fiber or satellite are used for communication	3. Communication is made using bluetooth, infrared or wireless devices.
4. Example: Computer Lab	4. Example: Cable TV Network	4. Example: Mobile phone network	4. Example: Wireless headphone, wireless printer.

Network Topologies

Network Topology is the structure to organize and interconnect computers on a network .

1. **Bus Topology:** Bus topology is a network type in which every computer and network device is connected to a single cable.



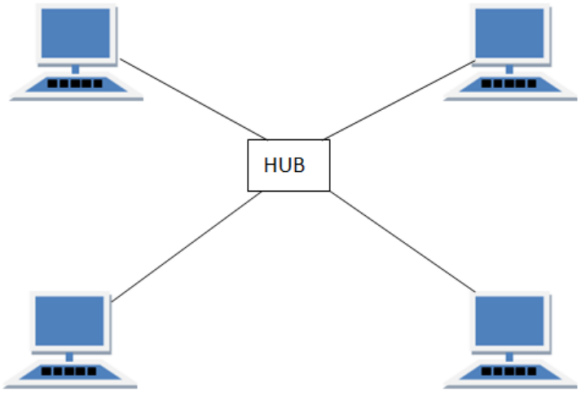
Advantages

1. Short cable length.
2. It is cost effective.
3. It is easy to add new nodes.

Disadvantages

1. It is difficult to find and correct errors on the network.
2. Only one computer transmits at a time.
3. If the main cable is dead, it will make the entire network dead.

2. **Star Topology:** In star topology, all the computers are connected to a single hub. This hub is the central node and all other nodes are connected to the central node.



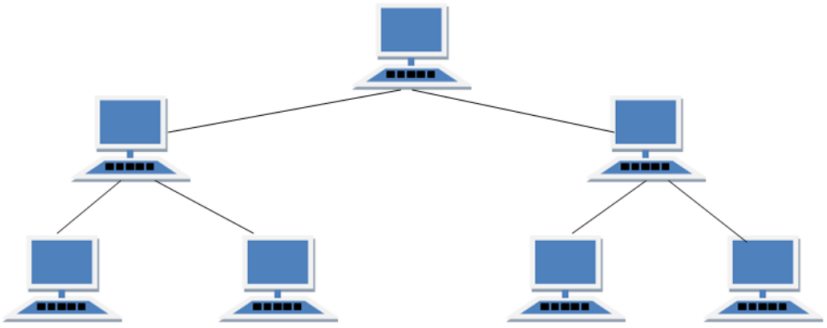
Advantages

1. Centralized control of the network.
2. It is easy to find and correct errors.
3. If one computer fails, it will have no effect on other computers on the network.

Disadvantages

1. Long cable length
2. If the hub fails then the whole network is stopped .
3. Wiring closet is required.

3. **Tree Topology:** It has a root node and all the other nodes are connected to it forming an inverted tree structure. It is actually an extended version of bus topology.



Advantages

1. It is easy to add a new node .
2. It can be easily managed and maintained.

Disadvantages

1. Long cable length.
2. It is difficult to locate and correct errors.

Network Devices: Devices which are used to connect to a network.

1. **MODEM:**
   - MODEM stands for Modulator/Demodulator.
   - It is a device which is used to convert analog signal to digital signal and vice versa.
   - It is basically used to run internet on your computer/device.
2. **Ethernet Card:**
   - It is also known as NIC (Network Interface) card.
   - It enables a computer to access an Ethernet network (LAN).
   - It has MAC id which gives it unique identity in the network.
3. **RJ-45 (Registered Jack 45):**
   - It stands for Registered Jack.
   - It is a common interface to connect Twisted Pair Cable.
   - It is used for Ethernet/LAN and Token Ring Network.
4. **Repeater:**
   - Repeater is a network device used to amplify weak signals.
   - Signal gets weak over long distance so we need a repeater to restrengthen it.
5. **Hub:**
   - Hub is a device having multiple ports used for interconnecting multiple computers together.
   - Hub provides shared bandwidth to all connected computers.

Hubs are of two types.

i. **Active hub**: It amplifies the signal when it moves from one computer to another.

ii. **Passive hub:** It allows the signal to pass from one computer to another without any change

6. **Switch:**
   - Switch is also a network multiport device that allows multiple computers to connect together.
   - Network switch inspects the packet, determines the source and destination address and routes the packet accordingly.
   - It operates at Data Link Layer (layer 2) of OSI model
7. **Router:**
   - A router is a network device used to interconnect networks having different protocols.
   - Router forwards data from one computer to another by shortest path.
8. **Gateway:**
   - A gateway is a network device used to interconnect dissimilar networks.
   - It establishes an intelligent connection between local networks with completely different structures.
9. **Wi-Fi Card (Wireless Fidelity Card):**
   - A WiFi card is an internal or external Local area network adapter with a builtin wireless radio and antenna.

➢ **Difference between Router and Switch**
  ❖ A network switch forwards data packets between groups of devices in the same network, whereas a router forwards data between different networks.

➢ **Difference between a Router and a Modem**
  ❖ A router forms networks and manages the flow of data within and between those networks, while a modem connects those networks to the Internet.

➢ **Difference between a Router and Gateway**
  ❖ A gateway is a concept while a router is a device that implements a gateway.

Router	Gateway
It ensure that data packets are switched to the right address with the best route.	To connect two networks of different protocols as a translator
It routes the data packets via similar networks	It connects two dissimilar networks
It supports dynamic Routing.	It does support dynamic Routing.

Network Protocols:

Protocol is a set of rules or standards that governs communication.

Types of Protocols:

- HTTP
- FTP
- PPP
- SMTP
- TCP/IP
- POP3
- HTTPS
- TELNET
- VoIP

HTTP (Hyper Text Transfer Protocol):

- It is an application-layer protocol for transmitting hypermedia documents, such as HTML.
- It is designed for communication between Client (Web Browser) and Web Server.
- It uses port number 80.
- It is a stateless protocol.

HTTPS (Hyper Text Transfer Protocol Secure):

- It is an extension of HTTP protocol for transmitting hypermedia documents, such as HTML securely over a network.

FTP (File Transfer Protocol):

- It is used to transfer files from one computer to another on a network.
- It is also used to transfer files from a computer to a web server.
- It is a stateful protocol.
- The default port is 21.

PPP (Point to Point Protocol):

- It is a communication protocol used to transmit multiprotocol data between two directly connected (point-to-point) computers.

SMTP (Simple Mail Transfer Protocol):

- It is used to transfer emails from one computer to another computer.
- It can send a single message to one or more recipients.

- Sending messages can include text, voice, video or graphics.
- It is a connection Oriented Protocol.

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

- TCP/IP is a collection of protocols that includes Transmission Control protocol and Internet protocol.
- TCP ensures that data reaches its destination successfully.
- IP is meant for establishing connection between two computers on a network.

POP3 (Post Office Protocol Version 3):

- It provides mechanism for retrieving emails from a remote server for a mail recipient.
- POP3 downloads the email from a server to a single computer, then deletes the email from the server.

Telnet (TErminaL NETwork):

- It is an application protocol that allows a user to communicate with a remote device.
- It uses port no 23.
- It is known for remote login.

VoIP (Voice over Internet Protocol):

- It is also known as Internet Telephony or Internet calling.
- It allows people to make voice calls using a broadband Internet connection instead of a regular (or analog) phone line.

  Advantages of VoIP:

  - Save a lot of money.
  - More than two people can communicate or speak.
  - Supports great audio transfer.
  - Provides conferencing facility.
  - Can transfer text, image, video along with voice.

  Disadvantages of VoIP:

  - Reliable Internet connection is required.
  - No location tracking for emergency calls.

Introduction to web services

1. **www (World Wide Web):**

- Tim Berners-Lee proposed the architecture of World Wide Web in 1989.
- It is a set of programs and protocols that allows the user to create and display multimedia web pages and is linked to the internet.
- It is based upon client-server architecture.
- The www client is called a web browser and a www server is called a web server.

2. **HTML (Hyper Text Markup Language):**
    - HTML is the standard markup language for creating Web pages which are then displayed by a web browser.
    - HTML elements tell the browser how to display the content.
    - HTML is used to format a web page.
    - It is used to create a static web page.
    - HTML describes the structure of a web page.
    - It supports multimedia documents and consists of audio, video, graphics, pictures etc.
    - HTML document can be written using any text editor such as notepad and save a file with either .htm or .html extension.
    - Any HTML document, in general, contains at least three elements - html, head and body.

      Various HTML tags are-

        - <html> represents the root of an HTML document
        - <head> element is a container for metadata (data about data) and is placed between the <html> tag and the <body> tag.
        - <title> tag defines the title of the document.
        - <body> defines the document's body.
        - </ br> Line Break Tags
        - <h1> <h2> .....</h6> - Heading Tags - tags are used to define HTML headings.
        - <font> - defines font face, font size, and color of text etc.

Structure of HTML document is as follows:

```
<html>
<head>
<title> This is my first page </title>
</head>
<body> I am writing my first page
</body>
</html>
```

3. **XML (Extensible Markup Language):**
    - XML stands for eXtensible Markup Language.
    - XML was designed to store and transport data.
    - Tags are user defined.
    - XML was designed to be both human- and machine-readable.
    - XML is a markup language much like HTML.
    - XML was designed to be self-descriptive.
    - XML is a W3C Recommendation.
    - It simplifies data sharing.
    - It simplifies data transport.
    - It simplifies platform changes.
    - It simplifies data availability.

Structure of XML document is as follows:

```
<?xml version =”1.0”>
<client>
<clientid> C012 </clientid>
<clientname> John </clientname>
<company> Apple </company>
</client>
<client>
<clientid> C015 </clientid>
<clientname> Johnson </clientname>
<company> HCL </company>
</client>
</xml>
```

The Difference between XML and HTML

HTML	XML
It designed to display the data	It is designed to carry data
Its tags are predefined	Its tags user defined
It is not case sensitive	It is case sensitive
It is static	It is dynamic
It is Markup Language	It is framework to define Markup language
Closing tags are not necessary in HTML	Closing tags are necessary in XML

3. Domain Names:

- A domain name is a website's address on the Internet.
- Domain names are used in URLs to identify to which server a specific webpage belongs.
- The domain name consists of a hierarchical sequence of names (labels) separated by periods (dots) and ending with an extension.
- Domain names make it easier to resolve IP addresses into names e.g., cbse.nic.in, google.com
- In the URL https://www.cbse.nic.in/welcome.htm, the domain name is cbse.nic.in.
- A domain name consists of the following parts -
    1. Top-level domain name or primary domain name
    2. Sub-domain name

    For e.g., In the domain name cbse.nic.in:

    in is the primary domain name

    nic is the sub-domain of nic

    cbse is the sub-domain of nic

Generic Domain names-

1. .com - commercial business
2. .edu - educational institutions
3. .gov - government agencies
4. .mil - military
5. .net - network organizations
6. .org - organizations

Country specific Domain names-

1. .in - India

2. .au - Australia
3. .ch - China
4. .pk - Pakistan

4. URL (Uniform Resource Locator):

- URL is the complete name of a document on a website.
- It includes the protocol being used, the address of the web site where the document is located, the sub-directory and name of the file.

A URL has three parts

- Protocol
- Domain name server where the page is located
- the filename for the page

E.g. http://www.yahoo.com/index.html

http is the protocol, www.yahoo.com is the domain name server, index.html is the filename of a file on the server.

5. **Website:**
    - It is defined as a collection of web pages which are related to each other through hyperlinks.
    - The web pages contain text, images and all types of multimedia files.
    - Examples of various websites are: cbse.nic.in, google.com, amazon.in etc

6. **Web Browser:**

- It is a software used to display web pages and web sites.
- The important web browsers are-
    1. Microsoft Internet Explorer
    2. Mozilla Firefox
    3. Google Chrome

7. Web Server:

- A web server stores web documents and responds to the requests made by web browsers.

8. Web Hosting:

- It is the process in which a website is stored on a computer in such a way so that it should be accessible by other computers through the internet.