1. 1 Data communication and computer Network

a) What is a computer network?

A computer network is a system of interconnected nodes, such as computers, printers, servers, etc. and network devices, that are linked together to facilitate communication and resource sharing.

b) How computer network is useful? (List any two advantages of Computer Network.)

Computer networks are useful in several ways, including:

1. **Communication:** Networks enable users to communicate with each other via email, instant messaging, video conferencing, and other means of electronic communication.
2. **Resource sharing:** Networks allow users to share hardware resources, such as printers, scanners, and storage devices, as well as software applications and data.

c) Write differences between client/server architecture and peer to peer network architecture.

Client/Server network architecture	Peer to peer network architecture
Centralized: A central server manages resources and data.	Decentralized: No central server; all nodes are equal.
Provides better security and centralized data control.	Less secure due to direct communication between devices.
Suitable for large networks with high scalability.	Suitable for small networks with fewer devices.
Expensive to set up and maintain.	Cost-effective and easy to implement.

d) List out two disadvantages of computer network.

Here are two disadvantages of computer networks:

1. **Security risks:** Networks are prone to threats like hacking, malware, and viruses, leading to data breaches, identity theft, and costly damages.
2. **Dependency on technology**: Any network failure can disrupt the system, causing downtime, reduced productivity, and expensive repairs.

e) Define bandwidth. How it is measured?

Bandwidth is the maximum amount of data that can be transmitted over a network in unit time. It is measured in units such as bits per second (bps), kilobits per second (Kbps), megabits per second (Mbps), or gigabits per second (Gbps) etc.

1. 1 Data communication and computer Network

f) Differentiate between LAN and WAN.

LAN (Local Area Network)	WAN (Wide Area Network)
Covers a smaller area, such as a building or campus.	Covers a larger area, including multiple cities, countries, or continents.
Typically owned and managed by a single organization.	Often a shared infrastructure managed by multiple organizations or service providers.
Lower cost due to limited geographic range and simpler infrastructure.	Higher cost due to long-distance connections and maintenance.
Usually has higher data transfer speeds due to short distances and fewer devices.	Lower data transfer speeds due to the need for long-distance transmission

g) "Internet is called network of network." Justify in your own language.

The Internet is called a "network of networks" because it connects millions of private, public, academic, business, and government networks globally.

These interconnected networks communicate using standardized protocols (TCP/IP), enabling seamless data sharing and communication. It allows devices worldwide to exchange information, access services, and collaborate without being part of the same physical network. This vast interconnection forms the backbone of the global Internet, making it a true network of networks.

h) Explain protocol with examples.

A protocol is a set of rules that defines how data is exchanged between devices in a network, ensuring accurate and efficient communication. Common examples include:

TCP/IP: Governs data transfer across the Internet with addressing and routing.

HTTP: Transfers web pages between browsers and servers.

FTP: Facilitates file upload and download.

SMTP/POP: Manages email sending and receiving.

DNS: Converts domain names into IP addresses for locating devices

i) What are three models of Network? Write about client/server model of Network.

There are three main network models: Client/Server, Peer-to-Peer (P2P), and Centralized Network.

The Client/Server model involves a central server providing resources and services to multiple clients. Clients send requests to the server, which responds with the requested data or services. The server manages shared resources like files, printers, or databases. This model is efficient, scalable, and commonly used in business and organizational networks.

1. 1 Data communication and computer Network

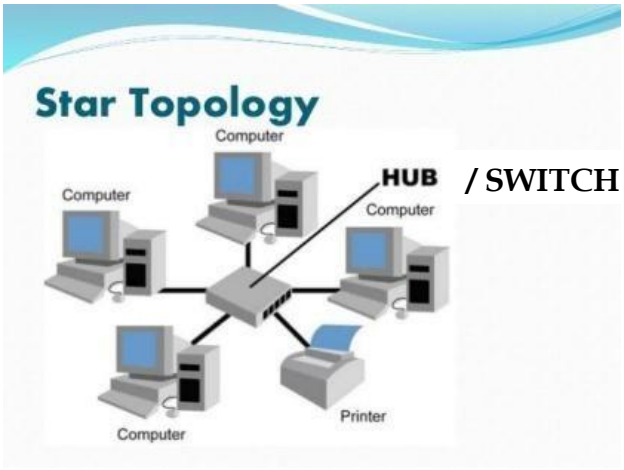
j) What is network topology?

Network topology refers to the physical or logical arrangement of devices, nodes, and connections in a computer network. It describes how devices are connected to one another and how data is transmitted between them. Some common network topologies are star topology, bus topology and ring topology etc.

k) **Write about star topology with suitable diagram.**

Star topology is a network topology in which all devices are connected to a central hub or switch, which acts as a central point of communication for all nodes on the network. Each node on the network is connected to the hub/switch separately.

Here is a diagram of a simple star topology network:



Advantages of Star Topology

Easy to manage: Adding or removing a node doesn't impact other nodes.

Scalable: New nodes can be connected easily by linking them to the central hub or switch.

Fault-tolerant: A failure in one node or cable doesn't affect the rest of the network.

Disadvantages of Star Topology

Cost: Requires a central hub or switch, making it more expensive than other topologies.

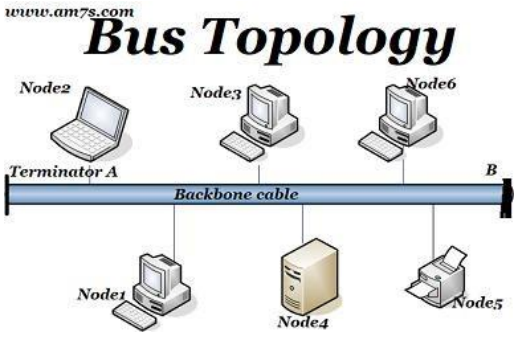
Single point of failure: If the hub or switch fails, the entire network is affected.

l) Write about Bus topology with suitable diagram.

Bus topology is a type of network topology in which all nodes or devices are connected to a single central cable or bus. The central cable acts as a shared communication medium for all nodes on the network.

Here is a diagram of a simple bus topology network:

1. 1 Data communication and computer Network



Advantages of Bus Topology

Simple and easy to install: Requires only a single cable to connect all nodes, making it straightforward to set up.

Cost-effective: Uses less cabling compared to other network topologies, reducing overall costs.

Disadvantages of Bus Topology

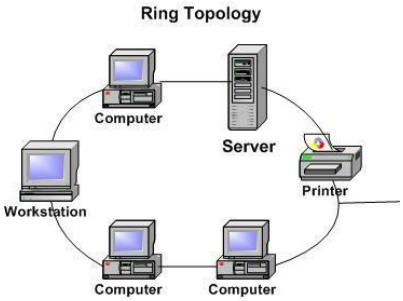
Single point of failure: A failure in the central cable can disrupt the entire network.

Limited scalability: Adding more nodes can degrade network performance, making it less suitable for larger networks.

m) Write about Ring topology with suitable diagram.

Ring topology is a type of network topology in which all nodes or devices are connected in a closed loop or ring. Each node is connected to two neighboring nodes, forming a circular network topology.

Here is a diagram of a simple ring topology network:

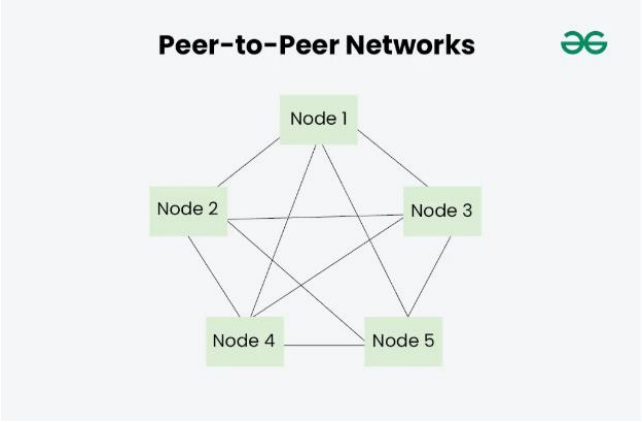


1. 1 Data communication and computer Network

Advantages of Ring Topology
Efficient: Data packets are transmitted in a unidirectional manner, reducing collisions and improving performance.
Easy to manage: Nodes can be easily identified and managed, simplifying network maintenance.
Disadvantages of Ring Topology
Limited scalability: Performance may degrade as more nodes are added to the network.
Single point of failure: A failure in the central cable or any node can disrupt the entire network.

n) Draw and briefly explain about peer-to-peer (P2P) network.
A peer-to-peer (P2P) network is a decentralized network where each device, or node, functions both as a client and a server. This means that devices can share resources and services directly with each other without relying on a central server. P2P networks are commonly used for file sharing, communication, and collaboration among devices.

Key Features
Decentralized: No central authority controls the network.
Resource Sharing: Each node shares its resources, such as files and storage, with other nodes.
Fault Tolerance: The network can continue functioning even if some nodes go offline.



o) What is communication media? Differentiate between bounded and unbounded media.
Communication media refers to the physical pathways through which data is transmitted in a network. It can be categorized into bounded (guided) and unbounded (unguided) media**.**

1. 1 Data communication and computer Network

Difference between Bounded and Unbounded Media

Guided/Bounded Media	Unguided/Unbounded Media
Uses physical cables or wires.	Uses wireless signals (no cables).
Examples: Twisted-pair, coaxial and optical fiber.	Examples: Radio waves, microwaves and infrared.
Limited range.	Wider range than bounded media.
Susceptible to physical interference.	Affected by weather and distance.

p) Give reasons that "Computer network reduces the cost of operation."

Computer networks can significantly reduce the cost of operation for several reasons:

1. **Resource Sharing**

Networks enable sharing of resources like printers, scanners, and storage devices, reducing the need to buy multiple devices.

2. **Centralized Management**

Centralized control of data, applications, and devices simplifies maintenance, lowering the need for large IT teams.

By minimizing equipment and personnel costs, networks improve efficiency and reduce operational expenses.

Short Notes:

Communication

Communication is exchange of ideas, views, understanding, facts or information between two or more persons.

Telecommunication

Telecommunication is a system of transmission of sounds, images, texts or data in the form of electronic signals over significant distance.

Data Communication

Data communication is a process of transferring data electronically from one device to other using different transmission mediums. Eg. Internet, E-Mail, Chat and phone calls.

1. 1 Data communication and computer Network

Components of Data Communication.

i) Data ii) Sender iii) Medium iv) Receiver v) Protocol

Data Transmission Mode [MF 2076]

Data transmission mode is the way of transmission of data from one location to another. There are three types of transmission mode:

a. Simplex Mode

Simplex mode is the transmission of data and information that takes place in only one direction. It is a unidirectional mode of data transmission.

Radio, television broadcasting, etc. are examples of simplex mode.

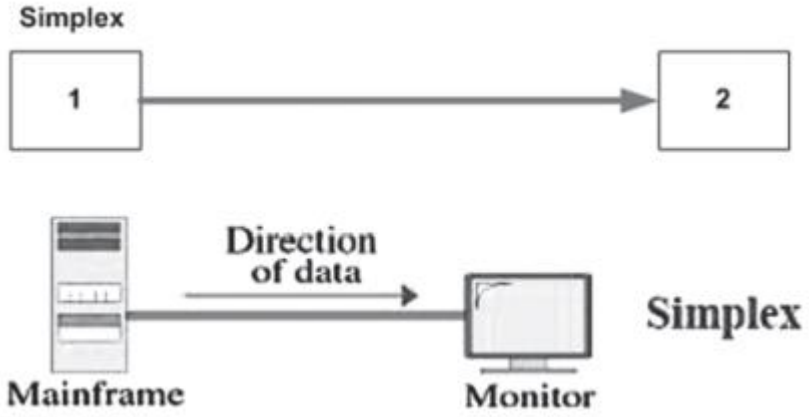


Fig: Simplex Transmission Mode

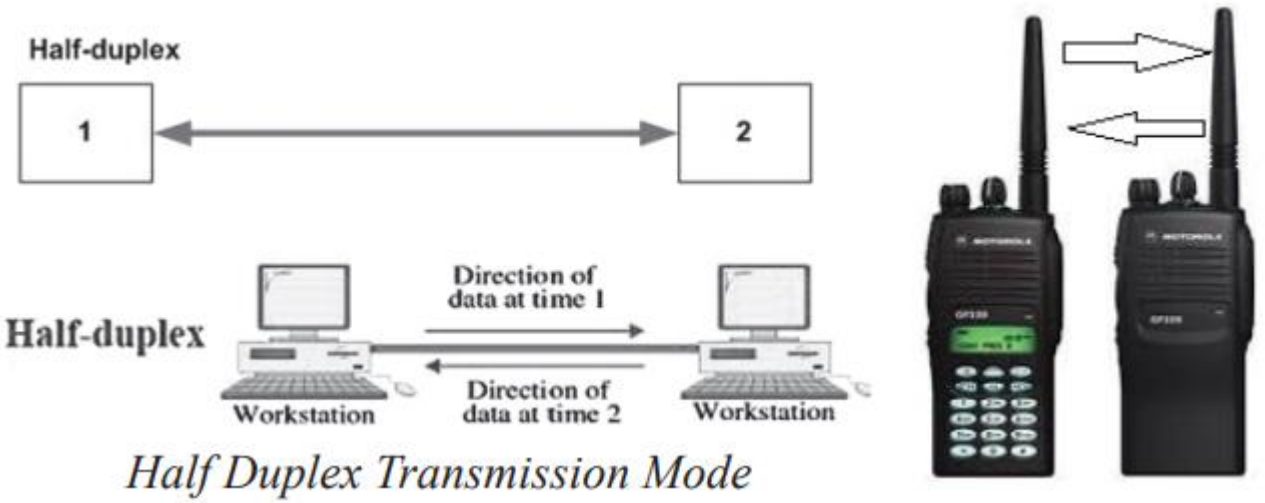
b. Duplex Mode

Duplex is mode of data transmission in which data and information flow in both directions. It is bi-directional mode of data transmission. The two types of duplex modes are:

i. Half Duplex

Half-duplex is the mode of data and information that flows in both directions but only one direction at a time. Walky-talky and wireless handset are examples of half-duplex mode.

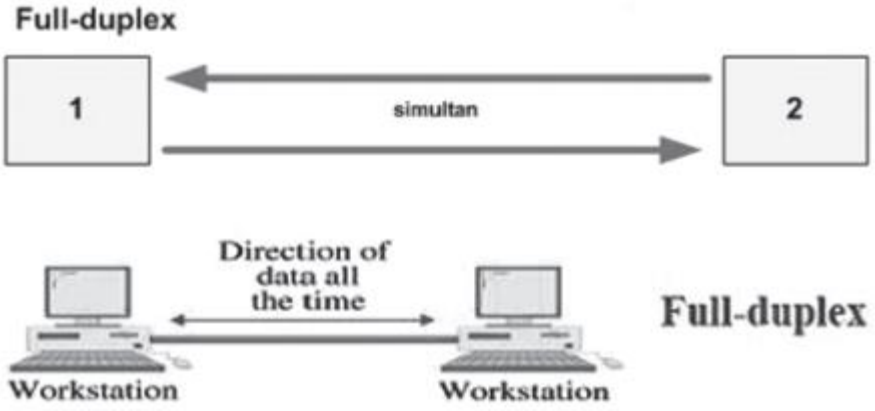
1. 1 Data communication and computer Network



ii. Full Duplex

In full duplex mode, data and information flow in both direction simultaneously on

the transmission path. Mobile and landline phones, Internet are examples of full duplex mode.



GUIDED AND UNGUIDED TRANSMISSION MEDIA

1. **Twisted pair cable**

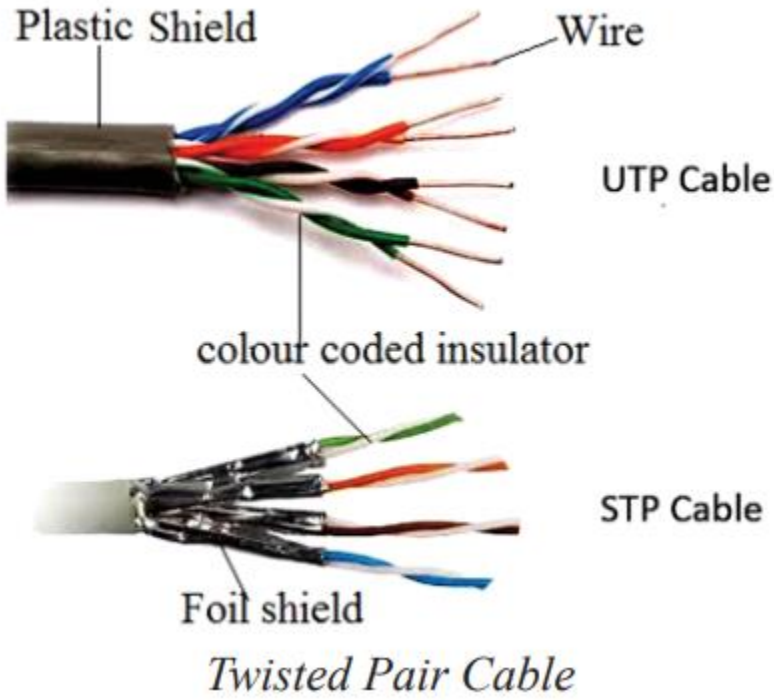
A pair of wires twisted with each other is known as *twisted pair cable*. A set of four pairs of twisted wires are bundled to form cable.

These are the most common medium for LAN. Wires are twisted with each other so as to reduce crosstalk (A disturbance caused by electromagnetic interference, along a circuit or a cable pair).

Its types are:

1.1 Unshielded Twisted Pair Cable (UTP)

1. 1 Data communication and computer Network



Twisted Pair Cable

Unshielded twisted pair (UTP)

Unshielded twisted pair is a popular type of cable that consists of two unshielded wires twisted around each other which are used in telephone wiring and local area networks (LANs). It is called unshielded because it has no additional foil wrap, or shield.

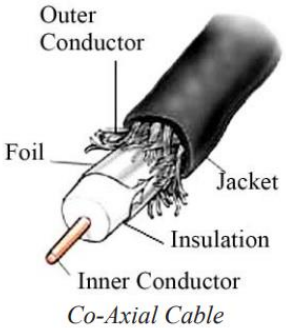
RJ-45 connector is commonly used with unshielded twisted pair.

1.2 Shielded twisted pair (STP)

Shielded twisted pair is a type of copper telephone wiring in which each of the two copper wires are twisted together and coated with an insulating coating. The extra covering in shielded twisted pair wiring protects the transmission line from electromagnetic interference.

D-shell connectors are used with shielded twisted pair.

2. **Co-axial cable**



Co-Axial Cable

Coaxial (or "coax") cable is a common type of cable used for transmitting data over long distances. They are most commonly used to transmit cable TV and Internet signals.

The connectors used with co-axial cables are BNC, T-connectors and terminators in bus topology.

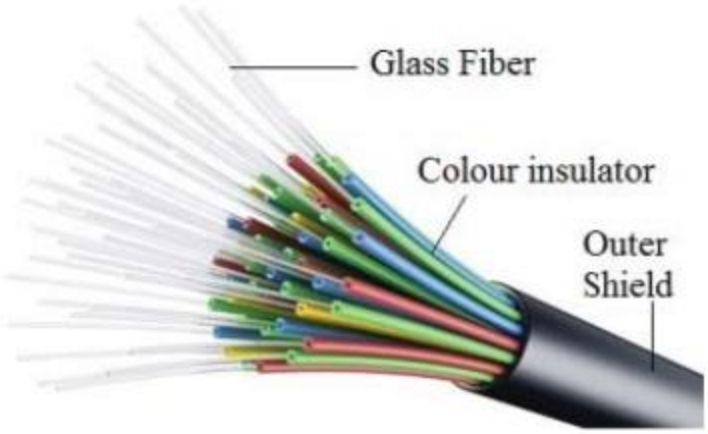
1. 1 Data communication and computer Network

3. **Fiber optic cable** is a high-speed medium used in data communication, transmitting data signals in the form of light through thin strands of glass or plastic. It offers significantly faster data transfer speeds and greater bandwidth compared to other types of cables.

Connectors in Fiber Optic Cable:
The common connectors used with fiber optic cables are:

1. **SMA (Screw Mounted Adapter)**
2. **ST (Spring-loaded Twist)**
3. **SC (Subscriber Connector)**
4. **FC (Ferrule Connector)**

Limitations:
Fiber optic cables are more expensive to produce, install, and maintain compared to other types of network cables



Fiber Optic Cable

2. Unguided / Unbounded transmission media

2.1 Radio wave transmission

Radio wave transmission involves the transfer of data using radio waves through the air. It supports low bandwidth communication and is widely used in various applications.

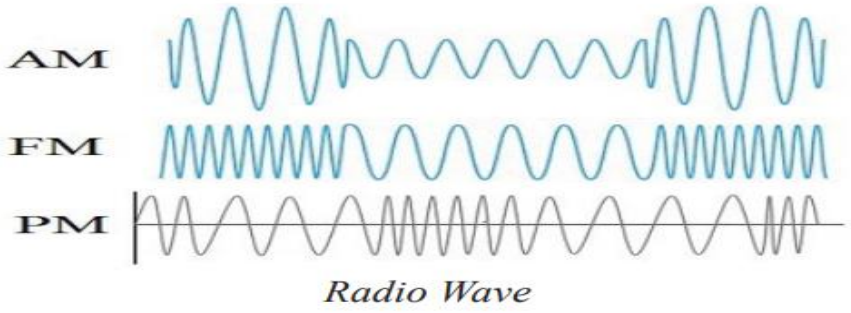
Uses:
Radio transmission is employed in devices and systems such as:

1. **Radio broadcasting**
2. **Television broadcasting**
3. **Cellular phones**

1. 1 Data communication and computer Network

Characteristics of radio wave:

- **Range:** The range of radio wave transmission varies based on the frequency, allowing it to cover both long and short distances.
- **Penetration:** Radio waves can penetrate walls and buildings, making them suitable for indoor and outdoor communication.
- **Line of Sight:** Unlike some other forms of wireless communication, radio wave transmission does not require a direct line of sight between the transmitter and receiver computer network.



Radio Wave

Microwave Transmission:
Microwave transmission is a line-of-sight wireless communication technology that uses high-frequency radio waves to transmit data, voice, and video at high speeds.

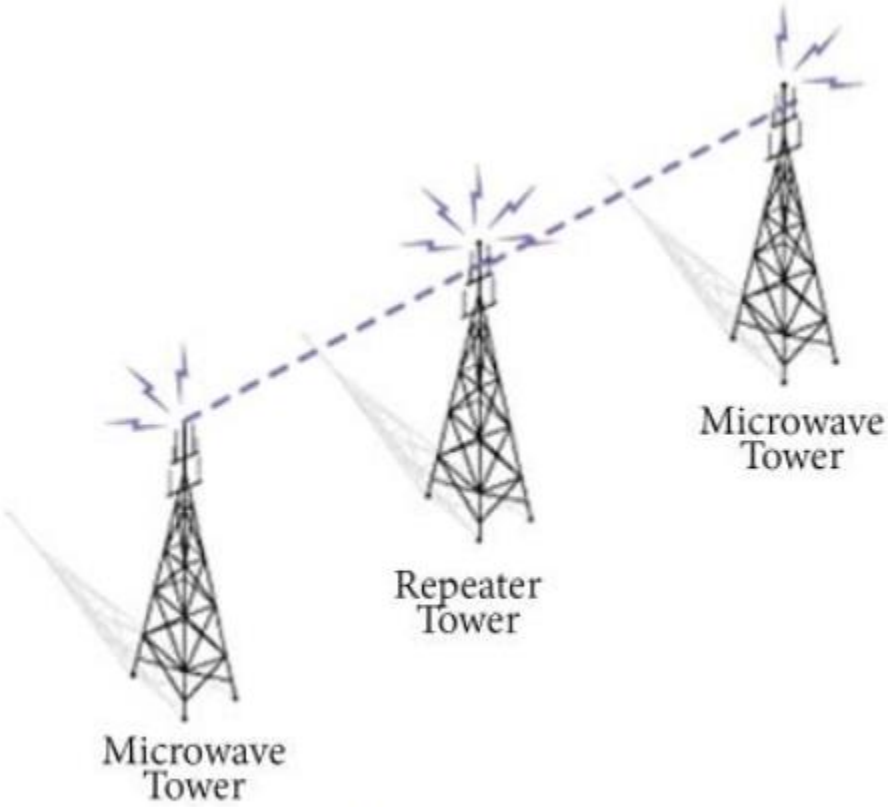
Uses:
Microwave transmission is commonly used in:

1. Telecommunication links
2. Satellite communication
3. Long-distance telephone services

Characteristics:

- **High Bandwidth**: It supports higher bandwidth, enabling fast data communication.
- **Line of Sight Requirement**: A clear, unobstructed path between the transmitter and receiver is necessary for efficient transmission.
- **Limitations:** Microwaves cannot pass through buildings, which limits their use in indoor environments

1. 1 Data communication and computer Network



Microwave

Infrared Transmission:

Infrared transmission involves sending data or voice signals using infrared (IR) light over short distances.

Characteristics:

Short Range: It is suitable for communication over limited distances.

Line of Sight Requirement: Infrared transmission requires an unobstructed line of sight between devices for proper communication.

Limitation: Infrared signals cannot penetrate walls, limiting its use to a single room or open space

Hardware components of a computer network (Elements of Network)

Physical parts and devices used to connect computers in the network environment are called hardware components. The hardware components of computer network are

a) Computer system (Server or Workstation) b) Network connectors c) Network cables
d) NIC Card e) MODEM f) Hub g) Bridge h) Switch

1. 1 Data communication and computer Network

i) Router j) Gateway k) Repeater

Server

A server is a computer or device on a network that provides services or resources to other devices or clients on the network. Servers can provide a variety of services, such as file storage, email, web hosting, database management, and application hosting.

Workstation

In a computer network, workstations are client devices that connect to a server or servers to access shared resources and services, such as data storage, printers, or applications.

Workstations are typically equipped with faster processors, more memory, and better graphics capabilities than standard desktop computers or laptops, making them well-suited for tasks that require high computing power and advanced capabilities.

Node

In a computer network, a node refers to any device or computer that is connected to the network and can communicate with other devices on the network. This can include computers, servers, routers, switches, printers, and other devices.

Each node on a network has a unique identifier, an IP address, which is used to identify and communicate with other devices on the network.

Connectors

Devices like RJ-45 connectors and ports used to link computers and peripherals to the network physically.

RJ- 45 connector

BNC connector

ST connector

Router

Router [MFT 2075]

A router is a networking device that is used to connect multiple networks together and route network traffic between them.

Routers use network protocols such as IP (Internet Protocol) to identify the best path for data to travel from one network to another, and use routing tables to determine the most efficient route for data packets.

1. 1 Data communication and computer Network

NIC Card

Network Interface Card (NIC) [SQE 2075K]

A **Network Interface Card (NIC)** A hardware card installed in a computer to enable it to connect and communicate over a network.

Hub

Hub [MF 2076]

A networking device that connects multiple devices and broadcasts data to all connected devices simultaneously.

Switch [MF 2076]

A smart networking device that connects multiple devices in a network and sends data only to the intended destination.

1. 1 Data communication and computer Network

Bridge

Bridge

Connects different network segments, reducing traffic by forwarding only necessary data to specific parts of the network. In modern networks, bridges are largely replaced by more advanced networking devices such as switches and routers.

Gateway

A device or software that connects networks using different protocols, enabling communication between them.

A gateway can be a standalone hardware device, such as a router or firewall, or it can be a software component running on a computer or server.

The primary function of a gateway is to provide connectivity and interoperability between different networks that use different protocols or communication methods. For example, a gateway can be used to connect a local area network (LAN) to the internet, allowing devices on the LAN to access resources and services on the internet.

Repeater

A repeater is a network device that is used to regenerate signals in a network, allowing them to travel longer distances without losing strength or clarity.

MODEM [MFT 2075]

A modem (short for modulator-demodulator) is a networking device that is used to convert digital signals to analog signals and vice versa, allowing digital devices to communicate over analog communication channels such as telephone lines.

Modulation

The process of translating digital signals of a computer to analog signals, which are then transmitted across the standard telephone lines, is known as modulation.

Demodulation

The process of translating analog signals from a phone line and converts then into digital signals for the computer is known as demodulation.

1. 1 Data communication and computer Network

Software components of a computer network

Network protocol

Network operating system

Device driver

Network operating system [PMT 2075K]

A network operating system (NOS) is a specialized operating system that manages and controls networking functions within a computer network. It provides the necessary services and tools for the administration, management, and security of a computer network.

Examples of network operating systems include: (only name is enough for the syllabus)

Windows Server: Developed by Microsoft, it is a popular NOS used in small and large businesses for managing and controlling network resources, user accounts, and security policies.

Linux: A free and open-source NOS that is widely used in computer networks for its stability, security, and flexibility. It provides a wide range of networking tools and services.

macOS Server: Developed by Apple, it is a NOS that provides advanced network services and tools such as file sharing, DNS, DHCP, and VPN.

Novell NetWare: A popular NOS used in the 1990s, it provided advanced networking features such as file and print sharing, directory services, and security management.

IBM OS/2: A NOS developed by IBM that provided advanced networking features such as file and print sharing, remote access, and security management. It was popular in the 1990s but has since been largely phased out.

Device driver

A device driver, also known as a driver, is a software component that enables communication between a computer's operating system and a specific hardware device.

1. 1 Data communication and computer Network

Types of Network

LAN (Local Area Network)

MAN (Metropolitan Area Network)

WAN (Wide Area Network)

LAN (Local Area Network):

A LAN is a network that connects devices within a small area, such as a room, building, or campus, using cables or wireless devices. It is managed by a single organization and uses private connection media. Examples include networks in schools, colleges, and offices. The maximum coverage is a few kilometers, and the speed ranges from 10 to 100 Mbps.

MAN (Metropolitan Area Network):

A MAN spans a larger area, typically covering a whole city. It is managed by one or more organizations and uses both private and public connection media. Examples include networks connecting different branches of an organization and internet service providers (ISP) offering services across a city. The bandwidth ranges from 128 Kbps to 1 Gbps.

WAN (Wide Area Network):

A WAN covers large geographical areas, such as cities, states, or even countries. It connects multiple LANs and MANs through public media like telephone lines, satellite links, or microwave systems. It is managed by multiple organizations. An example of a WAN is the internet. WANs generally have slower data transmission speeds compared to LANs and MANs.

Network architecture (Models of Computer Network)

Network Architecture refers to the design framework of a computer network. It encompasses how devices are organized and interact within the network, including the protocols, hardware, and software that enable communication between connected systems

Who controls internet?

Different organization like ISOC (Internet Society), W3C (World Wide Web Consortium), IAB (Internet Architecture Board), IEFT (Internet Engineering Task Force), IRTF (Internet Research Task Force), IESG (Internet Engineering Steering Group) and INIC (Internet Network information Centre) gives directive and guideline for the proper use of internet.

1. 1 Data communication and computer Network

Services of internet [SLC 2065] [SLC 2068] [SEE 2072] [MFT 2075] [U1]

WWW (World Wide Web)
The World Wide Web is an information system of linked hypertext documents accessible via the Internet using web browsers.

E-mail (Electronic Mail)
Email allows users to send and receive digital messages instantly over the Internet through email providers like Gmail and Outlook.

FTP (File Transfer Protocol)
FTP is a network protocol enabling file transfers between devices over the Internet, widely used for website updates and file sharing.

IRC (Internet Relay Chat)
IRC offers real-time text-based chat and discussion services, commonly used by developers and niche communities.

Newsgroup
A newsgroup is an online forum for discussions on specific topics like technology, politics, or hobbies.

Telnet
Telnet enables remote access to computers over the Internet but lacks encryption, making it less secure than SSH.

E-commerce
E-commerce involves buying and selling products or services online, enabling businesses to reach global customers through platforms like Amazon and Daraz.

There are several types of e-commerce models, including:

Business-to-consumer (B2C): where businesses sell products and services directly to consumers through their website or an online marketplace.

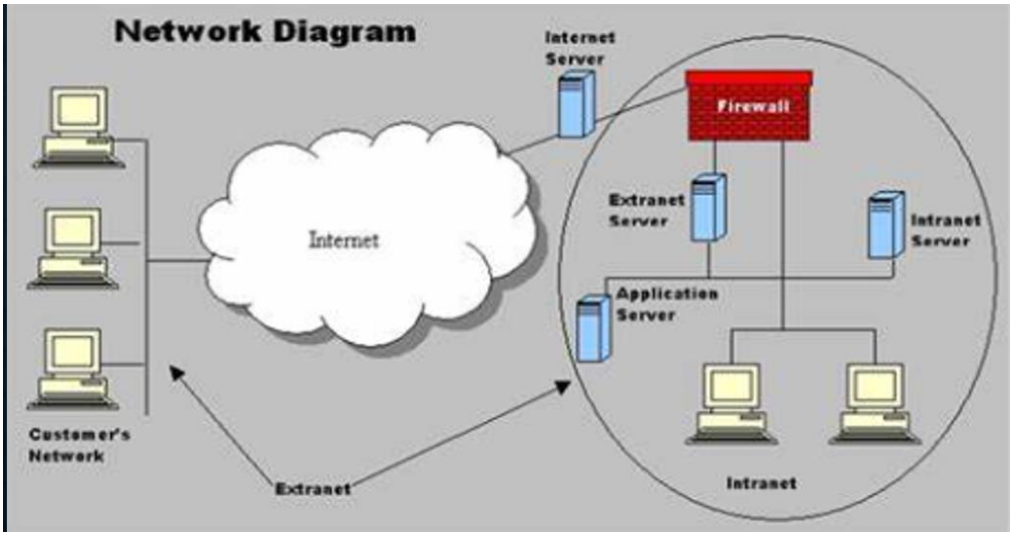
Business-to-business (B2B): where businesses sell products and services to other businesses through online marketplaces or specialized B2B platforms.

Consumer-to-consumer (C2C): where individuals sell products and services to other individuals through online marketplaces or classified websites.

Consumer-to-business (C2B): where individuals sell products or services to businesses, such as freelancers or consultants offering their skills or services to companies.

1. 1 Data communication and computer Network

Intranet & Extranet



An intranet is a private network used within an organization to share information, resources, and tools among employees securely.

Intranets can be used for a variety of purposes, including:

a. **Internal Communication**
   An intranet centralizes company communication, providing employees with easy access to important updates, announcements, and news.
b. **Document Management**
   Intranets help store, organize, and manage company documents, ensuring employees can quickly find necessary information.
c. **Collaboration**
   Intranets enable collaboration through tools for online discussions, file sharing, and project management among employees.
d. **Training and Development**
   Organizations use intranets to offer e-learning modules, training videos, and other educational resources for employee development.

Extranet

An extranet is a private network granting secure access to a company's internal information for external partners like suppliers and customers.

Some common uses of extranets include:

a. **Collaboration**
   Extranets facilitate collaboration by providing tools for shared discussions, document exchange, and project tracking with external partners.

b. **Supply Chain Management**
   Extranets improve supply chain efficiency by allowing suppliers to access inventory data and track shipments in real-time.
c. **Customer Service**
   Extranets enhance customer service by offering product information, order tracking, and support resources to clients.
d. **Secure Access**
   Extranets are usually password-protected and may use VPNs to ensure secure access for authorized external users.

ISP (Internet Service Provider)

An Internet service provider (ISP) is an organization that provides services for accessing and using the Internet. World Link, Mercantile, ClassicTech, Vianet etc are the ISPs of Nepal.

Web browser [SEE 2075 U] [SLC 2067] [MF 2076]

A web browser is a software application that is used to access and display web pages on the Internet. It is the primary tool for navigating the World Wide Web and viewing websites.

Examples of web browsers are Mozilla Firefox, Google chrome, Internet Explorer, opera etc. Browsing/ Surfing means searching information on the Internet.

URL (Uniform Resource Locator)

URL is a unique address that provides location of a webpage on the Internet.

Example of URL: http://www.abc.com/mainpage/first.html

Search engine [SEE 2074 U] [SQE 2075K]

A search engine is a software tool or a web-based service that enables users to search for information on the Internet.

Search engines use algorithms to crawl and index web pages, and they allow users to enter search queries in the form of keywords or phrases. The search engine then returns a list of relevant results based on the user's query, which are ranked based on their relevance to the search terms.

Popular search engines include Google, Bing, Yahoo!, and DuckDuckGo.

Blog (weblog)

A blog, short for "weblog," is an online journal or informational website that is regularly updated with new content.

Wi-Fi (Wireless Fidelity)

1. 1 Data communication and computer Network

Wi-Fi, short for "wireless fidelity," is a type of wireless networking technology that allows devices to connect to the Internet and communicate with each other without the need for physical cables.

Wi-Fi uses radio waves to transmit data between devices, such as laptops, smartphones, tablets, and smart home devices, over short distances.

DNS (Domain Name System)

DNS, short for Domain Name System, is a system used to translate human-readable domain names, such as www.example.com, into IP addresses, which are numerical identifiers that are used to identify devices and computers on the internet.

IP address

An IP address, short for "Internet Protocol address," is a unique numerical identifier assigned to every device connected to a computer network. It uses the Internet Protocol for communication. IP addresses enable devices to send and receive data over the Internet and other computer networks.

IP addresses consist of a series of four numbers, separated by periods, such as 192.168.1.1. IP addresses are divided into two types: IPv4 and IPv6.