CSC/ECE 570 Sections 001 and 006

Fall 2016

Homework #5

Keywords: Media Access, Data Link Layer Switching

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Instructions

- You can do this homework in groups of two (at most). Only one submission per group.
- The total number of points is 40.
- You must answer all questions for full credit.
- Use only this paper for your answers, in the space provided.
- The due date is as posted on the web page (please submit your answers through Wolfware).

Questions: Answer the following questions. Justify your answers and be as precise as possible. Do not make unnecessary assumptions.

[1] [4 points] Six stations, A through F, communicate using the MACA protocol. Is it possible for two transmissions to take place simultaneously? Explain your answer.

ANS:
When the six stations are arranged one after the other in a straight line and the range of each station is just until the next station

The following transmissions are possible to take place simultaneously using MACA protocol:

A	←	B		C	→	D		E		F
A	←	B		C		D	→	E		F
A	←	B		C		D		E	→	F
A		B	←	C		D	→	E		F
A		B	←	C		D		E	→	F
A		B		C	←	D		E	→	F
A	→	B		C	←	D		E		F
A	→	B		C	→	D		E		F
A	→	B		C		D	→	E		F
A	→	B		C		D		E	→	F
A		B	→	C		D	→	E		F
A		B	→	C		D		E	→	F
A		B		C	→	D		E	→	F

The highlighted scenarios are especially possible when MACA protocol is used.
MACA protocol solves the exposed terminal problem with the help of RTS and CTS frames. In the first case, say C transmits an RTS frame, B is in the range of C and will sense the RTS, B will then wait for the CTS Time. But B will not sense the CTS as D is not in the range of B. So B will start transmitting. This way B and C simultaneously communicate with A and D respectively.

[2] [4 points] Two CSMA/CD stations are each trying to transmit long (multiframe) files. After each frame is sent, they contend for the channel, using the binary exponential backoff algorithm. What is the probability that the contention ends on round *k*, and what is the mean number of rounds per contention period?

ANS:
Binary exponential backoff, the number of slot from which the delay is picked increases two times.

So, in the attempt i, the number of slots available = 2^{i-1}

In the ith attempt, Say station1 has picked a particular slot, the probability that station 2 picks the same slot (both stations start off at the same time & the number of slots is same) is $2^{-(i-1)}$.

Until the round (k-1), both the stations were picking the same slot because the contention is extending to Kth round.

The probability of failure till (k-1) = $\prod_{i=1}^{i=k-1} 2^{-(i-1)}$

Success in a round k = (1 - Failure in round k) = 1 - $2^{-(k-1)}$
The probability of failure till round k-1 & success in round k

$$= (1 - 2^{-(k-1)}) \times (\prod_{i=1}^{i=k-1} 2^{-(i-1)}) \text{ ------(1)}$$

$$\prod_{i=1}^{i=k-1} 2^{-(i-1)} = 2^{\sum_{i=1}^{k-1} -(i-1)} = 2^{-\sum_{i=1}^{k-1}(i-1)} \quad \text{----(2)}$$

$$\sum_{i=1}^{k-1}(i-1) = \sum_{i=1}^{k-1}(i) - \sum_{i=1}^{k-1}(1) = \frac{(k-1)(k-1\ +1)}{2} - (k-1) = \frac{(k-1)\,(k-2)}{2}$$

Substituting in (2)

$$\prod_{i=1}^{i=k-1} 2^{-(i-1)} = 2^{-\frac{(k-1)\,(k-2)}{2}}$$

The probability of failure till round k-1 & success in round k

$$= (1 - 2^{-(k-1)})\ 2^{-\frac{(k-1)\,(k-2)}{2}}$$

[3] [4 points] Ethernet frames must be at least 64 bytes long to ensure that the transmitter is still going in the event of a collision at the far end of the cable. Fast Ethernet has the same 64-byte minimum frame size but can get the bits out ten times faster. How is it possible to maintain the same minimum frame size?

ANS: In order to avoid collision, 2 times the propagation delay over the ethernet >= Time it takes to put a frame

The maximum propagation/ wire delay in ethernet is 10 times that of the fast ethernet.

Fast ethernet wire delay ~ 1/10th that of ethernet

Fast ethernet can therefore get bits out ten times faster than ethernet despite the same minimum frame size.

[4] [4 points] Suppose that an 11-Mbps 802.11b LAN is transmitting 64-byte frames back-to-back over a radio channel with a bit error rate of 10−7. How many frames per second will be damaged on average?

ANS: 64-byte frame = 64x8 bits/frame = 512 bits/frame
The number of frames per second = 11x10^6/512 = 21484.375 frames/sec
The number of bits per second = 512x 21484.375 bits/sec
With a bit error rate of 10-7, 512x21484.375x10-7 bits are the damaged bits/sec.
= 1.1

Therefore, The number of frames damaged per second is approximately 1.

[5] [4 points] An 802.16 network has a channel width of 20 MHz. How many bits/sec can be sent to a subscriber station?

ANS: It depends how far away the subscriber is. If the subscriber is close, QAM-64 is used for 120 Mbps. For medium distances, QAM-16 is used for 80 Mbps. For distant stations, QPSK is used for 40 Mbps

The speed that can be sent to a subscriber station in WiMax depends on the distance of the subscriber from the station.

I. If subscriber is close : 120 Mbps can be sent using QAM-64
II. If subscriber is far away : 40 Mbps can be sent using QPSK
III. If subscriber is not so close and not so far : 80 Mps can be sent using QAM-16

[6] [4 points] From Fig. 4-34, we see that a Bluetooth device can be in two piconets at the same time. Is there any reason why one device cannot be the master in both of them at the same time?

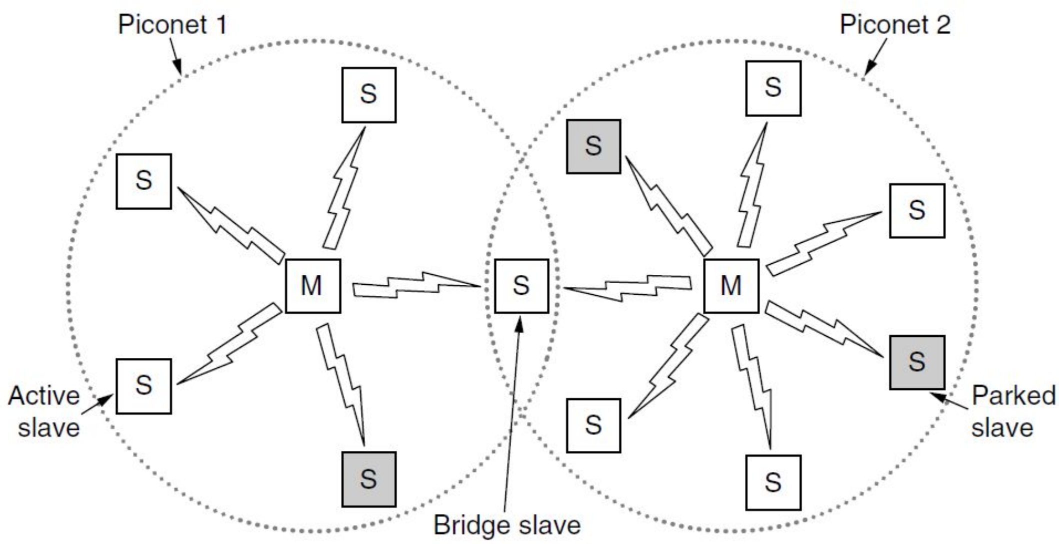

Figure 4-34. Two piconets can be connected to form a scatternet.

ANS:

1. The header gives 3 address bits to address the slaves. This means it can address only 8 slaves at maximum. If we have only one master for both piconets, then we can have 2*7= 14 slaves together but we still have the same 3 bits only to address the slaves and this is a problem clearly.
2. There is an access code associated with each frame. That is derived from the ID of the master. Based on this only the slaves know if the message belongs to its piconet or another one. If we have just one master, then both piconets are going to have the

same master and hence the same access code and we are not going to be able to differentiate between the 2 different piconets.

These are the 2 problems associated with having the same master for the 2 piconets.

[7] [4 points] Suppose that there are 10 RFID tags around an RFID reader. What is the best value of Q? How likely is it that one tag responds with no collision in a given slot?

ANS:

We want the best probability value i.e. optimal value for the probability such that only one station (one tag) transmits with probability p and all others with 1-p. For that we have the p=1/k =1/10 in this case. For this probability we need to have Q=10 slots.

The probability of one of the tags responding
= no.of slots * P[success] * (p[no success])^(no. of slots - 1)
= k * P[success] * (p[no success])^(k-1)
here p[success] = 1/k p[failure] = (k-1)/k = (k-1/k)^(k-1)

The Pr[success with optimal p] = (k-1/k)^(k-1)
= (9/10)^9 = 0.9^9
= 0.387 = 38.7% chance that one tag responds with no collision in a given slot.

[8] [4 points] A switch designed for use with fast Ethernet has a backplane that can move 10 Gbps. How many frames/sec can it handle in the worst case?

ANS:

The worst case scenario is when you have frames 64-byte that keep coming forever.

Frames per second it can handle is (10 * 10^9/8)/64 = 19531250 frames/sec

[9] [4 points] Consider the extended LAN connected using bridges B1 and B2 in Fig. 4-41(b). Sup- pose the hash tables in the two bridges are empty. List all ports on which a packet will be forwarded for the following sequence of data transmissions:

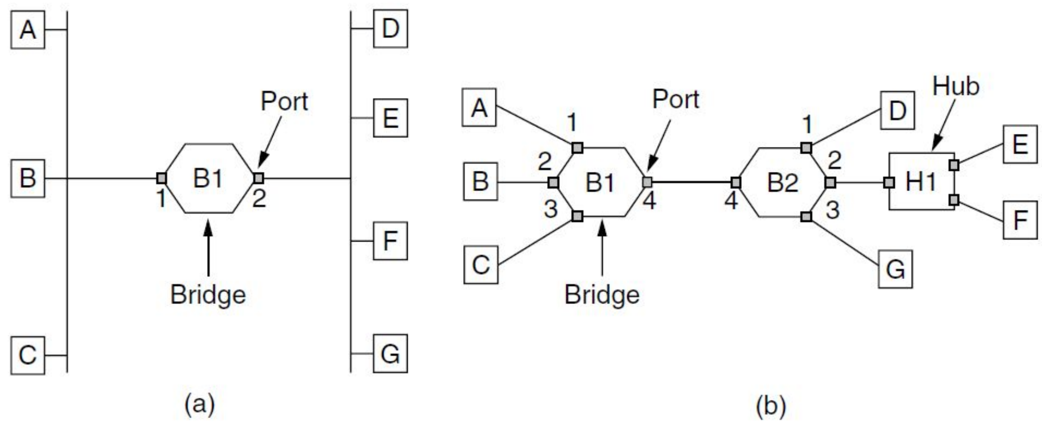

Figure 4-41. (a) Bridge connecting two multidrop LANs. (b) Bridges (and a hub) connecting seven point-to-point stations.

(a) A sends a packet to C.
(b) E sends a packet to F.
(c) F sends a packet to E.
(d) G sends a packet to E.
(e) D sends a packet to A.
(f) B sends a packet to F.

ANS:

The logic used here is that whenever a node of a switch becomes the sender, only then its MAC address is associated with the port to which it is connected. So the next time this node becomes the receiver, then flooding does not occur as the switch knows which port the particular MAC address is associated with.

(a) B1.2, B1.3, B1.4, B2.1, B2.2, B2.3.
(b) B2.1, B2.3,B2.4, B1.1, B1.2, B1.3.
(c) Not forwarded to any ports
(d) B2.2
(e) B2.4, B1.1.
(f) B1.1, B1.3, B1.4, B2.2.

[10] [4 points] It is mentioned in Section 4.8.3 that some bridges may not even be present in the spanning tree. Outline a scenario where a bridge may not be present in the spanning tree.

ANS:

Consider the case where there are bridges connected to a bridge A. Now if the shortest paths to the roots of all these bridges connected to bridge A does not go through (does not include) bridge A, then bridge A is not a part of the spanning tree because the shortest paths do not include bridge A even though it is a part of the loop.