Cpr E 489 Spring 2020
Homework #4 Solution

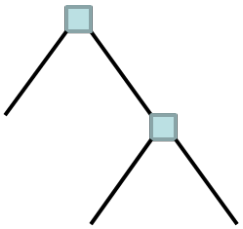
1. (40 points)

   a. (20 points) In Slotted ALOHA, time is divided into slots, and each time slot is **x** seconds long, where **x** is the frame transmission time; stations are allowed to transmit only at the beginning of a time slot. Consider a special version of Slotted ALOHA where each time slot is instead **0.7x** seconds long; the frame transmission time is still **x** seconds and stations are allowed to transmit only at the beginning of a time slot. What is the length of the vulnerable period for this special version of Slotted ALOHA? Justify your answer.

   Answer:
   Suppose that a data frame arrives at station A at time t, and t_0 is the beginning of very next time slot. So, station A starts transmission at t_0 and ends at $t_0 + X$. Now, if another data frame arrives at station B during:
   - $(-\infty, t_0 - 1.4X]$: At the latest, B starts transmission at $t_0 - 1.4X$ and ends at $t_0 - 0.4X \Rightarrow$ no collision
   - $(t_0 - 1.4X, t_0 - 0.7X]$: B starts transmission at $t_0 - 0.7X$ and ends at $t_0 + 0.3X \Rightarrow$ collision
   - $(t_0 - 0.7X, t_0]$: B starts transmission at t_0 and ends at $t_0 + X \Rightarrow$ collision
   - $(t_0, t_0 + 0.7X]$: B starts transmission at $t_0 + 0.7X$ and ends at $t_0 + 1.7X \Rightarrow$ collision
   - $(t_0 + 0.7X, t_0 + 1.4X]$: B starts transmission at $t_0 + 1.4X$ and ends at $t_0 + 2.4X \Rightarrow$ no collision
   - $(t_0 + 1.4X, +\infty)$: B starts transmission after $t_0 + 1.4X \Rightarrow$ no collision

   So, the length of the vulnerable period for this special version of Slotted ALOHA protocol is 2.1X seconds.

   b. (20 points) Suppose a CSMA/CD based LAN transmits at 135 Mbps. It has a tree topology as shown in the figure, with 4 segments connected by 2 repeaters. The maximum length of each segment is 100 meters; and the processing delay at each repeater is 1.5 μs. Signal propagates at $2*10^8$ m/s. What is the minimum frame size required for this CSMA/CD based LAN to operate properly? Justify your answer.



   Answer:
   t_{prop} = [(100 m * 3) / ($2 * 10^8$) m/s] + 1.5 μs * 2 = 4.5 μs
   mini-slot time = 2 * t_{prop} = 2 * 4.5 μs = 9 μs
   minimum frame size = 9 μs * 135 Mbps = 1215 bits

2. (30 points) Suppose a router has the following routing table:

Destination	Next-Hop Router
205.36.0.0/16	205.36.0.1
205.36.128.0/18	205.36.128.1
205.36.136.0/21	205.36.136.1
0.0.0.0/0	205.36.1.1

   Describe how the router looks up this routing table and makes the routing decision on where to forward a packet with the following destination IP address: (a) 205.63.130.1; (b) 205.36.140.2; (c) 205.36.150.3.

   a. 205.63.130.1
   Answer:
   205.63.130.1 & '/16' = 205.63.0.0 No Match
   205.63.130.1 & '/18' = 205.63.128.0 No Match
   205.63.130.1 & '/21' = 205.63.130.0 No Match
   205.63.130.1 & '/0' = 0.0.0.0 Match
   Matches the default entry only; so, the packet is forwarded to 205.36.1.1

b. 205.36.140.2

Answer:

205.36.140.2 & '/16' = 205.36.0.0 Match
205.36.140.2 & '/18' = 205.36.128.0 Match
205.36.140.2 & '/21' = 205.36.136.0 Match
205.36.140.2 & '/0' = 0.0.0.0 Match

Matches all entries; by applying the "Longest Prefix Match" rule, the packet is forwarded according to the third entry to 205.36.136.1

c. 205.36.150.3

Answer:

205.36.150.3 & '/16' = 205.36.0.0 Match
205.36.150.3 & '/18' = 205.36.128.0 Match
205.36.150.3 & '/21' = 205.36.144.0 No Match
205.36.150.3 & '/0' = 0.0.0.0 Match

Matches three entries; by applying the "Longest Prefix Match" rule, the packet is forwarded according to the second entry to 205.36.128.1

3. (30 points) An organization is assigned a Class-C network 200.120.80.0 and wants to form subnets for its three departments: D1 (60 hosts), D2 (90 hosts), and D3 (90 hosts). Describe a possible arrangement of subnets (i.e., give the network address and the subnet mask of each subnet) to make this possible. Note that a department may be assigned multiple subnets; subnets may have different sizes and they shall not overlap.

Answer: One possible different arrangement of the subnets to make this work is:

Department	# Hosts	Network	Subnet Mask	# IP addresses available to individual hosts on this subnet
D1	60	200.120.80.0/26	255.255.255.192	62
D2	90	200.120.80.128/26	255.255.255.192	62
		200.120.80.192/27	255.255.255.224	30
D3	90	200.120.80.64/26	255.255.255.192	62
		200.120.80.224/27	255.255.255.224	30