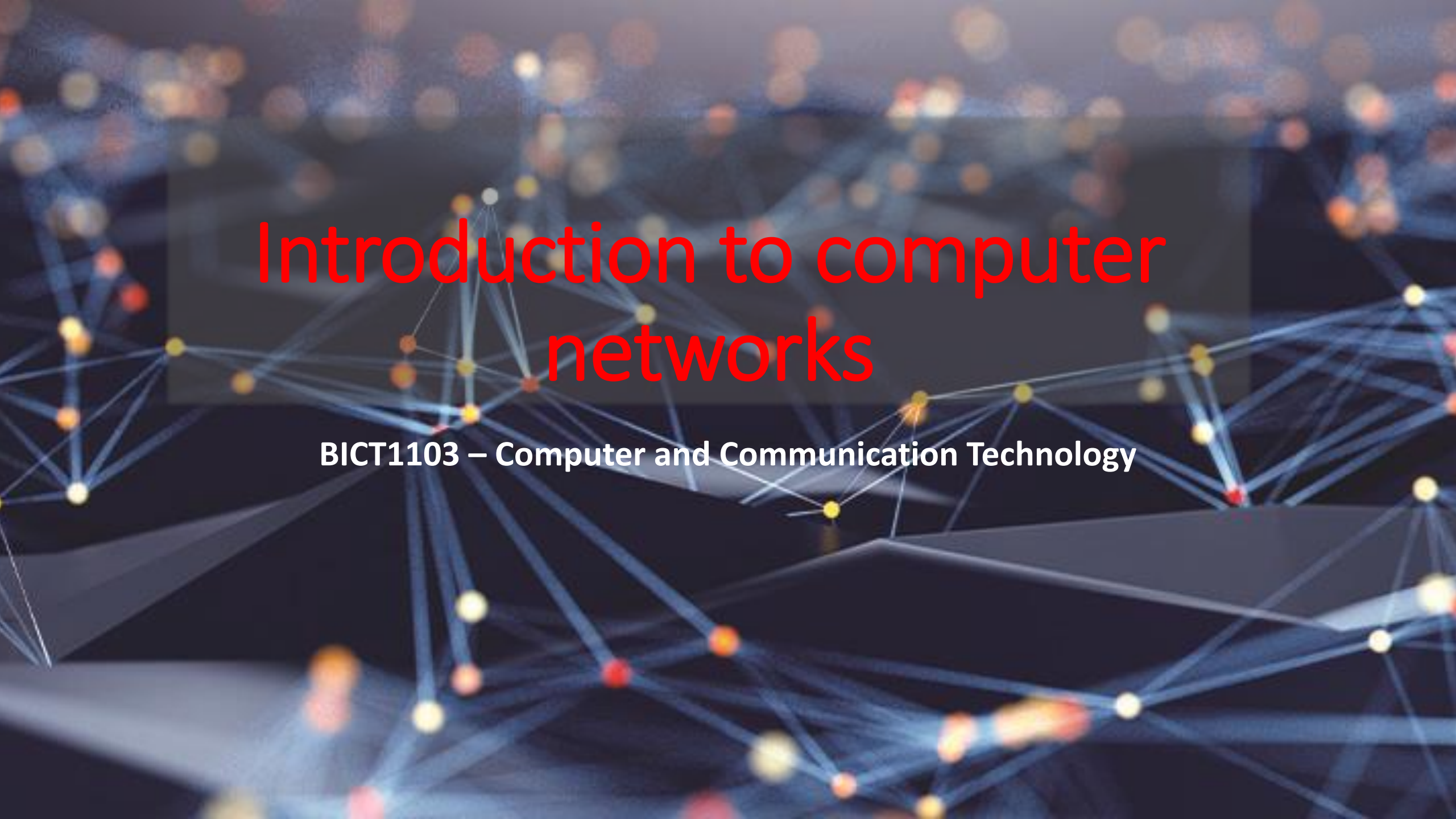
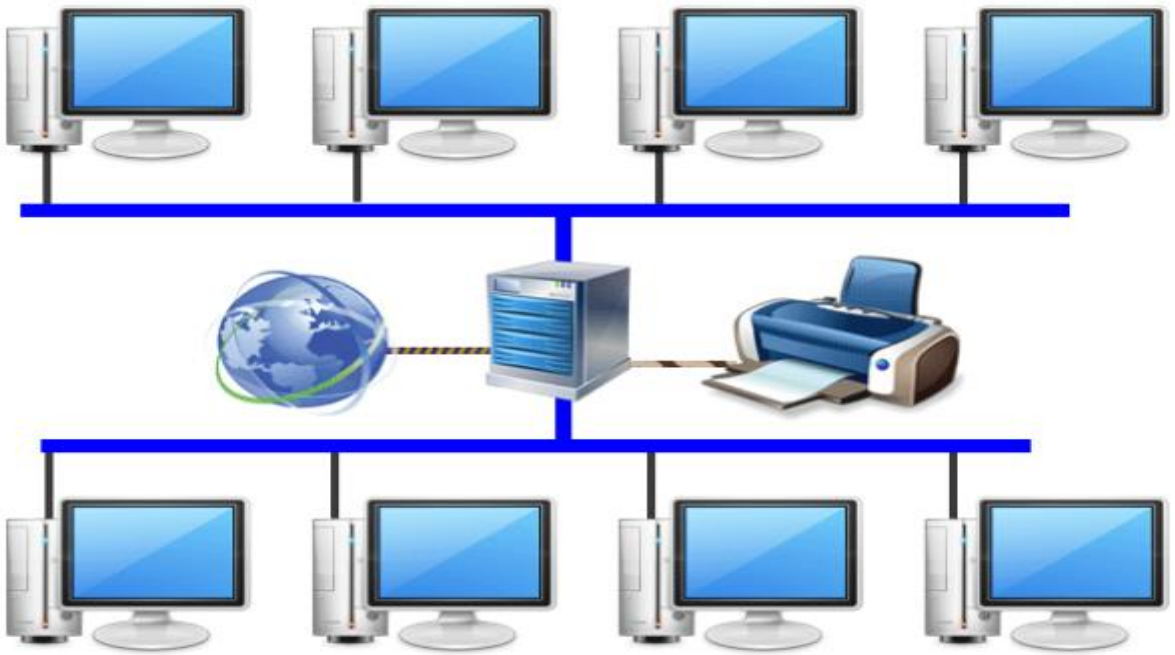


Introduction to computer networks

BICT1103 – Computer and Communication Technology

A **computer network** is a connection of two or more computing devices to transmit and share information.



- We may need a computer network in order to:

1. Share data, resources and services.
2. Access remote databases.
3. Communicate with others.
4. Save time.

Computer network types and sizes

- Computer networks can be categorized in different types and sizes.
- Some of these types include:
  1. Local Area Network (LAN)
  2. Wide Area Network (WAN)
  3. Metropolitan Area Network (MAN)
  4. Personal Area Network (PAN)
  5. Wireless Local Area Network (WLAN)

1. Local Area Network

- A network that connects devices within a limited geographical area, such as an office building or a home.
- It is generally limited to a geographic area such as a school building, office or a university campus.
- It is generally privately owned networks over a distance not more than **5 Km**. e.g. network in a college, school, hospital etc.
- It enables the sharing of resources, such as files and printers, among connected devices.

2. Wide Area Network

- WAN spans a large geographical area and connects multiple LANs or other networks together.
- The **internet** is the most well-known example of a WAN, which allows communication between devices across the globe.

3. Metropolitan Area Network

- A MAN is a network that covers a larger area than a LAN but smaller than a WAN, typically spanning a city or a metropolitan area.
- It interconnects multiple LANs within the same region.

4. Personal Area Network

- A PAN is a network that connects devices in close proximity to an individual, typically within a range of a few meters.
- Bluetooth is a common technology used for PANs, enabling connections between devices like smartphones, headphones, and wearable devices.

5. Wireless Local Area Network

- A WLAN is a type of LAN that uses wireless connections, such as Wi-Fi, to connect devices within a limited area.
- It allows devices to connect to a network without the need for physical cables.

Network Devices

- Network devices are hardware components that enable communication and data transfer within a computer network.
- These devices play a crucial role in **managing network traffic**, **connecting devices**, and ensuring **reliable and efficient** network operations.

- Some of these network devices include:

Network devices (continue…)

1. **Modem**
   - A modem (modulator/demodulator) is a hardware device that allows a computer to send and receive information over telephone lines.
   - When sending a signal, the modem converts (**modulates**) digital data to an analog signal and transmit it over a telephone line.
   - Similarly when an analog signal is received, the modem converts it back (**demodulates**) to a digital signal.

Fig. **Modem**

Network devices (continue…)

2. Network Hub

- A **Hub** is an electronic device that connects several computers together to form a network and redirects the received information to all the connected nodes in broadcast mode.
- The computer(s) for which the information is intended receive(s) this information and accept(s) it.
- Other computers on the network simply reject this information.

Types of Network Hubs:

1. **Passive Hub –** This type of Hub does not amplify or boost the signal. It does not manipulate or view the traffic that crosses it.
2. **Active Hub –** This amplifies the incoming signal before passing it to the other ports.

Fig. **Network Hub**

Network devices (continue…)

3. **Network Switch**
   - A **switch** is a network device which is used to interconnect computers or devices on a network. It filters and forwards data packets across a network.
   - The main difference between hub and switch is that hub replicates what it receives on one port onto all the other ports.
   - While switch keeps a record of the MAC addresses of the devices attached to it and forwards data packets onto the ports for which it is addressed across a network, that’s why switch is intelligent Hub.

Fig. **Switch**

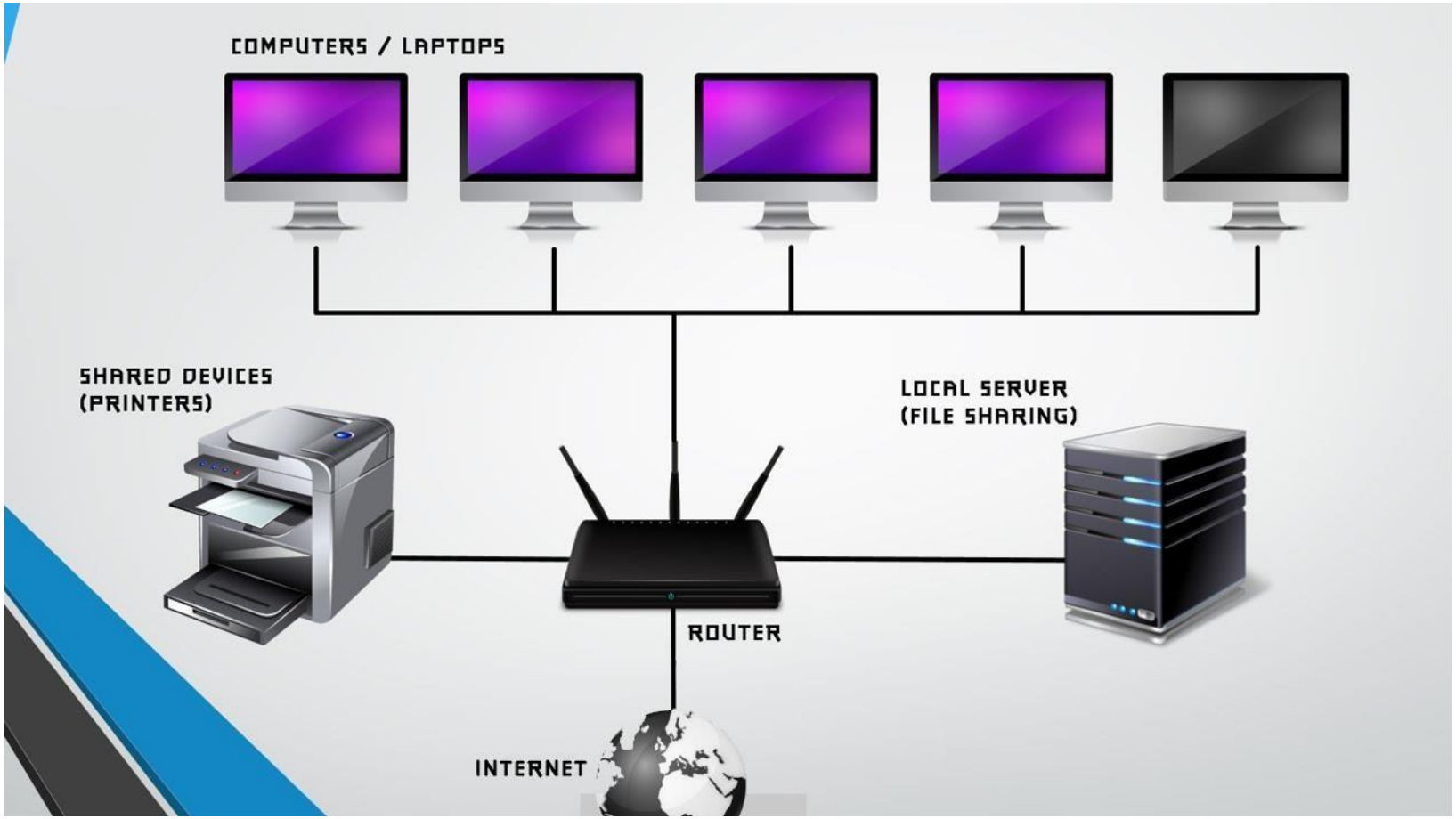
Network devices (continue…)

4. **Repeater**
   - A **Repeater** is a device that is used to amplify and regenerate a signal which is on its way through a communication channel.
   - A repeater regenerates the received signal and re-transmits it to its destination.

Network devices (continue…)

5. **Router**
   - A device that forwards data packets from one network to another by finding the shortest route, based on an internal routing table and the address of the destination network in the incoming packet.
   - The router determines whether to send the packet out (in other network) or keep it or forward within the own network.

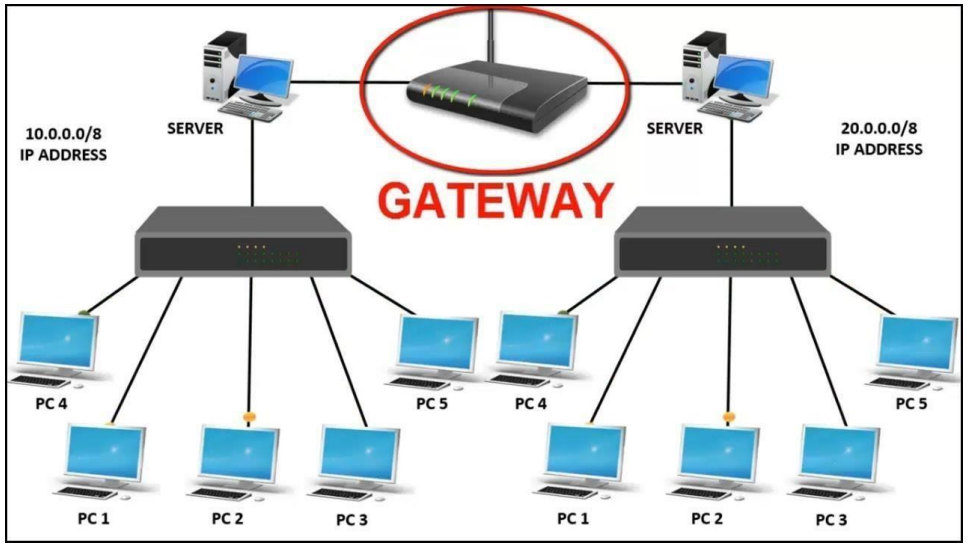
Fig: **Router**


COMPUTERS / LAPTOPS
SHARED DEVICES
(PRINTERS)
LOCAL SERVER
(FILE SHARING)
ROUTER
INTERNET

Network devices (continue…)

6. Gateway

- A **gateway** is a device that connects **dissimilar** networks (Networks with different software and hardware configurations and with different transmission protocol).



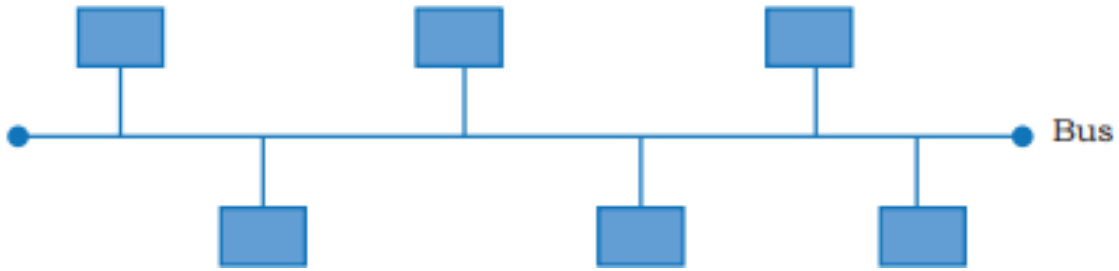
Network Topologies

- Network topology is the physical and logical arrangement of nodes in a network.
- Common network topologies are **bus**, **ring**, **mesh**, **star**, **tree/hierarchical and hybrid topology**.

Network Topologies (continue...)

1. Bus topology

- In a bus topology, all devices are connected to a common backbone, which is a single communication channel.
- Each device shares this channel, and data transmitted by one device is received by all devices on the network.



Network Topologies (continue...)

1. **Bus topology (continue…)**

Advantages

1. It is easy to install.
2. It is cost effective as requires less cable length.
3. Failure of one node does not affect the network.

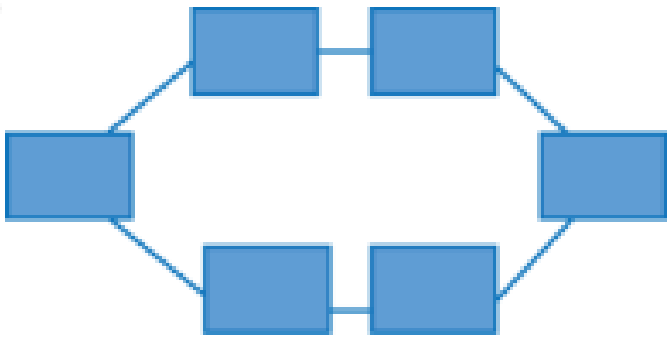
Disadvantages

1. In case of cable or terminator fault, the entire network breaks down.
2. Not suitable for a large number of computers.
3. At a time only node can transmit data.

Network Topologies (continue…)

2. Ring topology

- In a ring topology, devices are connected in a circular loop, where each device is connected to two neighboring devices.
- Data travels in one direction around the ring, passing through each device until it reaches the intended recipient.
- The sending and receiving of data is done with the help of a token.



Network Topologies (continue...)

2. **Ring topology (continue…)**

Advantages

1. **Data Transmission Efficiency** - In a ring topology, data travels in a single direction, which reduces the chances of data collisions and congestion. This leads to efficient data transmission and relatively fast speeds.
2. **Simplicity** - Ring topologies are relatively simple to implement and manage.
3. **Scalability** - Ring networks can be easily expanded by adding or removing devices.
4. **Fault isolation** - In a ring topology, if a device or cable fails, the data can be rerouted through the opposite direction of the ring.

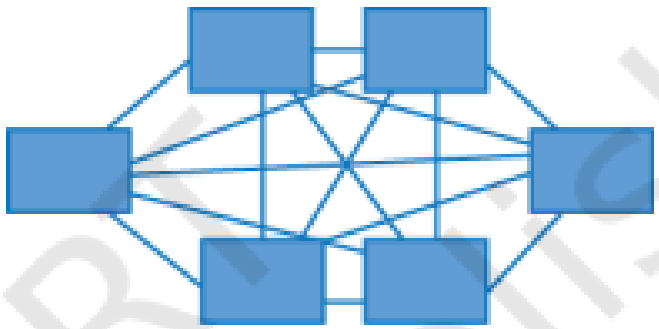
Disadvantages

1. **Limited Bandwidth** - the available bandwidth is shared among all devices on the network. As the number of devices increases, the available bandwidth per device decreases, potentially leading to slower data transmission speeds.
2. **Difficulties in Network Modification** - Adding or removing devices often requires disrupting the entire ring.
3. **Costly** - Implementing a ring topology may require additional hardware such as ring concentrators or repeaters to maintain the signal strength as it circulates through the loop.

Network Topologies (continue...)

3. Mesh topology

- In a mesh topology, every device is connected to every other device in the network.
- It offers redundancy and multiple paths for data to travel, ensuring high reliability and fault tolerance.



Network Topologies (continue...)

3. Mesh topology (continue…)

Advantages

1. **Fault Tolerance** - each device is connected to every other device in the network. If one link or device fails, the network can automatically reroute data through alternative paths, ensuring that communication is not disrupted.
2. **Scalability** - Mesh topologies are highly scalable as new devices can be easily added without affecting the existing network.
3. **Increased Bandwidth** - With multiple paths between devices, a mesh topology can provide high bandwidth capabilities. Data can be transmitted simultaneously through different routes, improving overall network performance and reducing congestion.

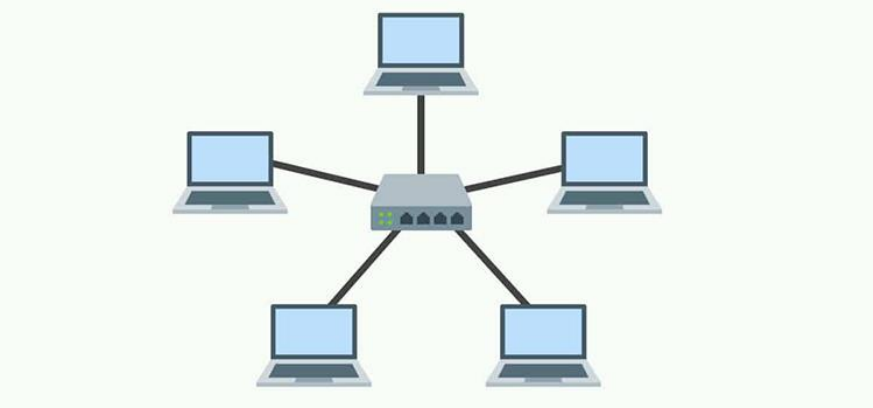
Disadvantages

1. **Complexity** - Mesh topologies can be complex to design, implement, and manage, especially as the number of devices increases.
2. **Costly** - Implementing a mesh topology can be expensive due to the high number of required connections and cables.
3. **Maintenance** - With numerous connections, identifying and troubleshooting connectivity issues can be time-consuming and complex, requiring skilled network administrators.

Network Topologies (continue…)

4. Star topology

- In a star topology, all devices are connected to a central node (device), usually a switch or hub.
- The central device acts as a junction point, and all communication between devices goes through it.



Network Topologies (continue...)

4. Star topology (continue…)

Advantages

1. Easy to troubleshoot.
2. A single node failure does not affect the entire network.
3. Fault detection and removal of faulty is easier.

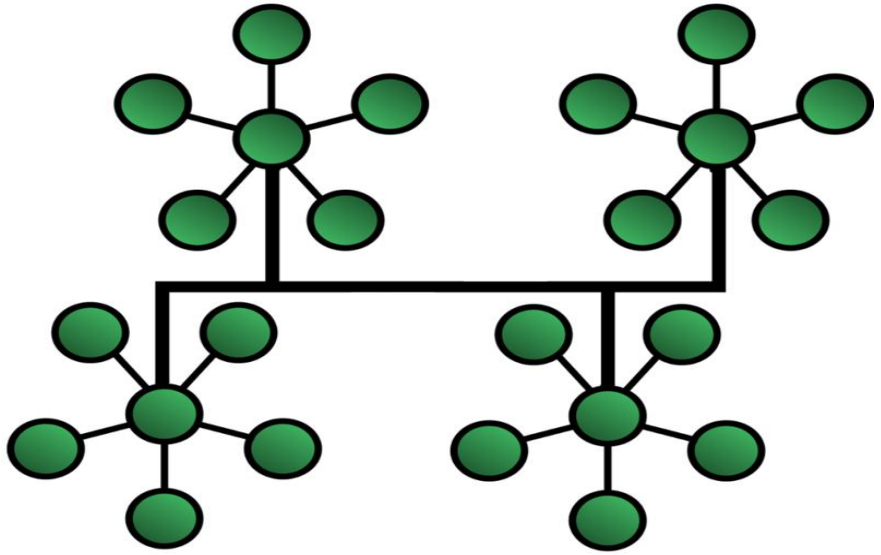
Disadvantages

1. **Single point of failure -** If the central device malfunctions or becomes unavailable, the entire network loses connectivity.
2. **Limited Scalability** - While star topologies are relatively easy to expand by adding devices, they have limitations in terms of the number of devices they can support. The capacity of the central switch or hub determines the maximum number of devices that can be connected.

Network Topologies (continue…)

5. Tree/Hierarchical topology

- This topology is a combination of bus and star topologies. Devices are organized in a hierarchical structure, where multiple star topologies are connected to a main bus.
- It allows for scalability and easier management of larger networks.



Network Topologies (continue...)

5. **Tree/hierarchical topology (continue…)**

Advantages

1. Tree topology provides easy maintenance and easy fault identification can be done.

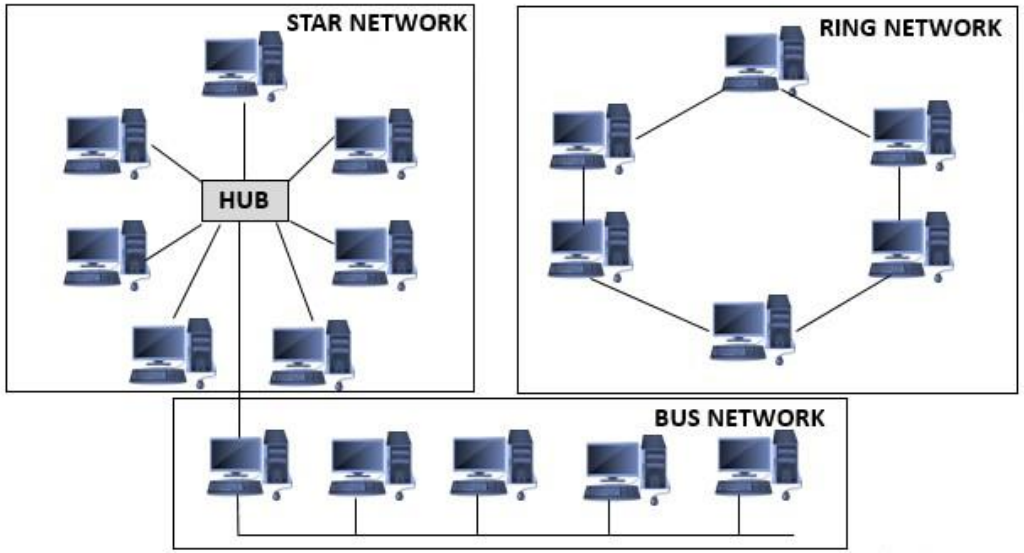
Disadvantages

1. Requires a large number of cables compared to star and ring topology.
2. The Backbone appears as the failure point of the entire segment of the network.

Network Topologies (continue…)

6. Hybrid topology

- A hybrid topology is a combination of two or more different topologies.
- For example, a network might use a combination of star and ring topologies to provide redundancy and flexibility



Network Topologies (continue...)

5. **Hybrid topology (continue…)**

Advantages

1. **Improved Performance** - By combining different topologies, a hybrid topology can achieve better performance.
2. **Flexibility** - Hybrid topology combines multiple topologies, allowing for flexibility in designing a network that suits specific needs. It enables organizations to customize the network by incorporating the strengths of different topologies.

Disadvantages

1. **Complexity** – Due to the combination of different topologies.
2. **Costly**

Data communication and characteristics

- Data communication refers to the transmission and reception of digital data between two or more devices or systems.
- It involves the exchange of information over a network or a communication channel.
- Data communication have characteristics and these include:

1. **Data Transmission**: Data communication involves the transmission of data from a sender to a receiver. The data can be in various forms, such as text, numbers, images, audio, or video. It is typically represented in binary format (0s and 1s) to facilitate digital communication.
2. **Protocols**: Data communication relies on protocols, which are a set of rules and standards that govern the format, encoding, transmission, and interpretation of data. Protocols ensure that data is transmitted and received correctly and enable interoperability between different devices and systems.

Data communication and characteristics (continue…)

3. **Communication Channels**: Data is transmitted over communication channels, which can be physical or wireless. Physical channels include copper wires, fiber optic cables, or coaxial cables, while wireless channels use radio waves, microwaves, or satellite links.
4. **Bandwidth**: Bandwidth refers to the capacity of a communication channel to carry data. It determines the speed at which data can be transmitted and received. Higher bandwidth allows for faster data transfer rates, enabling large amounts of data to be transmitted in a shorter time.
5. **Security**: Data communication often involves sensitive information that needs to be protected from unauthorized access or interception. Security measures, such as encryption, authentication, and access controls, are implemented to safeguard data and ensure confidentiality, integrity, and authenticity.

Synchronous and Asynchronous transmission

- Synchronous and asynchronous transmission are two different methods of transmitting data over a communication channel.
- They differ in how data is synchronized and the timing of data transmission.

1. **Synchronous transmission.**
   - In synchronous transmission, data is transmitted in a continuous stream, and the sender and receiver are synchronized with a common clock signal.
   - The clock signal ensures that both the sender and receiver operate at the same speed and timing.
   - Data is transmitted in fixed-length units called frames.

Characteristics of synchronous transmission

1. **Synchronization**: Both sender and receiver use a shared clock signal to maintain synchronization.
2. **Timing**: Data is transmitted in a continuous stream, and each character or frame is transmitted at regular intervals.
3. **Efficiency**: Synchronous transmission is generally more efficient for transmitting large amounts of data because it does not require additional control information for each character.
4. **Overhead**: It has a lower overhead compared to asynchronous transmission since there is no need for start and stop bits for each character.

2. Asynchronous transmission.

- In asynchronous transmission, data is transmitted character by character, with each character being framed individually.
- The sender and receiver do not require a shared clock signal to stay synchronized. Instead, start and stop bits are used to mark the beginning and end of each character.

Characteristics of asynchronous transmission

1. **Start/Stop Bits**: Each character is framed with start and stop bits, which indicate the beginning and end of the character, respectively. These bits allow the receiver to identify and synchronize with each character.
2. **Variable Timing**: There is no fixed timing between characters. Each character can be transmitted at its own pace, and the timing between characters can vary.
3. **Overhead**: Asynchronous transmission has higher overhead compared to synchronous transmission due to the inclusion of start and stop bits for each character.
4. **Flexibility**: Asynchronous transmission is more flexible and tolerant to variations in transmission speed, making it suitable for applications with lower data rates and less stringent timing requirements.

Directions of transmission flow

- The direction of transmission flow in a computer network refers to the path taken by data as it moves between devices or systems.
- There are three primary directions of transmission flow:

1. **Simplex** - data flows in only one direction, from a sender to a receiver. The sender can transmit data, but the receiver cannot send any data back. It is a unidirectional flow of information. Examples of simplex transmission include television broadcasts.
2. **Half-duplex -** data can flow in both directions, but not simultaneously. Devices can both transmit and receive data, but only one device can send data at a time, while the other device listens and waits for its turn to transmit. It is a bidirectional flow, but not concurrent. Examples of half-duplex transmission include two-way radio systems.
3. **Full-duplex** - data flows in both directions simultaneously. Devices can transmit and receive data at the same time without waiting for turns. This allows for real-time, concurrent communication. Examples of full-duplex transmission include telephone conversations and most modern computer networks.