LAN Switching

- Circuit switching re-visited
- LAN Hub Operation
- LAN (layer 2) switching
- MAC & Global addressing
- Switching architectures and methods
  - Store-and-forward switching
  - Cut-through switching
  - Fragment-free switching
- Switching versus routing
Circuit Switching Re-visited

- Telephone circuit switching
- All phones are on-hook
- No circuits are established

Circuit Switching Re-visited...

- 555-1111 goes off-hook
- Dials 555-4444; 554-4444 rings

Circuit Switching Re-visited...

- 4444 goes off-hook, connects to 1111
- Circuit is completed, stays until dropped
- The circuit is dedicated to these 2 stations
Circuit Switching Re-visited . . .

- Why not use circuit switching for data?
  - Voice is (more or less) continuous
  - Data is very "bursty" & large bandwidth
  - Too much set-up and tear-down time
  - Very inefficient use of transmission facilities

LAN Hub Operation

- LAN hub operation re-visited
  - Physical structure is actually a bus
  - Ethernet operating as CSMA/CD

LAN Hub Operation . . .

- Let’s examine some transmissions
  - Station 39 listens, hears nothing
    - 39 sends a frame to station 45
LAN Hub Operation . . .
- All other stations hear the frame
- No other station can transmit
  - Station 45 receives the frame

LAN Hub Operation . . .
- Now station 45 wants to respond
- All is quiet, so station 45 sends a frame
  - But 72 also sends a frame at the same time

LAN Hub Operation . . .
- The two frames have a “collision”
- Both stations back off for a random time
  - Time is lost while waiting; the LAN is slowed
**LAN Hub Operation . . .**

- The 10 Mbps LAN becomes <2 Mbps LAN
  - More stations & more traffic slow it down
  - The common shared bus does not “scale”
- We need another architecture
  - But we have already purchased all these LAN stations, NIC cards, the hub and all cabling

**Enter LAN Switching**

- Change out the LAN hub for a “switch”
- The physical structure is unchanged
  - All LAN stations, NICs & cabling remain
  - One switch replaces one hub
  - The packet structure is unchanged

**Enter LAN Switching . . .**

- A changed architecture by changing 1 box
  - Stations no longer share a bus structure
  - Stations unaware of change: hub to switch
  - Each station still operates CSMA/CD
  - Never hears any traffic except for its own
Let’s examine some transmissions
- Station 39 listens, hears nothing
  - 39 sends a frame to station 45
  - The switch sets up a direct connection to 45
  - No other station hears and can send at will

Now station 45 wants to respond
- Station 45 sends a frame
  - But 72 also sends to 16 at the same time
  - Both frames are sent simultaneously
  - The LAN is operating at “wire speed”

The LAN switch adds several functions
- The switch isolates collision domains
- All stations can transmit immediately
- Effectively multiplies LAN's total bandwidth
- No station, NIC or cable modification needed
Enter LAN Switching . . .

- LAN switch functions . . .
  - Allows speed inter-operation: 10, 10/100
  - Even higher if the cabling will support
  - Stations migrate to higher speeds individually
  - LAN switching: depends on MAC addresses

Global Addressing

- 1-234-555-1111 is globally unique
  - 1 is the country code
  - 234 is the area-code (NPA)
  - 555 is the exchange (NXX)
  - 1111 is the subscriber line
- MAC addresses are also globally unique
  - Organizationally Unique Identifier (OUI)
  - Network Interface Card Specific (NIC)

Media Access Control

- MAC Addressing (802.2 Ethernet)
  - Preamble: 7 Bytes & Start of Frame: 1 Byte
  - Destination & Source Addresses: 6 Bytes
  - Length: 2 Bytes & Data: 46 to 1500 Bytes
  - Frame Check Sequence: 4 Bytes
Media Access Control . . .

- MAC Addressing (802.2 Ethernet) . . .
- Global MAC OUI addresses:
  - NN-NN-NN are NIC specific from vendor
  - Examples:
    - Linksys: 00-04-5A-NN-NN-NN
    - Cisco: 00-00-0C-NN-NN-NN
    - IBM: 00-02-55-NN-NN-NN
    - 3COM: 00-01-03-NN-NN-NN
    - Apple: 00-03-93-NN-NN-NN

Global Addressing . . .

- Internet Protocol addresses globally unique
  - IPv4 addresses are 32 bits long
    - Example IP address: 163.122.34.153
    - 10100011.01111010.00100010.10011001
  - IPv6 addresses are 128 bits long
    - Example: 2001:db8:85a3::8a2e:370:7334
    - Details will be examined later in this class
  - IP addresses are assigned at configuration
    - Network Administrators assign to each device
    - No two addresses can be the same (ex. Private)

LAN Switches

- Really intelligent hubs with memory
  - Shared Bus architecture
  - Matrix architecture
- Three basic switching methods
  - Store-and-forward switching
  - Cut-through switching
  - Fragment-free switching
Store-and-Forward Switching
- Switch buffers incoming frames
  - Learns destination & source addresses
  - "Remember" source port MAC addresses
  - Does a CRC check on incoming frames
  - Discards failing CRC frames
  - Forwards the full frame to destination
- Performance drawback
  - The entire frame is stored

Cut-Through Switching
- Switch examines incoming frames
  - Learns destination & source addresses
  - "Remember" source port MAC addresses
  - Sends frame immediately after header
  - Significant reduction in switch "latency"
  - However, bad frames may be forwarded
  - Cut-Through switching use is limited
    - Used in network cores where errors limited

Fragment-free Switching
- Switch examines incoming frames
  - Learns destination & source addresses
  - "Remember" source port MAC addresses
  - Stores the first 64 bytes
  - If no errors, flows frame to destination
    - Assumption: most errors occur in 1st 64 B
  - Compromise between S&F & Cut-Thru
LAN Switches

- Workgroup switches: 10/100 support
- Backbone switches: 100/G/10G
  - Support multi, simultaneous sending
  - Segment networks to balance traffic
  - Buffer and flow control network traffic
  - Support full duplex transmission
    - Thereby eliminating all collisions
- Best practice: remove hubs, use switches

Switching vs. Routing

- Switching at Layer 2
  - MAC addresses learned by the switch
  - Each switch learns independently
  - Addresses not learned sent upward
- Routing at Layer 3 (switching exists)
  - Routers learn addresses from each other
  - RIP & OSPF messages are exchanged
  - Routing will be studied later in this class

Week 5 Summary

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