Government Polytechnic Mumbai

Course: Computer Network Unit no.: 1

1.Basics of Computer Network

1.1Introduction to Computer Network: Definition of Computer network, sharing information, sharing resources, file sharing.

(a) Define Network:

Ans.: Definition of Network:

- A network consists of two or more nodes (e.g. computers) that are linked in order to share resources (such as printers and CDs), exchange files, or allow electronic communications.
- The computers on a network may be linked through cables, telephone lines, radio waves, satellites, or infrared light beams.

(b) State Network Goals

Ans: NETWORK GOALS:

1. The main goal of networking is "Resource sharing", and it is to make all programs, data and equipment available to anyone on the network without the regard to the physical location of the resource and the user.
2. A second goal is to provide high reliability by having alternative sources of supply. For example, all files could be replicated on two or three machines, so if one of them is unavailable, the other copies could be available.
3. Another goal is saving money. Small computers have a much better price/performance ratio than larger ones. Mainframes are roughly a factor of ten times faster than the fastest single chip microprocessors, but they cost thousand times more. This imbalance has caused many system designers to build systems consisting of powerful personal computers, one per user, with data kept on one or more shared file server machines. This goal leads to networks with many computers located in the same building. Such a network is called a LAN (local area network).
4. Another closely related goal is to increase the systems performance as the work load increases by just adding more processors. With central mainframes, when the system is full, it must be replaced by a larger one, usually at great expense and with even greater disruption to the users.
5. Computer networks provide a powerful communication medium. A file that was updated or modified on a network can be seen by the other users on the network immediately.

(c) Enlist Network Application.

Ans.: NETWORK APPLICATIONS:

a) Access to remote programs.
b) Access to remote databases.
c) Value-added communication facilities.

(d) Define Computer network.

Ans. Definition of Computer network:

- It can be defined as Computer networking refers to interconnected computing devices that can exchange data and share resources with each other is called **Computer Network.**
- A computer network is defined as a system that connects two or more computing devices for transmitting and sharing information.
- Computer Networks are used for data communications
- **Definition:** A computer network can be defined as a collection of nodes. A node can be any device capable of transmitting or receiving data. The communicating nodes have to be connected by communication links.

- A Compute network should ensure reliability of the data communication process, should c security of the data 7 performance by achieving higher throughput and smaller delay times
- These networked devices use a system of rules, called **communications protocols**, to transmit information over physical or wireless technologies.It used to perform **sharing information, sharing resources, file sharing.**
- Modern computer networks can **operate virtually, Integrate on a large scale, Respond quickly to changing conditions & Provide data security.**

(e) Explain the following with respect to computer networks.
(i) Sharing information (ii) Sharing resources (iii) File sharing

Ans.: The following with respect to computer networks.

(i) Sharing Information:

1. When we communicate, we are sharing information. This sharing can be local or remote. Between individuals, local communication usually occurs face to face, while remote communication takes place over distance. The term telecommunication, which includes telephony, telegraphy, and television, means communication at a distance (tele is Greek for "far").
2. The word data refers to information presented in whatever form is agreed upon by the parties creating and using the data. Data communications are the exchange of data between two devices via some form of transmission medium such as a wire cable.
3. For data communications to occur, the communicating devices must be part of a communication system made up of a combination of hardware (physical equipment) and software (programs).
4. **The effectiveness of a data communications system depends on four fundamental characteristics: delivery, accuracy, timeliness, and jitter.**
5. Here are several ways information can be shared in a computer network:

   File Sharing:
   - Network File System (NFS): NFS is a distributed file system protocol that allows a user on a client computer to access files over a network in a manner similar to how local storage is accessed.
   - Server Message Block (SMB): SMB is a network file sharing protocol that provides shared access to files, printers, and other resources between nodes on a network.

   Email:
   - Simple Mail Transfer Protocol (SMTP): Used for sending emails from one server to another.
   - Post Office Protocol (POP) and Internet Message Access Protocol (IMAP): Used by email clients to retrieve messages from a mail server.

   Web-Based Sharing:
   - HTTP/HTTPS: Hypertext Transfer Protocol and its secure counterpart, used for sharing web pages, documents, and other resources on the World Wide Web.
   - FTP (File Transfer Protocol): Used for transferring files between a client and a server on a computer network.

   Collaboration Platforms:
   - Intranets and Extranets: Internal and external networks that facilitate collaboration within an organization or between organizations.
   - Collaborative Software (e.g., Microsoft Teams, Slack): Platforms that enable real-time communication, file sharing, and collaboration among users.

   Database Sharing:
   - Database Management Systems (DBMS): Systems like MySQL, PostgreSQL, or Oracle facilitate the sharing and management of structured data.

   Peer-to-Peer (P2P) Sharing:
   - BitTorrent: A P2P protocol used for distributing data across a network.

   Cloud Storage:
   - Services like Google Drive, Dropbox, or OneDrive: Enable users to store and share files over the internet.

   Instant Messaging:

- Internet Relay Chat (IRC), XMPP, or proprietary solutions like Slack or Microsoft Teams: Used for real-time communication and information sharing.

Remote Access:

- Virtual Private Network (VPN): Allows secure access to a private network over the internet, facilitating information sharing with remote users.

Print Sharing:

- Internet Printing Protocol (IPP): Enables remote printing over a network.

Streaming and Multimedia Sharing:

- Real-Time Streaming Protocol (RTSP), HTTP Live Streaming (HLS): Used for sharing audio and video content.

Social Media Platforms:

- Twitter, Facebook, LinkedIn: Platforms for sharing information and updates within a social network.

(ii) Sharing resources:

1. A computer network is a system that connects two or more computing devices for transmitting and sharing information. Computing devices include everything from a mobile phone to a server.
2. These devices are connected using physical wires such as fiber optics, but they can also be wireless. The development of resource-sharing networks can facilitate the provision of a wide range of economic and reliable computer services.
3. Computer-communication networks allow the sharing of specialized computer resources such as databases, programs, and hardware. Such a network consists of both the computer resources and a communications system interconnecting them and allowing their full utilization to be achieved.
4. In addition, a resource-sharing network provides the means whereby increased cooperation and interaction can be achieved between individuals. An introduction to computer-to-computer networks and resource sharing is provided and some aspects of distributed computation are discussed.
5. In computing, a shared resource, or network share, is a computer resource made available from one host to other hosts on a computer network. It is a device or piece of information on a computer that can be remotely accessed from another computer transparently as if it were a resource in the local machine. Network sharing is made possible by inter-process communication over the network.
6. Sharing resources in a computer network is essential for efficient collaboration and utilization of available assets. Here are various ways resources can be shared in a computer network:

   Printers:

   - Print Server: A dedicated server manages printers and allows users to print documents over the network.

   Files and Storage:

   - Network Attached Storage (NAS): Dedicated devices or servers that provide centralized and shared storage accessible over a network.
   - Distributed File System (DFS): Allows users to access and manage files distributed across a network as if they were all in one location.

   Processing Power:

   - Cluster Computing: Multiple computers work together as a single system to share processing tasks.
   - Grid Computing: Distributes processing tasks across a network of computers to solve complex problems.

   Memory Sharing:

   - Distributed Shared Memory (DSM): Allows multiple computers to share a common memory space.

   Peripheral Devices:

   - USB over IP: Allows USB devices to be shared over a network, enabling multiple users to access peripherals like printers or scanners.

   Internet Connection:

- Internet Connection Sharing (ICS): A feature that allows multiple devices to share a single internet connection through a host computer.

Collaboration Tools:
- Shared Calendars and Scheduling: Enables users to schedule and coordinate activities.
- Project Management Software: Facilitates collaboration on projects by sharing tasks, timelines, and documents.

Communication Resources:
- VoIP (Voice over Internet Protocol) Systems: Shared voice communication over the network.
- Video Conferencing Platforms: Allows users to share audio and video resources for virtual meetings.

Database Access:
- Centralized Database Servers: Multiple users can access and manipulate data stored on a centralized server.

Remote Access:
- Virtual Private Network (VPN): Allows remote users to access shared resources securely over the internet.

Application Sharing:
- Remote Desktop Services (RDS): Enables multiple users to run applications on a server while interacting with them from their local devices.

Energy Management:
- Wake-on-LAN (WoL): Allows remote computers to be powered on over the network, enabling energy-efficient resource management.

Sensor Networks:
- Internet of Things (IoT): Networked sensors and devices share information for monitoring and control applications.

Cloud Services:
- Infrastructure as a Service (IaaS): Provides virtualized computing resources over the internet.
- Platform as a Service (PaaS): Offers a platform with tools and services for application development and deployment.

7. Effective resource sharing enhances productivity and optimizes resource utilization in a networked environment. Security measures, such as access controls and encryption, should be implemented to protect shared resources from unauthorized access and ensure data integrity.

(iii) File sharing:

1. The term file sharing traditionally means shared file access, especially in the context of operating systems and LAN and Intranet services, for example in Microsoft Windows documentation. Though, as BitTorrent and similar applications became available in the early 2000s, the term file sharing increasingly has become associated with peer-to-peer file sharing over the Internet.
2. File sharing in a computer network allows users to access, retrieve, and store files on a shared storage system. There are various protocols and methods for file sharing, each with its own characteristics. Here are some common approaches:

   Network File System (NFS):
   - Description: NFS is a distributed file system protocol that allows a user on a client computer to access files over a network as if they were on the local storage.
   - Use Case: Commonly used in Unix and Linux environments.

   Server Message Block (SMB)/Common Internet File System (CIFS):
   - Description: SMB/CIFS is a network file sharing protocol that provides shared access to files, printers, and other resources between nodes on a network. It's widely used in Windows environments.

- Use Case: Windows file sharing, printer sharing, and interoperation with various operating systems.

File Transfer Protocol (FTP):

- Description: FTP is a standard network protocol used for transferring files from one host to another over a TCP-based network.
- Use Case: Uploading and downloading files between a client and a server.

Secure File Transfer Protocols:

- Secure FTP (SFTP): Provides secure file transfer over an encrypted channel.
- Secure Copy Protocol (SCP): A secure version of the `cp` command used for copying files securely between hosts.
- FTPS (FTP Secure): Adds a layer of security to FTP using SSL/TLS.

Web-Based File Sharing:

- HTTP/HTTPS: Web servers can be used to share files through direct download links or web interfaces.
- Cloud Storage Services (e.g., Google Drive, Dropbox): Allow users to upload, share, and collaborate on files over the internet.

Peer-to-Peer (P2P) File Sharing:

- BitTorrent: Distributes data across a network of peer computers, enabling users to download and share files.

Network-Attached Storage (NAS):

- Description: Dedicated devices or servers that provide centralized and shared storage accessible over a network.
- Use Case: Centralized file storage and access for multiple users or devices.

Distributed File Systems:

- Description: Systems that distribute file storage and retrieval across multiple servers or nodes.
- Use Case: Scalable and fault-tolerant file storage systems, such as Hadoop Distributed File System (HDFS).

Email Attachments:

- Description: Sending files as attachments via email for sharing with specific recipients.
- Use Case: Sharing documents, images, or other files through email communication.

Bluetooth File Transfer:

- Description: Allows file transfer between Bluetooth-enabled devices in proximity.
- Use Case: Sharing files between mobile devices or laptops.

Point-to-Point File Transfer Protocols:

- Direct cable connection or Ad-hoc Wi-Fi: Connecting two devices directly to transfer files without a central server.

3. When implementing file sharing in a network, it's important to consider security measures such as access controls, encryption, and authentication to protect sensitive data from unauthorized access.

1.2 Categories of Network:

a. **Based on scope - LAN, MAN, WAN .**
b. **Based on Connection - Peer to Peer network, Client- Server Network, Centralized network, Distributed network.**

(a) Short note on Categories of Network: Based on scope - LAN, MAN, WAN .

Ans.: Based on scope:

Networks are categorized on the basis of their size. The three basic categories of computer networks are-

A. **Local Area Networks (LAN)** is usually limited to a few kilometers of area. It may be privately owned and could be a network inside an office on one of the floor of a building or a LAN could be a network consisting of the computers in an entire building.
B. **Wide Area Network (WAN)** is made of all the networks in a (geographically) large area. The network in the entire state of Maharashtra could be a WAN
C. **Metropolitan Area Network (MAN)** is of size between LAN & WAN. It is larger than LAN but smaller than WAN. It may comprise the entire network in a city like Mumbai.

There are different types of Networks such as point to point, broadcast, multicast, unicast. Apart from this, networks can be broadly classified as PAN, LAN, MAN, WAN, Wireless Networks, Home Networks, Intranetworks and Internetworks.

- **Local Area Networks (LAN)**
  - A local area network (LAN) is usually privately owned and links the devices in a single office, building, or campus (see Figure).
  - Depending on the needs of an organization and the type of technology used, a LAN can be as simple as two PCs and a printer in someone's home office; or it can extend throughout a company and include audio and video peripherals.
  - Currently, LAN size is limited to a few kilometers.
  - Diagram:

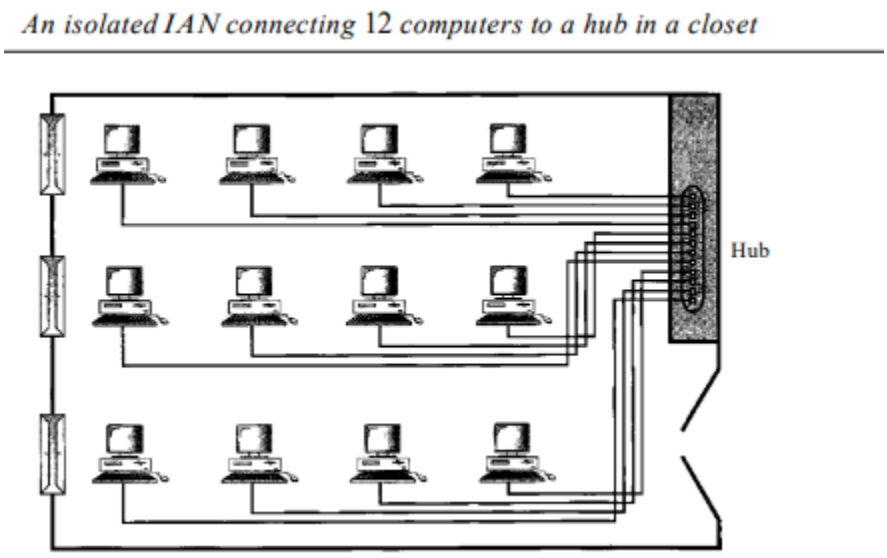


Figure : LAN Implementation

  - LANs are designed to allow resources to be shared between personal computers or workstations. The resources to be shared can include hardware (e.g., a printer), software (e.g., an application program), or data.

- **A common example of a LAN,** found in many business environments, links a workgroup of task-related computers, **for example,** engineering workstations or accounting PCs. One of the computers may be given a large capacity disk drive and may become a server to clients. Software can be stored on this central server and used as needed by the whole group. In this example, the size of the LAN may be determined by licensing restrictions on the number of users per copy of software, or by restrictions on the number of users licensed to access the operating system.
- In addition to size, LANs are distinguished from other types of networks by their transmission media and topology. In general, a given LAN will use only one type of transmission medium.
- **The most common LAN topologies are**
    1. Bus,
    2. Ring, and
    3. Star.
- **Benefits are**
    1. Early LANs had data rates in the 4 to 16 megabits per second (Mbps) range.
    2. Today, however, speeds are normally 100 or 1000 Mbps.

- **Metropolitan Area Networks (MAN)**
    - A metropolitan area network, or MAN, covers a city.
    - A metropolitan area network (MAN) is a network with a size between a LAN and a WAN. It normally covers the area inside a town or a city.
    - It is designed for customers who need high-speed connectivity, normally to the Internet, and have endpoints spread over a city or part of the city.
    - Kindly Refer the figure.:

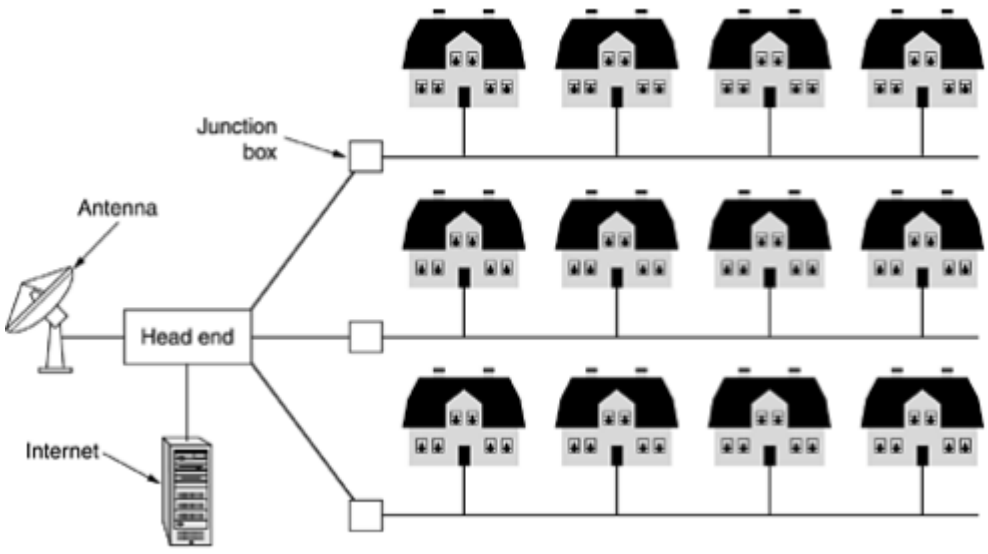


Figure: A metropolitan area network based on cable TV

- **Example of a MAN:** The cable television network available in many cities.
  Cable television is not the only MAN. Recent developments in high-speed wireless Internet access resulted in another MAN, which has been standardized as IEEE 802.16.
- **A good example of a MAN** is the part of the telephone company network that can provide a high-speed DSL line to the customer. Another example is the cable TV network that originally was designed for cable TV, but today can also be used for high-speed data connection to the Internet

- **Wide Area Networks (WAN)**
  - A wide area network, or WAN, spans a large geographical area, often a country or continent. It contains a collection of machines intended for running user (i.e., application) programs.
  - A wide area network (WAN) provides long-distance transmission of data, image, audio, and video information over large geographic areas that may comprise a country, a continent, or even the whole world.
  - A WAN can be as complex as the backbones that connect the Internet or as simple as a dial-up line that connects a home computer to the Internet. We normally refer to the first as a switched WAN and to the second as a point-to-point WAN **(Figure).**

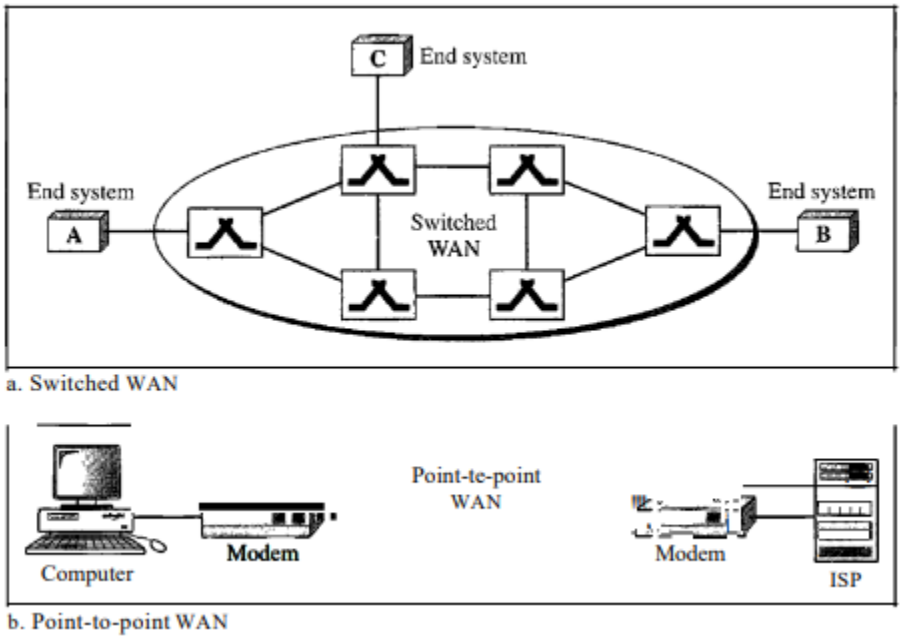
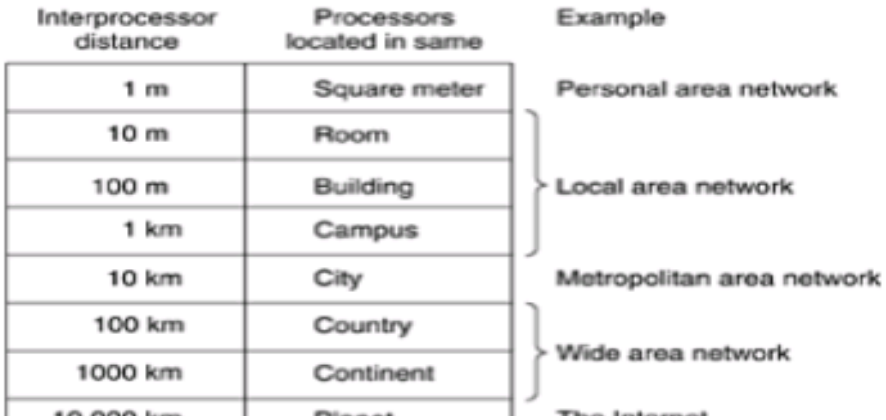


Figure: WAN Implementation

  - The switched WAN connects the end systems, which usually comprise a router (internetworking connecting device) that connects to another LAN or WAN. The point-to-point WAN is normally a line leased from a telephone or cable TV provider that connects a home computer or a small LAN to an Internet service provider (ISP). This type of WAN is often used to provide Internet access.
  - The hosts are owned by the customers (e.g., people's personal computers), whereas the communication subnet is typically owned and operated by a telephone company or Internet service provider. The job of the subnet is to carry messages from host to host, just as the telephone system carries words from speaker to listener.
  - **Example:**
    1. An early example of a switched WAN is X.25, a network designed to provide connectivity between end users. X.25 is being gradually replaced by a high-speed, more efficient network called Frame Relay.
    2. A good example of a switched WAN is the asynchronous transfer mode (ATM) network, which is a network with fixed-size data unit packets called cells.
    3. Another example of WANs is the wireless WAN that is becoming more and more popular.
  - Wireless networks can be divided into three main categories:
    1. System interconnection.
    2. Wireless LANs.
    3. Wireless WANs.



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

Figure 1: Classification of interconnected processors by scale

Comparison Chart :

Sr.No	Parameter	LAN	WAN	MAN
1	Ownership of Network	Private	Private or Public	Private or Public
2	Area covered	Small	Very large(states or countries)	Moderate (City)
3	Design and Maintenance	Easy	Not Easy	Not Easy
4	Communication medium	Coaxial Cable	PSTN or Satellite links	Coaxial cables, PSTN, Optical Fiber Cables, Wireless
5	Data rates	High	Low	Moderate

6.	**Mode of communication**	**Each station can transmit and receive**	**Each station cannot transmit**	**Each station can transmit or receive**
7	**Principle**	**Operates on the principle of broadcasting**	**Switching**	**Both**
8	**Propagation Delay**	**Short**	**Long**	**Moderate**

(b) Explain Peer to Peer network,

Ans.: Peer to Peer network:

- A peer-to-peer (P2P) architecture consists of a decentralized network of peers - nodes that are both clients and servers.
- P2P networks distribute the workload between peers, and all peers contribute and consume resources within the network without the need for a centralized server.
- P2P architecture is completely decentralized. However, in application, sometimes there is a central tracking server layered on top of the P2P network to help peers find each other and manage the network.
- A Peer-to-Peer (P2P) network is a type of decentralized network where computers, also known as nodes, communicate directly with each other without the need for a central server or authority.
- In a P2P network, each node can act as both a client and a server, sharing resources and information directly with other nodes on the network.
- Here's a simple example of small P2P network.

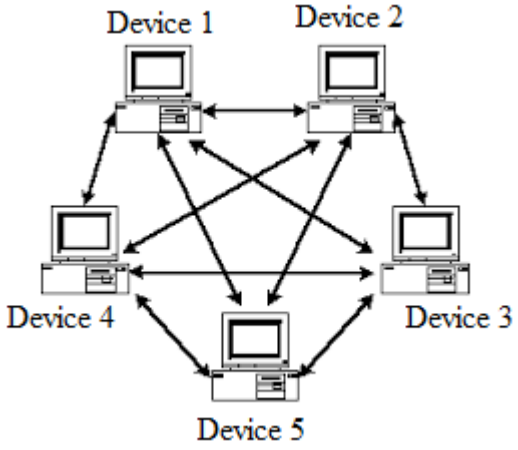


Figure: Peer-to-Peer Network.

- **Some uses of P2P architecture:**
    1. File sharing
    2. Instant messaging
    3. Voice Communication
    4. Collaboration
    5. High Performance Computing

- **Some examples of P2P architecture:**
    1. Napster - it was shut down in 2001 since they used a centralized tracking server
    2. BitTorrent - popular P2P file-sharing protocol, usually associated with piracy
    3. Skype - it used to use proprietary hybrid P2P protocol, now uses client-server model after Microsoft's acquisition
    4. Bitcoin - P2P cryptocurrency without a central monetary authority
- **Advantages/Change Resilience P2P networks have many advantages-**
    1. For example, there is no central server to maintain and to pay for (disregarding tracking servers), so this type of network can be more economical.
    2. That also means there is no need for a network operating system, thus lowering cost even further.
    3. There is no single point of failure, unless in the very unlikely case that the network is very small.
    4. P2P networks are very resilient to the change in peers; if one peer leaves, there is minimal impact on the overall network.
    5. If a large group of peers join the network at once, the network can handle the increased load easily. Due to its decentralized nature, P2P networks can survive attacks fairly well since there is no centralized server.
- **Disadvantages-**
    1. P2P networks introduce many security concerns. If one peer is infected with a virus and uploads a chuck of the file that contains the virus, it can quickly spread to other peers.
    2. Also, if there are many peers in the network, it can be difficult to ensure they have the proper permissions to access the network if a peer is sharing a confidential file.
    3. P2P networks often contain a large number of users who utilize resources shared by other nodes, but who do not share anything themselves. These type of freeriders are called the leechers.

(c) Explain Client- Server Network.

Ans: Client- Server Network:

- **Client**
    - A client is a single-user workstation that provides presentation services, database services and connectivity along with an interface for user interaction to acquire business needs.
- **Server**
    - A server is one or more multi-user processors with a higher capacity of shared memory which provides connectivity and the database services along with interfaces relevant to the business procedures.
- Client/Server computing provides an environment that enhances business procedures by appropriately synchronizing the application processing between the client and the server.

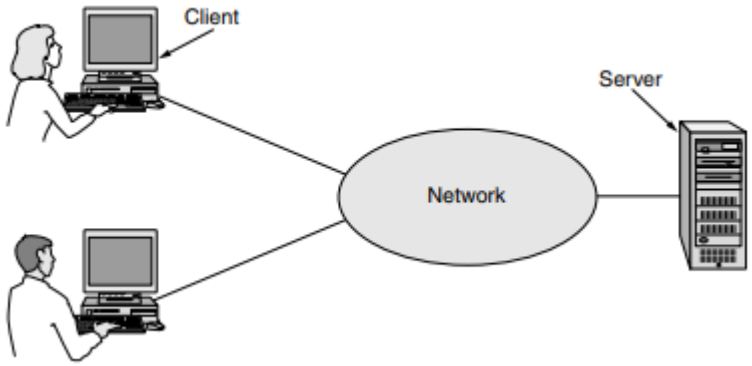
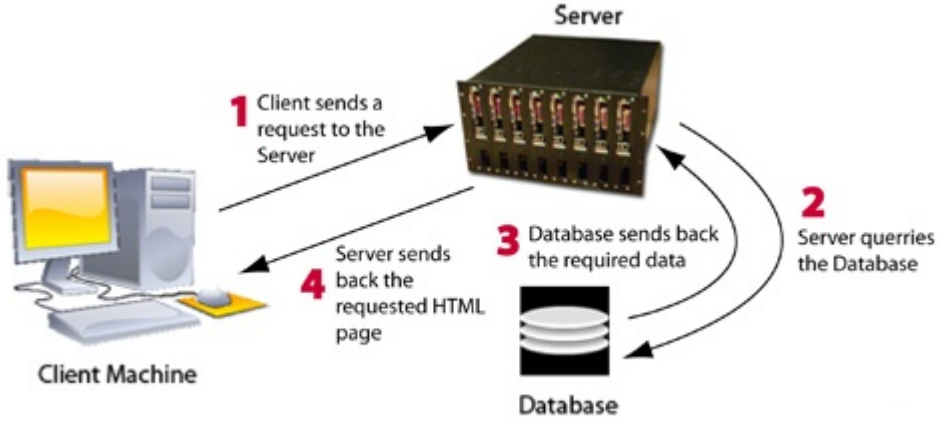


Figure: A network with two clients and one server.

- **Refer the Below Figure:**



- **Clients - Server Communication,**
    1. Client sends a request to the server
    2. Server queries the database.
    3. Database sends back the required data.
    4. Server sends back the requested HTML page.
- **Characteristics of The Client And The Server-**
    1. **Service:** The client/server is basically a relationship between processes running on distributed devices, server process considered as a supplier of services where the client process is a consumer of services. Briefly, this methodology provides a separation of functionalities subject to offered services.
    2. **Resource sharing:** A server is eligible of handling clients simultaneously, controlling the service access for the resources.
    3. **Inter- Communication via messages:** Interaction between clients and servers is obtained through a message-passing mechanism mainly to deliver service requests and responses.
    4. **Encapsulation of services:** A server is specialized in satisfying client requests varyingly and can be upgraded without affecting its external environment (clients, shared resources) as long as the message broadcasting interface remains the same.
    5. **Scalability:** Client/Server systems can be scaled horizontally or vertically. Horizontal scaling implies the addition or removal of client workstations with a minor impact in performance. Migration to more efficient servers or dividing the work load over numerous servers is considered as vertical scaling.
    6. **Integrity:** Since the server code and server data is managed centrally, maintenance cost is less and results in shared data consistency and undependability of clients.
- The client-server architectural concept has several advantages:
    1. Centralization
    2. Scalability
    3. Easy Management
    4. Accessibility
    5. Data Security

(d) Explain Centralized network.

Ans. Centralized network:

- A centralized network is a type of network architecture where a central entity, often referred to as a server or hub, controls and manages the flow of information, resources, and services to other connected devices or nodes in the network.
- In a centralized network, communication typically occurs between individual nodes and the central server, which acts as a focal point for coordinating and facilitating the interactions within the network.

- **Examples of centralized networks include traditional client-server architectures commonly found in:**
    1. Client-Server Applications: Web applications, email servers, and databases often follow a client-server model where clients (user devices) request services or data from a central server.
    2. Cloud Computing: Cloud services often operate in a centralized fashion, where users access computing resources and storage through a central cloud server.
    3. Social Media Platforms: Many social media platforms have a centralized structure where user interactions, data storage, and content distribution are managed by central servers.

- **Key characteristics of centralized networks include:**
    1. **Central Control:** A central server or authority has control over the network operations, managing tasks such as resource allocation, communication routing, and overall network management.
    2. **Dependency:** Nodes in a centralized network depend on the central server for various services and resources. The centralization of control means that the network's functionality is reliant on the health and availability of the central server.
    3. **Scalability Challenges:** As the number of nodes or users in the network increases, the central server may face scalability challenges in handling the growing demands for services and resources.
    4. **Single Point of Failure:** Since the central server plays a crucial role in the network, any failure or disruption to the server can have a significant impact on the entire network, making it vulnerable to single points of failure.
    5. **Communication Bottlenecks:** Communication between nodes often goes through the central server, leading to potential bottlenecks and increased latency, especially as the network scales.

(e) Explain Distributed network.

Ans.: Distributed network:

- A distributed network is a type of network architecture in which the processing and communication tasks are spread across multiple nodes, and there is no single central point of control.
- In a distributed network, each node operates independently and collaborates with other nodes to achieve a common goal. This approach is designed to enhance fault tolerance, scalability, and overall system efficiency.
- **Examples of distributed networks include:**
    1. **Blockchain Networks:** Blockchain technology relies on a distributed network of nodes that work together to validate and record transactions. Each node in the network maintains a copy of the blockchain, ensuring redundancy and decentralization.
    2. **Distributed Databases:** Systems like Apache Cassandra or Amazon DynamoDB use a distributed architecture to store and manage data across multiple nodes, improving scalability and fault tolerance**.**
    3. **Content Delivery Networks (CDNs):** CDNs distribute content across multiple servers strategically located around the world. This allows users to access content from servers closer to their geographical location, improving performance and reducing latency.
    4. **Peer-to-Peer Networks:** While peer-to-peer (P2P) networks can be considered a form of distributed network, they have unique characteristics, as mentioned in a previous response**.**
- **Characteristics of distributed networks:**
    1. **Decentralization:** Unlike centralized networks, distributed networks lack a single point of control or authority. Instead, decision-making, processing, and data storage are distributed among multiple nodes.
    2. **Autonomy:** Each node in a distributed network has a degree of autonomy and can make decisions locally. Nodes can operate independently and still contribute to the overall functionality of the network.
    3. **Fault Tolerance:** Distributed networks are often more resilient to failures because there is no central point of failure. If one node becomes unavailable or experiences issues, the network can continue to operate using other available nodes.

4. **Scalability:** Distributed networks can be easily scaled by adding more nodes to the system. As the number of nodes increases, the network's capacity and performance can improve, making it more adaptable to growing demands.
5. **Redundancy:** Distributed systems often incorporate redundancy, where multiple nodes may perform similar functions or store copies of the same data. This redundancy helps ensure that the loss of any individual node does not result in the loss of critical functionality or information.

1.3 Network Architecture:-Features and Applications

I) Network architecture encompasses several key features that are essential for building and maintaining a robust and efficient network. Some of these features include:

1. Scalable Network: Network architecture should be designed to accommodate the growth of network traffic and the addition of new devices or users without compromising performance.
2. Reliable Network: A reliable network architecture ensures consistent connectivity, minimizing downtime and disruptions in communication.
3. Network Security: Network architecture incorporates security measures to protect against unauthorized access, data breaches, and other cyber threats.
4. Network Performance: Network architecture aims to optimize network performance, ensuring fast and efficient data transfer, low latency, and minimal packet loss.
5. Flexible Network: A flexible network architecture allows for easy adaptation and configuration changes, enabling efficient management and future-proofing the network.

II) Network architecture has various applications across different industries and sectors. Some common applications include:

1. Data Centers: Network architecture is crucial in designing and managing data centers, which are responsible for storing and processing large amounts of data.
2. Cloud Computing: Network architecture plays a vital role in enabling communication and data transfer between cloud service providers and users, ensuring reliable and secure access to cloud resources.
3. Internet of Things (IoT): Network architecture is essential for connecting and managing a vast number of IoT devices, enabling seamless communication and data exchange.
4. Telecommunications: Network architecture is used in designing and maintaining telecommunications networks, including wired and wireless communication systems.
5. Enterprise Networks: Network architecture is applied in creating and managing internal networks within organizations to facilitate efficient communication and data sharing among employees and departments.
6. Financial Institutions: Network architecture helps ensure secure and reliable connectivity for financial institutions, enabling secure transactions and data transfer.

1.4 Applications and Benefits of Computer Network.

I) Computer networks have a wide range of applications across various industries and sectors. Some common applications include:

1. Communication and Collaboration: Computer networks enable seamless communication and collaboration among individuals and teams, allowing for the sharing of information, resources, and ideas.
2. Internet and World Wide Web: The internet is a global computer network that connects millions of devices worldwide, facilitating access to information, online services, and communication platforms.
3. Business Operations: Computer networks are essential for businesses to connect their offices, branches, and remote locations, enabling efficient data sharing, centralized management, and streamlined operations.
4. E-commerce and Online Banking: Computer networks support secure online transactions, enabling e-commerce platforms and online banking systems to function effectively.
5. Education and E-learning: Computer networks play a vital role in educational institutions, providing access to online learning resources, virtual classrooms, and remote education opportunities.
6. Entertainment and Media Streaming: Networks are used to deliver streaming services, such as video-on-demand platforms, music streaming, and online gaming.
7. Internet of Things (IoT): Computer networks connect and manage IoT devices, allowing for the exchange of data and control of interconnected devices and systems.
Note : application of Network Architecture will also be added computer network application points.

II) Computer networks offer numerous benefits that enhance communication, collaboration, and efficiency. Some key benefits include:
1. Communication and Connectivity: Computer networks enable seamless communication and connectivity between individuals, departments, and organizations, fostering effective collaboration and information sharing.
2. Resource Sharing: Networks allow for the sharing of hardware devices, software applications, and data resources, reducing costs and increasing efficiency.
3. Data Sharing and Centralized Storage: Networks facilitate the sharing and storage of data in a centralized location, making it easily accessible to authorized users and ensuring data consistency.
4. Improved Efficiency and Productivity: By providing instant access to information, resources, and tools, computer networks enhance productivity and streamline workflows, enabling faster decision-making and task completion.
5. Cost Savings: Networks enable organizations to optimize resource utilization, reduce hardware and software duplication, and centralize management, resulting in cost savings over time.
6. Enhanced Collaboration: Networks enable real-time collaboration, allowing multiple users to work on the same project simultaneously, regardless of their physical location.
7. Scalability and Flexibility: Networks can easily accommodate the addition of new users, devices, and applications, providing scalability and flexibility to adapt to changing business needs.
8. Improved Security: Networks allow for the implementation of security measures, such as firewalls, encryption, and access controls, to protect sensitive data and systems from unauthorized access.