# Chapter Three

## Network hardware Components,and Topology

# Networking Hardware Components

- Hardware is used to establish a physical connection between devices.

  The four categories contain devices which can be defined as:

➢ Those which operate at the physical layer (a repeater or a hub).

➢ Those which operate at the physical and data link layers (a bridge or a two-layer switch).

➢ Those which operate at the physical, data link, and network layers (a router or a three-layer switch).

➢ Those which can operate at all five layers (a gateway).

# Hardware components (cont')

- **Workstations** are computers that use network resources, but that do not host resources of their own. E.g client.

  **Servers** are computers that are dedicated to the task of hosting network resources.

  **Network Adapters (**network cards, NICs); Its job is to physically attach a computer to a network.

- The network card has to match the network medium.
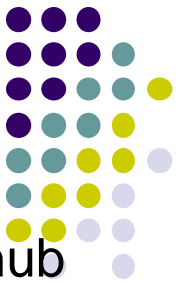
# NIC's (Network Interface Cards)

➢ This NIC has interfaces for twisted pair, thicknet, and thin-net connectors.



➢ Computers use NICs to send and receive data. The data is transmitted over Ethernet cables.  Ethernet uses Baseband communications. Baseband uses separate wires for sending and receiving data.

# Hubs

- Note a cross over cable to build a network limited to two PCs . A hub is a device that acts as a central connection point computers on a network. Hub connects the wires from different branches . It is OSI layer 1 hardware

- Hubs regenerate and retransmit network signals

- They cannot filter network traffic and determine best path

- They are really multi-port repeaters

- There are two types of hubs: active and passive. *Passive hubs* simply connect all ports together electrically and are usually not powered.

- ***Active hubs*** use electronics to amplify and clean up the signal before it is broadcast to the other ports.

In the category of active hubs, there is also a class called "intelligent" hubs, which are hubs that can be remotely managed on the network.

# Hubs (cont')

➢ Any computer can send a transmission at any given time, which results <span style="color:red">in collusion</span>.

➢ If two pcs transmits at the same time there will be collusion .

➢ Both PCs then have to <span style="color:red">wait for a random amount of time</span> and attempt to retransmit the packet that was destroyed.

➢ As the number of PCs on a collision domain increases, so does the <span style="color:red">number of collisions</span>.

➢ As the number of collisions increase, <span style="color:red">network efficiency is decreased</span>.

# Switch

- Shared ethernet networks perform best when kept to 30-40 percent full capacity

- This is a result of CSMA/CD

- A LAN switch is a high-speed multiport bridge which segments each port into its own collision domain and can access the full bandwidth.

➢ Switches are made to solve the problems regarding the bandwidth & collision in the networks.

➢ The switch uses a set of internal logic circuits to establish a **dedicated, logical path between the two PCs.**

➢ Two PCs are free to communicate with each other, without having to **worry about collisions** .

➢ Switch learns MAC address statically or dynamically in MAC table & forward the frame very intelligently without high traffic.

# **Switches**

- Each port is a simulated segment to itself

- Switches can establish parallel communications paths.

  i.e.  While Computer A is communicating with computer B, and computer C can also simultaneously communicate with computer D.

# Store and Forward Switches

- **Do error checking on each frame after the entire frame has arrived into the** switch

- If the error checking algorithm determines there is no error, the switch looks in its MAC address table for the port to which to forward the destination device.

- Highly reliable because doesn't forward bad frames

- Slower than other types of switches because it holds on to each frame until it is completely received to check for errors before forwarding.

# Cut Through Switch

- Faster than store and forward because doesn't perform error checking on frames
- Reads address information for each frame as the frames enter the switch.
- After looking up the port of the destination device, frame is forwarded
- **Forwards bad frames**
  - Performance penalty because bad frames can't be used and replacement frames must be sent which creates additional traffic.

# Layer 3 switch

- By definition a switch filters or forwards frames based on MAC addresses. This makes a switch a layer 2 device.

- Now we have layer 3 switches which have routing capability. If a data frame can't be switched it is routed.

- Each port is a separate LAN port, but the forwarding engine actually calculates and stores routes based on IP addresses, not MAC addresses

- Usually support only IP or IP and IPX

# VLAN Switches

- Virtual local area network
- Each port on a switch defines a collision domain
- The entire switch forms a single broadcast domain
- VLANs can define multiple broadcast domains
- Network traffic that is directed to all computers on the network can be segmented to transmit only on a specific VLAN.
- **Improves bandwidth** on a the VLAN's because each VLAN filters the **network-to-network broadcast** traffic as well as the collision traffic from other VLAN's

# VLAN Switches

- None of the VLAN's can communicate unless each VLAN is connected to a router or layer 3 switch

- Each VLAN is separating collision traffic associated with MAC Addresses (layer 2) and each VLAN is separating the network-to-network broadcast traffic. In other words each VLAN is acting as a separate network so a layer 3 device is necessary for them to communicate

# Repeaters

- Signal attenuation or signal loss – signal degrades over distance
- Repeaters clean, amplify, and resend signals that are weakened by long cable length.
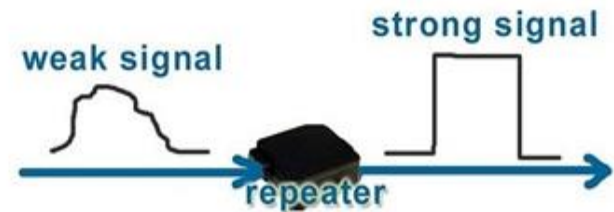- Built-in to hubs or switches

advantage

It can extend the physical length of networks

It can link the various Ethernet segments

of any media type



Repeater : Weak digital signals are regenerated into strong signals.
It has become obsolete because of Hubs and Switches.

Disadvantage

It doesn't know the different protocols and the address

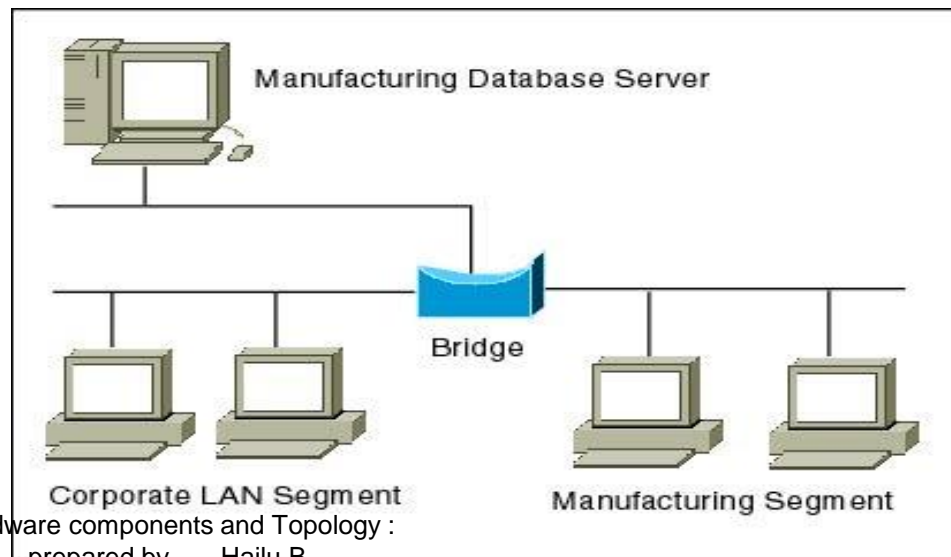it cannot connect the network of two different architecture such as Token ring and Ethernet.

# Bridges

- A layer 2 device designed to create two or more LAN segments, each of which is a separate collision domain.

- The purpose is to filter traffic on a LAN, to keep local traffic local, yet allow connectivity to other segments of the network.

- Filter traffic by looking at the MAC address, Frame filtering

- If the frame is addressed to a MAC address on the local side of the bridge, it is not forwarded to the other segment



Manufacturing Database Server

Bridge

Corporate LAN Segment

Manufacturing Segment

Hardware components and Topology : prepared by      Hailu B.

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# Bridges

- MAC addresses on the other segment are forwarded
- Bridges maintain a MAC address table for both segments they are connected to
- Solve the problems of collision and bandwidth.
- Able to connect different media with the networks.
- Network traffic reduction.
- Use MAC table during the data transmission.

- Can link two similar networks together.

- The main disadvantage is that it is not able to handle the multiple paths.

# Router

- Routers are **highly intelligent devices** that connect multiple network types and determine the **best path for sending data**.

- They link separate network and provide access of internet to the users. The advantage of using a router over a bridge is that routers can determine the best path

- routers can be a **hardware**, **software or both** which can connect two different networks such as (a) Ethernet to Ethernet , (b) token ring to Ethernet, (c) MAN to WAN

**Some of the function of routers:**
✓Removal of corrupt packets or data
✓Interconnection between **different networks architectures, physical media** etc.
✓Provide a suitable path for packets transfer
✓Performs **complex mathematical** calculations
✓Routers find the **shortest and the easiest** path to transfer the data
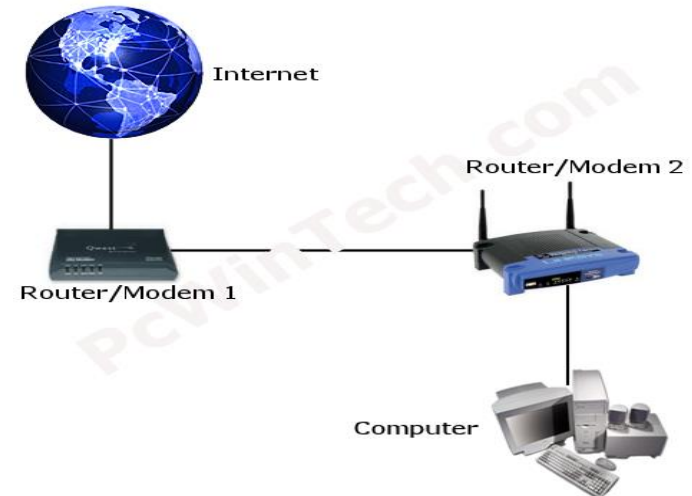
# Gateway

- It can perform the overall function of bridge & routers

- It is capable to converts the entire protocol of different networks.

- It operates at all the seven layer of OSI model.

- The main & important function of the gateway is protocol conversion. E.g  the gateway converts the Token ring protocol to Ethernet protocol

- Generally a normal gateway used in the connection between the dissimilar LANs ( software installed on the router )

# Devices and the layers at which they operate

| Layer | Name of Layer | Device |
|---|---|---|
| 3 | Network | Routers, layer 3 switches |
| 2 | Data Link | Switches, bridges, NIC's |
| 1 | Physical | Hubs |

| | hubs | bridges | routers | Ethernet switches |
|---|---|---|---|---|
| traffic isolation | no | yes | yes | yes |
| plug and play | yes | yes | no | yes |
| optimal routing | no | no | yes | no |
| cut-through | yes | no | no | yes |

# **Network Topologies**

- **Physical Topology :** Topology refers to the layout of connected devices on a network

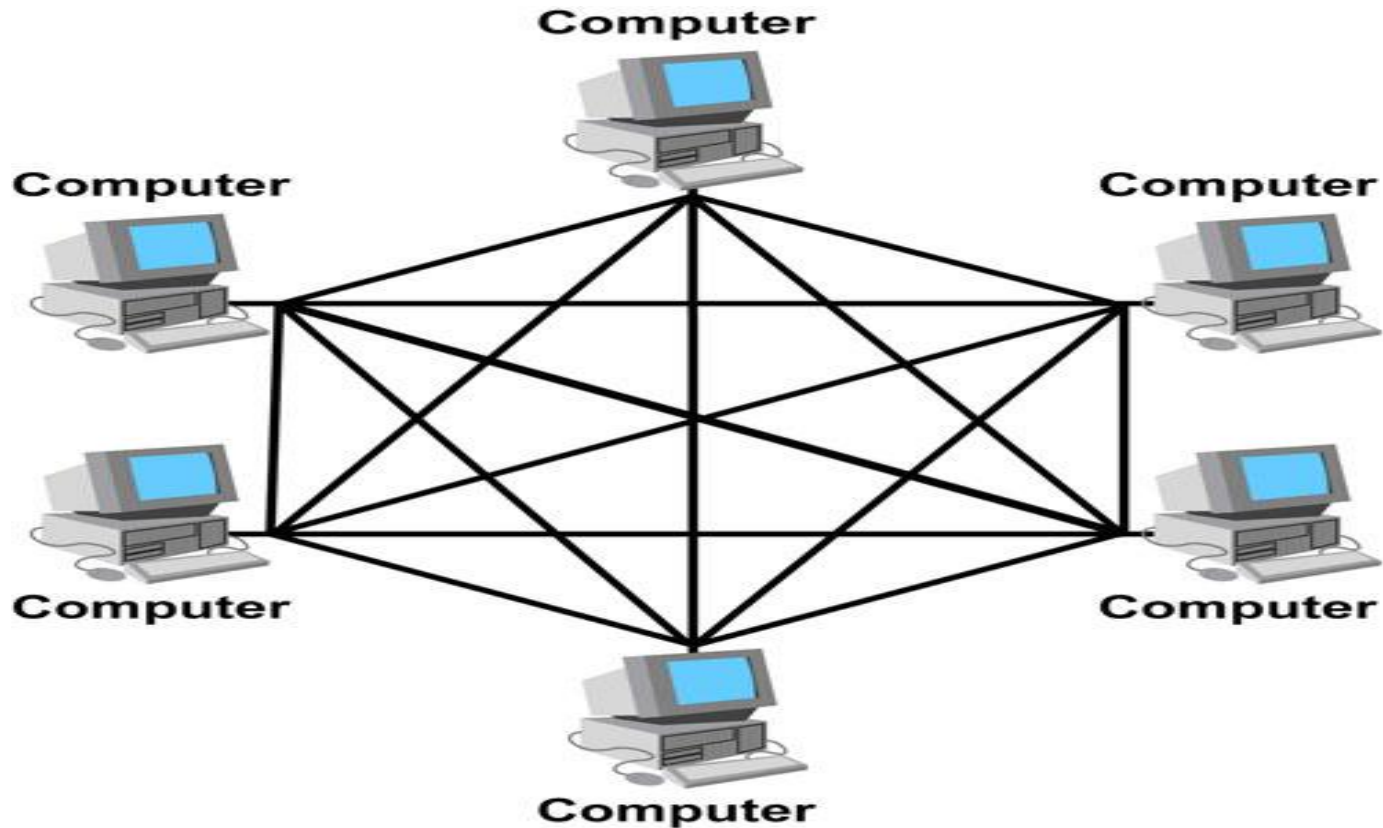**G**eometric representation of the relationship of all the links and linking devices
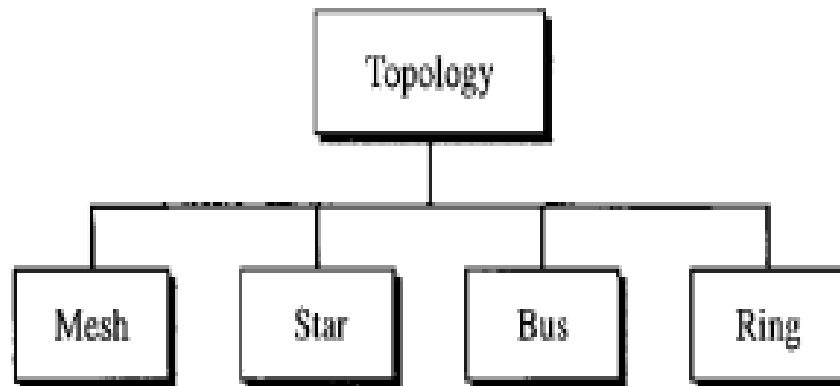
# Mesh Topology

- Here every device has a <span style="color:red">point to point</span> link to every other device.

- Node 1 node must be connected with <span style="color:red">n-1</span> nodes.

- A fully connected mesh can have <span style="color:red">n(n-1)/2</span> physical channels to link <span style="color:red">n</span> devices.

- It must have <span style="color:red">n-1</span> I/O ports.

# Mesh Topology

# Mesh Topology

## *Advantages:*

1. They use dedicated links so each link can only carry its own data load. So <span style="color:red">traffic problem</span> can be avoided.

2. It is robust. If <span style="color:red">any one link get damaged</span> it cannot affect others.

3. It gives **privacy and security**.(Message travels along a dedicated link)

4. Fault **identification and fault** isolation are easy.

# Mesh Topology

- *Disadvantages:*
1. The amount of <span style="color:red">cabling</span> and the number of <span style="color:red">I/O ports</span> required are very large. Since every device is connected to each devices through dedicated links.
2. The sheer bulk of wiring is larger then the available space.
3. Hardware required to connected each device is highly expensive.

- *Applications:*
1. Telephone Regional office.
2. WAN.(Wide Area Network).

# Star Topology

- Here each device has a dedicated point-to-point link to the central controller called <span style="color:red">"Hub"(Act as a Exchange)</span>.

- There is no direct traffic between devices.

- The transmission are occurred only through the central "hub".

- When device 1 wants to send data to device 2; First sends the data to hub. Which then relays the data to the other connected device.

# Star Topology

**STAR TOPOLOGY:**
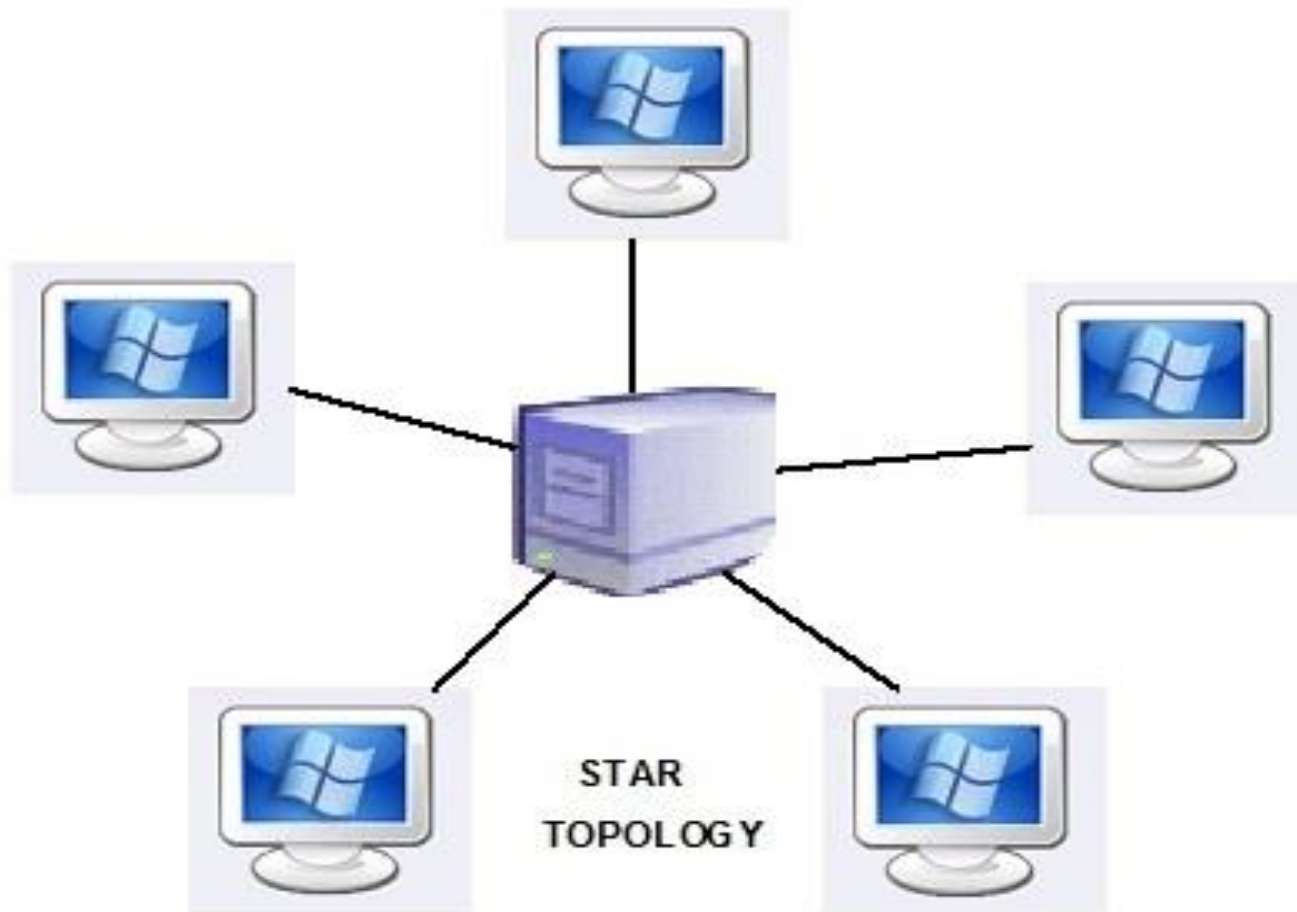


STAR
TOPOLOGY

# Star Topology

- *Advantages:*

1. Less expensive then mesh since each device is connected only to the hub.

2. Installation and configuration are easy.

3. Less cabling is need then mesh.

4. Robustness.(if one link fails, only that links is affected. All other links remain active)

5. Easy to fault identification & to remove parts.

6. No distruptions to the network then connecting(or) removing devices.

# Star Topology

- *Disadvantages:*

1. Even it requires less cabling then mesh when compared with other topologies it still large.(Ring or bus).

2. Dependency(whole n/w dependent on one single point(hub). When it goes down. The whole system is dead.

*Applications*

- Star topology used in Local Area Networks(LANs).
- High speed LAN often used STAR.

# Bus Topology

- A bus topology is multipoint.

- Here one long cable act as a backbone to link all the devices are connected to the backbone by drop lines and taps.

- Drop line- is the connection b/w the devices and the cable.

- Tap- is the splitter that cut the main link.

- This allows only one device to transmit at a time.

- A device want to communicate with other device on the network sends a broadcast message onto the wire all other devices see.

- But only the intended devices accepts and process the message

# Bus Topology
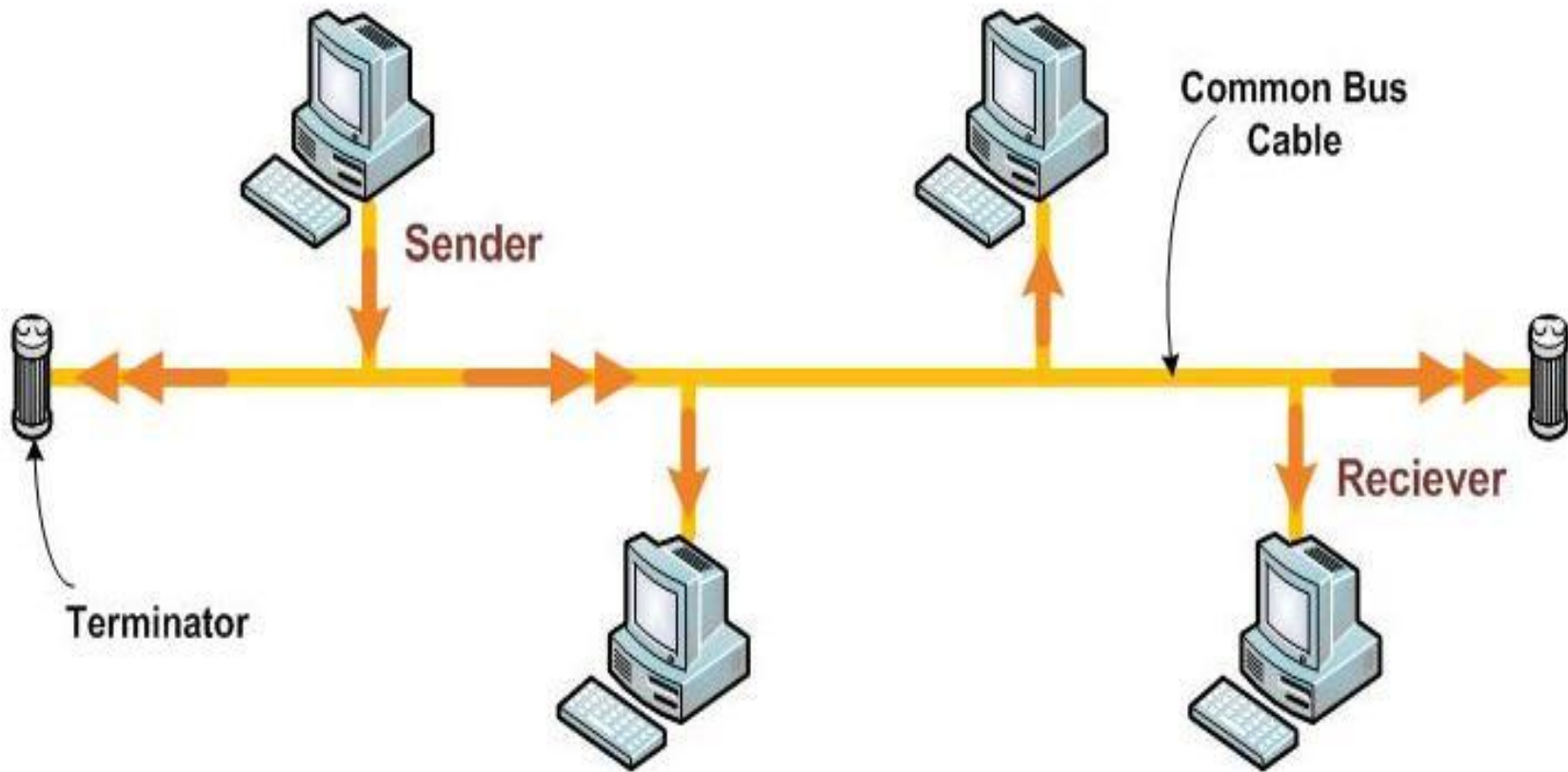
# Bus Topology

- *Advantages:*

1. Ease of installation
2. Less cabling

*Disadvantages:*

1. Difficult reconfiguration and fault isolation.
2. Difficult to add new devices.
3. Signal reflection at top can degradation in quality.
4. If any fault in backbone can stops all transmission.

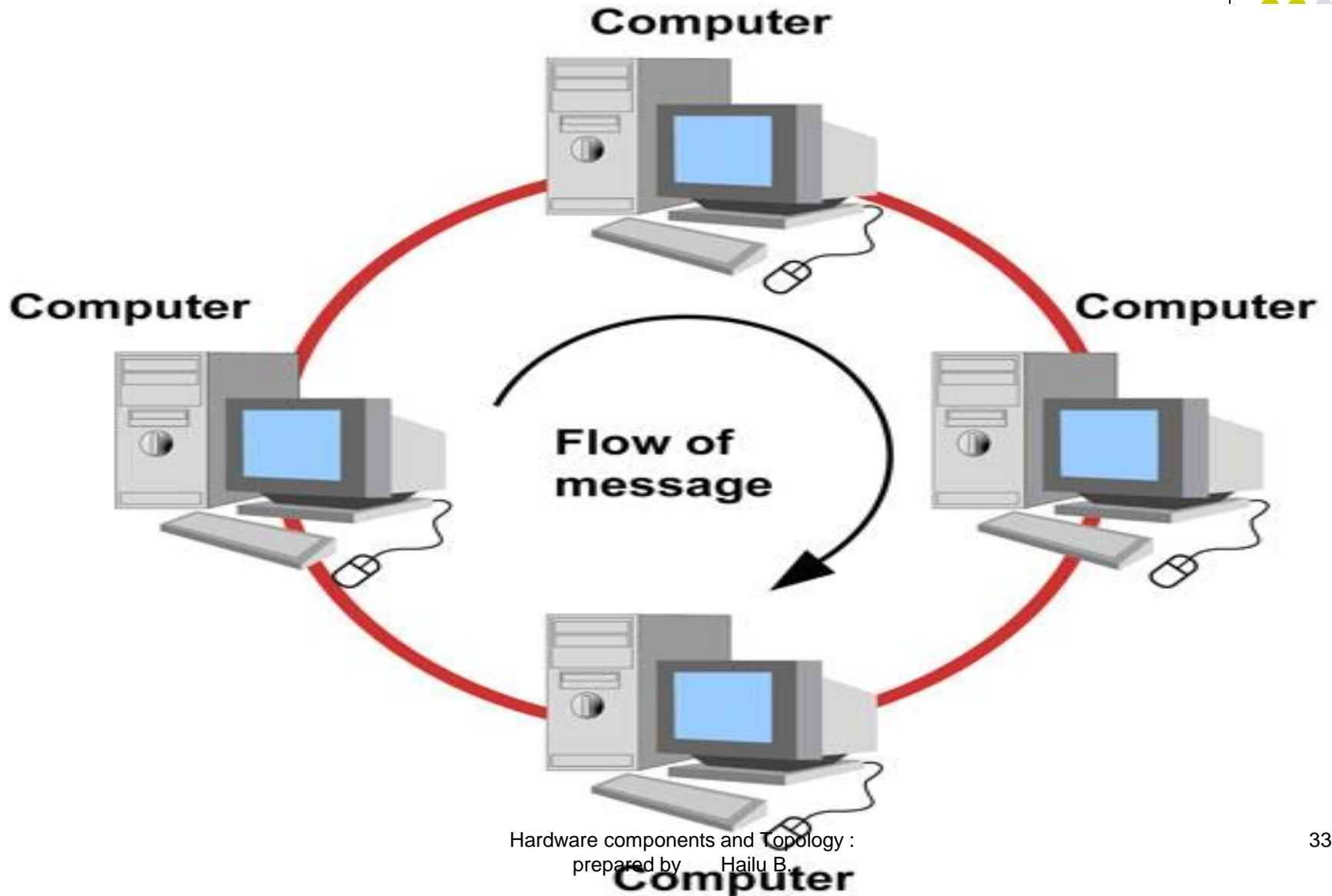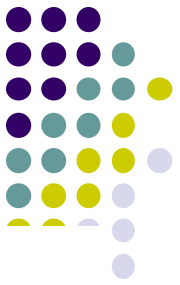- *Applications:*

Most computer motherboard.

# Ring Topology

- Here each device has a dedicated connection with two devices on either side.

- The signal is passed in one direction from device to device until it reaches the destination and each device have <span style="color:red">repeater</span>.

- When one device received signals instead of intended another device, its repeater then <span style="color:red">regenerates</span> the data and passes them along.

- To add or delete a device requires changing only two connections.

# Ring Topology



Computer

Computer

Computer

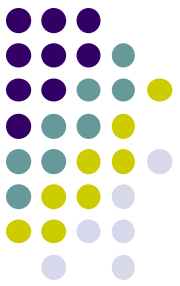Flow of message

Computer

# Ring Topology

- *Advantages:*

1. Easy to install.

2. Easy to reconfigure.

3. Fault identification is easy.

*Disadvantages:*

1. Unidirectional traffic.

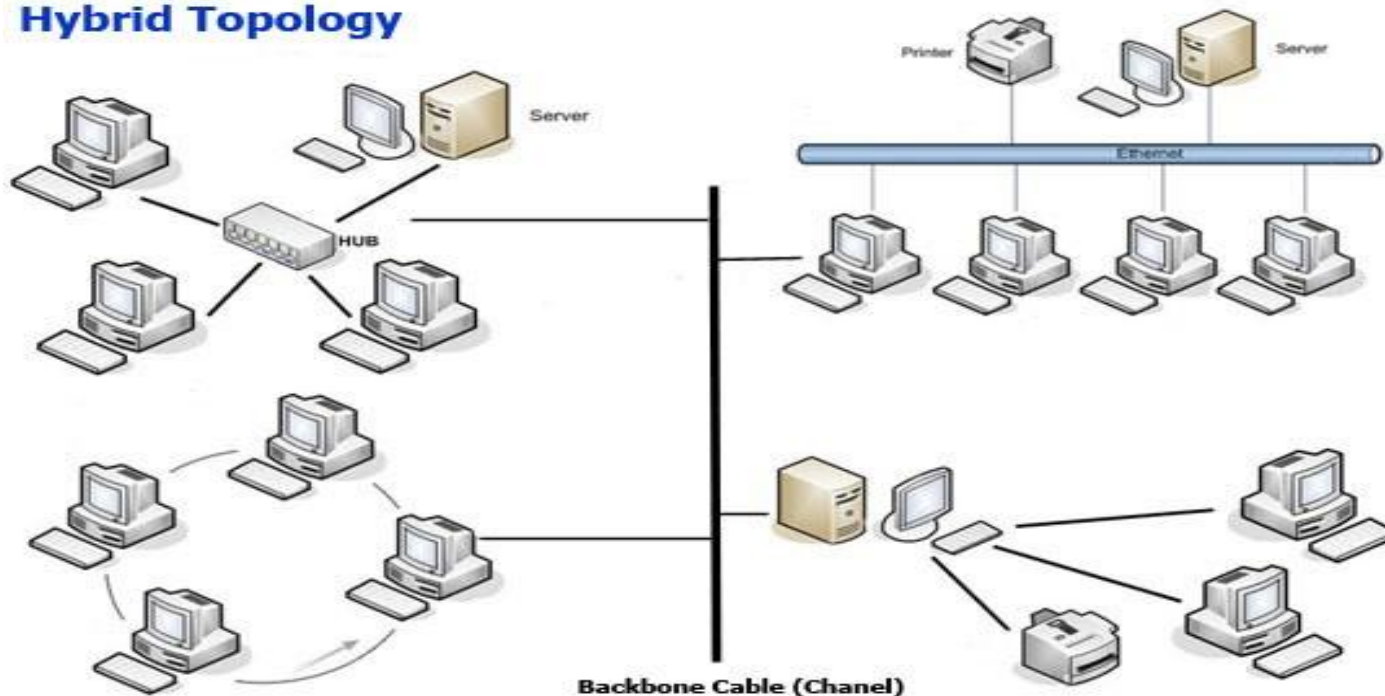2. Break in a single ring can break entire network.

- *Applications:*

  ➢ Ring topologies are found in some office buildings or school campuses.

  ➢ Today high speed LANs made this topology less popular.

# Hybrid Topology

- A network which contain all type of physical structure and connected under a single backbone channel.

# Considerations for choosing topology

- **Money**-Bus n/w may be the least expensive way to install a n/w.

- **Length**-of cable needed- the linear bus n/w uses shorter lengths of cable.

- **Future growth**-with star topology, expending a n/w is
  easily done by adding another devices.

- **Cable type**-most common used cable in commercial organization  is twisted pair. Which often used with star topologies.

Full **mesh topology** is theoretically the best since every device is connected to every other device.(thus maximizing speed and security. however, it quite expensive to install)