CS 640 Introduction to Computer Networks

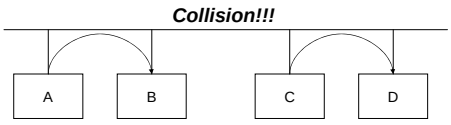
Lecture 19

Today's lecture

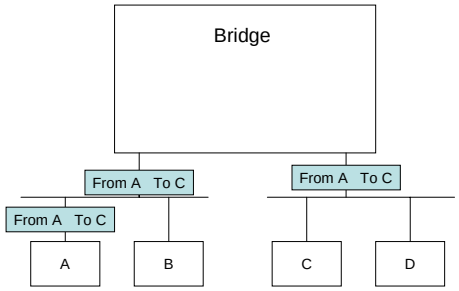
- Ethernet bridging
  - The learning bridge
  - Spanning tree algorithm for bridges
  - VLANs (Virtual LANs)
- Auxiliary protocols between layers 2 and 3
  - ARP
  - DHCP

Why use Ethernet bridges?

- Larger networks
- More concurrent communication
- Extend Ethernet without changing computers



Basic transparent bridge



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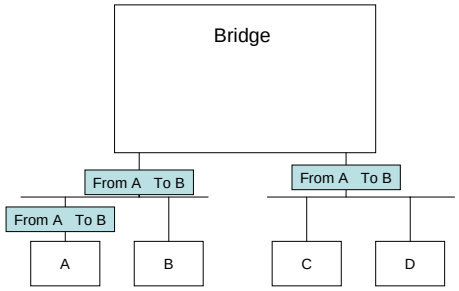
Basic transparent bridge



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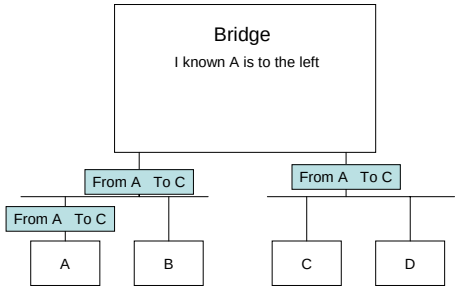
Learning bridge



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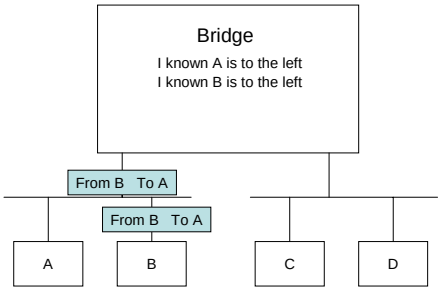
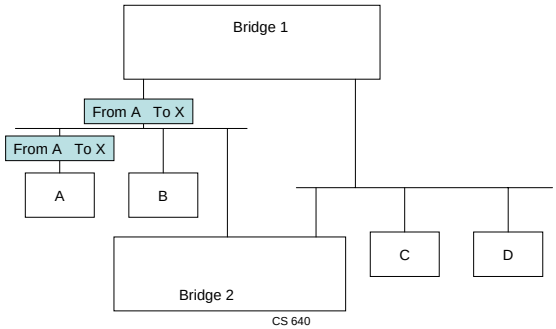
Learning bridge



Learning bridges

- Initially forward frames onto all ports
- Learn where hosts are based on **source** address
- For known addresses only forward to right port
- Multicast/broadcast go to all ports
- Terminology
  - For twisted pair based Ethernet
    - Repeaters are called hubs
    - Bridges are called switches
  - A segment or collision domain has wires and hubs
    - LAN vs. extended LAN

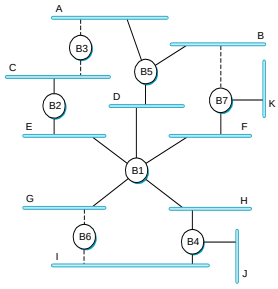
What happens with cycles



Solution: eliminate cycles

- On power up Ethernet bridges run a distributed spanning tree algorithm
  - Node with lowest ID is root
  - Spanning tree is the tree of shortest paths to root
  - Break ties based on bridge IDs
- Ports that are not part of the spanning tree are turned off to data traffic
  - All cycles eliminated

Spanning tree algorithm details



- Message format: (root, distance, bridgeID)
- Each bridge stores best message for each port
- Each bridge picks port closest to root
- Best message is flooded with distance incremented
- Each segment "elects" a designated bridge
- The root repeats message
- Messages are timed out

Ethernet today

- Limits to growth of bridged LANs
  - Traffic due to broadcast/multicast frames still goes to all segments
  - Throughput at root switch becomes bottleneck
    - Can have faster switches towards the middle
- Bonus for switched Ethernet: better security
  - Hosts cannot snoop on others' traffic
  - Today switches have advanced features (VLANs)

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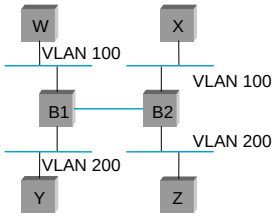
Why restrict reachability?

- Security – multiple defenses
  - Sometimes you don't want some computers to communicate with the outside world
- Performance
  - Protect the performance of virtual networks from the effects of the rest of the traffic
  - VLANs cut down on broadcast traffic
- And sharing infrastructure reduces costs!!!

VLANs

- Bridges never forward frames from one VLAN to the other
- Each port is assigned to one VLAN
- Some ports assigned to many VLANs
  - Must add VLAN ID to frames



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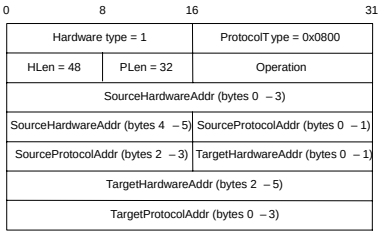
Address Translation

- To build Ethernet frame carrying IP packet, sender needs to find out Ethernet address of destination
- Cannot encode it in 32 bit IP address
- ARP (Address Resolution Protocol)
  - Table of IP to MAC address bindings
  - Broadcast request if IP address not in table
  - Target machine responds with its MAC address
  - Table entries are discarded if not refreshed

ARP Details

- Request Format
  - HardwareType: type of physical network (e.g., Ethernet)
  - ProtocolType: type of higher layer protocol (e.g., IP)
  - HLEN & PLEN: length of physical and protocol addresses
  - Operation: request or response
  - Source/Target-Physical/Protocol addresses
- Other details
  - Table entries timeout in about 10 minutes
  - Add entry to table with source of packets you receive
    - If entry exists, update/reset timer
  - Do not refresh table entries upon reference

ARP Packet Format



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Dynamic Configuration

- Computers running IP needs some network configuration information (own address, router's addr.)
- Can store information in per host configuration file
  - Hard to manage
  - Does not help with laptops moving between WLANs
- Dynamic configuration is the primary method for IP address allocation used today
  - IP address management centralized in DHCP server
  - No persistent configuration information stored on computers

Dynamic Host Configuration Protocol

- Server keeps pool of available IPs for use on demand
  - Computers request address when booting
  - IP addresses ***leased*** (may renew to keep same IP address)
- Administrator may assign permanent IP addresses to given hosts (as identified by Ethernet address)
- DHCP also manages other IP-related configuration
- The protocol relies on broadcast to find DHCP server