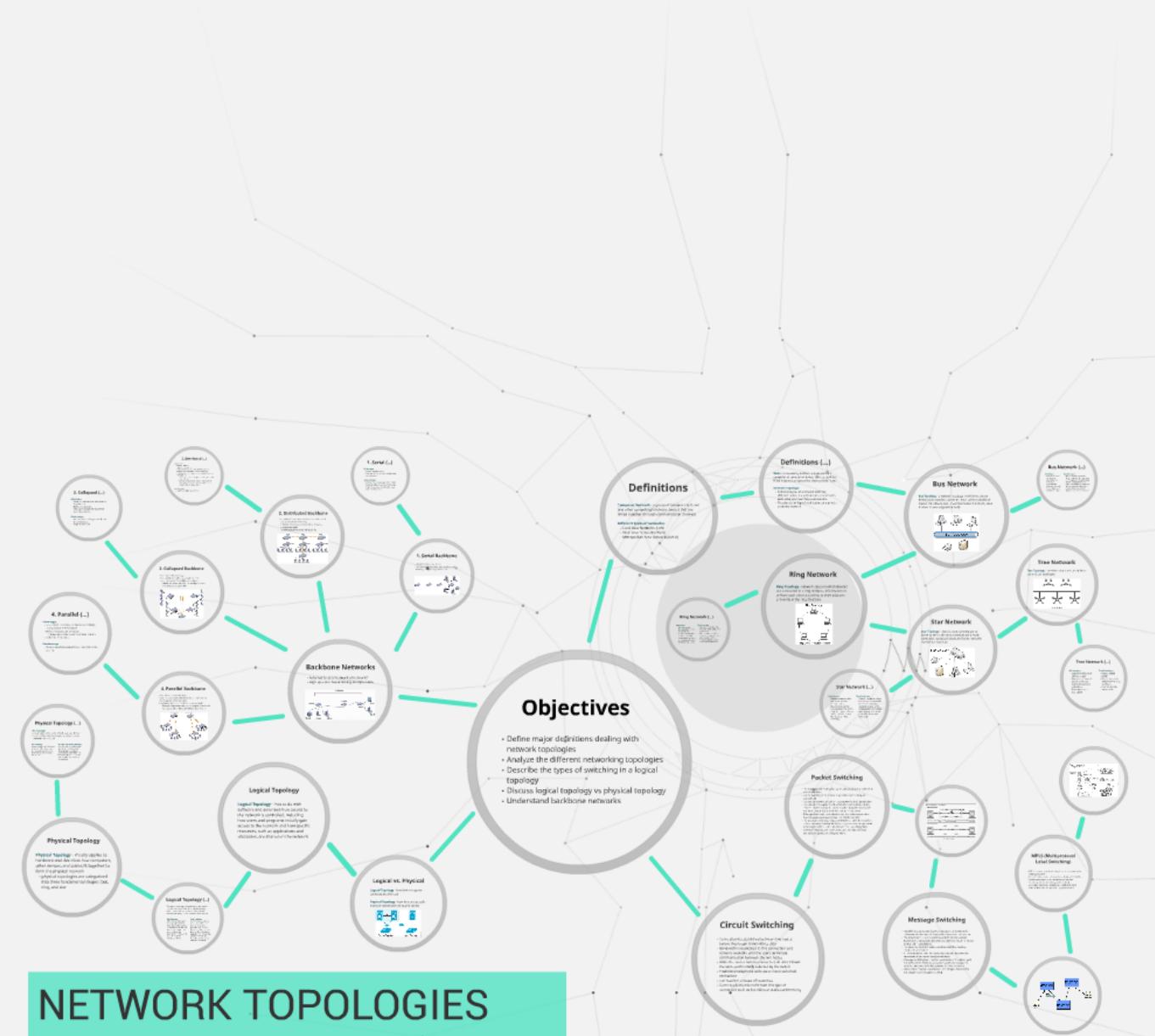


NETWORK TOPOLOGIES

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NETWORK TOPOLOGIES

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NETWORK TOPOLOGIES

Objectives

- Define major definitions dealing with network topologies
- Analyze the different networking topologies
- Describe the types of switching in a logical topology
- Discuss logical topology vs physical topology
- Understand backbone networks

Definitions

Computer Network: A group of computer systems and other devices that are connected together through communication channels.

Different types of networks:
- Local Area Networks (LAN)
- Wide Area Networks (WAN)
- Metropolitan Area Networks (MAN)

Definitions (...)

Network Topology: A network's topology is the geometric arrangement of the various components of the network, such as the number of nodes, links, and their arrangement.

Network Topology: The way in which a network is organized or structured.

- The physical or logical structure of a network.

Bus Network

Bus Topology: A network topology in which each node is connected to a single central bus.

The bus is a shared medium that transmits signals to all nodes attached to it.

Advantages:
- Simple and cost-effective.
- Easy to install and maintain.

Disadvantages:
- If one node fails, it can affect the entire network.

Bus Network (...)

Star Topology: A network topology where each node is connected to a central hub or switch.

The central hub or switch acts as a single point of connection for all nodes.

Advantages:
- High reliability.
- Easy to troubleshoot.

Disadvantages:
- Expensive to install and maintain.

Tree Network

Tree Topology: A hierarchical network topology where each node is connected to a single parent node.

The root node is at the top of the hierarchy.

Advantages:
- Scalable.
- Efficient for large networks.

Disadvantages:
- Difficult to troubleshoot.

Tree Network (...)

Ring Network

Ring Topology: A network topology where nodes are connected in a ring and pass information to the next node in the ring, creating a closed loop.

Advantages:
- High reliability.
- Easy to troubleshoot.

Disadvantages:
- Limited scalability.

Star Network

Star Topology: A network topology where each node is connected to a central hub or switch.

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Ring Network

Ring Topology: A network topology where nodes are connected in a ring and pass information to the next node in the ring, creating a closed loop.

Advantages:
- High reliability.

Disadvantages:
- Limited scalability.

Packet Switching

Packet Switching: A switching technique used for connecting multiple users to a single communication channel.

Advantages:
- Efficient use of bandwidth.

Disadvantages:
- Higher latency.

MPHS (Multiprotocol Label Switching)

MPHS: A switching technique used for switching packets between different protocols.

Advantages:
- High efficiency.

Disadvantages:
- Complex implementation.

Message Switching

Message Switching: A switching technique used for switching messages between different protocols.

Advantages:
- High reliability.

Disadvantages:
- Low efficiency.

Circuit Switching

Circuit Switching: A switching technique used for establishing a dedicated connection between two nodes.

Advantages:
- High reliability.

Disadvantages:
- Low efficiency.

Logical vs. Physical

Logical Topology: How nodes appear connected to the user.

Physical Topology: How devices are physically connected.

Logical Topology

Logical Topology: How nodes appear connected to the user.

Physical Topology

Physical Topology: How devices are physically connected.

Backbone Networks

Backbone Networks: A network of networks.

Advantages:
- High speed.

Disadvantages:
- Complex.

1. Serial Backbone

Serial Backbone: A backbone network where data is transmitted sequentially from one node to the next.

2. Distributed Backbone

Distributed Backbone: A backbone network where data is transmitted simultaneously from multiple nodes.

3. Collapsed Backbone

Collapsed Backbone: A backbone network where data is transmitted simultaneously from multiple nodes.

4. Parallel Backbone

Parallel Backbone: A backbone network where data is transmitted simultaneously from multiple nodes.

Physical Topology

Physical Topology: How devices and connections are physically connected.

Logical Topology

Logical Topology: How nodes appear connected to the user.

Logical vs. Physical

Objectives

- Define major definitions dealing with network topologies
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- Understand backbone networks

Definitions

Computer Network - a group of computer systems and other computing hardware devices that are linked together through communication channels

Different types of networks:

- Local Area Networks (LAN)
- Wide Area Networks (WAN)
- Metropolitan Area Networks (MAN)

Definitions (...)

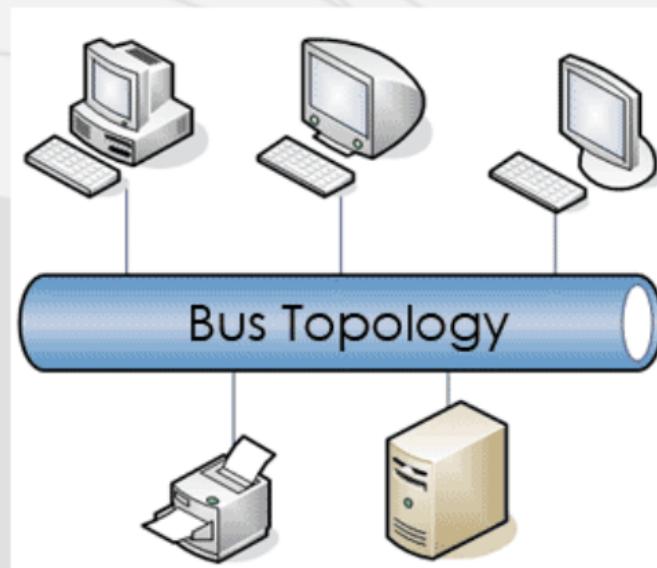
Node - a processing location. A node can be a computer or some other device, such as a printer. If the node is a computer it is often called a "host".

Network Topology:

- Refers to layout of a network and how different nodes in a network are connected to each other and how they communicate
- The physical or logical architecture of a private computer network

Bus Network

Bus Topology - a network topology in which nodes are directly connected to a common linear (or branched) half-duplex link called a bus. Linear Bus network is mostly used in small networks (good for LAN).



Bus Network (...)

Advantages

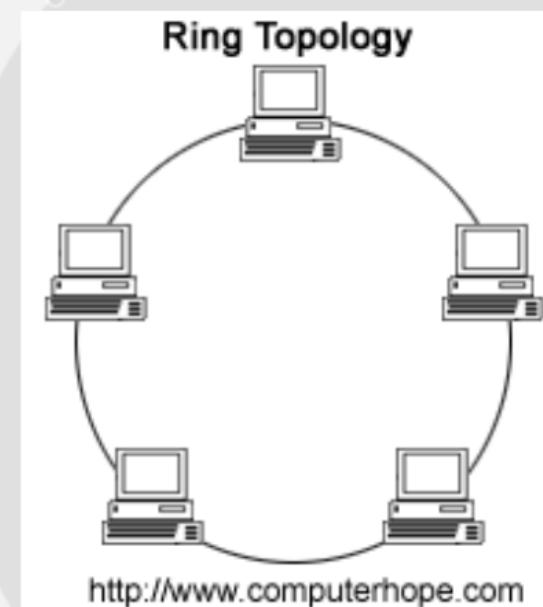
- Easy to connect a computer or peripheral to a linear bus
- Cost effective
- Requires less cable length than other network topologies

Disadvantages

- Entire network shuts down if there is a break in the main cable
- Terminators are required at both ends of the backbone cable
- Difficult to identify the problem if the entire network shuts down
- Security issues since data is broadcasted across the network

Ring Network

Ring Topology - network setup in which devices are connected in a ring and pass information to or from each other according to their adjacent proximity in the ring structure



Ring Network (...)

Advantages

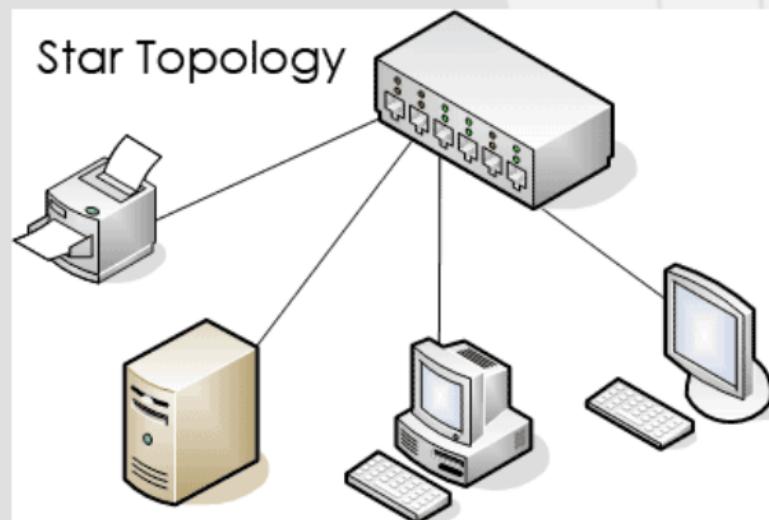
- Data can transfer between workstations at high speeds
- Additional workstations can be added without impacting performance of the network(handles high volume of traffic)

Disadvantages

- The entire network will be impacted if one workstation shuts down
- The hardware needed to connect each workstation to the network is more expensive than Ethernet cords and hubs/switches

Star Network

Star Topology - there is a central computer or server to which all the workstations are directly connected. Many businesses and home networks use the star topology.



Star Network (...)

Advantages

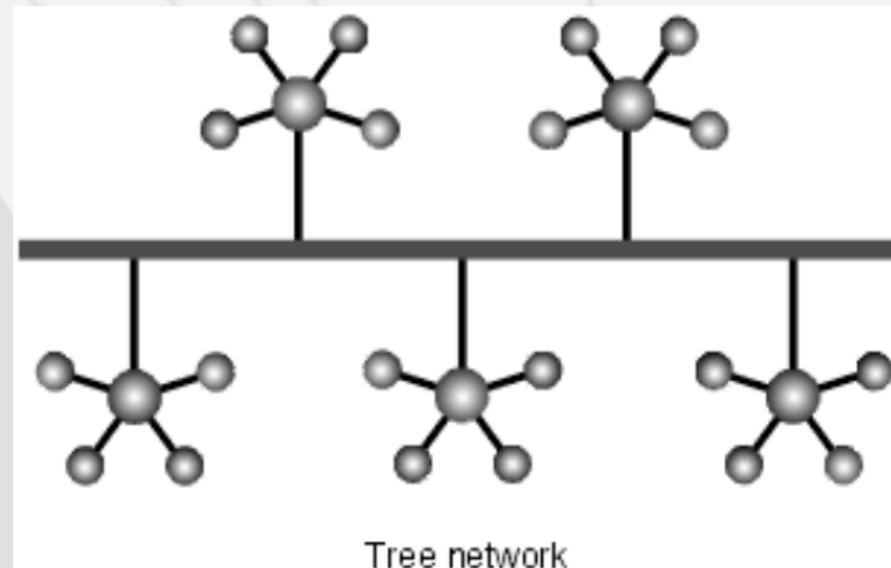
- Fast performance with few nodes and low network traffic
- Easy to troubleshoot
- Easy to setup and modify
- Only that node is affected which has failed rest of the nodes can work smoothly

Disadvantages

- Cost of installation is high
- If the hub is affected then the whole network is stopped because all the nodes depend on the hub
- More devices connected can make the network slow down

Tree Network

Tree Topology - combines characteristics of linear bus and star topologies



Tree Network (...)

Advantages

- Extension of bus and star topologies
- Expansion of nodes is possible and easy
- Easily managed and maintained
- Error detection is easily done

Disadvantages

- Heavily cabled
- Costly
- If more nodes are added maintenance is difficult
- Central hub fails, network fails

Circuit Switching

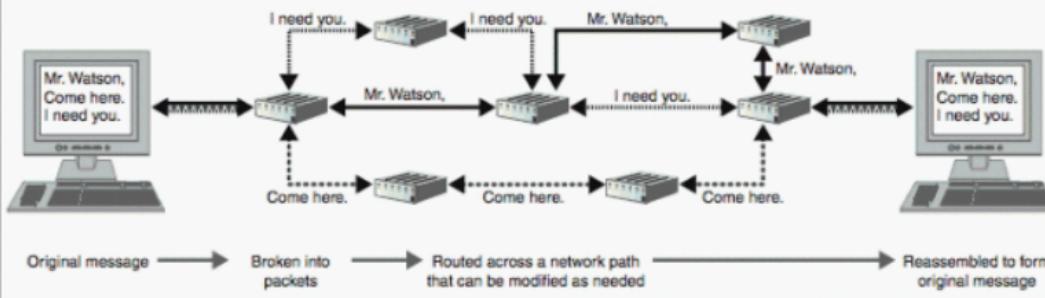
- Connection is established between two nodes before they begin transmitting data
- Bandwidth is dedicated to this connection and remains available until the users terminate communication between the two nodes
- While the nodes remain connected, all data follows the same path initially selected by the switch
- Traditional telephone calls use a circuit switched connection
- Can result in a waste of resources
- Some application benefit from this type of connection such as live video or audio conferencing

Packet Switching

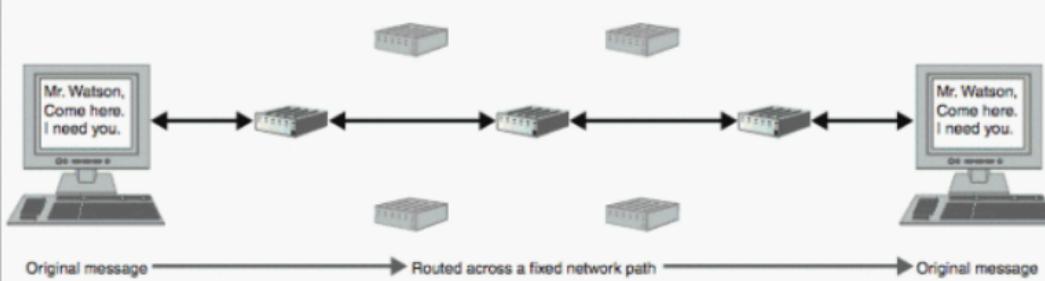
- The most popular method for connecting nodes on a network is packet switching
- Packet switching breaks data into packets before they are transported
- Packets can travel any path on the network to their destination
- Packets can attempt to find the fastest circuit available at any instant - they need not follow each other along the same path, nor must they arrive at their destination in sequence
- When packets reach their destination, the node reassembles them in sequence based on their control information
- The greatest advantage of packet switching lies in the fact that it does not waste bandwidth by holding a connection open until a message reaches its destination as circuit switching does
- Ethernet networks and the Internet are the most common examples of packet switching networks

Figure 1: Packet Switching vs. Circuit Switching

Packet-switched network



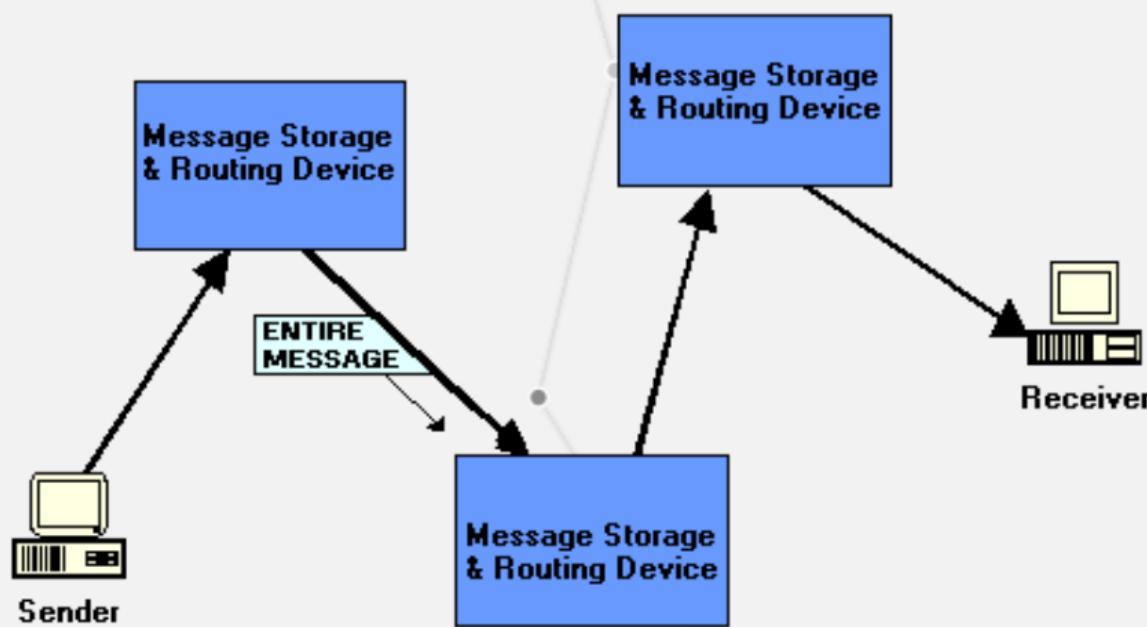
Circuit-switched network



Source: GAO analysis; Art Explosion (images).

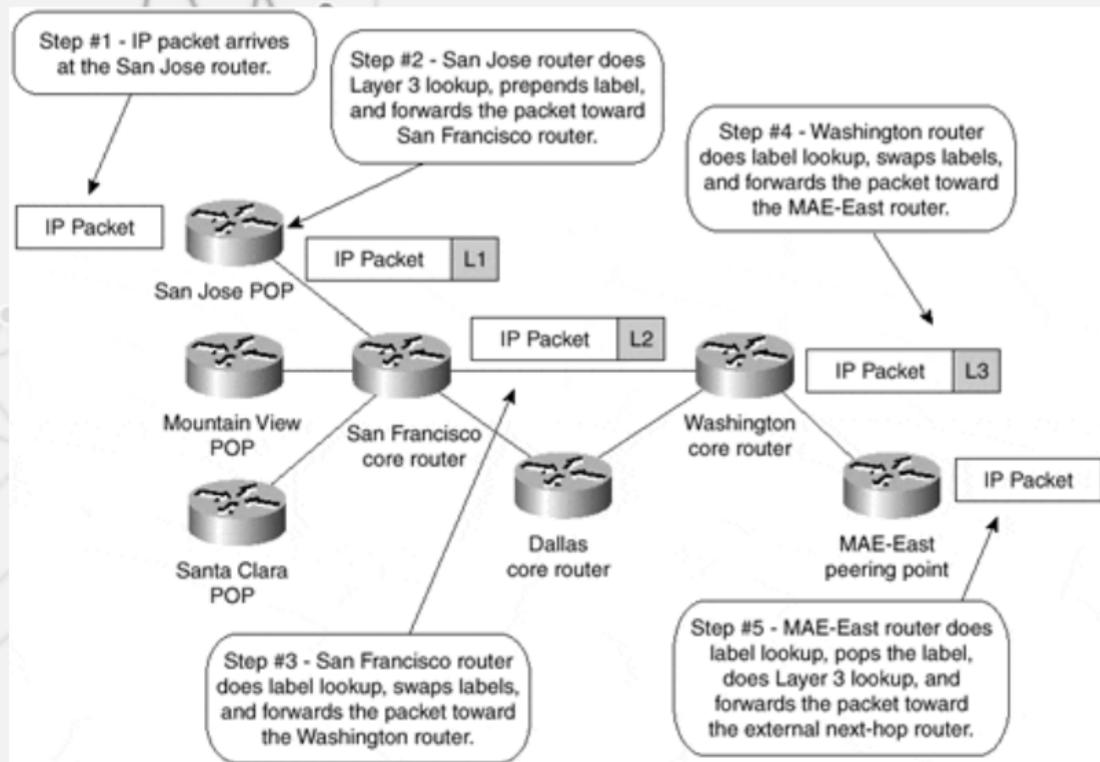
Message Switching

- Establishes a connection between two devices, transfers the information to the second device, then breaks the connection
- The information is stored and forwarded from the second device after a connection between that device and a third device on the path is established
- The store and forward routine continue until the message reaches its destination
- All information follows the same physical path, however the connection is not continuously maintained
- Message switching requires that each device in the data's path has sufficient memory and processing power to accept and store the information before passing it to the next node
- None of the network transmission technologies discussed in this chapter use message switching



MPLS (Multiprotocol Label Switching)

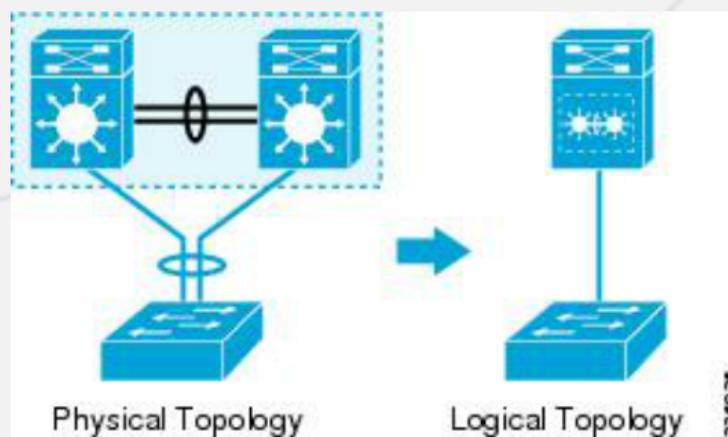
- MPLS is a new type of switching that was introduced in 1999 by the IETF
- It is commonly used with protocols designed for LAN's
- It addresses some of the limitations of packet switching (i.e. faster routing, prioritization)
- It is often called a shim because it adds additional information onto the packet being transported



Logical vs. Physical

Logical Topology - how devices appear connected to the user

Physical Topology - how they are actually interconnected with wires and cables



Logical Topology

Logical Topology - has to do with software and describes how access to the network is controlled, including how users and programs initially gain access to the network and how specific resources, such as applications and databases, are shared on the network

Logical Topology (...)

The logical topology defines how the data should transfer. Contrast this to the physical topology, which consists of the layout of cables, network devices and wiring. Two of the most common are:

Bus Topology

Ethernet uses the logical bus topology to transfer data. Under a bus topology a node broadcasts the data to the entire network. All other nodes on the network hear the data and check if the data is intended for them.

Ring Topology

In this topology, only one node can be allowed to transfer the data in a network at a given time. This mechanism is achieved by token (the node having token only can transmit the data in a network) and hence the collision can be avoided in a network.

Physical Topology

Physical Topology - mostly applies to hardware and describes how computers, other devices, and cables fit together to form the physical network

- physical topologies are categorized into three fundamental shapes: bus, ring, and star

Physical Topology (...)

Bus Topology

A single cable to which all network nodes are directly connected. The cable has terminators at each end to prevent the loss of signal

Star Topology

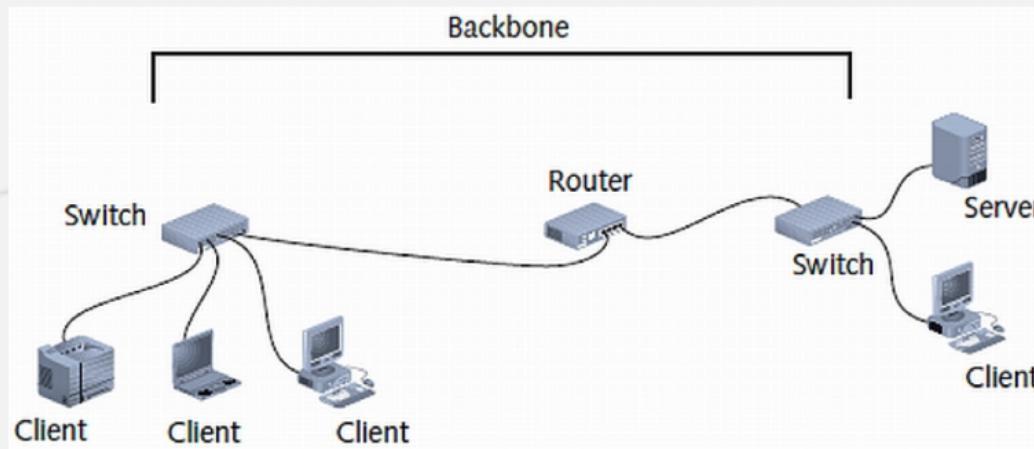
A topology with a single access point or a switch at the center of the topology; all the other nodes are connected directly to this point

Tree (Extended Star) Topology

A combination of both the star and the linear bus topologies. This topology has multiple access points connected to the linear bus, while the nodes are connected to their respective access points.

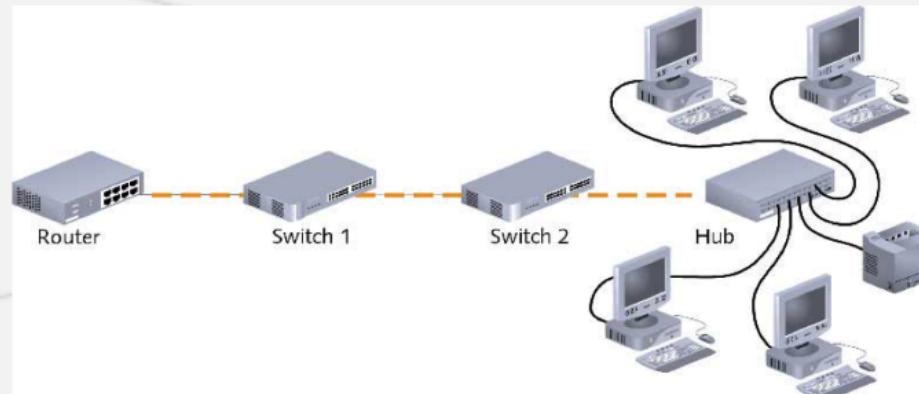
Backbone Networks

- Referred to as a “network of networks”
- High speed network linking multiple LANs



1. Serial Backbone

- Simplest network backbone
- 2 or more hubs/switches connected to each other by a single daisy-chain cable



1. Serial (...)

Advantages

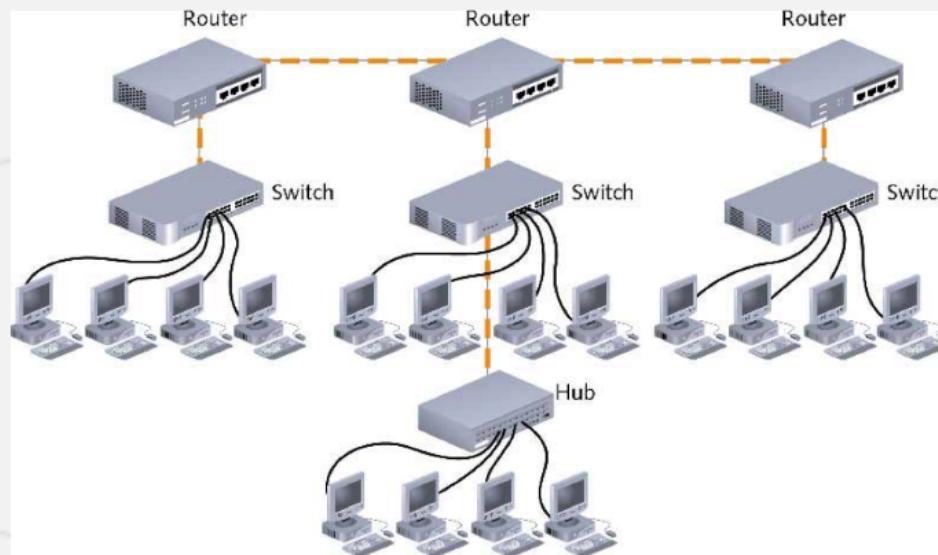
- Logical growth solution
- Low cost LAN infrastructure expansion
- Set standards

Disadvantages

- Limited distance between each device
- Exceeding the set standard will cause intermittent and unpredictable data transmission errors

2. Distributed Backbone

- A number of hubs connected to a series of central hubs or routers in a hierarchy
- All devices that access the backbone share the transmission media
- Typically used by large-scaled networks



2. Distributed (...)

Advantages

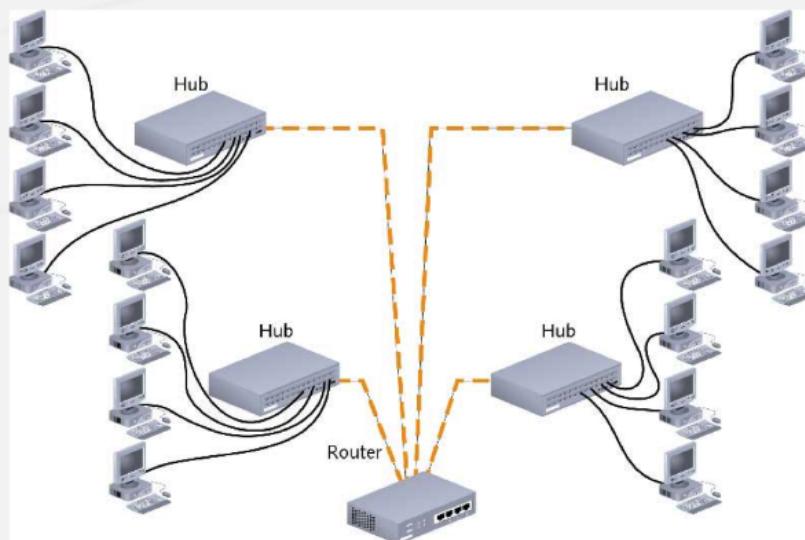
- Simple expansion
- Limited capital outlay
- Provides network admins the ability to segregate workgroups, which makes it easier to manage.
- Adapts well to an enterprise-wide network confined to a single building
 - Layers of hubs can be assigned according to the floor or department
 - Each floor or department has a wiring closet with their main hub or router connected to a bus style network using backbone cabling

Disadvantage

- Potential for single failure points

3. Collapsed Backbone

- Uses star or tree topology
- Uses a router or switch as a single central connection point for multiple subnetworks
 - Switch or router must contain multiprocessors to handle the heavy traffic



3. Collapsed (...)

Advantages

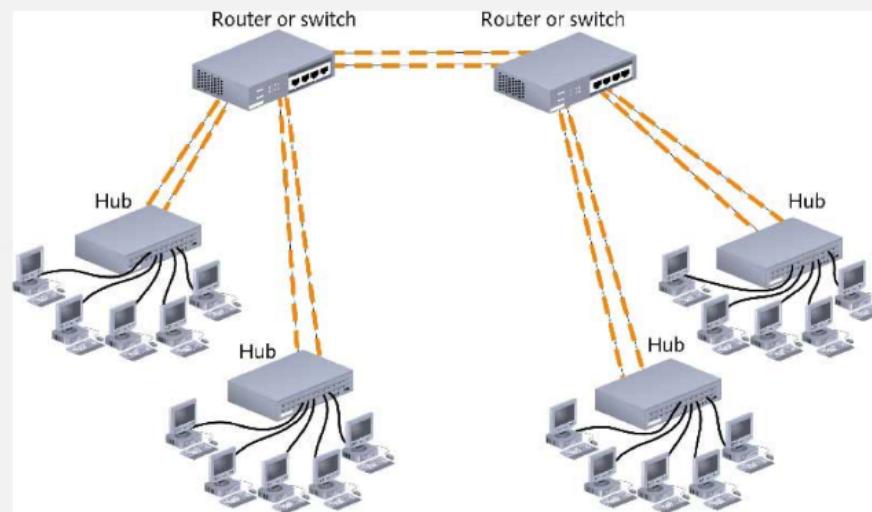
- Easier to manage since backbone is in single location
- Easier to keep secure
- Less costly because there are fewer networking devices

Disadvantage

- Requires extra cabling, especially over longer distances
- Single Failure Point

4. Parallel Backbone

- Most robust network backbone
- More than one connection from the central router or switch by more than one cable
- Used when there are critical devices on network
 - Example: important data, such as payroll, that should be accessed at all times by multiple departments



4. Parallel (...)

Advantages

- Redundant links ensure network connectivity to any area of the enterprise
- Offers increased performance
 - Makes up for the cost of additional cabling
- Better fault tolerance

Disadvantage

- Most expensive because it requires much more cabling

NETWORK TOPOLOGIES

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Definitions

Computer Network: A group of computer systems and other devices that are connected together through communication channels.

Different types of networks:
- Local Area Networks (LAN)
- Wide Area Networks (WAN)
- Metropolitan Area Networks (MAN)

Definitions (...)

Media: A connecting device or a medium used to connect two or more nodes in a network.

Network Topology: The physical arrangement of the network components and their interconnections.

- The physical or logical structure of a network.

Bus Network

Bus Topology: A network topology in which each node is connected to a single central bus line.

The bus acts as a shared medium for all nodes connected to it.

Advantages:
- Simple and cost-effective.
- Easy to install and maintain.

Disadvantages:
- If one node fails, it can affect the entire network.

Bus Network (...)

Star Topology: A network topology where each node is connected to a central hub or switch.

Advantages:
- High reliability.
- Easy to troubleshoot.

Disadvantages:
- Expensive to install.

Tree Network

Tree Topology: A hierarchical network structure where each node has a single parent node, except for the root node which has no parent.

Advantages:
- Scalable.
- Efficient for large networks.

Disadvantages:
- Difficult to troubleshoot.

Tree Network (...)

Ring Network

Ring Topology: A network topology where nodes are connected in a ring and pass information to the next node in the ring sequentially.

Advantages:
- High reliability.
- Easy to troubleshoot.

Disadvantages:
- Limited scalability.

Star Network

Star Topology: A network topology where each node is connected to a central hub or switch.

Advantages:
- High reliability.
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Disadvantages:
- Expensive to install.

Star Network (...)

Packet Switching

Packet switching refers to dividing messages into small packets and sending them over a network.

Advantages:
- Efficient use of bandwidth.

Disadvantages:
- Higher latency.

Packet Switching (...)

Message Switching

Message switching refers to sending the entire message at once.

Advantages:
- Lower latency.

Disadvantages:
- Higher bandwidth requirements.

Message Switching (...)

Circuit Switching

Circuit switching is a connection-oriented data transfer method.

Advantages:
- Low latency.

Disadvantages:
- High bandwidth requirements.

Circuit Switching (...)

Logical vs. Physical

Logical Topology: How nodes appear connected to the user.

Physical Topology: How devices are physically connected.

Advantages:
- Simplified management.

Disadvantages:
- Increased complexity.

Logical Topology (...)

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- Increased complexity.

Physical Topology (...)

Backbone Networks

Backbone Networks: A network of networks.

Advantages:
- High-speed backbone linking multiple LANs.

Disadvantages:
- Complex to manage.

Backbone Networks (...)

1. Serial Backbone

Serial Backbone: A backbone network where data is transmitted sequentially between nodes.

Advantages:
- Simple to implement.

Disadvantages:
- Low bandwidth.

Serial Backbone (...)

2. Distributed Backbone

Distributed Backbone: A backbone network where data is transmitted simultaneously between nodes.

Advantages:
- High bandwidth.

Disadvantages:
- Complex to implement.

Distributed Backbone (...)

3. Collapsed Backbone

Collapsed Backbone: A backbone network where data is transmitted sequentially between nodes.

Advantages:
- Simple to implement.

Disadvantages:
- Low bandwidth.

Collapsed Backbone (...)

4. Parallel Backbone

Parallel Backbone: A backbone network where data is transmitted simultaneously between nodes.

Advantages:
- High bandwidth.

Disadvantages:
- Complex to implement.

Parallel Backbone (...)

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Physical Topology (...)

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