ECE 435 – Network Engineering
Lecture 21

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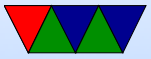
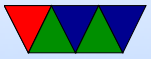
Announcements

- HW#10 will be posted
- New faculty interviews wed/thurs/next-thurs
- Don't forget course evals
- Will send out project schedule
- Will review for final on Thursday
- Project presentations will be in class, but remote over zoom. Aim for around 8 minutes
- Writeup due last day of finals



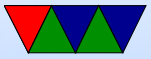
Homework #8 Review

- Questions
  1. S/N is 25. db=10 log S/N, roughly 14dB
  2. 100MHz, 17dB, Shannon? bps = Hlog 2 (1 + S/N)
     S/N = 50, bps = 100M*log2(1+50) = 567Mbps
  3. Fiber over copper
     Speed? This varies, Electrons in copper 50-90% of speed of light, Light in fiber 70-90%
  4. Satellite over fiber:
     no need to run cables everywhere



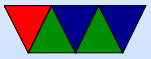
Can broadcast over greater area

5. Fiber over satellite:
   less secure (easier to tap)
   longer latency
   Cost? Which is more expensive?
   faster?
6. FCC won't let me be
   Though they only regulate consumer, federal govt (like military, FAA, etc, NTIA National Telecommunications and Information Administration) 4.3GHz airport/radio navigation



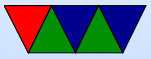
FCC database lists numerous companies, but they don't own freq, just have license to make radio altimeters

100W sounds like a lot, but as long as you're not holding it in your hands not really that large for a transmitter. HAM radios, 100W light bulbs.

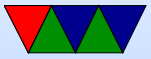


Bridging

- How do you connect together multiple groups of machines into one big LAN?
- An interconnection at the link layer is called a MAC bridge, or bridge. Also a Layer-2 switch
- IEEE 802.1D
- Transparent bridge, as users are not aware of them
- Bridge acts in promiscuous mode (receives every frame

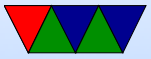


on the LAN) so it can find ones that need to forward on across the bridge



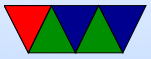
Backward/Self Learning

- How does bridge learn the MAC addresses?
- It watches for frames coming in and their source address. Puts in table.
- How does it learn where destination is? It broadcasts to all. Once the destination also sends a frame (so its source is known) then the switch updates its table and no longer broadcasts.
- How do you handle machines that are moved? Aging



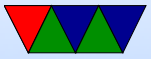
mechanism. If not heard from for a while, expire the table

- Multicast or Broadcast, can follow GMRP or GARP to limit how far it is broadcast



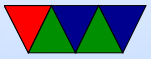
Bridge vs Switch

- Before 1991 a switch was a bridge (in the standard)
- In 1991 Kalpana made a “switch” and differentiated it by cut-through instead of store and forward
- Store and forward – whole frame received before resent larger latency, no problem with broadcast, can check FCS
- cut-through – can start transmitting before receiving completely (destination MAC at beginning). Slightly



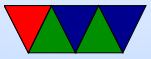
better latency, broadcast not possible, too late to check FCS

- These day most are store and forward



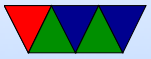
Terminology

- repeater – purely electronic, resends voltages (original Ethernet allowed four)
- hubs – frames coming in one port sent to all others
  creates a collision domain
- bridge – connects two or more LAs. Each line own collision domain
  can maybe bridge different types of networks (Ethernet/token, wired/wireless)
- switch – point-to-point frame routing, sort of like one



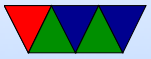
bridge per port

- router – higher layer, actually strips off headers and looks at packets



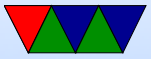
Switch Implementation

- Can implement in software with an OS like Linux
- Multiple ethernet cards
- Use operating system bridge support to bridge the interfaces together



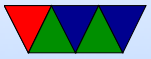
Spanning Tree Protocol

- Invented by Radia Perlman at DEC
- Can have problems if cause a loop in the topology. Frames can circulate loop forever
- Why have a loop then? Redundancy.

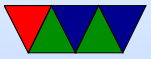


Spanning Tree Protocol – 802.1D

- Each switch and port assigned an ID with priority
- Each link assigned a cost, inversely proportional to link speed
- The lowest ID gets to act as root (there is a protocol on how to elect the root)
- Each LAN connected to upstream port in active topology, called the dedicated port. Receives from root port
- Config info comes from root as bridge protocol data unit (BPDU) on reserved multicast address 01:80:c2:00:00:00

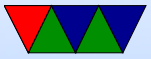


- Switch may configure itself based on BPDU.
- Can take 30-50s to notice failure



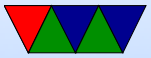
Rapid Spanning Tree Protocol – 802.1w

- Modern replacement
- Can detect failure in milliseconds



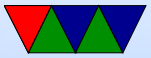
Bridging 802.11 to 802.3

- Need to strip off one header, put new one on
- Need to put fields in as needed, recalc checksum, etc
- What if bridging faster net to slower one
- What if maximum frame size different on different LANs? Can't always fragment
- What if one has encryption and one doesn't
- What of quality of service?



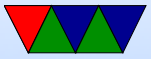
Why might you want to split up LANs

- Bandwidth concerns
- Different groups, privacy/security
- Equipment costs
- Distance
- Reliability (equipment failure)
- Security (someone in promisc mode not see everything)



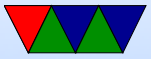
- Load – two groups, one not happy if other group takes up all bandwidth

- Broadcasting – when asks for a connection, broadcasts to all broadcast storms – entire LAN brought down with all machines broadcasting



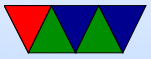
VLAN

- How to switch machines between networks? Request? Someone in wiring closet?
- Physical LAN
- What if want to partition a switch so some nodes are on one and one on another (virtual LANs)



802.1Q

- IEEE 802.1Q
- can have priority
- link aggregation, combine two links for higher bandwidth
- how to bridge VLANs?
  - special VLAN field in Ethernet frame
  - priority, CDI (makes connectionless interface have some manner of connection)



- Changes Ethernet frame, but only between bridges. Endpoints don't see modified frames