



# **COMPUTER NETWORK TOPOLOGIES**

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# DATA COMMUNICATION

- Data Communication is the exchange of data (in the form of 0s and 1s) between two devices via some form of transmission medium (such as wire cable).
- Local – communicating devices are in the same building or a similarly restricted geographical area.
- Remote – devices are farther apart
- Devices must be a part of a communication system made up of a combination of hardware and software.

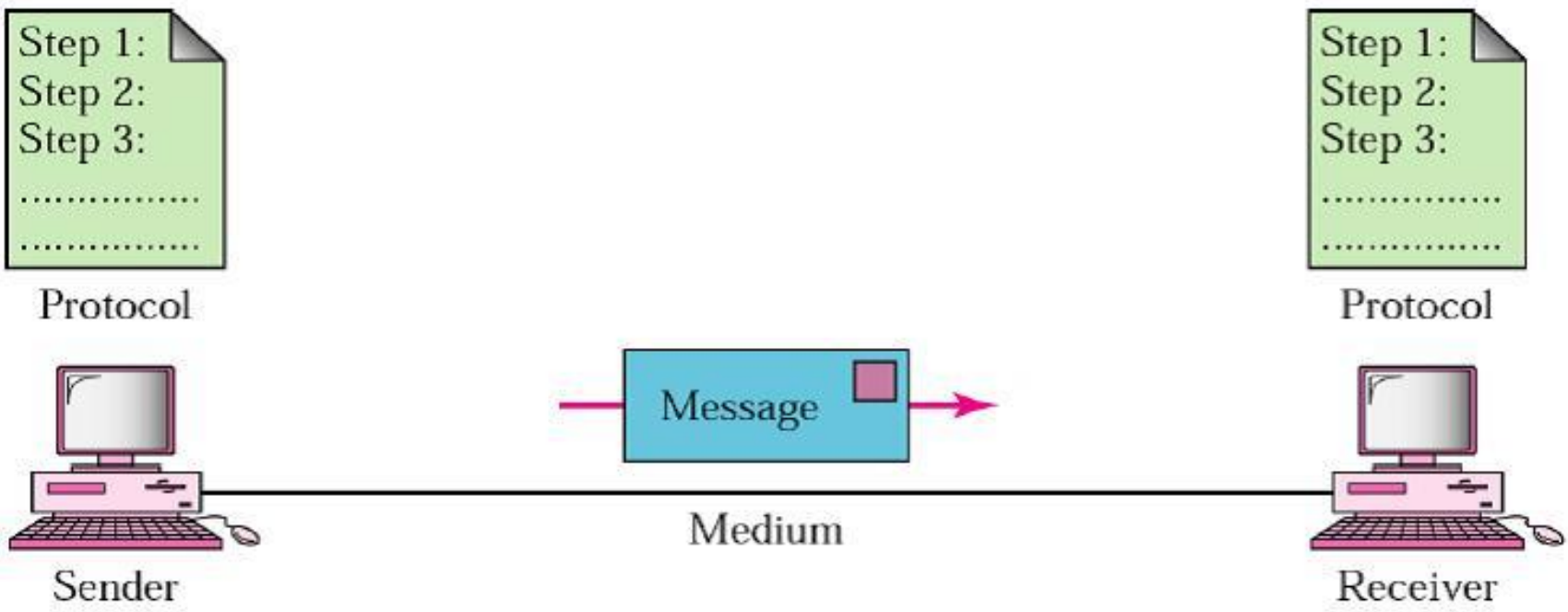
# FUNDAMENTAL CHARACTERISTICS

- The effectiveness of a data communication system depends on 3 fundamental characteristics:
- Delivery:
  - The system must deliver data to the correct destination. Data must be received by the intended device or user and only by that device or user.
- Accuracy:
  - The system must deliver data accurately. Altered or uncorrected data are unusable.
- Timeliness:
  - The system must deliver data in a timely manner. Data delivered late are useless e.g. video, audio and voice data.

# COMPONENTS OF D.C.

- Message:
  - information to be communicated
- Sender:
  - device that sends the data message
- Receiver:
  - device that receives the message
- Medium :
  - transmission medium is the physical path by which a message travels from sender to receiver.
- Protocol :
  - set of rules that govern data communication i.e. agreement between two devices.

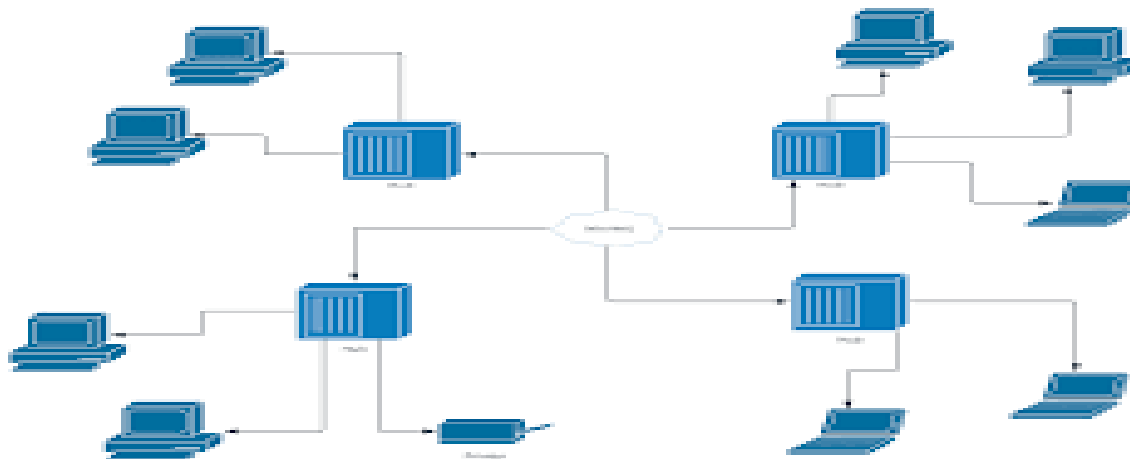
# COMPONENTS



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# NETWORKS – DEFINITION

- A network is a set of devices (often referred to as nodes) connected by media links.
- A node can be a computer, printer, or any other device capable of sending and/or receiving data, generated by other nodes on the network.
- The links connecting the devices are often called communication channels.



# DISTRIBUTED PROCESSING

- Task is divided into among multiple computers.
- Advantages are:
- Security/ Encapsulation e.g. accessing own account through ATM
- Distributed databases e.g. www
- Faster Problem Solving
- Security through redundancy
- Collaborative Processing e.g. multiuser network games

# NETWORK CRITERIA

- To be considered effective and efficient, a network must meet a number of criteria:
  - Performance
  - Reliability
  - Security
- Helps to improve network functionality



# 1. PERFORMANCE

- Can be measured in many ways including transit time and response time.
- Transit time – amount of time required for a message to travel from one device to another.
- Response time – elapsed time between an inquiry and a response
- Depends on following factors:
  - Number of users
  - Type of transmission medium
  - Hardware
  - Software

## 2. RELIABILITY

- Measured by :
- Frequency of failure
- Recovery time of a network after a failure
- Protection from Catastrophic events e.g. fire, earthquake, theft, etc.

### 3. SECURITY

- Network security issues include protecting data from
  - unauthorised access
    - Lowest level – user identification codes and passwords
  - and viruses
    - Higher level – encryption techniques

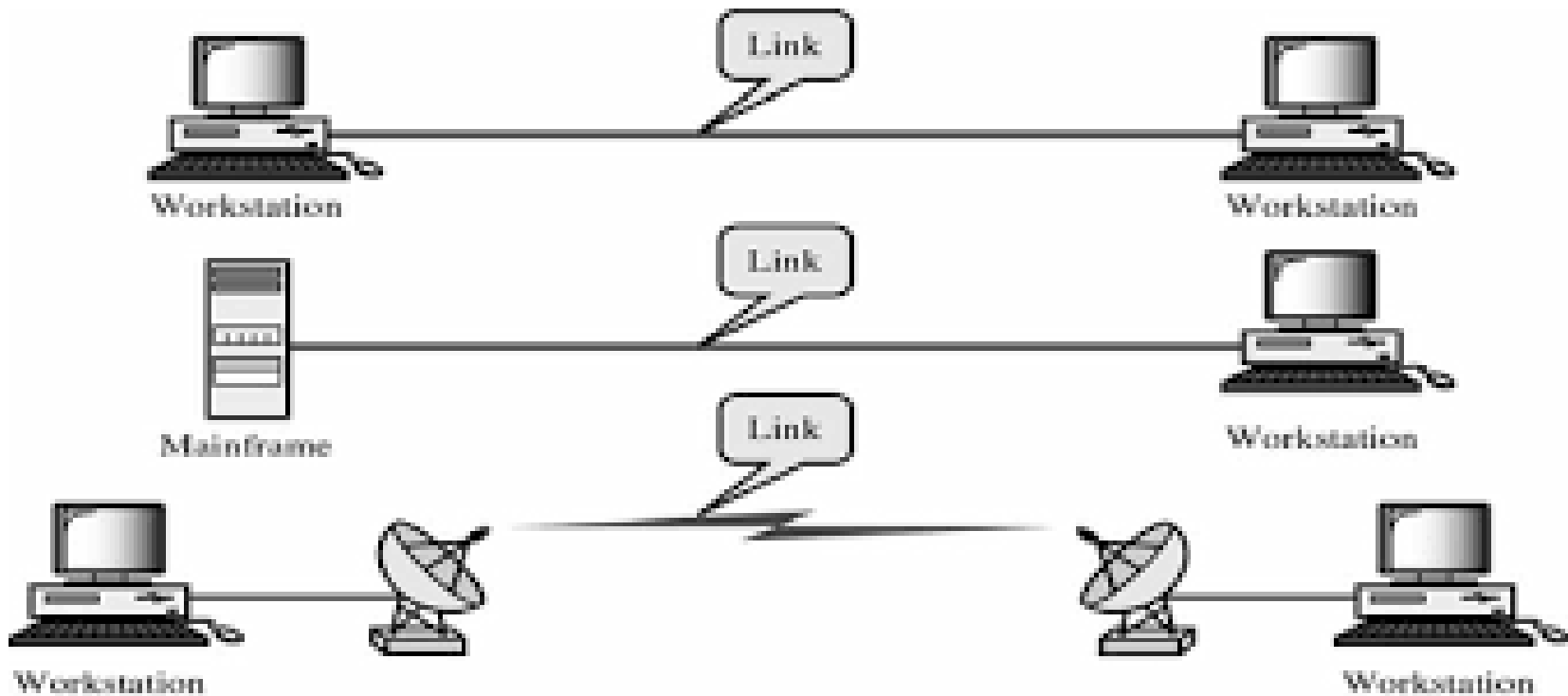
# NETWORK APPLICATIONS

- Marketing & Sales
- Financial Services
- Manufacturing
- Electronic messaging
- Directory Services
- Information Services
- Electronic Data Interchange (EDI)
- Teleconferencing
- Cellular telephone
- Cable television

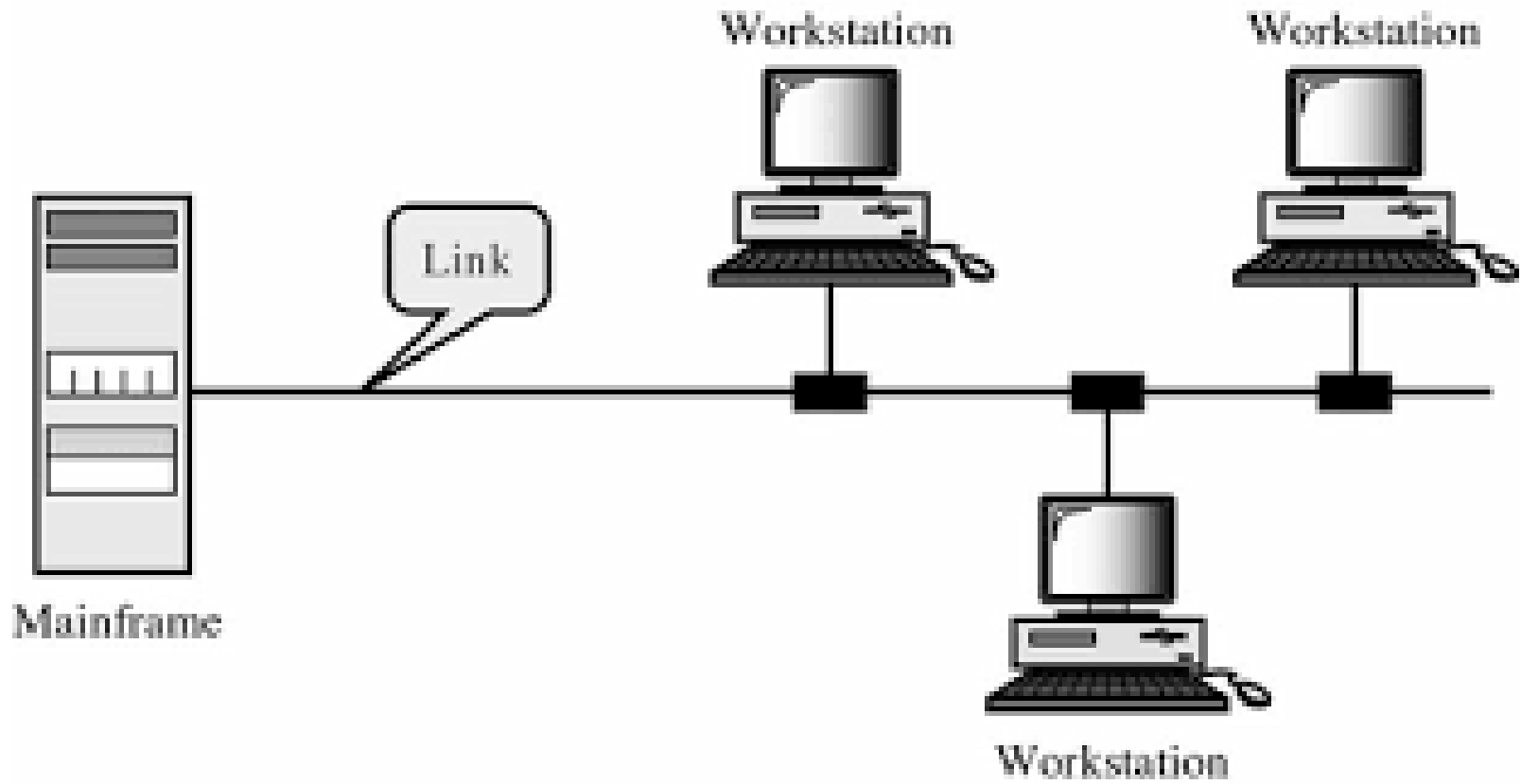
# LINE CONFIGURATION

- The way two or more communication devices attach to a link.
- Link – physical communication pathway that transfers data from one device to another.
- Point-to-point
  - Dedicated link between two devices (use of entire capacity)
- Multipoint (Multidrop)
  - More than two specific devices share a single link (shared channel capacity)
    - Spatially shared (using link simultaneously)
    - Time shared (users taking turns)

# POINT TO POINT LINE CONFIGURATION



# MULTIPOINT LINE CONFIGURATION

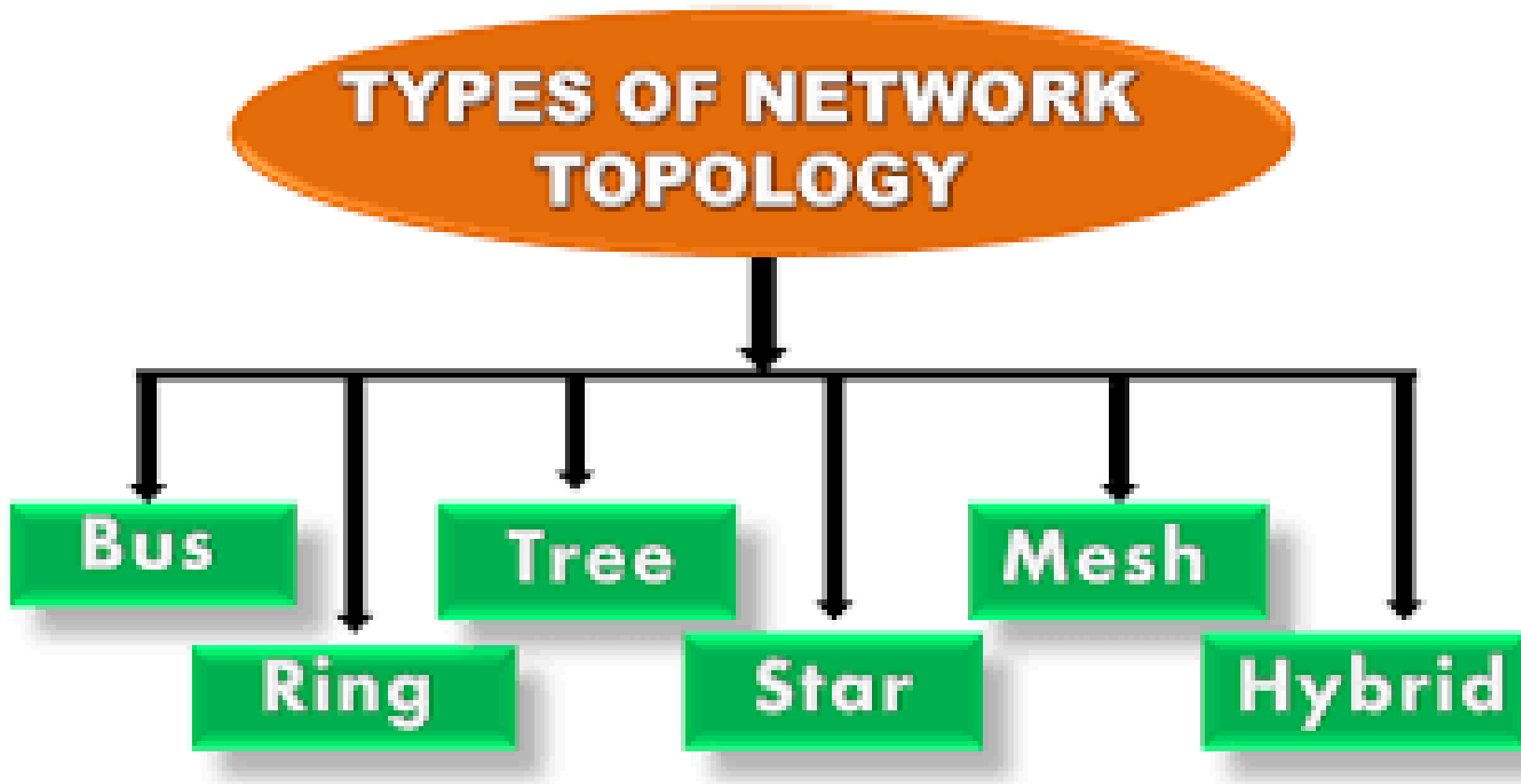


# TOPOLOGY

- Topology defines the physical or logical arrangement of links in a network.
- Two or more devices connect to a link & two or more links form a topology
- Topology of a network is the geometric representation of the relationship of all the links and linking devices (usually called nodes) to each other.



# CATEGORIES OF TOPOLOGIES

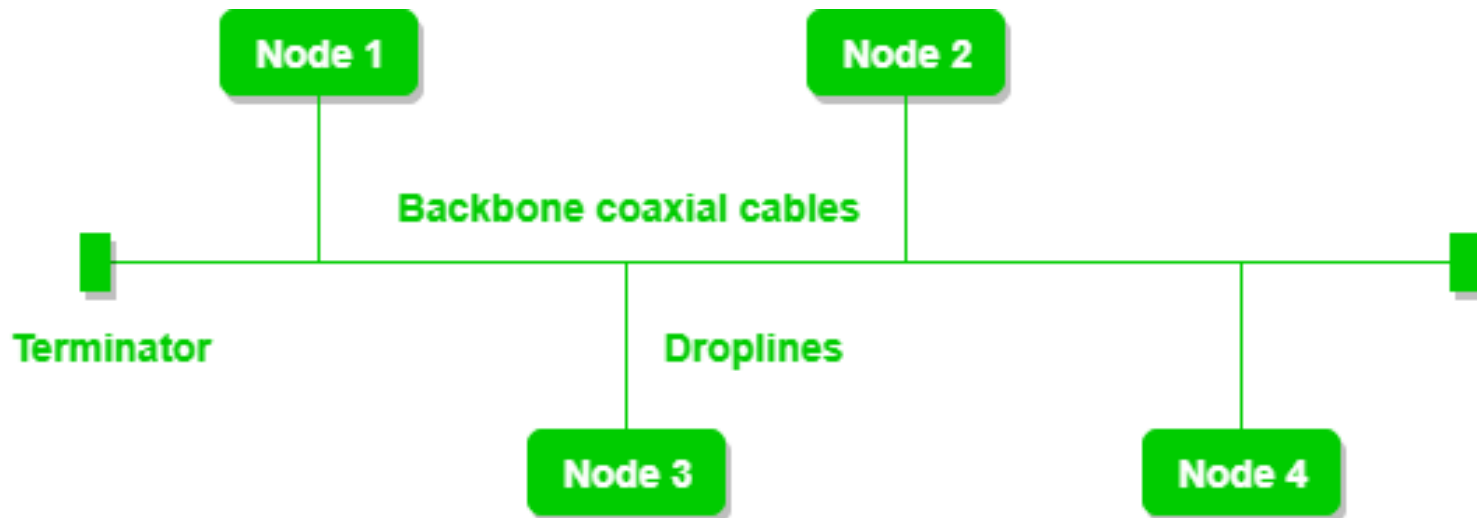


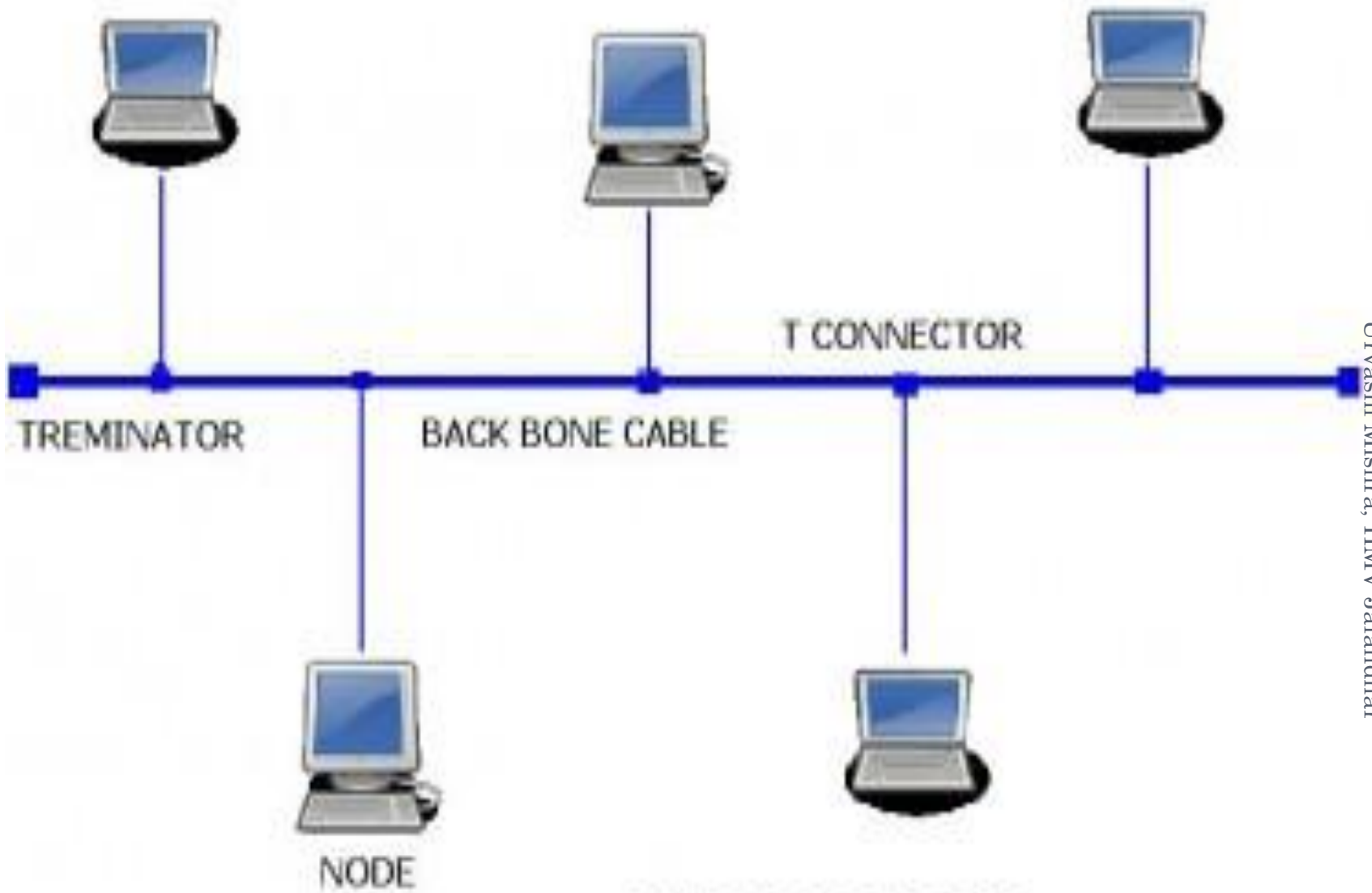
# 1. BUS TOPOLOGY

- Multipoint
- One long cable acts as a backbone to link all the devices
- Nodes are connected to the bus cable by drop lines and taps.
- **Drop Line** – connection running between the device and the main cable
- **Tap** – connector that either splices into the main cable or punctures the sheathing of a cable to create a contact with the metallic core.

# FEATURES OF BUS

- It transmits data only in one direction
- Every device is connected to a single cable.





## **BUS TOPOLOGY**



# ADVANTAGES OF BUS

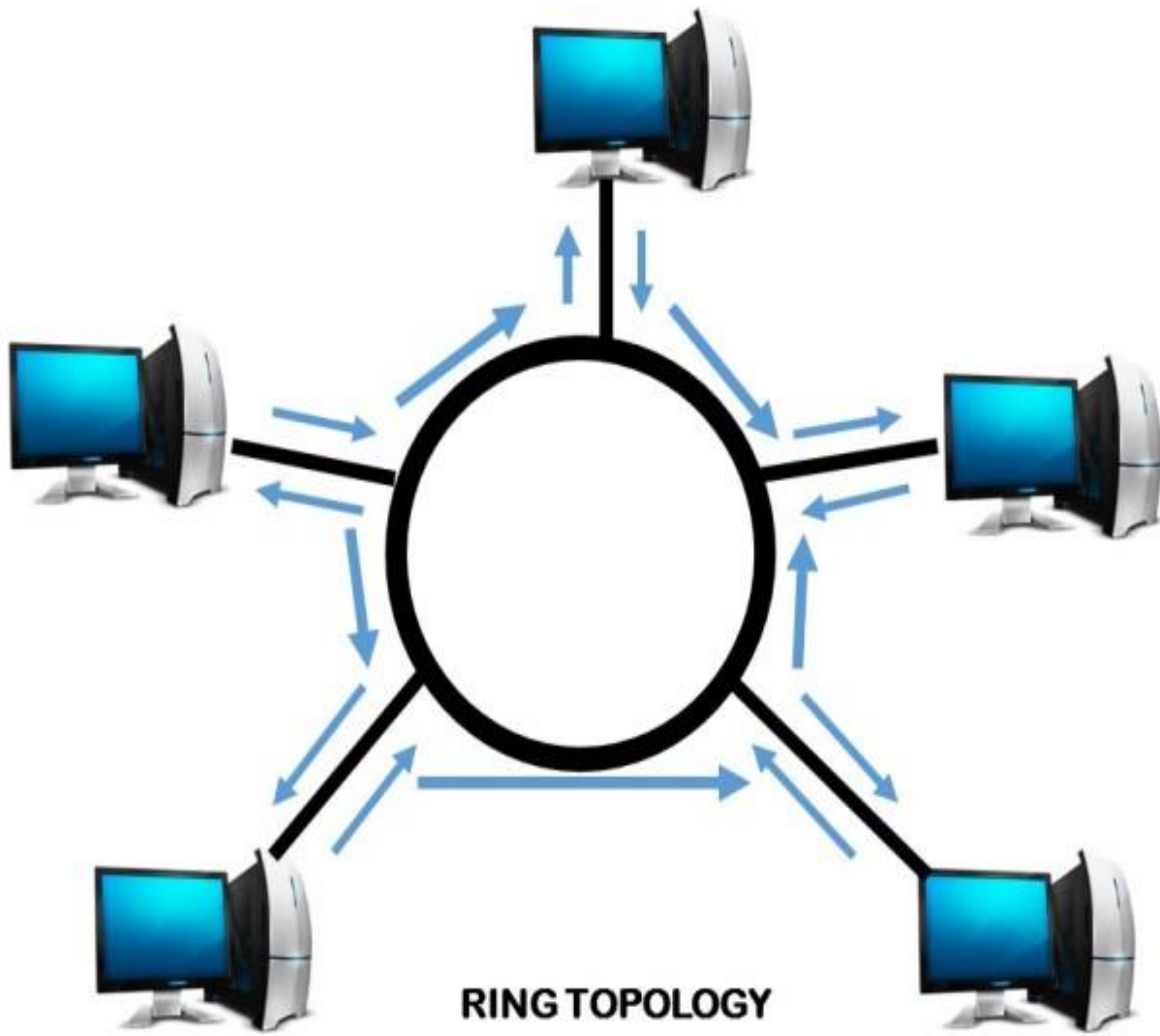
- Ease of installation
- Uses less cabling than mesh, star or tree
- It is easy to connect a device to the network.
- It is cheaper than other network options
- The failure of one station does not affect the rest of the network
- No hubs or switches are required
- Extensions can be made to the network
- Multiple nodes can be installed without difficulty
- Multiple peripherals can be supported through bus topology

# DISADVANTAGES OF BUS TOPOLOGY

- Additional devices slow the network down
- Size limitations are always present
- Security options are limited with bus topology
- Maintenance costs are higher
- A break in the backbone can cause an entire network to collapse
- The quality of the data is placed at-risk on large bus topology setups.
- Bus termination issues can lead to network issues
- The computers may share data, but they don't communicate
- A T-connection failure immediately limits access.

# RING TOPOLOGY

- Each device has a dedicated point-to-point line configuration only with the two devices on either side of it.
- Signal is passed along the ring in one direction, from device to device, until it reaches its destination.
- Each device incorporates a repeater.
- When a device receives a signal intended for another device, its repeater regenerates the bits and passes them along.





# ADVANTAGES OF RING

- Easy to install and reconfigure
- All data flows in one direction, reducing the chance of packet collisions.
- A network server is not needed to control network connectivity between each workstation.
- Data can transfer between workstations at high speeds.
- Additional workstations can be added without impacting performance of the network.

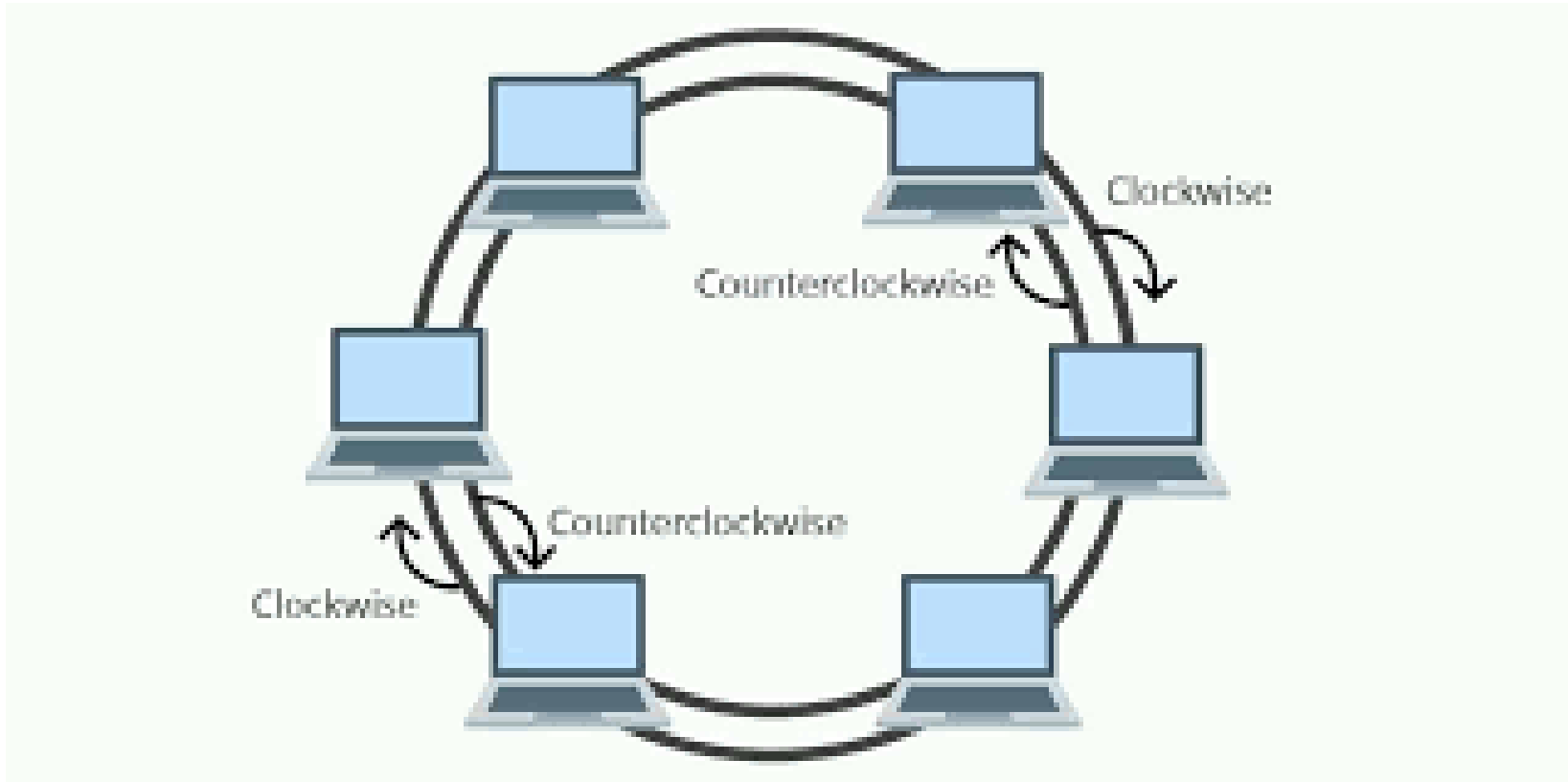
# DISADVANTAGES OF RING

- All data being transferred over the network must pass through each workstation on the network, which can make it slower than a star topology.
- The hardware needed to connect each workstation to the network is more expensive than Ethernet cards and hubs/switches.
- (Unidirectional) A break in the ring (such as disabled station) can disable the entire network. This weakness can be solved by using a dual ring.

# TYPES OF RING TOPOLOGY

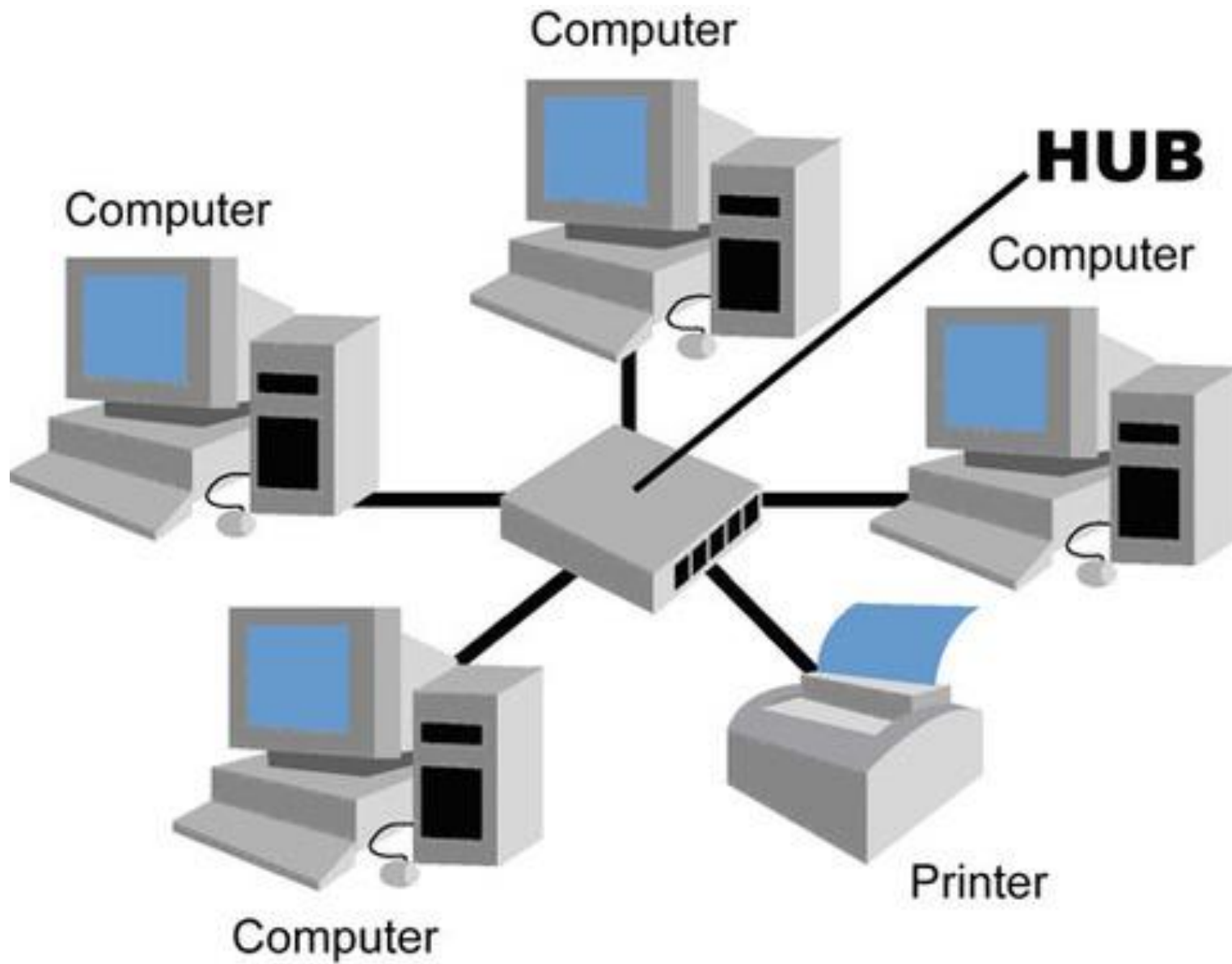
- Two types based on the data flow:
- Unidirectional
  - A Unidirectional ring topology handles data traffic in either clockwise or anticlockwise direction. This data network, thus, can also be called as a half-duplex network. A Unidirectional ring topology is thus easy to maintain compared to the bidirectional ring topology.
- Bidirectional
  - A bidirectional ring topology handles data traffic in both the directions and can be a full-duplex network.

# BIDIRECTIONAL RING



# STAR TOPOLOGY

- Each device has a dedicated point-to-point link only to a central controller, usually called a hub.
- Devices are not directly linked to each other.
- Does not allow direct traffic between devices.
- Controller acts as an exchange. If one device wants to send data to another, it sends the data to the controller, which then relays the data to the other connected device.



# CHARACTERISTICS OF STAR

- High Speed
- Very Flexible
- High Reliability
- High Maintainability

# ADVANTAGES OF STAR

- Easy to manage and maintain the network because each node require separate cable.
- Easy to locate problems because cable failure only affect a single user.
- Easy to extend the network without disturbing to the entire network
- Due to Hub, device network control and management is much easier.
- Fault identification and removing nodes in a network is easy.
- It provides very high speed of data transfer.

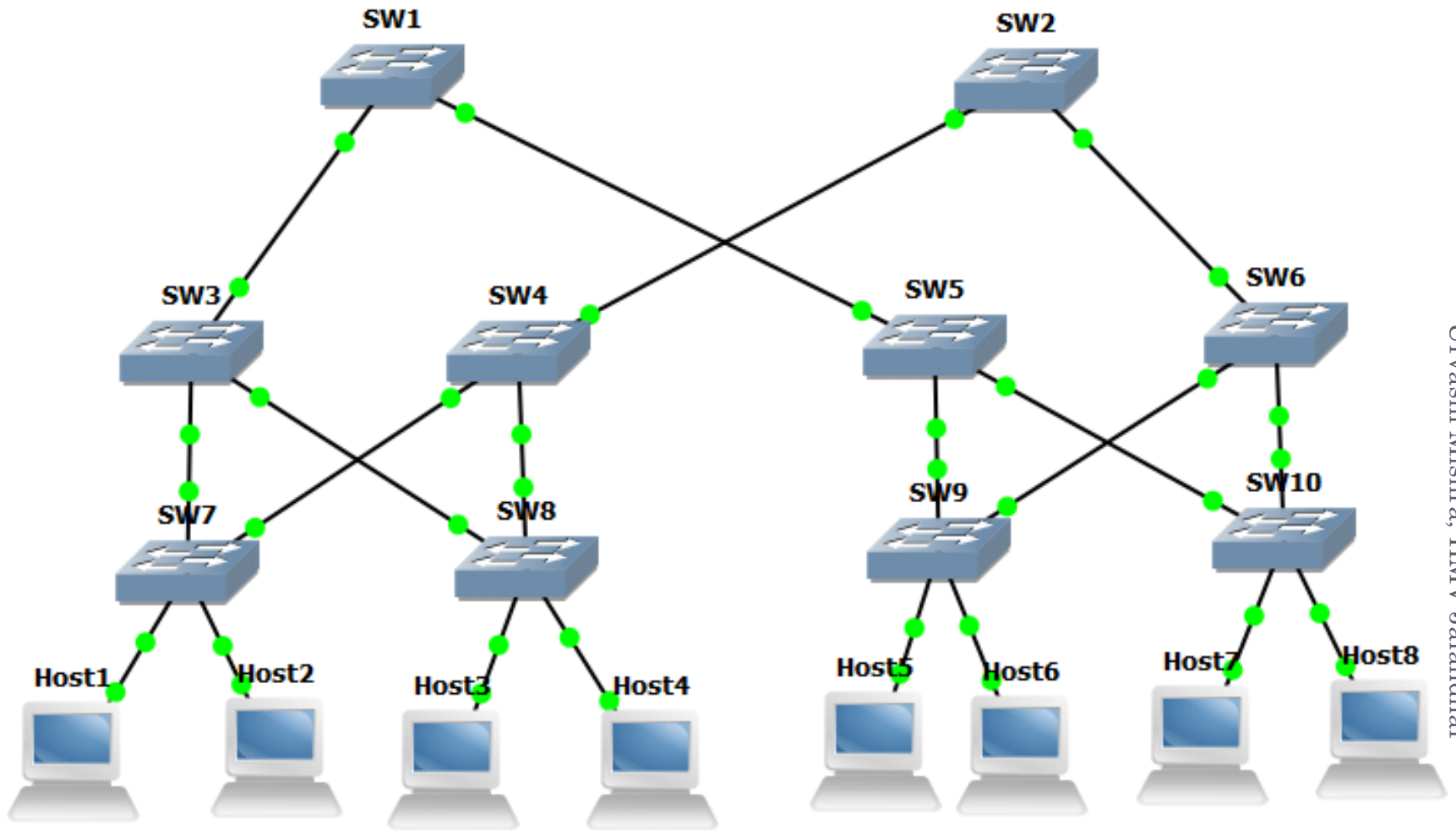


# DISADVANTAGES OF STAR

- Entire performance of the network depends on the single device hub.
- If the hub device goes down, the entire network will be dead.
- Star topology requires more wires compared to the ring and bus topology.

# TREE TOPOLOGY

- Variation of Star
- Nodes in a tree are linked to a central hub that controls the traffic to the network but not every device plugs directly into the central hub



# NEED OF TREE

- Certain special cases where tree topology is more effective:
  - Communication between two networks
  - A network structure which requires a root node, intermediate parents node, and leaf nodes (just like we see in an n-tree) or a network structure which exhibits three level of hierarchy because two level of hierarchy is already displayed in the star topology.
  - Tree is an extension of Star and bus Topologies, so in networks where these topologies can't be implemented individually for reasons related to scalability, tree topology is the best alternative.

# ADVANTAGES OF TREE

- Expansion of Network is possible and easy.
- The whole network is divided into segments (star networks), which can be easily managed and maintained.
- Error detection and correction is easy.
- Each segment is provided with dedicated point-to-point wiring to the central hub.
- If one segment is damaged, other segments are not affected.
- Scalable as leaf nodes can accommodate more nodes in the hierarchical chain.
- Easier maintenance and fault finding

# DISADVANTAGES OF TREE

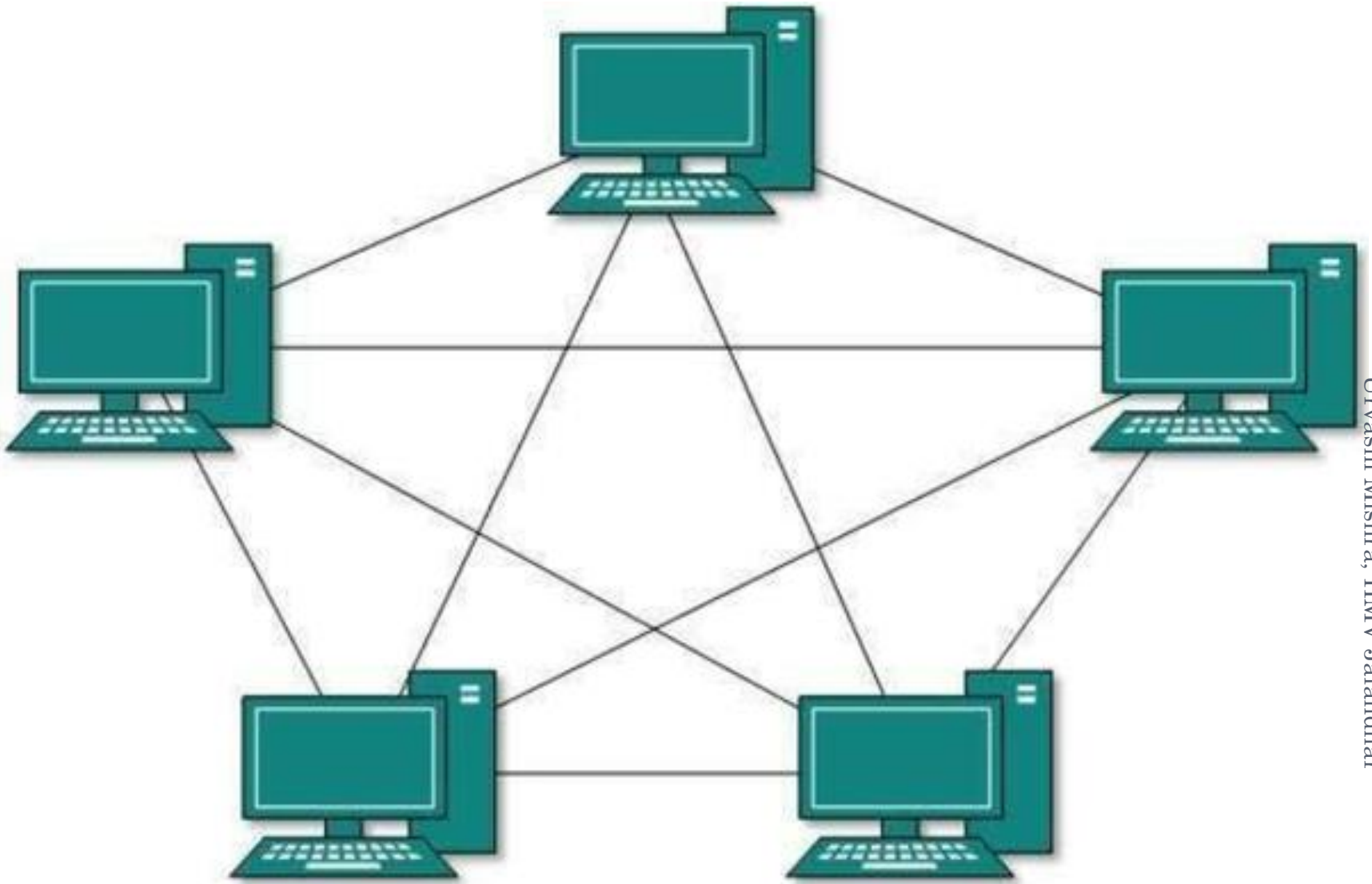
- Huge cabling is needed
- Backbone forms the point of failure. Because of its basic structure, tree topology, relies heavily on the main bus cable, if it breaks whole network is crippled.
- As more and more nodes and segments are added, the maintenance becomes difficult.
- Scalability of the network depends on the type of cable used.

# CONSIDERATIONS

- There are some considerations when choosing a topology which are:
  - Money: The user should look if the topology is costly or not.
  - Length of the cable needed.
  - Type of cable to be used in the topology.

# MESH TOPOLOGY





# TYPES OF MESH

- Unlike other network topologies, it can be divided into two kinds:
- Fully connected mesh topology
  - A **fully connected mesh topology** has all the nodes connected to every other node. If you know the graph theory, then it is like a fully connected graph where all the nodes are connected to every other node.
- Partially connected mesh topology
  - A **partially connected mesh topology** does not have all the nodes connected to each other.

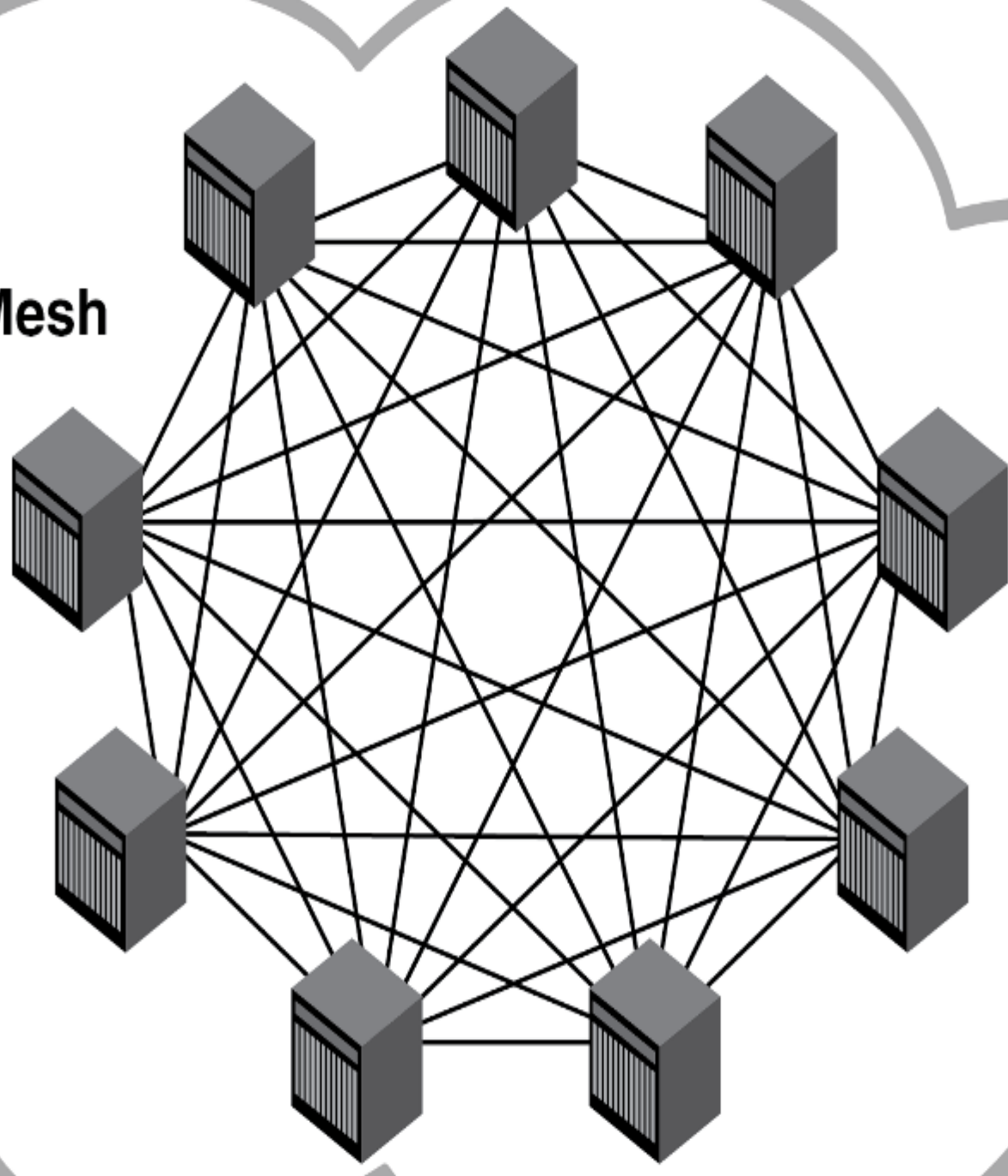
# ADVANTAGES OF MESH

- Each connection can carry its own data load
- A fault is diagnosed easily
- Provides security and privacy
- Manages high amounts of traffic, because multiple devices can transmit data simultaneously.
- A failure of one device does not cause a break in the network or transmission of data.
- Adding additional devices does not disrupt data transmission between other devices.

# DISADVANTAGES OF MESH

- Building and maintaining the topology is difficult and time consuming.
- The chance of redundant connections is high, which adds to the high costs and potential for reduced efficiency.
- Cabling cost is more and the most in case of a fully connected mesh topology
- Bulk wiring is required
- Overall cost of this network is too high as compared to other network topologies.
- Owing to its complexity, the administration of a mesh network is difficult.

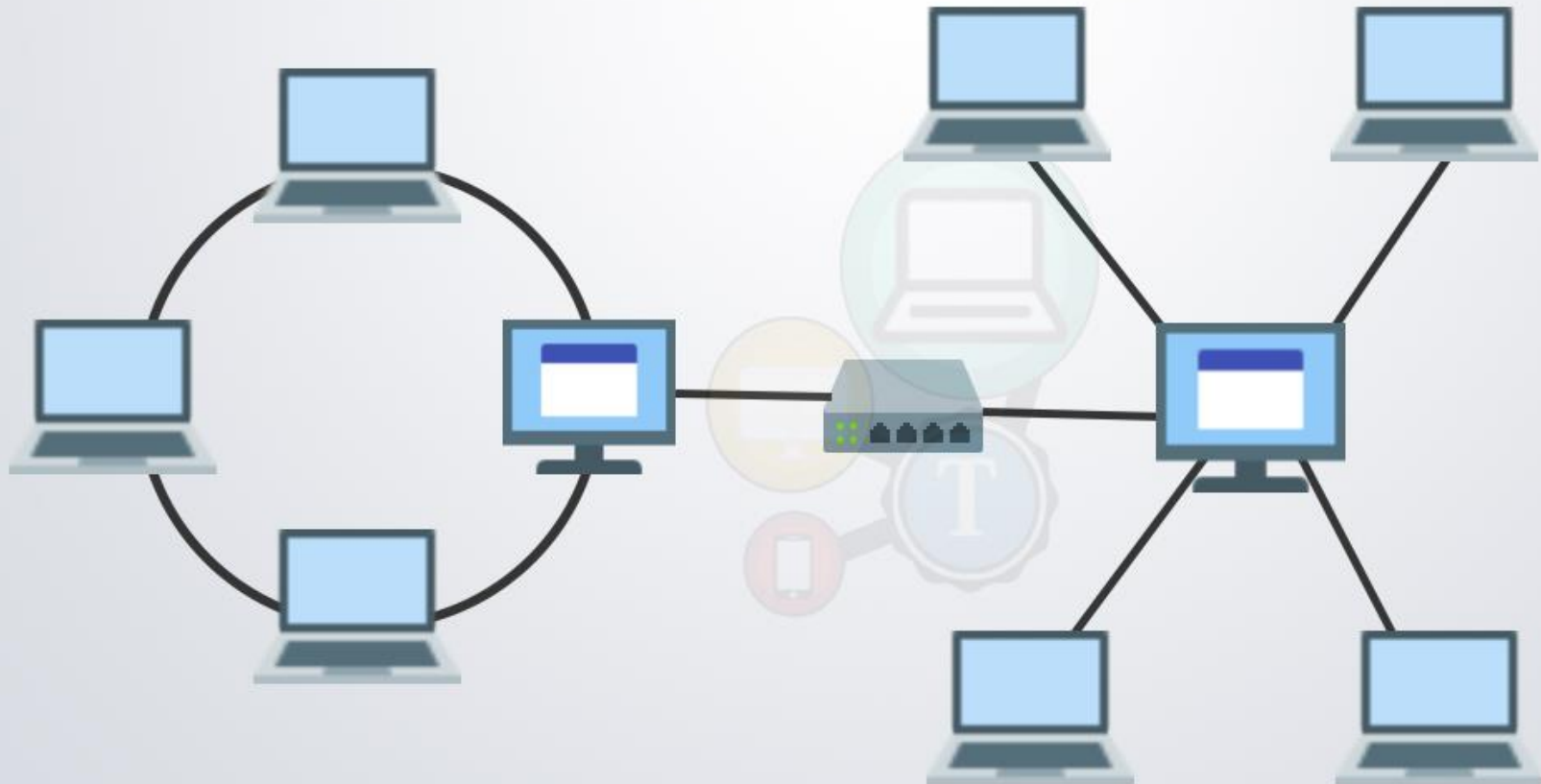
# Full Mesh



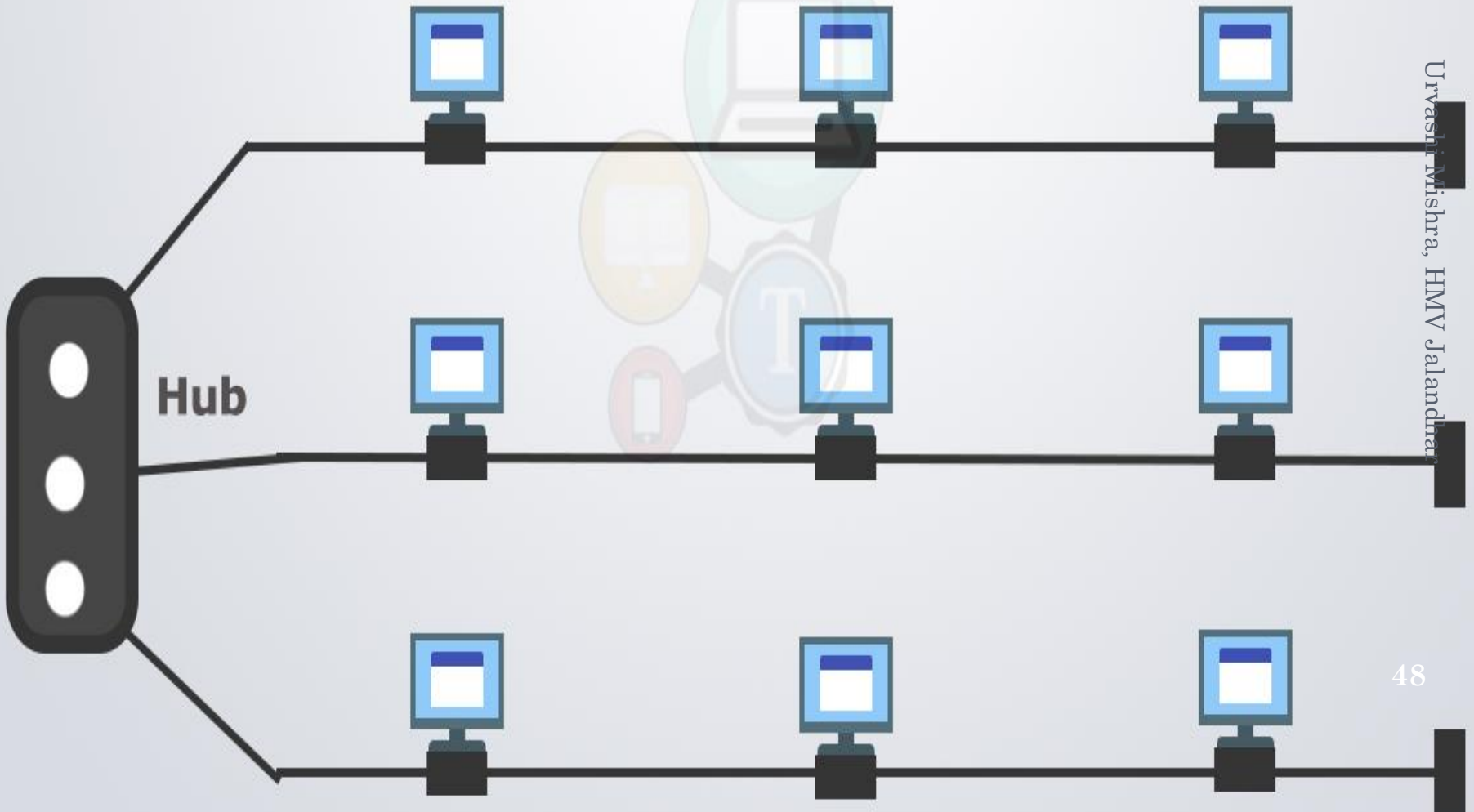
# HYBRID NETWORK TOPOLOGY

- Combines the physical and logical layout both of all basic types of topology like Star, Bus, Mesh and Ring.
- Have to select one Network Topology arrangement as a backbone. like Bus Topology Cable can be selected as a backbone. Central Device like Hub or Switch is another good option for as backbone.
- In this way you can extend whole Network by attaching Network Segments.
- Each Network Segment can have different Network Topology configured.
  - For example, you can have Hybrid Topology with a Star Backbone and the Ring Network. On the other hand you can have Star Mesh Hybrid Topology. Whenever main backbone fails, whole Computer Network can stop functioning.

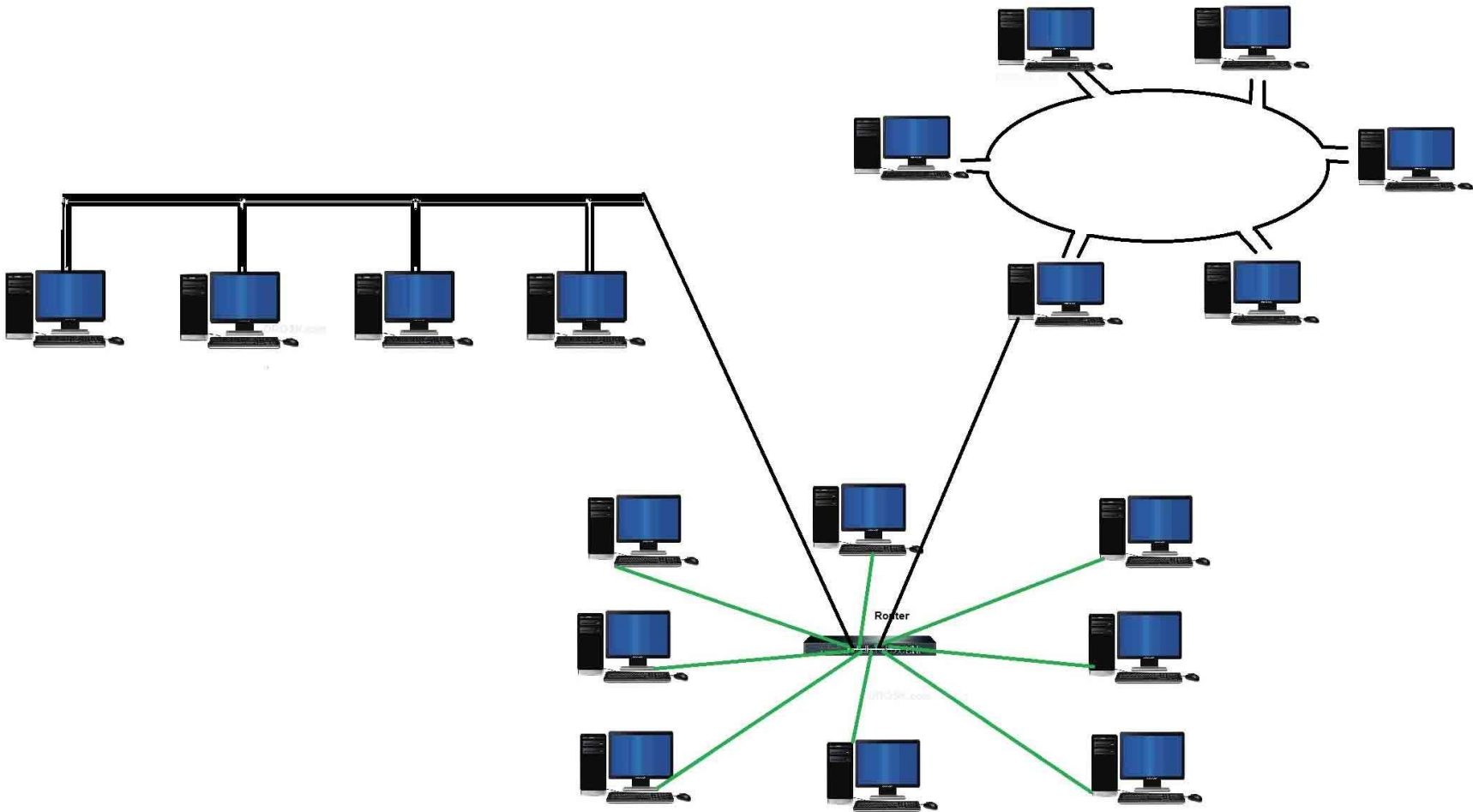
# EXAMPLE 1 – STAR RING HYBRID NETWORK TOPOLOGY



# EXAMPLE 2 – STAR BUS HYBRID NETWORK TOPOLOGY







# ADVANTAGES OF HYBRID

- **Reliable**: Its reliability is due to *sub networks*. In case of problem in one or more *sub network*, whole *Computer Network* can still be operational.
- **Effective**: By employing this configuration one can take advantage of plus points of different *Types of Network Topology*. For example, due to inclusion of *Ring Network*, has good data reliability and *Star Network* makes a *sub network* fault tolerant.
- **Flexible**: This *Type of Network* can be extended easily. In such *Networks* you have a lot of extension points. It can be easily upgraded and downgraded in accordance with user needs.

- **Scalable:** Hybrid networks are built in a fashion which enables for easy integration of new hardware components like additional concentration points. It's quite simple to extend the size of network with the addition of new elements, without disturbing existing architecture.

## DISADVANTAGES OF HYBRID

- Backbone of a *Hybrid Network* is the major area of concern. Any damage or problem to the backbone will surely stop the *Network* operations.
- Due to the use of multiple types of *Network Devices*, it is highly expensive to create, extend and manage.
- Complexity is one of the major drawbacks of *Network* configured with this scheme. Sometimes troubleshooting requires great deal of expertise. A lot of *Network Engineers* feel problems even in establishing this *Type of Topology*.

# THANKS!