Link Layer Review

CS244A Winter 2008

March 7, 2008

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Announcements

- PA3 due today
- PS3 due next Wednesday
- PA4 due next Friday
- Final Exam
  - Review session next Friday
  - 7-10 PM on Thursday, March 20

Multiple Access Protocols

Protocol	Efficiency	Notes
Slotted Aloha	In best case, Np*(1-p*)^(N-1) as N goes to infinity => 1/e = 0.37	
CSMA/CD	1/(1+5a)	a = PROP/TRANSP TRANSP > 2 * PROP; cable length and packet size limited
Token Passing (RAR)	1/(1+a)	
Token Passing (RAT)	1/(1+a/N)	

Routers, Switches, and Hubs

- Routers are network layer devices
  - Modify IP datagram (decrement TTL)
  - Hosts and other routers must be aware of them
- Switches and hubs are link layer devices
  - Only care about frames, don’t modify IP datagram
  - Transparent to network

Hubs

- Operate as a repeater
  - Broadcast an incoming frame to all ports, except for the ingress port
  - Like having a longer Ethernet cable that all the hosts tap into
  - All ports are on single collision domain!
- Advantages: simple, restores signal, potentially fast since we don’t have to buffer or examine frame
- Disadvantages: poor bandwidth due to collisions

Hub Question 1

- A 10-port hub is connected to 10 hosts using gigabit links. What is the maximum aggregate transfer rate of data flowing through this network?
  - All ports are part of the same collision domain--only one device can send at a time
  - Therefore, peak bandwidth is one gigabit

Hub Question 2

- Recall that 100Mbps Ethernet restricts cable lengths to 100m. Suppose we want to connect two hosts which are 1000m apart. Can we use 10 100m cables with 9 hubs in series to accomplish this?
  - No. Since all ports are on same collision domain, max network diameter (1km) is too large to meet the TRANSP > 2 * PROP constraint of CSMA/CD
  - In reality, the IEEE standard limits number of hubs in series and specifies maximum network diameter

Switches

- Must store and examine frame before forwarding
- Simple learning protocol—no configuration
  - Given incoming frame (MAC_{src}, MAC_{dst}) on port x:
  - Add (MAC_{src}, x) to switch table
  - Look up port for MAC_{dst} for in switch table
    - If entry is there, forward frame to that port
    - Else, broadcast frame to all ports (except ingress port)
- Collision domain is a single port—switch will make sure that the frame it sends out does not collide with another frame being sent on the same link

Spanning Tree Protocol

- Industrial switches run Spanning Tree Protocol to prevent switching loops
- Each bridge is given its own unique ID by the network admin. Then:
  - Find the root (lowest ID)
  - For each network segment, turn on the link through switch that is on the least-cost path back to the root
    - Break ties by sending through switch with lower ID
  - Disable all other ports in the topology
- Full distributed algorithm in lecture notes

STP Example

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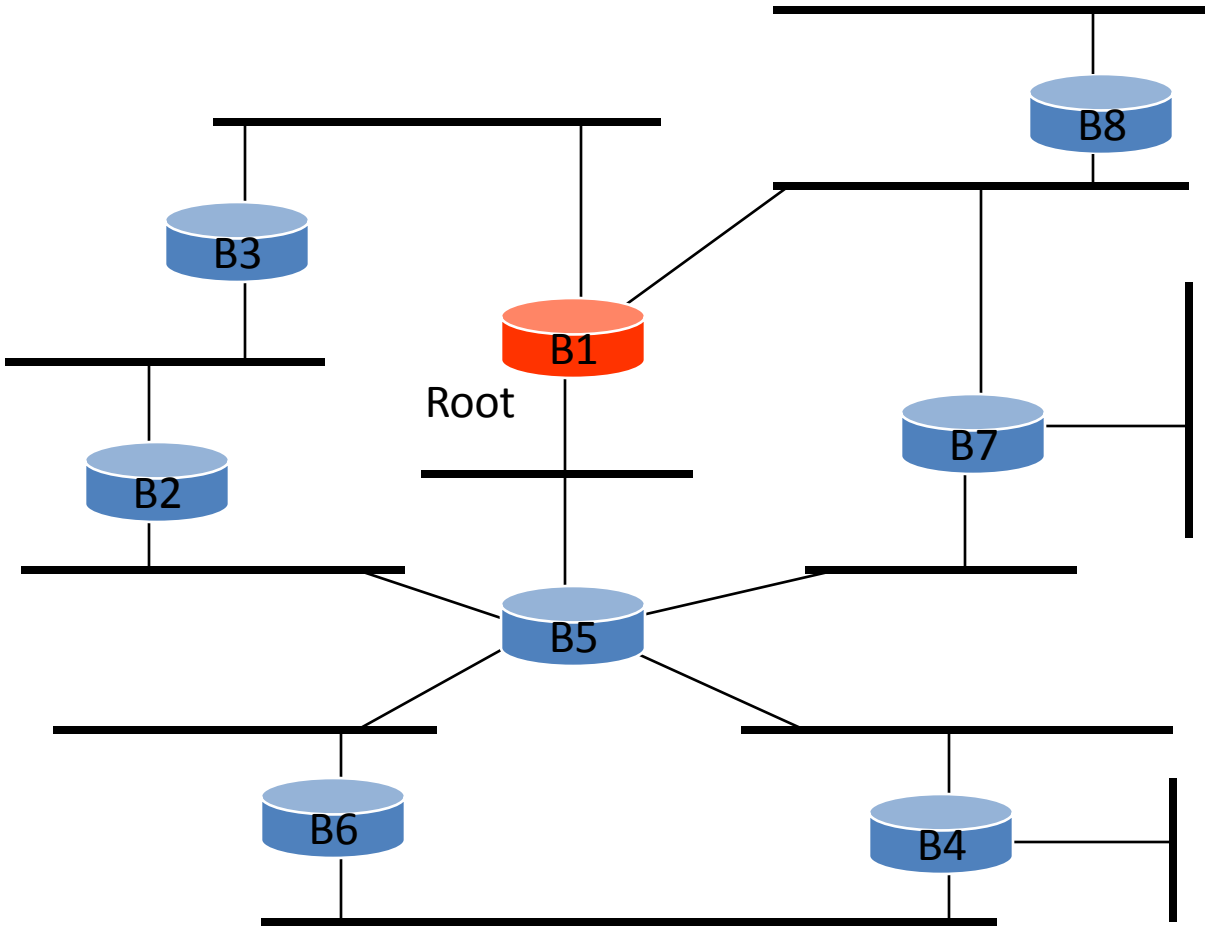
- For each network segment, turn on the link through the switch that is on the least-cost path back to the root
- Break ties by sending through switch with lower ID



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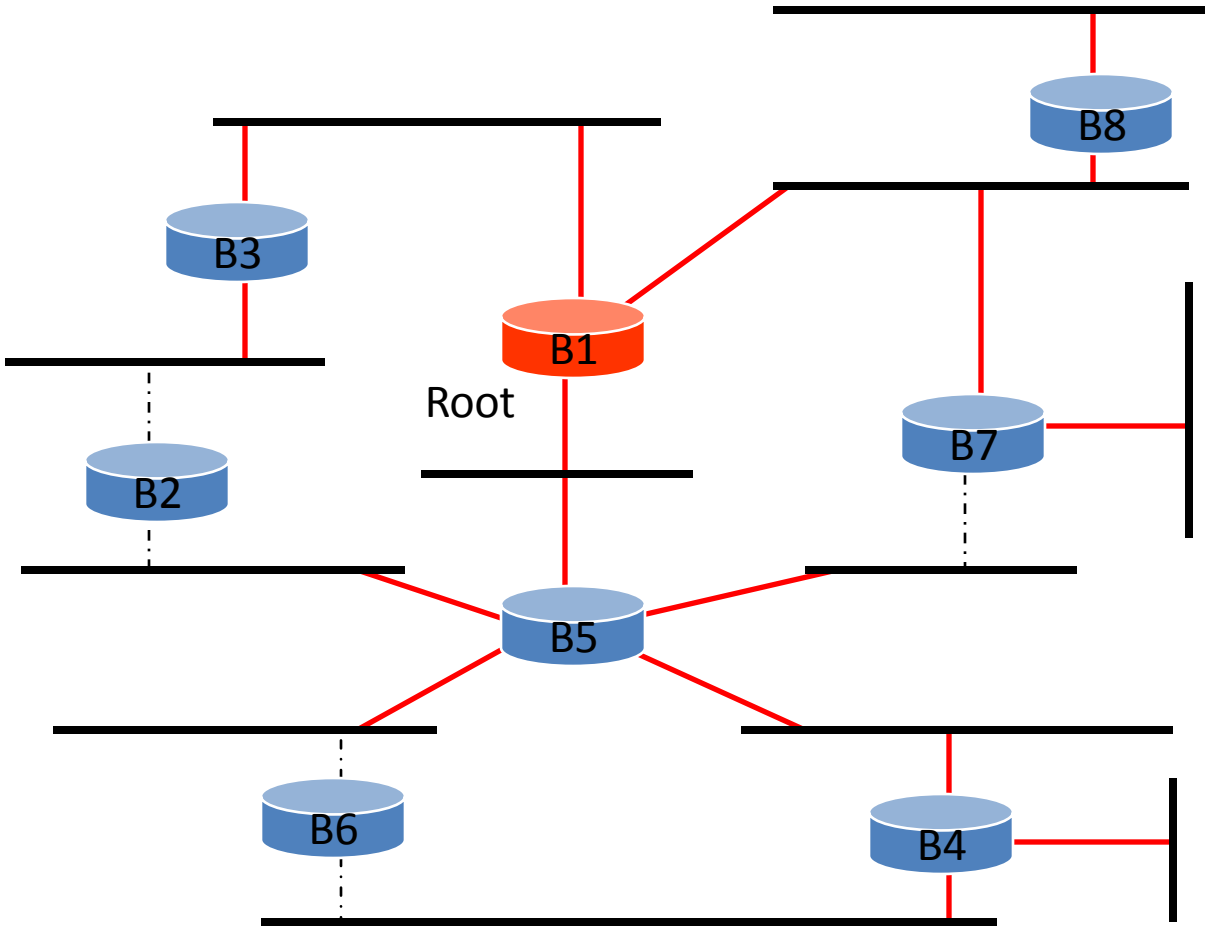

Shannon Capacity

- Given:
  - B: Bandwidth of channel in Hz
  - S/N: signal to noise power ratio (or solve for it using $dB = 10 \log_{10} (S/N)$
  - Channel restricted by Gaussian noise
- Then, using any data encoding technique, the amount of information C in bits per second that can be transmitted over the link is:
  - $C = B \log_2 (1+S/N)$

Manchester Encoding

- Synchronous digital systems need a clock to trigger sampling of data
- Manchester encoding allows us to encode the clock with the data stream
  - The preamble to the Ethernet frame is used to synchronize the sender clock with the receiver clock
- In Manchester encoding:
  - Transmitter samples data on edge of clock (usually rising edge)
  - If we sample a 1, it is encoded by a rising edge
  - If we sample a 0, it is encoded by a falling edge

Manchester Encoding Question

- Suppose a 10Mbps NIC sends into a link an infinite stream of zeros using Manchester encoding. The signal emerging from the adapter will have how many transitions per second?
  - 2 transitions per bit time
  - Bit times occur at clock frequency of 10MHz
  - Transitions occur at 20 MHz