LAN Overview (Part 3)

CSE 3213

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Interconnecting LANs

- Bridges
- Hubs
- Layer 2 switches
- Layer 3 switches

HUBS

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Hubs

- Active central element of star layout
- Each station connected to hub by two lines
  - Transmit and receive
- Hub acts as a repeater
- When single station transmits, hub repeats signal on outgoing line to each station
- Line consists of two unshielded twisted pairs
- Limited to about 100 m
  - High data rate and poor transmission qualities of UTP
- Optical fiber may be used
  - Max about 500 m
- Physically star, logically bus
- Transmission from any station received by all other stations
- If two stations transmit at the same time, collision

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Hub Layouts

- Multiple levels of hubs cascaded
- Each hub may have a mixture of stations and other hubs attached to from below
- Fits well with building wiring practices
  - Wiring closet on each floor
  - Hub can be placed in each one
  - Each hub services stations on its floor

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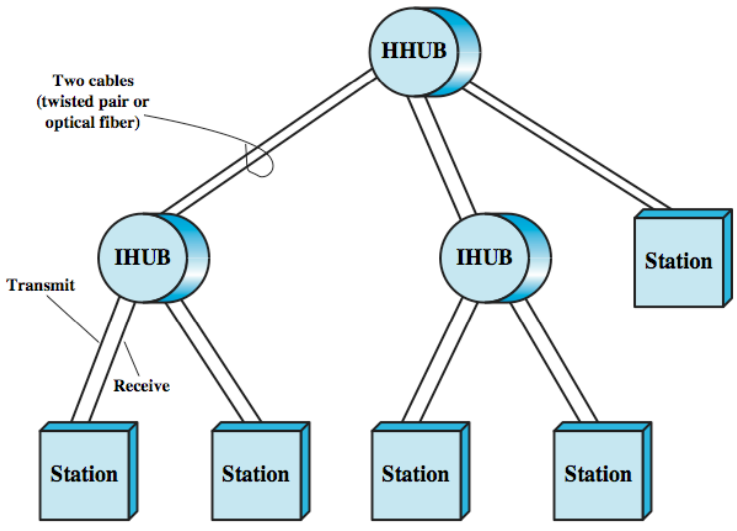
Two Level Hub Topology



Buses, Hubs and Switches

- Bus configuration
  - —All stations share capacity of bus (e.g. 10Mbps)
  - —Only one station transmitting at a time
- Hub uses star wiring to attach stations to hub
  - —Transmission from any station received by hub and retransmitted on all outgoing lines
  - —Only one station can transmit at a time
  - —Total capacity of LAN is 10 Mbps
- Improve performance with layer 2 switch
  - —can switch multiple frames between separate ports
  - —multiplying capacity of LAN

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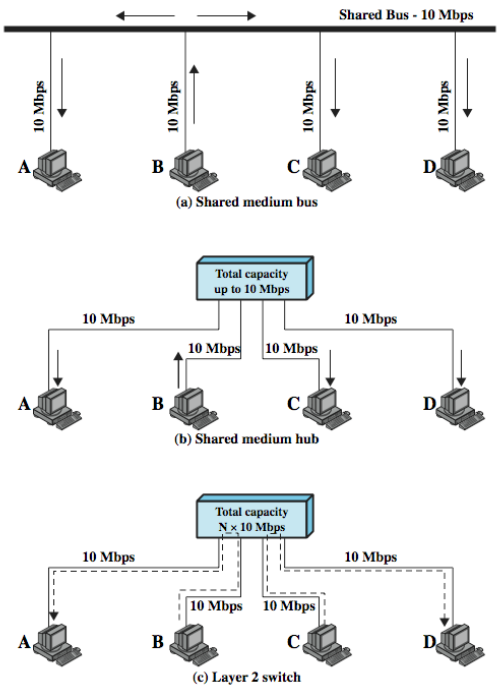
Shared Medium Bus and Hub



LAYER 2/3 SWITCHES

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Layer 2 Switches

- Central hub acts as switch
- Incoming frame from particular station switched to appropriate output line
- Unused lines can switch other traffic
- More than one station transmitting at a time
- Multiplying capacity of LAN

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Layer 2 Switch Benefits

- No change to attached devices to convert bus LAN or hub LAN to switched LAN
- For Ethernet LAN, each device uses Ethernet MAC protocol
- Device has dedicated capacity equal to original LAN
  - Assuming switch has sufficient capacity to keep up with all devices
  - For example if switch can sustain throughput of 20 Mbps, each device appears to have dedicated capacity for either input or output of 10 Mbps
- Layer 2 switch scales easily
  - Additional devices attached to switch by increasing capacity of layer 2 switch

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Types of Layer 2 Switch

- Store-and-forward switch
  - Accepts frame on input line
  - Buffers it briefly,
  - Then routes it to appropriate output line
  - Delay between sender and receiver
  - Boosts integrity of network
- Cut-through switch
  - Takes advantage of destination address appearing at beginning of frame
  - Switch begins repeating frame onto output line as soon as it recognizes destination address
  - Highest possible throughput
  - Risk of propagating bad frames
    - Switch unable to check CRC prior to retransmission

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Layer 2 Switch vs Bridge

- Layer 2 switch can be viewed as full-duplex hub
- Can incorporate logic to function as multiport bridge
- Bridge frame handling done in software
- Switch performs address recognition and frame forwarding in hardware
- Bridge only analyzes and forwards one frame at a time
- Switch has multiple parallel data paths
  - Can handle multiple frames at a time
- Bridge uses store-and-forward operation
- Switch can have cut-through operation
- Bridge suffered commercially
  - New installations typically include layer 2 switches with bridge functionality rather than bridges

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Layer 2 Switch Problems

- broadcast overload
  - users share common MAC broadcast address
  - broadcast frames are delivered to all devices connected by layer 2 switches and/or bridges
  - broadcast frames can create big overhead
  - broadcast storm from malfunctioning devices
- lack of multiple links
  - limits performance & reliability

Problems with Layer 2 Switches (1)

- As number of devices in building grows, layer 2 switches reveal some inadequacies
- Broadcast overload
- Lack of multiple links
- Set of devices and LANs connected by layer 2 switches have flat address space
  - All users share common MAC broadcast address
  - If any device issues broadcast frame, that frame is delivered to all devices attached to network connected by layer 2 switches and/or bridges
  - In large network, broadcast frames can create big overhead
  - Malfunctioning device can create broadcast storm
    - Numerous broadcast frames clog network

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Problems with Layer 2 Switches (2)

- Current standards for bridge protocols dictate no closed loops
  - Only one path between any two devices
  - Impossible in standards-based implementation to provide multiple paths through multiple switches between devices
    - Limits both performance and reliability.
- Solution: break up network into subnetworks connected by routers
- MAC broadcast frame limited to devices and switches contained in single subnetwork
- IP-based routers employ sophisticated routing algorithms
  - Allow use of multiple paths between subnetworks going through different routers

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Problems with Routers

- Routers do all IP-level processing in software
  - —High-speed LANs and high-performance layer 2 switches pump millions of packets per second
  - —Software-based router only able to handle well under a million packets per second
- Solution: layer 3 switches
  - —Implement packet-forwarding logic of router in hardware
- Two categories
  - —Packet by packet
  - —Flow based

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Packet by Packet or Flow Based

- Operates insame way as traditional router
- Order of magnitude increase in performance compared to software-based router
- Flow-based switch tries to enhance performance by identifying flows of IP packets
  - —Same source and destination
  - —Done by observing ongoing traffic or using a special flow label in packet header (IPv6)
  - —Once flow is identified, predefined route can be established

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Typical Large LAN Organization

- Thousands to tens of thousands of devices
- Desktop systems links 10 Mbps to 100 Mbps
  - Into layer 2 switch
- Wireless LAN connectivity available for mobile users
- Layer 3 switches at local network's core
  - Form local backbone
  - Interconnected at 1 Gbps
  - Connect to layer 2 switches at 100 Mbps to 1 Gbps
- Servers connect directly to layer 2 or layer 3 switches at 1 Gbps
- Lower-cost software-based router provides WAN connection
- Circles in diagram identify separate LAN subnetworks
- MAC broadcast frame limited to own subnetwork

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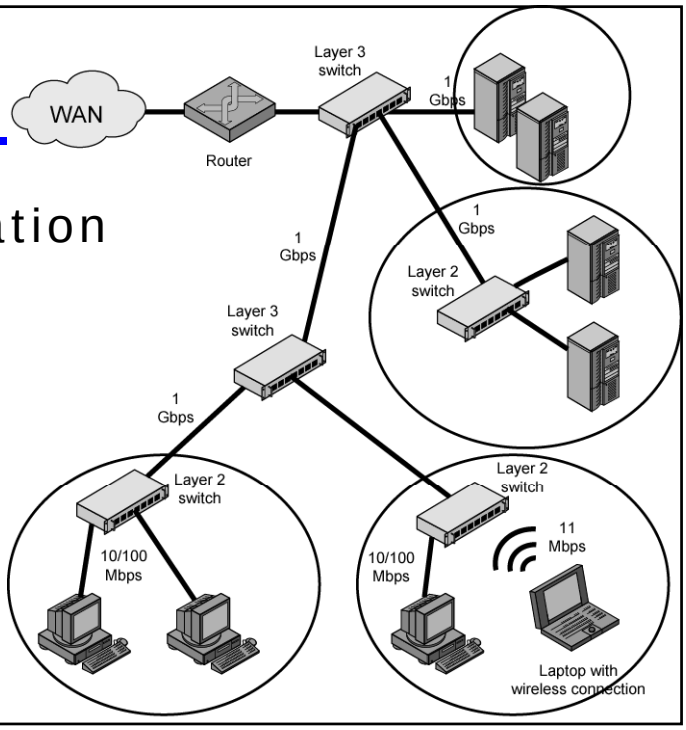
Typical Large LAN Organization Diagram



Reading

- Chapter 15, Stallings' book
- Chapter 6, Leon-Garcia's book (optional)

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