

Full Stack Software Development

Course: Basics of Networking

Lecture on: Introduction to
Networking

Instructor: Unnati Vora

Course Road Map

- Introduction to networking concepts
- Networking models



Today's Agenda

- What is networking?
- Reasons for networking
- What is the Internet? Its history
- Wired and wireless networks
- Server and client
- Network architectures
- Centralised, decentralised and distributed networks
- Types of network
- IP address and MAC address
- Network components
- Network topologies



WHAT IS NETWORKING?



A network consists of multiple connected computers connected sharing resources.

The computers in a network are either linked through cables, telephone lines, radio waves, satellites or infrared light beams.

REASONS FOR NETWORKING



- Eases sharing of files
- Eases sharing of resources
- Enhances storage capacity
- Provides flexibility in data storage



No Internet Connection

Slow or no Internet connection

Check your connection or try again

TRY AGAIN

- The Internet is made up of a large number of independently operated networks.
- It is basically a network of networks.
- Internet enables us to access nearly any information, communicate with anyone in the world and do much more.
- The Internet is a global network of wireless connections.
- A computer sends a request over these wires to a server, and the server responds with the requested data.



The Internet is a universal network of computers and other electronic devices.



HISTORY OF THE INTERNET

- The Internet was a result of the US Defence Department's research project known as the **Advanced Research Projects Agency Network or ARPANET**.
- With an aim to develop a communication system that would survive a nuclear attack, a distributed network system was created.
- Later, the distributed packet switched network was developed, which breaks down messages into blocks and sends them in every direction as fast as possible.



Poll 1 (15 Seconds)

Fill in the blank.

The first Internet network was known as _____.

1. ARPANET
2. DARPA
3. INTRANET
4. INTERNET

Poll 1 (Answer)

Fill in the blank.

The first Internet network was known as _____.

1. ARPANET
2. DARPA
3. INTRANET
4. INTERNET

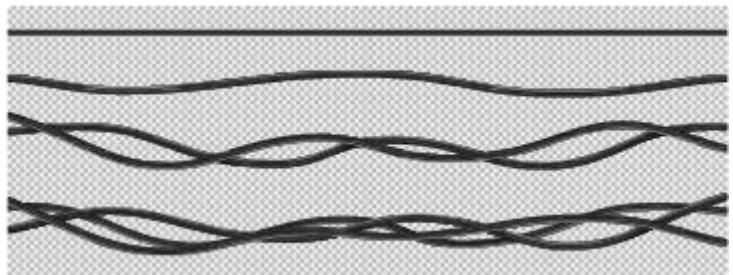
- In a wired network, two or more devices are connected via a cable, commonly known as the Ethernet cable.
- Wired networks are most commonly used in local area networks.

Advantages:

- Less prone to network interference
- More secure
- Dedicated bandwidth

Disadvantages:

- Not very cost-effective
- Less flexibility in terms of changing the location



- In a wireless network, devices are not connected to each other via cables.
- Wi-Fi hotspot is an application of wireless networks.

Advantages:

- Increases mobility of devices connected in the network
- Easy to install
- Cost-effective
- Easily expandable

Disadvantages:

- More prone to network interference
- Less secure
- Transmission speed is limited by spectrum



01

The client-server model denotes the relationship between cooperating programs in an application.

02

Clients initiate requests for services, and servers provide the function or service.

03

Clients are typically personal computers or mobile devices with network software applications installed. IoT devices also act as clients.

04

A server is used to refer to the program serving the clients as well as the physical devices that host these programs.

Servers are usually devices with files and databases stored inside them, including complex applications.

05

Servers have high-powered central processors, larger disk drives and more memory than clients.

Servers come with enterprise-grade reliability, availability and serviceability.

06

The server fulfils the clients' requests by sharing resources with the client.

Poll 2 (15 Seconds)

State if the below statement is true or false.

Clients initiate requests for services, and servers provide the function or service.

1. True
2. False

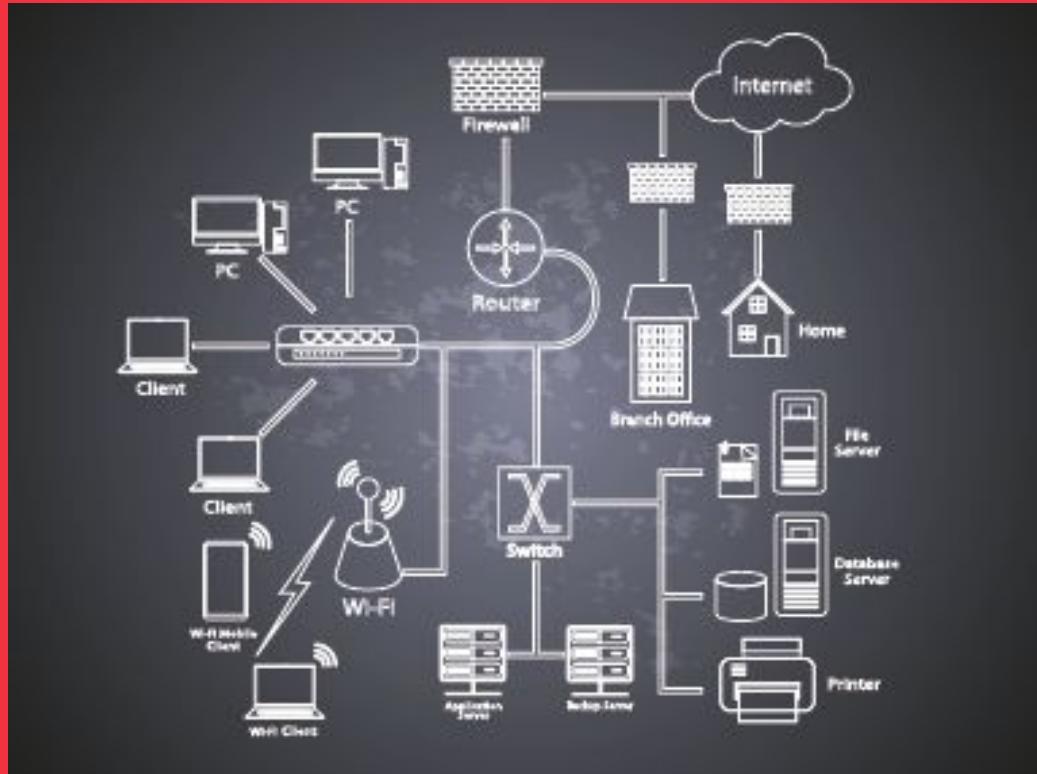
Poll 2 (Answer)

State if the below statement is true or false.

Clients initiate requests for services, and servers provide the function or service.

1. True
2. False

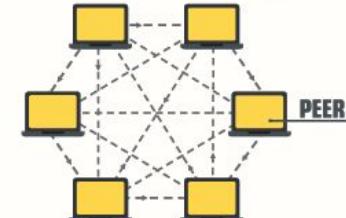
Network Architectures



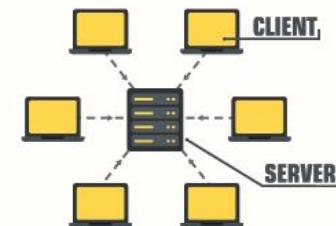
- Computer network architecture is the physical and logical design of software, hardware, protocols, and media. We can say that network architecture defines how the computers in the network are organised and how they are allocated.
- The following two types of network architectures are used:
 - Peer-to-peer network
 - Client/server network

NETWORK TYPES

PEER-TO-PEER (P2P) NETWORK

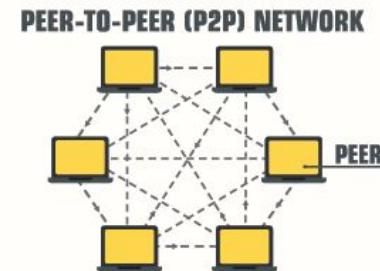


CLIENT-SERVER NETWORK



Peer-To-Peer Network

- In a peer-to-peer network, all the computers are linked together with equal privilege and responsibilities for processing the data.
- This network is useful for small environments, usually up to 10 computers.
- No dedicated server.
- Each computer is assigned a special permissions for sharing the resources, but this can lead to problems if a computer with the specified resource is down.
- A peer-to-peer (P2P) network is used to share large files. Most common examples of a P2P network are downloading of online games and downloading of Linux OS updates from BitTorrent.



Peer-To-Peer Network

Advantages

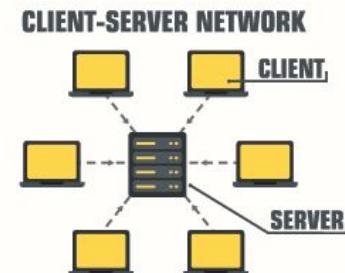
- Less costly, because it does not contain any dedicated server.
- The network does not fail easily.
- Easy to set up and maintain.
- It provides privacy.

Disadvantages

- A peer-to-peer network does not contain a centralised system.
- Therefore, it cannot back up the data, as the same data could have different versions on different locations, leading to consistency issues.
- It is less secure, as each device manages itself.

Client/Server Network

- A client/server network is a network model designed for end-users called clients to access a central computer known as a server.
- All the primary operations, such as security and network management, is taken care of by the server.
- A server is responsible for managing all resources, such as files, directories and printers.
- All the clients communicate amongst each other via a server. For example, if client 1 wants to send some data to client 2, it first sends the server's request for permission. Then, the server sends the response to client 1 to initiate its communication with client 2.



Client/Server Network

Advantages

- A client/server network contains a centralised system. Therefore, we can back up the data easily.
- A client/server network has a dedicated server that improves the overall performance of the entire system.
- Security is better in a client/server network, as a single server administers the shared resources.

Disadvantages

- A client/server network is expensive, as it requires a server with enterprise-grade processors, memory and storage.
- A server has an Network Operating System (NOS) to provide resources to clients, but a NOS cost is exceptionally high.

Poll 3 (15 Seconds)

State if the below statement is true or false.

A peer-to-peer network has no dedicated server.

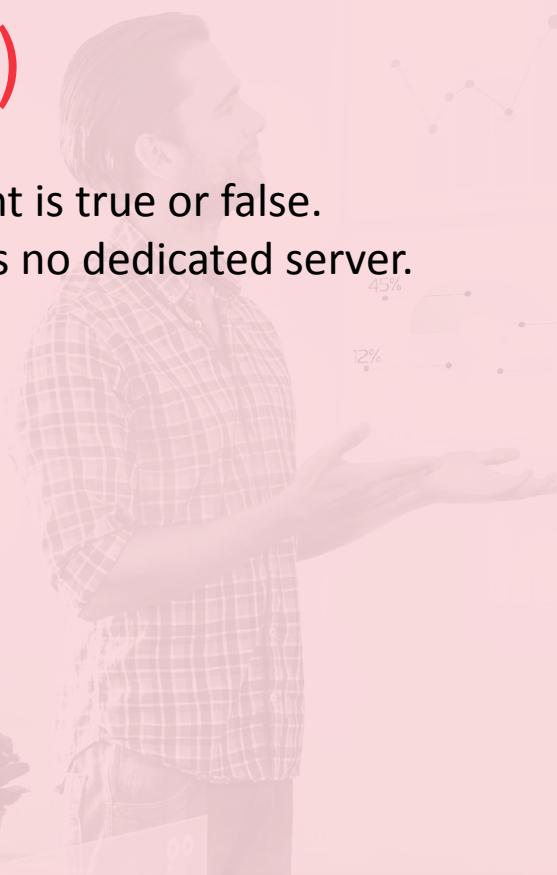
1. True
2. False

Poll 3 (Answer)

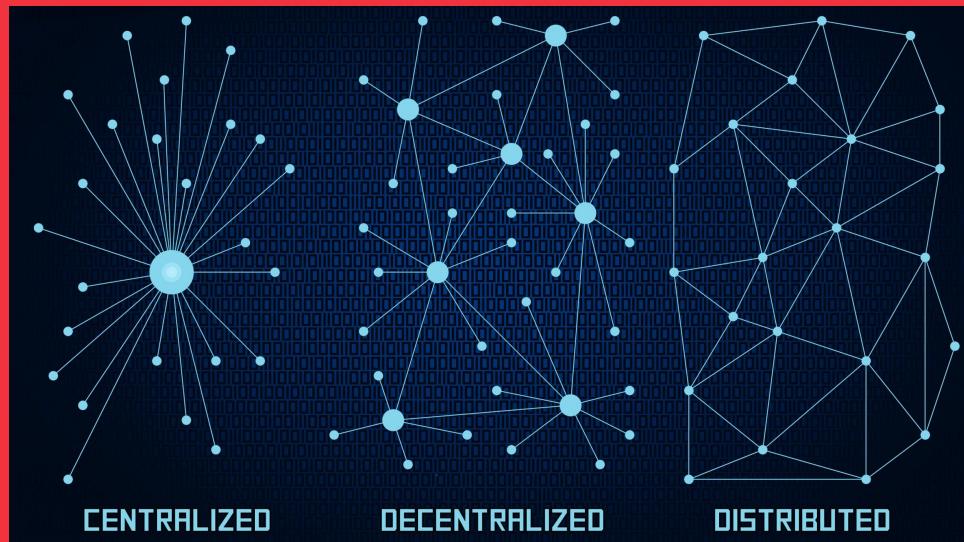
State if the below statement is true or false.

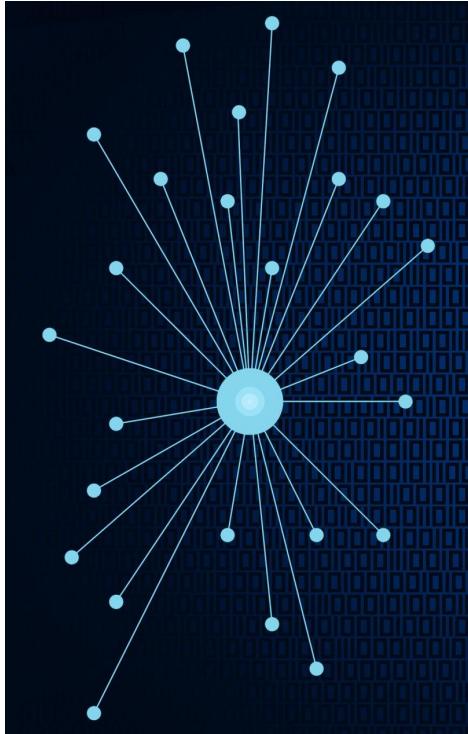
A peer-to-peer network has no dedicated server.

- 1. True**
2. False



Centralised, Decentralised and Distributed Networks





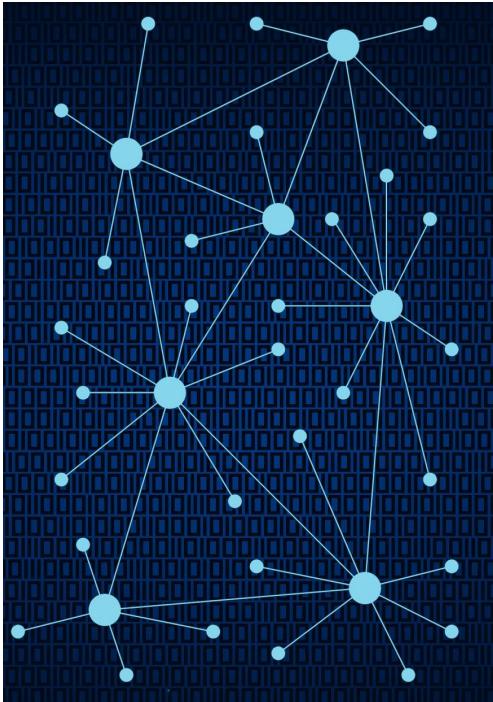
- In a centralised network, one or more clients are connected to a central server.
- Here, the central server manages the storage and processing of all the connected clients.
- Examples: Wikipedia, government databases

Advantages:

- Efficient
- Cost-effective

Disadvantages:

- Difficult to maintain
- Not easily scalable



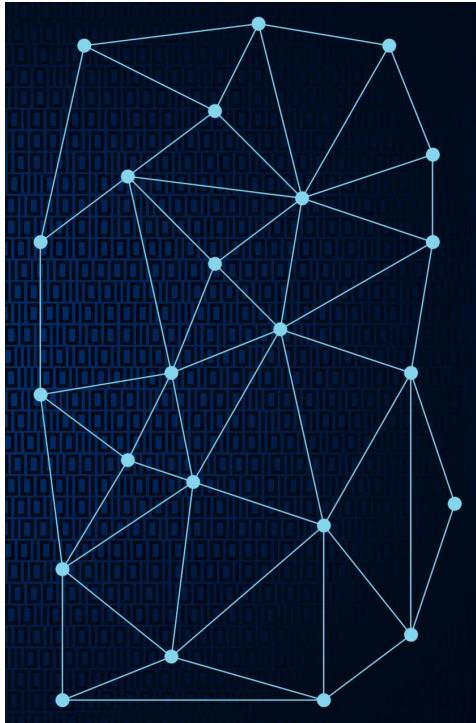
- In a decentralised network, several independent devices are connected together in a fashion that each device takes its own decision.
- Here, the final outcome is the collective decision, and a single device does not respond to a request.
- Example: Bitcoin

Advantages:

- More scalable
- More reliable
- More secure
- More robust

Disadvantages:

- Expensive
- High on maintenance



- In a distributed network, multiple nodes share the process and a centralised decision is made.
- Example: Google

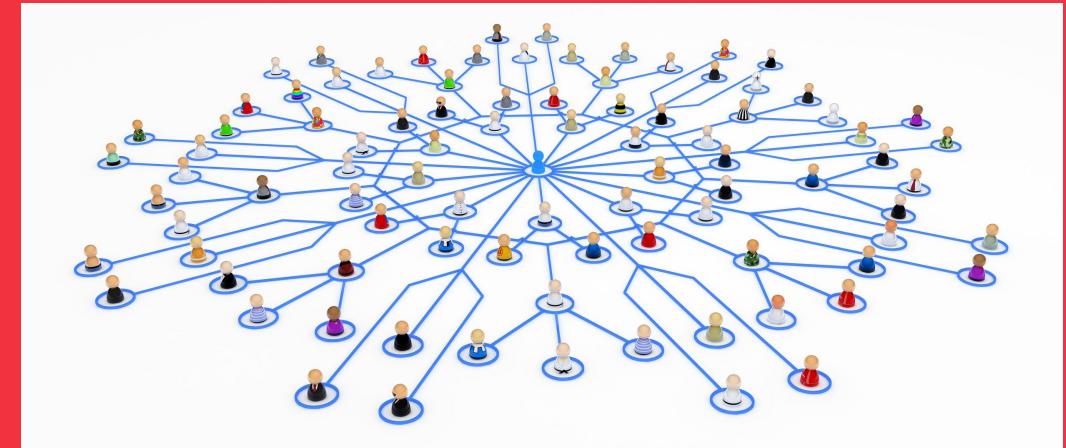
Advantages:

- Low latency
- Secure
- Scalable
- Enables resource sharing

Disadvantages:

- High maintenance cost

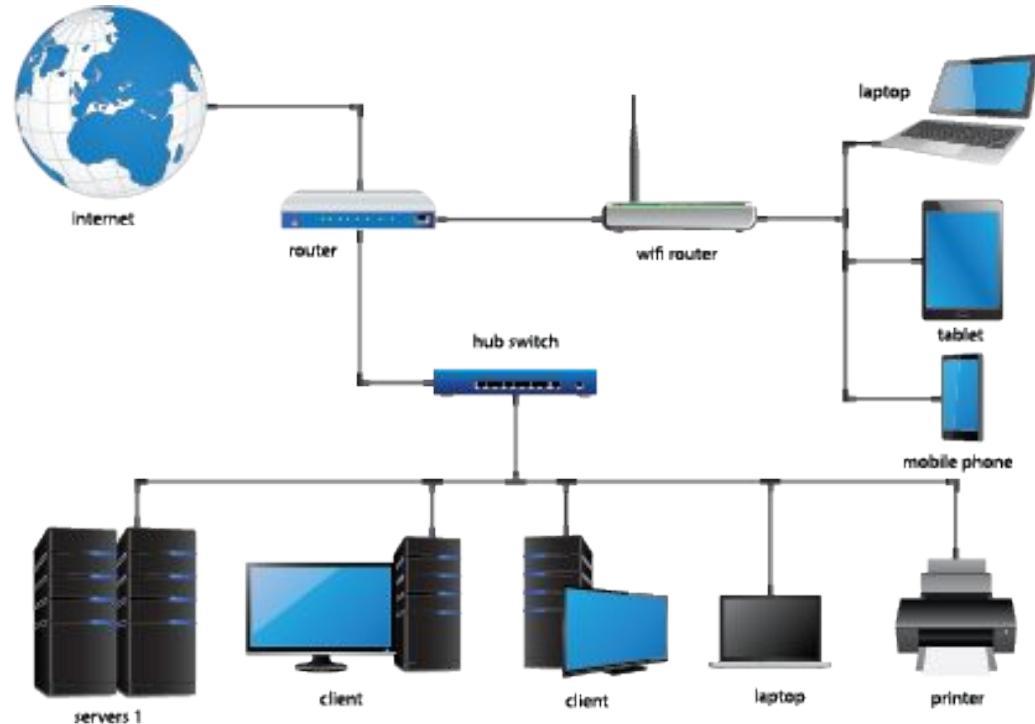
Types of Network



TYPES OF NETWORK

There are four major types of network based on the size as mentioned below:

- Personal Area Network (PAN)
- Local Area Network (LAN)
- Wide Area Network (WAN)
- Metropolitan Area Network (MAN)



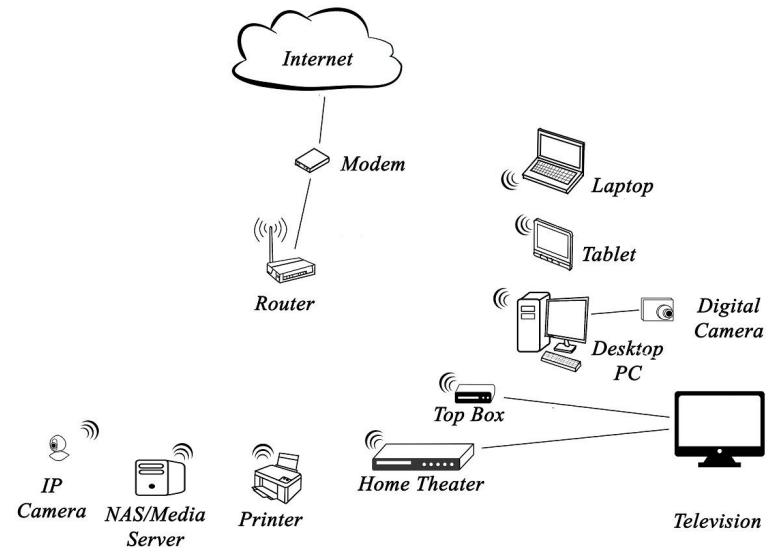
LAN Network Diagram

Personal Area Network (PAN)

PAN is a computer network around a personal space. PAN consists of a computer and a mobile or personal digital assistant. PAN can establish communication among these personal devices for connecting to a digital network and the Internet.

Characteristics of PAN:

- It is primarily a personal device's network equipped within a limited area.
- It allows you to handle the interconnection of IT devices around a single user.
- PAN includes mobile devices, tablets and laptops.
- PAN devices: Cordless mice, keyboards and Bluetooth systems



Personal Area Network (PAN)

Advantages

- PAN networks are relatively secure and safe.

Disadvantages

- A PAN network is strictly restricted to a small area.

Local Area Network (LAN)

- A Local Area Network (LAN) is a batch of computers and peripheral devices interconnected within a limited area such as a school, laboratory, home or office building.
- It is popularly used for sharing resources such as files, printers, games and other applications.
- The simplest method of a LAN network is to connect computers and a printer to someone's home or office. In general, LAN can be used as a transmission medium.
- It is a network that consists of less than 5,000 interconnected devices across several buildings.

Characteristics of LAN:

- It is a private network.
- LAN operates at a relatively higher speed as compared with other Wide Area Network systems.
- There are various types of media access control methods such as token ring and Ethernet.

Local Area Network (LAN)

Advantages

- Computer resources such as hard disks, DVD-ROM and printers can be shared over local area networks thus, significantly reducing the cost of hardware purchases.
- Data of all network users can be stored on a single hard disk of the server computer.
- You can quickly transfer data and messages over networked computers.
- LAN makes it easy to manage data in only one place, which makes data more secure.
- This network offers the facility to share a single Internet connection among all the LAN users.

Local Area Network (LAN)

Disadvantages

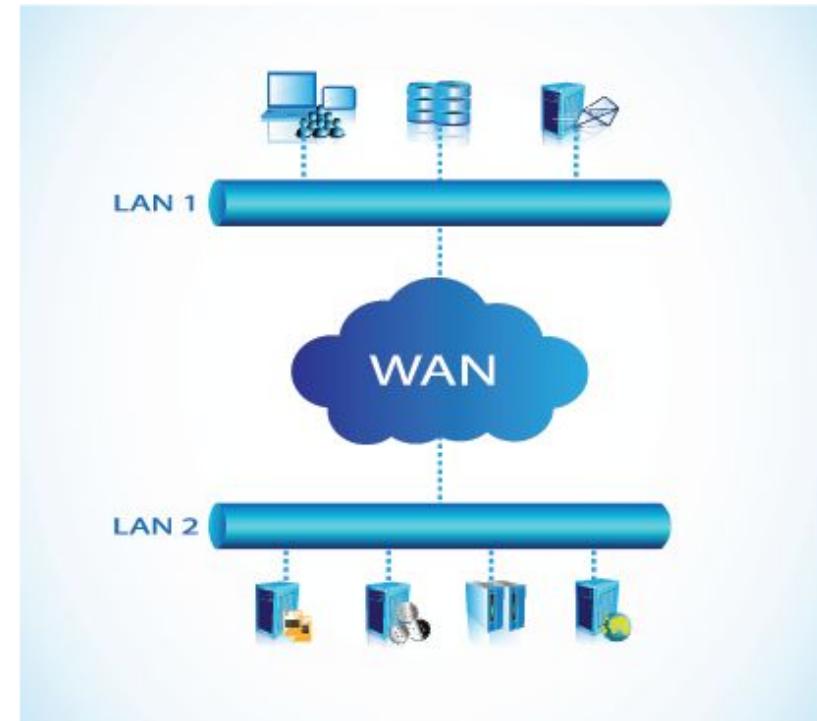
- LAN will help to save cost because of shared computer resources, but the initial cost of installing local area networks is quite high.
- The LAN admin can check personal data files of every LAN user, so users' privacy may be compromised.
- Unauthorised users can access critical data of an organisation in case the LAN admin is not able to secure a centralised data repository.
- A local area network requires constant LAN administration, as issues related to software setup and hardware failures may come up.

Wide Area Network (WAN)

- A **Wide Area Network (WAN)** is another important computer network that is spread across a large geographical area.
- A WAN could be a connection of multiple LAN networks. It is mostly limited to an enterprise or an organisation.

Characteristics of WAN:

- Any organisation can form its global integrated network using WAN.
- WAN enables sharing of resources within a region.



Wide Area Network (WAN)

Advantages

- WAN helps you cover a larger geographical area. Therefore, business offices situated at longer distances can communicate easily.

Disadvantages

- The initial setup cost of investment is extremely high.
- It is difficult to maintain a WAN network. You need skilled technicians and network administrators for it.
- WAN has higher number of faults and issues due to the wide coverage.
- It offers lower security compared with other types of network.

Metropolitan Area Network (MAN)

- A **Metropolitan Area Network (MAN)** consists of a computer network across an entire city, college campus or a small region. This type of network is more significant than a LAN.
- Depending upon the type of configuration, this type of network allows you to cover an area from several miles to tens of miles.



Characteristics of MAN:

- It primarily covers towns and cities in a maximum 50-kilometres range.
- Its most used mediums are optical fibres and cables.
- Data rates are adequate for distributed computing applications.

Metropolitan Area Network (MAN)

Advantages

- It offers fast communication using high-speed carriers, such as fibre optic cables.
- It provides excellent support for an extensive network and greater access to WANs. A MAN network primarily includes some areas of a city or an entire city.
- The dual bus in a MAN network provides support to transmit data in both directions concurrently.

Disadvantages

- You need more cables to establish a MAN connection from one place to another; thus, it becomes expensive.
- In a MAN network, it is tough to make the system secure from hackers as it is not easy to add a security filter at each level in such an extensive network.

Poll 4 (15 Seconds)

Fill in the blank.

WAN stands for _____.

1. Widerange Area Network
2. World Area Network
3. Wide Area Network
4. WiFi Area Network

Poll 4 (Answer)

Fill in the blank.

WAN stands for _____.

1. Widerange Area Network
2. World Area Network
- 3. Wide Area Network**
4. WiFi Area Network

IP Address



01

An IP (Internet Protocol) address is a numerical representation that uniquely identifies a specific interface on the network.

02

An IP address serves two purposes: Host or network interface identification and location addressing.

03

Computers translate URLs into numerical addresses. These are known as DNS servers.

04

Computers use these addresses to send data to the correct location.

05

Whenever we visit a website, our computer sends data packets to the other end of the connection's IP address.

06

Computers also receive packets destined for their own IP address.

IPv4

- 32-bit address
- Initial version of the Internet Protocol
- Address representation is in decimal

Example: 172.216.1.1

IPv6

- 128-bit address
- New version of the Internet Protocol
- Address representation is in hexadecimal

Example: 1001:0ABB: A010: 1001

01

IP addresses enable our servers, computers, telephones, printers, etc., to communicate with each other.

02

Without an IP address, the data transfer would have happened only through CDs, DVDs, hard disks or flash storages.

03

IP addresses help devices to send data without human intervention.

04

Emails became a reality with the help of IP addresses instead of paper letters and memos.

05

Even ordering items online became a reality with the help of the Internet and IP address.

Poll 5 (15 Seconds)

State if the below statement is true or false.

IP addresses require human intervention to send data between devices.

1. True
2. False

Poll 5 (Answer)

State if the below statement is true or false.

IP addresses require human intervention to send data between devices.

1. True
2. False

MAC Address



01

A MAC address is a 48-bit unique number of a computer.

02

It is embedded into the Network Interface Card while manufacturing.

03

The MAC address is also known as the physical address of a network device.



04

It is a 12-digit hexadecimal number mostly represented by colon-hexadecimal notation.

05

The first six digits of the MAC address identify the manufacturer and are collectively known as an OUI (Organizationally Unique Identifier).

DIFFERENCE BETWEEN IP ADDRESS AND MAC ADDRESS



A MAC address is provided by the chipmaker, while an IP address is provided by the Internet Service Provider.



A MAC address identifies the devices on a network, while an IP address identifies the connection of a network.

An IP address is used to transport data from one network to another, while a MAC address is used to deliver data to the right device on a network.



Poll 6 (15 Seconds)

State if the below statement is true or false.

A MAC address is used to transport data from one network to another, while an IP address is used to deliver data to the right device on a network.

1. True
2. False

Poll 6 (Answer)

State if the below statement is true or false.

A MAC address is used to transport data from one network to another, while an IP address is used to deliver data to the right device on a network.

1. True
2. False

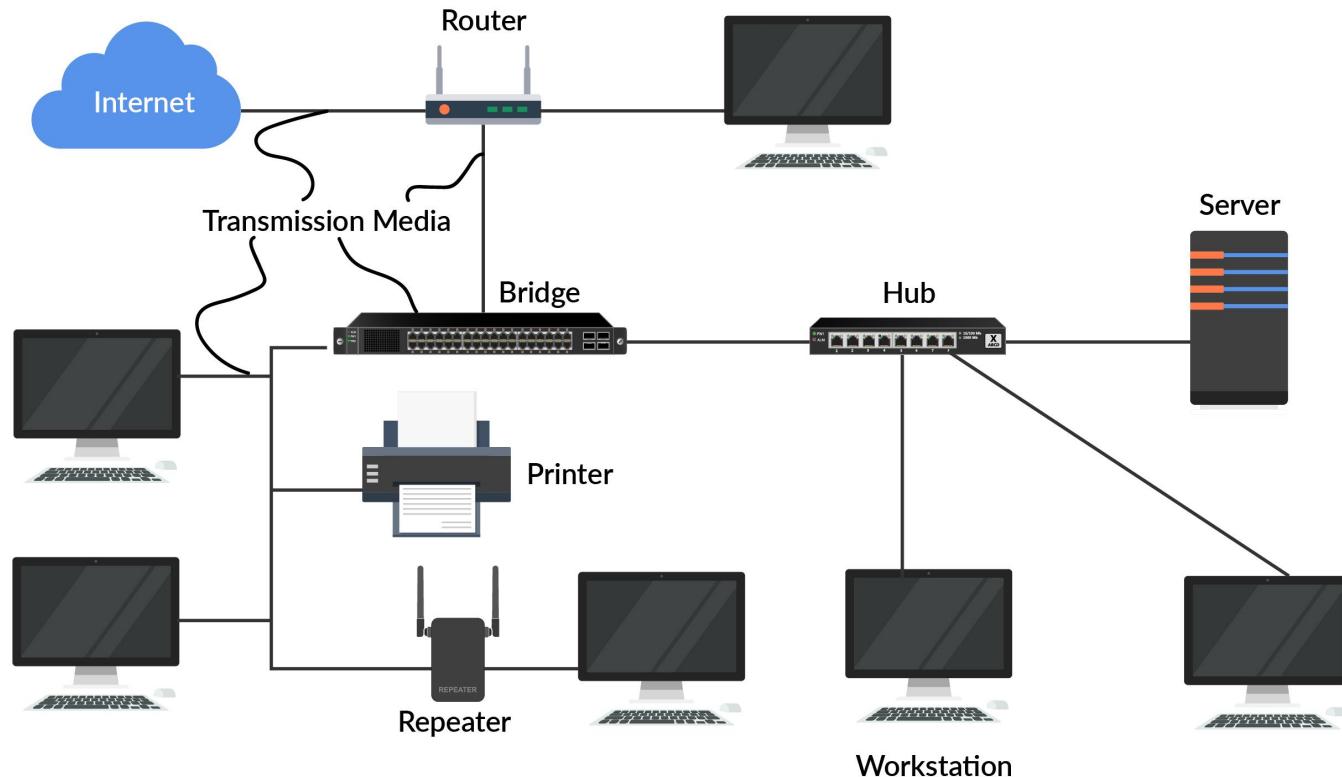
Network Interface Card

- A network interface card (NIC) is a hardware component used to connect a computer over a network.
- Network Interface Card is also called Network Interface Controller or Network Adapter or LAN Adapter.
- A NIC converts data into electrical signals that can be transmitted over the network. The purposes of NIC are as follows:
 - NIC allows both wired and wireless communications.
 - NIC allows communications between computers connected via a local area network (LAN) and communications over a large-scale network through Internet Protocol (IP).

N etwork
I nterface
C ontroller

Network Components

NETWORK COMPONENTS



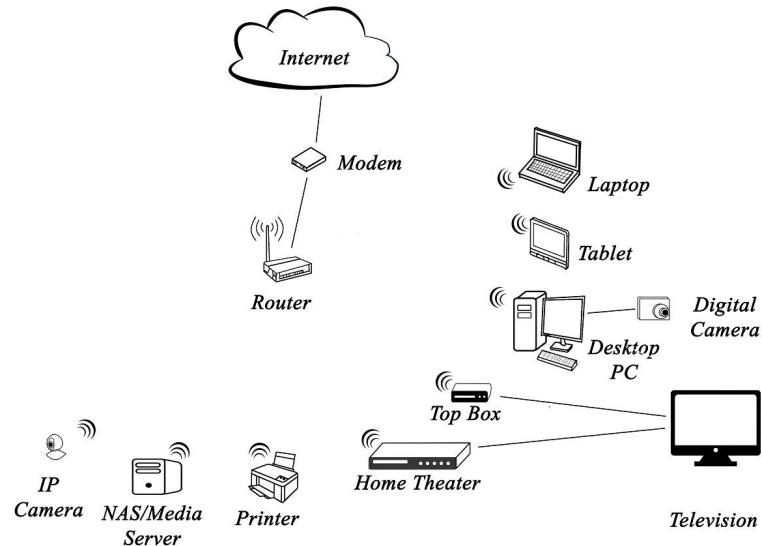
Router

- A router forwards a data packet between networks, often from one router to the next, until it reaches its destination.
- When a data packet arrives from one data network, the router reads the network address information to determine the ultimate destination. Using the information in its routing table or routing policy, it directs the packet to the next network.



Modem

- Modem is a network device that modulates and demodulates analogue carrier signals for encoding and decoding digital information.
- It is a network device that forwards data packets between computer networks. Routers perform the traffic directing functions on the Internet. Data sent through the Internet, using a web page or email, is in data packets. A packet is typically forwarded from one router to another through the network until it reaches its destination node.

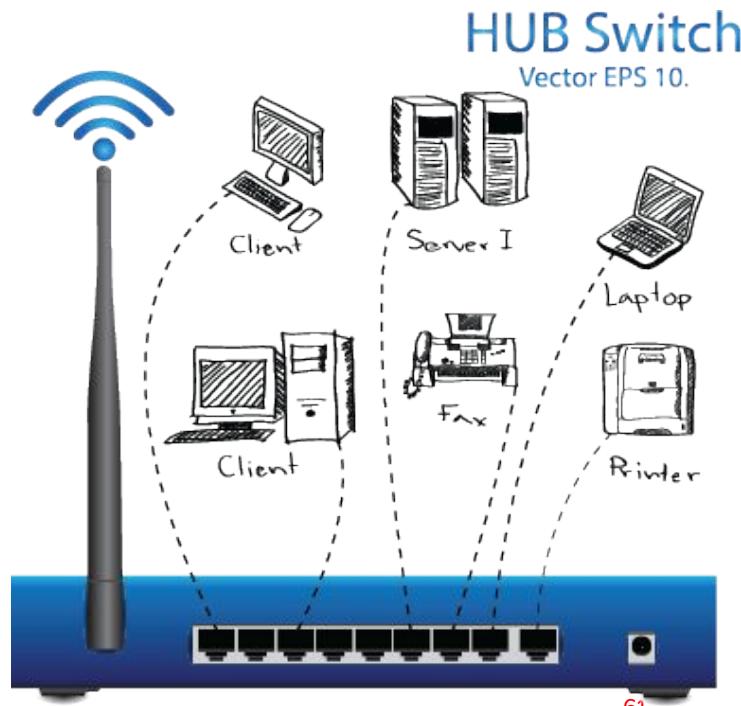


Bridge

- A bridge connects two or more network devices.
- It has a single input port and a single output port.
- It filters the data based on the MAC addresses of the source and the destination.

Hub

- A hub is a primary networking device that helps in connecting multiple computers or other network devices.
- A network hub has no routing tables or intelligence on where to send information and broadcasts all network data across each connection. When a data packet arrives at a port, it is copied to other ports so that all the segments of a local area network (LAN) can see all the data packets.
- When using a hub, data packets are passed to each of its ports regardless of where the packet is destined. The Ethernet hub is not able to determine which port a packet should be sent to. Bypassing data to every port, a hub ensures that it will reach its intended destination.
- Most hubs can detect basic network errors such as collisions, but having all information broadcasted to multiple ports is a security risk and causes bottlenecks.
- Hubs do not have IP addresses.



Switch

- A switch is more complex than a hub. Switch filters and forwards data packets between the segments of a local area network (LAN).
- A network switch can work with the MAC addresses of the devices connected to it. Using this information, it can identify the computers or other units on each of its ports. This way, it can send data packets to the relevant ports and the appropriate devices without crowding the network with unnecessary data.
- Additionally, a switch can allocate total bandwidth to each of its ports, i.e. with any number of devices operating, users will always have access to the maximum amount of bandwidth.
- Unmanaged switches do not have IP addresses, while managed switches do.

Repeater

- A repeater is used to regenerate the signal over the network.
- It strengthens the signal and does not let it get corrupted while travelling long distances.
- It does not amplify the signal. Instead, it regenerates the signal bit by bit.



Poll 7 (15 Seconds)

Fill in the blank.

A hub does not have a/an _____.

1. MAC address
2. IP address

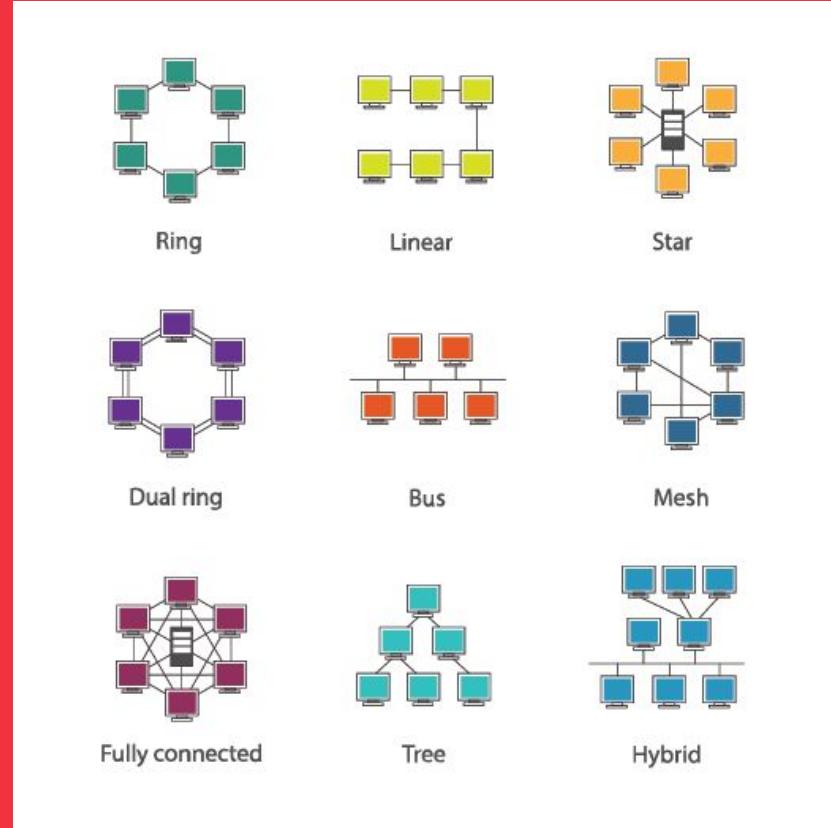
Poll 7 (Answer)

Fill in the blank.

A hub does not have a/an _____.

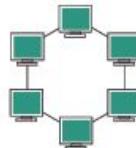
1. MAC address
2. IP address

Network Topologies



WHAT IS NETWORK TOPOLOGY?

- It is the arrangement of nodes in a network.
- There are several types of network topologies.
 - BUS
 - RING
 - STAR
 - MESH
 - TREE
 - HYBRID



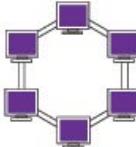
Ring



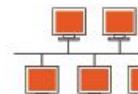
Linear



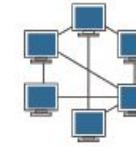
Star



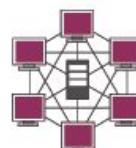
Dual ring



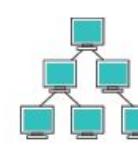
Bus



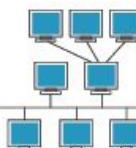
Mesh



Fully connected



Tree



Hybrid

BUS Topology

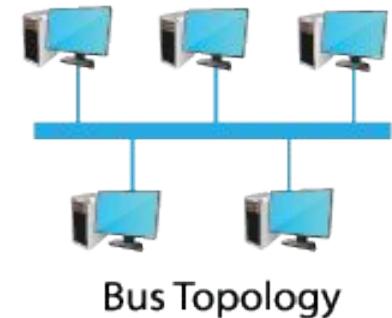
A **BUS topology** is a network in which all the computer nodes and network systems are connected to a single transmission channel.

Features:

- It transfers data in a single direction.
- There is a single connection between the node/system and the channel.

Advantages:

- Easy to connect devices
- Takes less time to set up
- Best suited for small networks
- Easy to expand



Disadvantages:

- If the backbone cable fails, then the entire network will be down
- No bi-directional communication
- Not suitable for heavy traffic data transmission, as it increases the chance of collision

RING Topology

In a **RING topology**, the device forms a ring in which each device is connected to its neighbour on both sides through a point-to-point connection and where the first and last nodes are connected to each other.

Functionality of a RING topology:

- In this topology, a device known as monitor station takes responsibility for the operation.
- A station has to hold the token to transmit the data.
- When no station is holding the token, the token is circulated in the ring.

Features:

- To prevent the loss of transmission data from the first node to the last node, say, 1000th node, a number of repeaters are deployed in the network.
- Dual ring topology: This refers to bi-directional connections between each network node.
- Data is transmitted in a sequential manner, and it cannot skip the device in between.



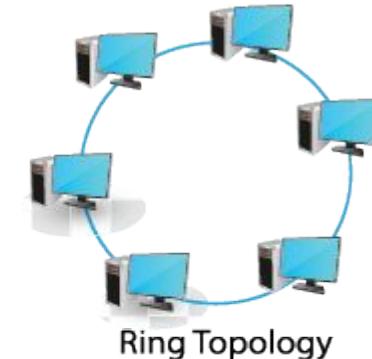
RING Topology

Advantages:

- Less chance of collision
- Cheap to set up and expand

Disadvantages:

- Difficult to troubleshoot
- Failure in a single computer can disturb the entire network
- Adding or removing a computer will disturb the transmission of the data in the network



Ring Topology

Poll 8 (15 Seconds)

Fill in the blank.

In a _____, data is transmitted in a single direction.

1. BUS topology
2. RING topology

Poll 8 (Answer)

Fill in the blank.

In a _____, data is transmitted in a single direction.

1. **BUS topology**
2. RING topology

STAR Topology

In a **STAR topology**, all the computers are connected to a single central node called a hub through a cable. All the transmission of data is done through the hub.

Features:

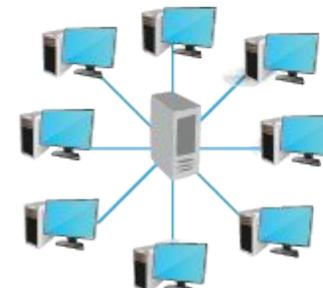
- Every single computer in a network is connected to the hub through a dedicated connection/cable.
- A hub also acts as a repeater.

Advantages:

- Easy to troubleshoot
- If one computer fails in the network, other computers will not be affected
- Easy to add or remove a computer in a network
- A hub can be easily replaced

Disadvantages:

- Performance of transmission depends on the hub
- High installation cost
- If the hub fails, the transmission won't stop



Star Topology

MESH Topology

In a **MESH topology**, every single computer is connected to another computer via dedicated channels.

Features:

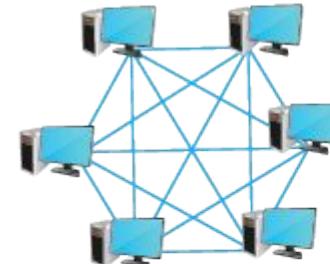
The total number of ports required by every device is $N-1$ (If 5 devices are connected, then 4 ports are required.). Thus, the total number of dedicated links that would be required to connect the devices is $N(N-1)/2$, i.e., if there are 5 computers connected to, then the required dedicated links will be $5*4/2 = 10$.

Advantages:

- Robust
- A fault is diagnosed easily
- Provides privacy and security

Disadvantages:

- The cost of implementation and maintenance is high
- Configuration and installation are difficult
- Suitable for less number of devices, as cable cost is high



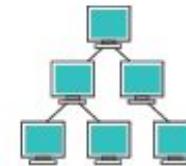
Mesh Topology

TREE Topology

A **TREE topology** has a root node, and other nodes are connected to the root node. There is only one connection between any two connected nodes. It has a parent-child hierarchy.

Advantages:

- Adding a new computer to a node is easy
- Easier fault-finding and maintenance
- Has features of STAR and BUS topologies



Tree

Disadvantages:

- Requires a huge cable
- Costly to implement
- If the root node fails, then the entire network will fail and stop its processing

Hybrid Topology

- A hybrid topology is a combination of two or more types of network topologies.
- This type of network topology is usually implemented by the organisation.

Advantages:

- Scalable: It is easy to increase the size of the network by adding new components.
- Effective: Designed in such a way that the strength of constituent topologies is maximised
- Flexible: Can be designed according to the requirement of the organisation
- Reliable: Error or fault detection is easy

Disadvantages:

- Costly to implement: The cost of infrastructure, hub and expertise increases
- Difficult to manage, as it is complex in design



Poll 9 (15 Seconds)

Fill in the blank.

A _____ topology has a parent-child hierarchy.

1. MESH
2. STAR
3. TREE
4. BUS

Poll 9 (Answer)

Fill in the blank.

A _____ topology has a parent-child hierarchy.

1. MESH
2. STAR
3. **TREE**
4. BUS

Key Takeaways

- You understood what networking is and why it is important.
- Then, you learnt about different network architectures.
- You also learnt about network components and their applications.
- Finally, you learnt about different network topologies, their features, and their advantages and disadvantages.

In the next class...

- Networking models



Thank you!