Second Midterm for ECE374

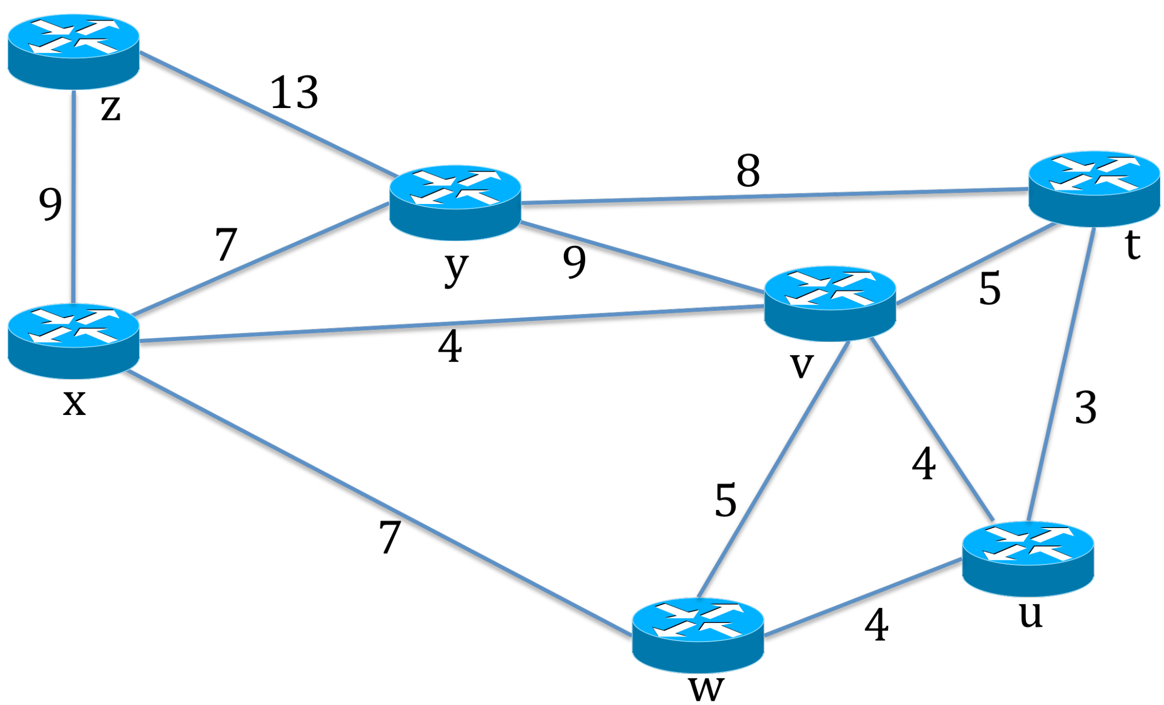
04/21/11

Solution!!

Note: *In all written assignments, please show as much of your work as you can. Even if you get a wrong answer, you can get partial credit if you show your work.* If you make a mistake, it will also help the grader show you where you made a mistake.

Problem 1:

Consider the following network. With the indicated link costs, use Djikstra's shortest-path algorithm to compute the shortest path from *x* to all network nodes. Show how the algorithm works by computing a table similar to XXXX.



Step	*N'*	*D(t),p(t)*	*D(u),p(u)*	*D(v),p(v)*	*D(w),p(w)*	*D(y),p(y)*	*D(z),p(z)*
0							
1							
2							
3							
4							
5							
6							

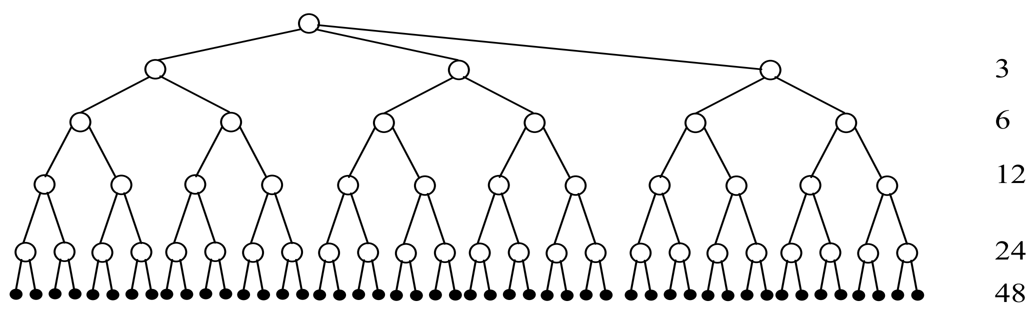
Solution:

Step	*N'*	*D(t),p(t)*	*D(u),p(u)*	*D(v),p(v)*	*D(w),p(w)*	*D(y),p(y)*	*D(z),p(z)*

0	x	∞	∞	4,x	7,x	7,x	9,x
1	xv	9,v	8,v	4,x	7,x	7,x	9,x
2	xvu	9,v	8,v	4,x	7,x	7,x	9,x
3	xvuw	9,v	8,v	4,x	7,x	7,x	9,x
4	xvuwy	9,v	8,v	4,x	7,x	7,x	9,x
5	xvuwyt	9,v	8,v	4,x	7,x	7,x	9,x
6	xvuwytz	9,v	8,v	4,x	7,x	7,x	9,x

Problem 2:
Consider a network in which all nodes are connected to three other nodes. In a single time step, a node can receive all transmitted broadcast packets from its neighbors, duplicate the packets, and send them to all of its neighbors (except the to the node that sent a given packet). At the next time step, neighboring nodes can receive, duplicate, and forward these packets, and so on. Suppose that uncontrolled flooding is used to provide broadcast in such a network. At time step *t*, how many copies of the broadcast packet transmitted, assuming that during time step 1, a single broadcast packet is transmitted by the source node to its three neighbors. Start solving this problem with illustrating the graph representing the network described above. Give the answers for step 1,2, and 3 before deriving the general solution.

Solution:
After 1 step 3 copies are transmitted, after 2 steps 6 copies are transmitted. After 3 steps, 12 copies are transmitted, and so on. After k steps, $3*2^{k-1}$ copies will be transmitted in that step.



Problem 3:
Consider two nodes, A and B, that use the slotted ALOHA protocol to content for a channel. Suppose node A has more data to transmit than node B, and node A's retransmission probability p_A is greater than node B's probability p_B.

a. Provide a formula for node A's average throughput (i.e. probability of successful transmission for a given slot). What is the total efficiency of the protocol with these two nodes?

b. If $p_A = 2p_B$, is node A's average throughput twice as large as that of node B? Why or why not? If not, how can you choose p_A and p_B to make that happen?
c. In general, suppose there are N nodes, among which node A has retransmission probability $2p$ and all other nodes have retransmission probability p. Provide expressions to compute the average throughput of node A and of any other node.

Solution:

a. A's average throughput is given by $p_A(1\text{-}p_B)$.
Total efficiency is $p_A(1\text{-}p_B) + p_B(1\text{-}p_A)$.

b. A's throughput is $p_A(1\text{-}p_B)=2p_B(1\text{-}p_B)= 2p_B\text{-} 2(p_B)^2$.
B's throughput is $p_B(1\text{-}p_A)=p_B(1\text{-}2p_B)= p_B\text{-} 2(p_B)^2$.
Clearly, A's throughput is not twice as large as B's.
In order to make $p_A(1\text{-}p_B)= 2\ p_B(1\text{-}p_A)$, we need that $p_A= 2 - (p_A / p_B)$.

c. A's throughput is 2p(1-p)N-1, and any other node has throughput p(1-p)N-2(1-2p).

Problem 4:

Suppose two nodes, A and B, are attached to opposite ends of an 800m cable, and that they each have one frame of 1,500 bits (including all headers and preambles) to send to each other. Both nodes attempt to transmit at time $t = 0$. Suppose there are four repeaters between A and B, each inserting a 20-bit delay. Assume the transmission rate is 100 Mbps, and CSMA/CD with backoff intervals of multiples of 512 bits is used. After the first collision, A draws $K = 0$ and B draws $K = 1$ in the exponential backoff protocol. Ignore the jam signal and the 96-bit time delay.

a. What is the one-way propagation delay (including repeater delays) between A and B in seconds? Assume that the signal propagation speed is $2 * 10^8$ m/sec.
b. At what time (in seconds) is A's packet completely delivered at B?
Derive the solution to this question by answering the following steps:
What's the time when A and B detect collisions?
What's the time they sensed that channel is cleared?
What's the time A starts retransmission?
What's the time the first and last bit of A's retransmission arrive at B?

Solution:

a)

$$\frac{800m}{2\cdot 10^8\, m/\sec} + 4\cdot\frac{20bits}{100\times 10^6\, bps}$$

$$= (4\times 10^{-6} + 0.8\times 10^{-6})\sec$$

$$= 4.8\mu\sec$$

b)
First note, the transmission time of a single frame is give by 1500/(100Mbps)=15 micro sec, longer than the propagation delay of a bit.

- At time $t = 0$, both A and B transmit.
- At time $t = 4.8\mu\sec$, both A and B detect a collision, and then abort.
- At time $t = 9.6\mu\sec$ last bit of B's aborted transmission arrives at A.
- At time $t = 14.4\mu\sec$ first bit of A's retransmission frame arrives at B.
- At time $t = 14.4\mu\sec + \frac{1500 bits}{100\times10^{6} bps} = 29.4\mu\sec$ A's packet is completely delivered at B.

Problem 5:
Suppose there are two ISPs providing WiFi access in an Internet café, with each ISP operating its own AP and having its own IP address block.

a. Further suppose that by accident, each ISP has configured its AP to operate over channel 11. Will the 802.11 protocol completely brake down in this situation? Discuss what happens when two stations, each associated with a different ISP, attempt to transmit at the same time.
b. Now suppose that one AP operates over channel 1 and the other over channel 11. How do your answers change.

Solution:

a. The two APs will typically have different SSIDs and MAC addresses. A wireless station arriving to the café will associate with one of the SSIDs (that is, one of the APs). After association, there is a virtual link between the new station and the AP. Label the APs AP1 and AP2. Suppose the new station associates with AP1. When the new station sends a frame, it will be addressed to AP1. Although AP2 will also receive the frame, it will not process the frame because the frame is not addressed to it. Thus, the two ISPs can work in parallel over the same channel. However, the two ISPs will be sharing the same wireless bandwidth. If wireless stations in different ISPs transmit at the same time, there will be a collision. For 802.11b, the maximum aggregate transmission rate for the two ISPs is 11 Mbps.
b. Now if two wireless stations in different ISPs (and hence different channels) transmit at the same time, there will not be a collision. Thus, the maximum aggregate transmission rate for the two ISPs is 22 Mbps for 802.11b.