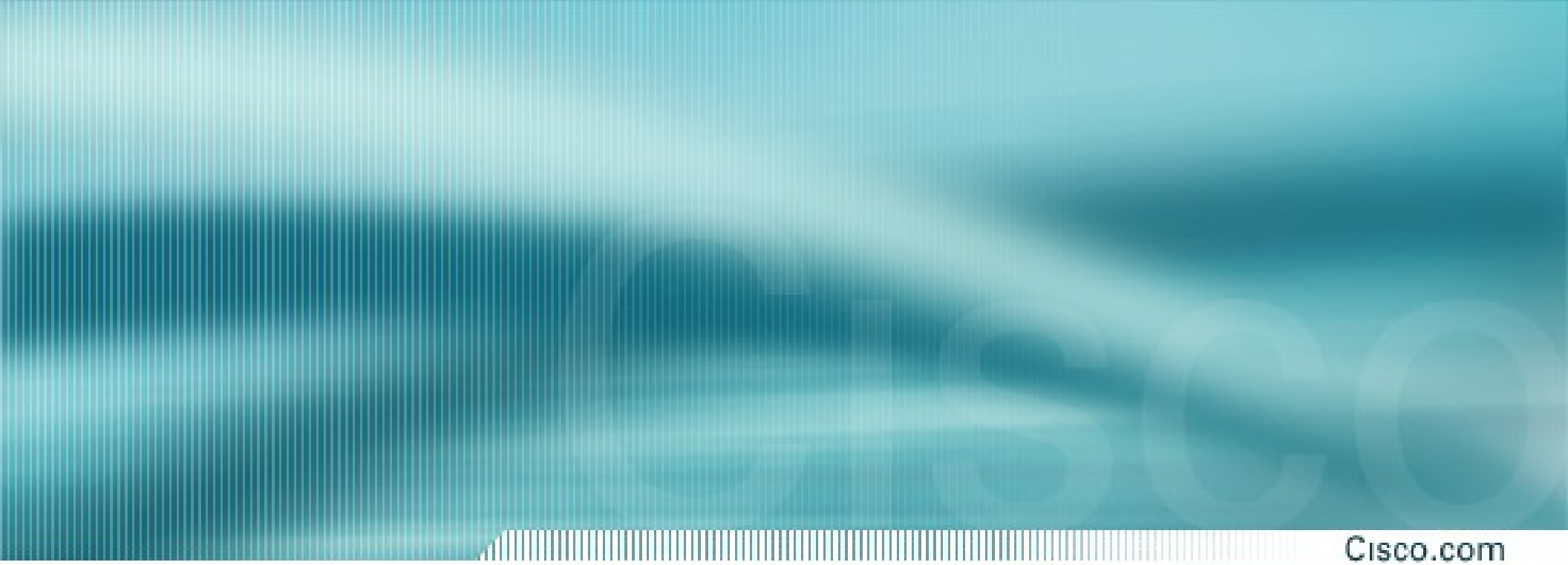


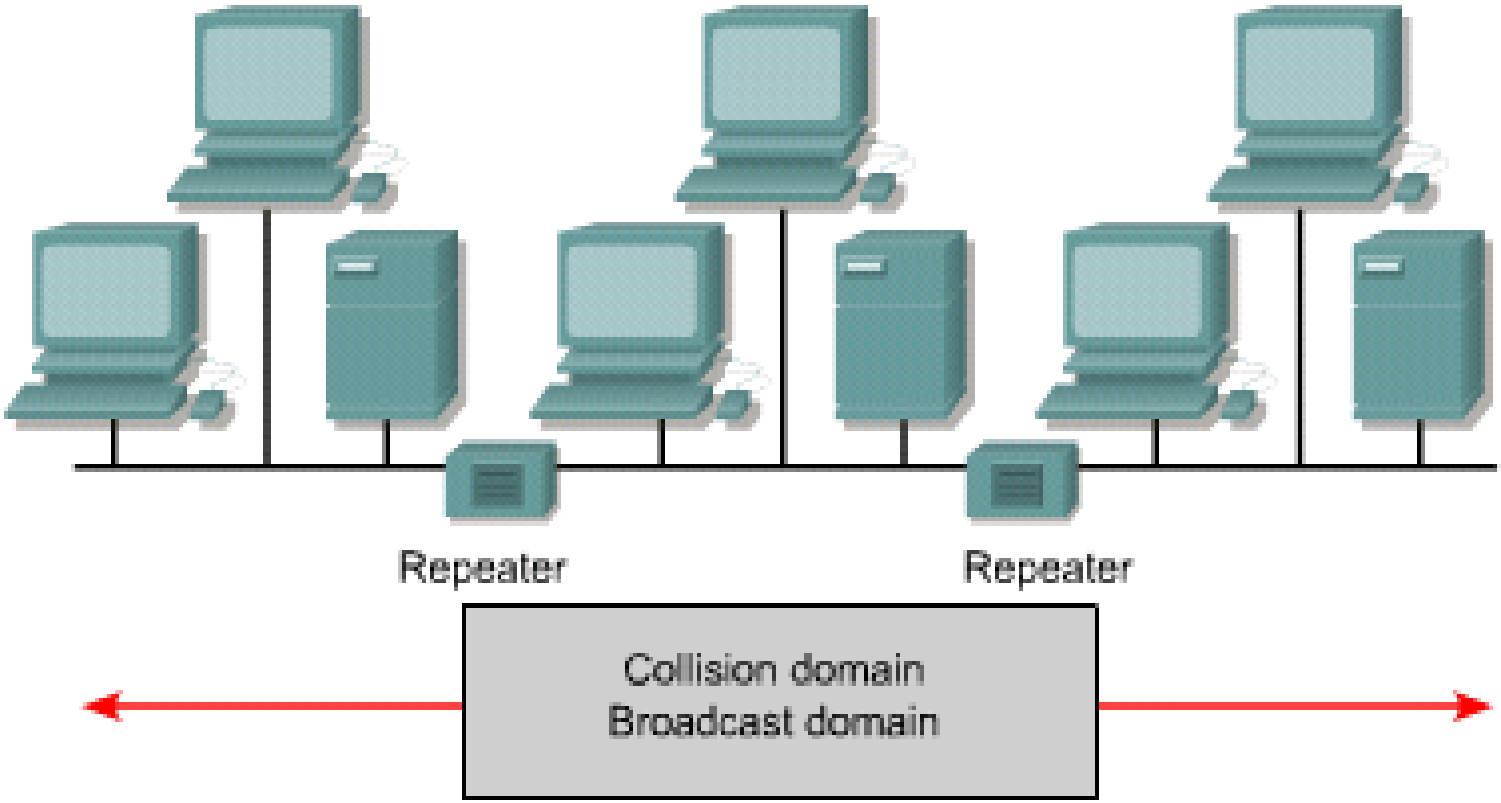
Switching Concepts

Slide Set 5

Switches and Bridges

- Make decisions when frames are received
  - select a path or circuit to send a frame to its destination
- Layer 2 devices
  - increases the number of collision domains
  - hosts connected to the switch are part of the same broadcast domain
- Used to
  - increase available bandwidth
  - reduce network congestion
- Switch segments a LAN into microsegments
  - segments with only a single host
  - creates multiple collision-free domains

Repeaters



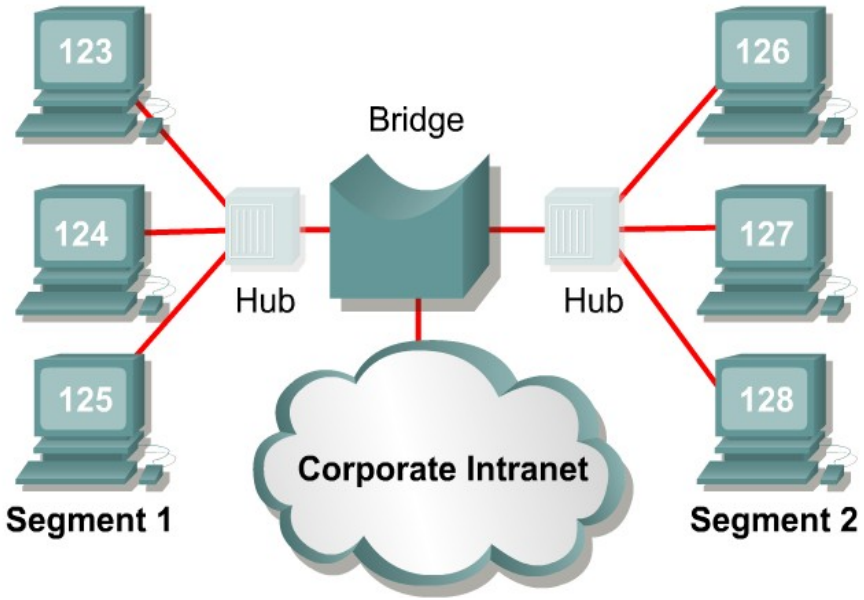
- Repeaters are Layer 1 devices that regenerate the signal, and pass it on
- Repeaters allow a longer end-to-end distance
- Repeaters increase the collision domain size
- Repeaters increase the broadcast domain size

Hub

- Layer 1 device (*physical layer*)
- Ethernet concentrator or a multi-port repeater
- No decision made at this level (*no addressing*)
- Takes data signal in one port
  - Regenerates, retimes and amplifies the data signals
  - Sends (*Broadcasts*) data signal out all other ports
- All users connected to the hub compete for the same bandwidth (*shared bandwidth*)
  - 50% – 60% bandwidth available
- Increase collision domains (*extends*)
- Increase broadcast domains (*extends*)
- Only 1 device can transmit at a time

Bridge

- Layer 2 device (*data link layer)*
- Creates 2 network segments
  - 2 collision domains – creates smaller collision domains
  - 2 bandwidth domains
- Do not restrict broadcast traffic – (forwards broadcasts)
- Learns MAC address of all devices on each segment
  - Use this to build bridging table
  - Forwards/blocks traffic based on table
- Makes decisions based on MAC
  - Increase latency by 10 to 30 percent
  - Switching occurs using software
- Store and forward device
- Adds 10% to 30% latency



Switch

- Layer 2 device (*data link layer*)
- Multiport bridge or switching hubs
- Provides microsegmentation (point-to-point link)
  - It isolates traffic among segments
  - creates a collision free environment between the source and destination
  - Each segment uses CSMA/CD (allows multiple communications on different segments)
  - Each port has dedicated bandwidth (100% bandwidth available)
- Makes decisions based on MAC addresses
  - Held in Content Addressable Memory
  - Switching occurs using hardware
- Decreases collision domain
  - 1 collision domain per segment (increases number of collision domains)
- Increases broadcast domain (*Extends*)
  - Broadcasts sent out very port

Network Performance

- LANs are increasingly congested and overburdened
  - Growing population of network users
  - Multitasking environment
    - increased demand for network resources
  - The use of network intensive applications
    - e.g. WWW, multimedia, e-mail
  - Client/server applications
- This has resulted in
  - a need for more bandwidth
  - slower response times
  - longer file transfers
  - network users becoming less productive

Elements of Ethernet 802.3

- Used to transport data between devices on a network (*computers, printers, and file servers*)
- Multi-access broadcast technology
  - Shared media
- Uses CSMA/CD to allows one station transmit at a time
- Latency as frames travel across media
- Repeaters extend distances (*increase latency*)
- Layer 2 devices improve performance

Network Latency

- Latency, or delay, is the time a frame or a packet takes to travel from the source to the final destination
- Latency sources:

Transmit delay and Buffering delay (NIC Delay)

The time it takes to inject the data (as pulses) on the network at the sender and the time to buffer the data at the receiver

Transmit delay = Buffering delay = size of data/bandwidth available

Propagation delay

Signal takes time to travel along the cable = Distance traveled/speed of signal

About 0.556 microseconds per 100 m for Cat 5 UTP

Networking devices

Layer 1 no decisions less latency

Layer 2 devices make layer 2 decisions increased latency

Layer 3 devices make layer 3 decisions most latency

Ethernet X-BaseT Transmission

- The time it takes a frame to be transmitted

  Number of bits being sent * Technology Bit time

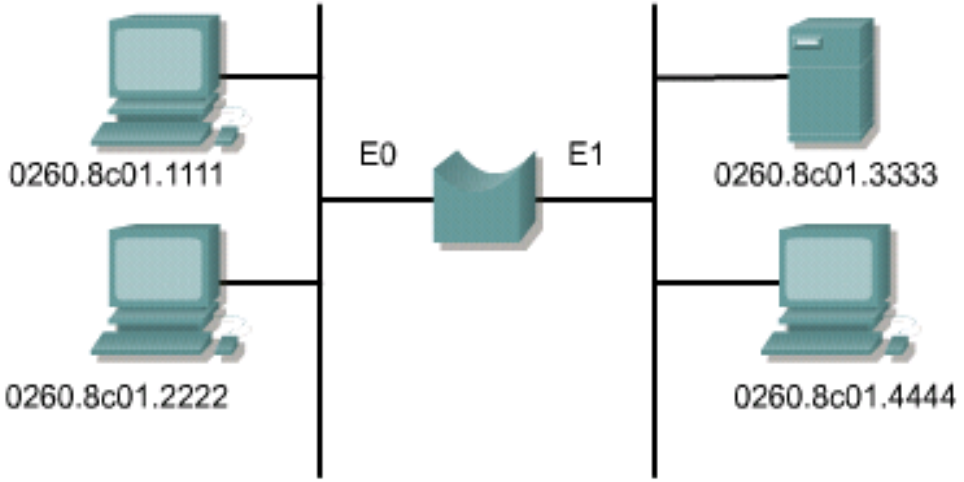
- 10 Mbps Ethernet bit has a 100 ns transmission window (bit time of 100 ns)

  1 byte is 8bits * 100ns = 800 ns to transmit

- 100Mbps = 10ns
- 1000Mbps = 1 Gbps = 1ns

Frame Size in Bytes	Transmission Time in Microseconds
64	51.2
512	410
1000	800
1518	1214

LAN Segmentation with Bridges



Interface	MAC address
E0	0260.8c01.1111
E0	0260.8c01.2222
E1	0260.8c01.3333
E1	0260.8c01.4444

Operation of a bridge is transparent to other network devices

Bridge increases latency by 10% to 30%

- Due to decision making process

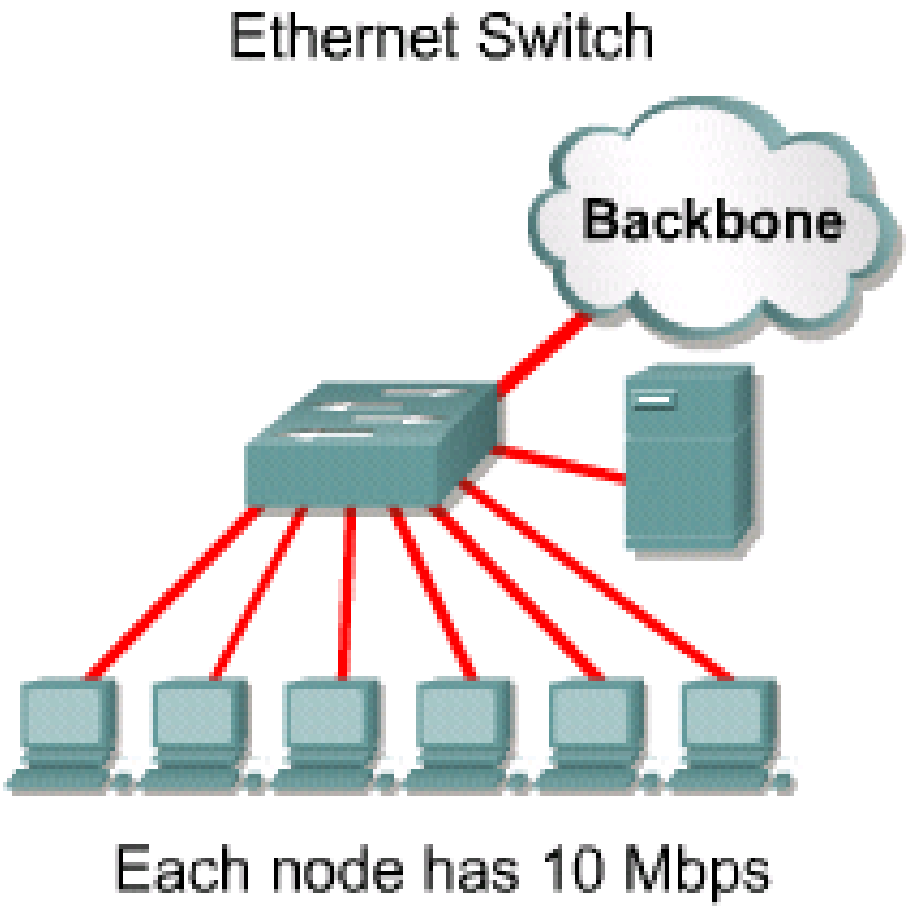
Bridge is a store-and-forward device

- Examine the destination address field
- Calculate the cyclic redundancy check (CRC)
- Forward the frame

Bridge can temporarily store the frame if a port is busy

Forward broadcasts

LAN Segmentation with Switches



Segment LAN into microsegments

Decreases collision domains size

Extends broadcast domain

Virtual network circuit is established within the switch and exists only when the nodes need to communicate

How do Switches and Bridges Filter Frames

- Bridges are capable of filtering frames based on any Layer 2 fields
- Bridge can be programmed to reject/not forward

  All frames sourced from a particular network

  Based on upper network layer protocols

  filters out unnecessary broadcast and multicast packets
- Ignoring a frame is called filtering.
- Copying the frame is called forwarding.

Symmetric and Asymmetric Switching

- based on the way bandwidth is allocated to the switch ports
- Symmetric switch

  switched connections between ports with the same bandwidth (all 10Mbps or all 100Mbps)
- Asymmetric switch

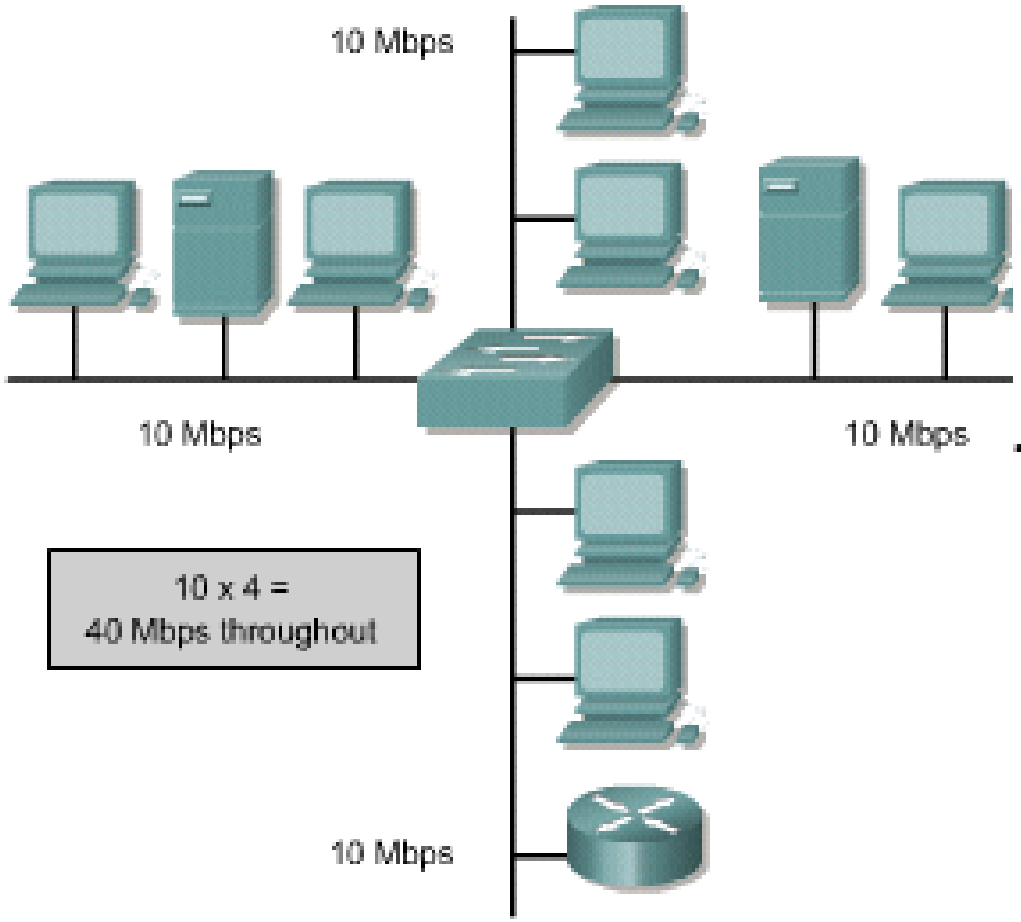
  switched connections between ports of unlike bandwidth

  combination of 10 and 100 Mbps ports

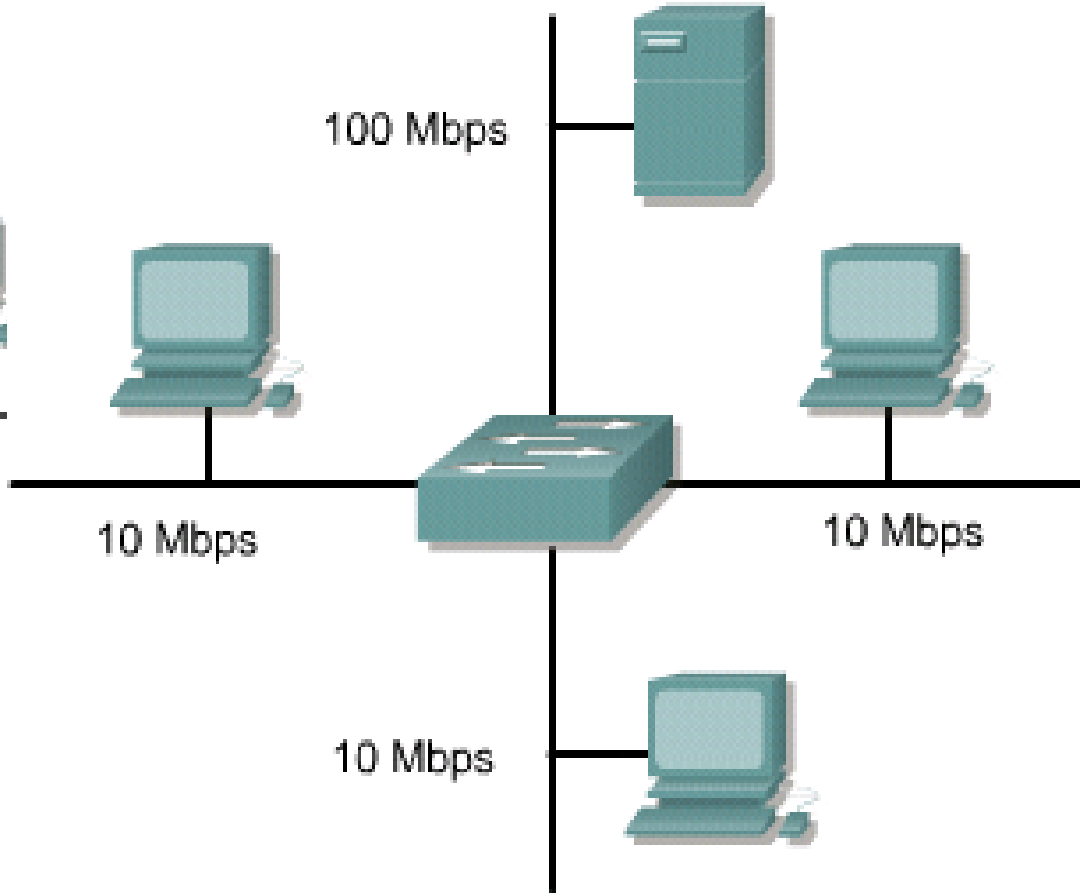
  Enables more bandwidth to be dedicated to the server switch port in order to prevent a bottleneck

  Memory buffering is required (keeps the frames contiguous between different data rate ports)

Symmetric Switching



Asymmetric Switching



Switching Methods

1. Store and Forward

   Entire frame is received before any forwarding

   Increases latency

   Filters can be applied to destination and source addresses

   Frame can be checked for errors and hence discarded if corrupted

2. Cut-Through

   At least the frame destination address must be read before the frame can be forwarded

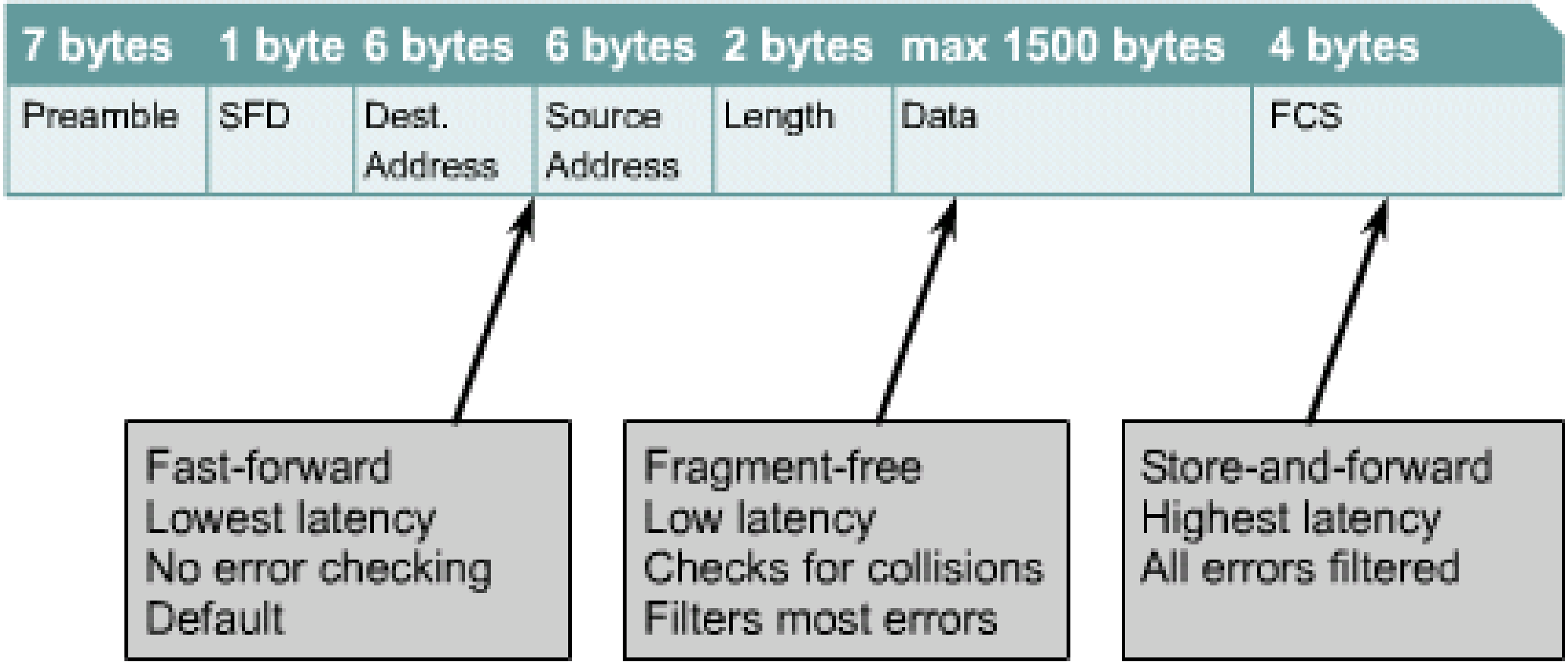
   Decreases latency (Buffer time at switch decreases proportionally)

   No error detection

Types of Cut-Through Switching

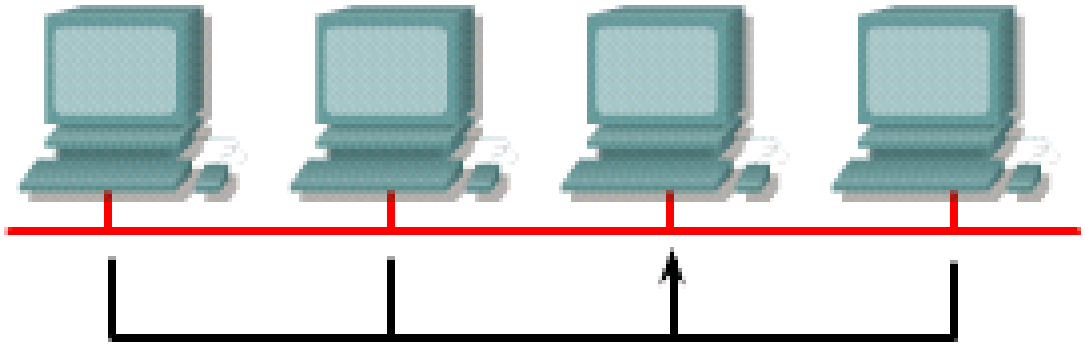
1. **Fast-forward**
   - Lowest level of latency
   - Immediately forwards packet after reading destination address
   - No error checking
   - Destination network adapter will discard the faulty packet upon receipt
2. **Fragment-free**
   - Filter out collision fragments before forwarding begins
   - Reads first 64 bits to identify if a collision occurred

Frame Transmission Modes



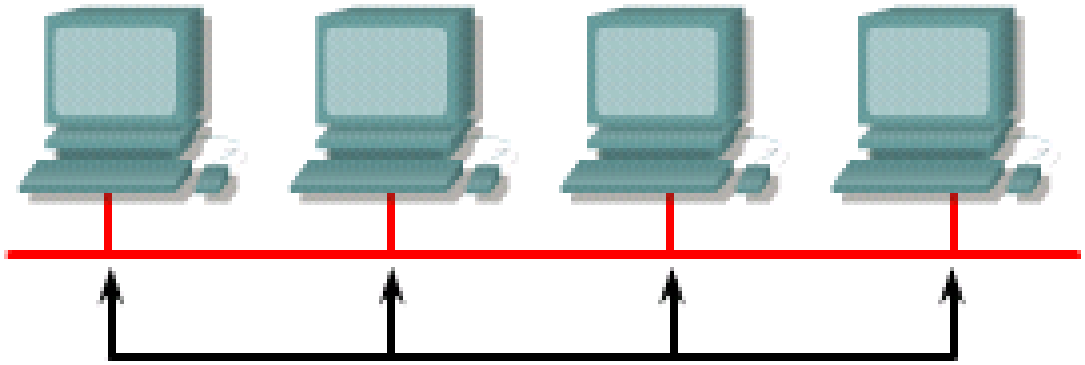
Switches and Broadcast Domains

Unicast



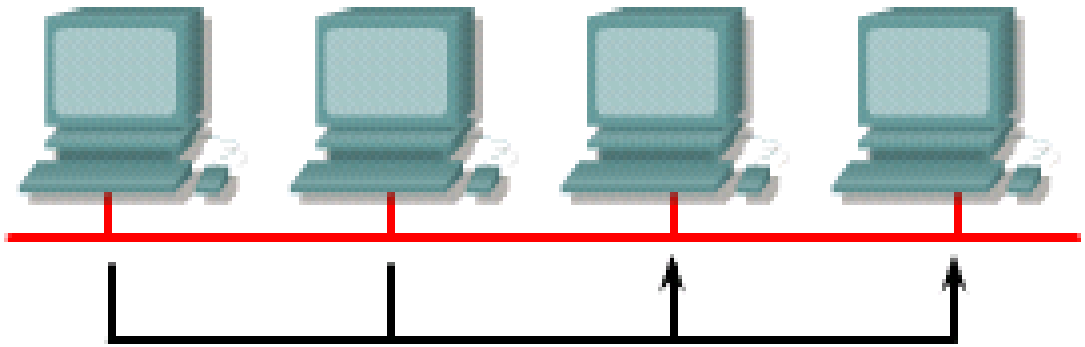
one transmitter tries to reach one receiver

Broadcast



one transmitter
tries to reach only a subset or a group
of the entire segment.

Multicast



one transmitter
tries to reach all receivers in the network

- When a device wants to send out a Layer 2 broadcast
  - Destination MAC address in the frame is set to all ones
  - FF:FF:FF:FF:FF:FF in hexadecimal
  - MAC broadcast domain
- When a switch receives a broadcast
  - it forwards it to each port on the switch except the incoming port
  - Each attached device must process the broadcast frame
- Broadcasts reduce available bandwidth