CSE 4215/5431 Midterm test
Winter 2010
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1. (a) (1 point) Order in decreasing order of magnitude: transmission radius, interference radius, detection radius.

   Solution: Int radius, Det radius, Transmission radius

   (b) (1 point) Draw a picture of received power vs time to illustrate the difference between long term fading and short term fading.

   Solution: See fig 2.15 in the text.

   (c) (1 point) What is the difference between amplitude modulation and amplitude shift keying?

   Solution: AM is a analog modulation technique. ASK is for digital signals (bits).

   (d) (1 point) What is space-division multiple access (SDMA)?
   Solution: See Ch 2.5.1 in the text.

2. (a) (3 points) Explain very briefly the hidden and exposed terminal problems.

   Solution: Explained in Ch 3.1.1 in the text.

   (b) (3 points) Explain if/how the RTS/CTS mechanism mitigates the above problems.

   Solution: If A is hidden from C in Fig 3.1 in the text, and A wishes to communicate to B or vice versa, C receives the RTS or CTS (whichever is sent by B) and knows that the medium will be busy. This prevents the hidden terminal problem.
   For the exposed terminal problem, again the RTS or CTS received by C is enough to let C know that A will not see a collision due to any message sent by C and therefore C can proceed with its transmission.

3. (a) (4 points) This question addresses polling. In a system where packets are rarely generated (and transmitted) is polling efficient or inefficient in terms of bandwidth usage? What about when almost every node has packets to send at almost every time step? Describe a scenario when polling is of great advantage.

   Solution: In general, polling is inefficient when few nodes have packets to send because it wastes time and bandwidth. When the network is busy, this is not true. However, in the scenario that most or all nodes have packets to send, one could use piggybacked requests for reservation and slots could be reserved even without explicit polling. Polling may provide lower latency compared to piggybacked requests when there are many short sessions that start and finish quickly. The scheduler (or the node that does the polling) can also schedule transmissions using the priorities of packets and optimizing whatever criterion it chooses. Also piggybacked requests require that the scheduler listen to all communication and examine every packet header. Polling allows the scheduler to sleep periodically.

   (b) (3 points) In cellular networks, what are the advantages and disadvantages of having 3 cell clusters versus 7 cell clusters?

   Solution: See Ch 2.8.

   (c) (3 points) In IEEE 802.11, packet priorities are encoded as inter-frame spaces. Briefly explain how.
   Solution: See Ch 7.3.4.3.

4. (a) (6 points) In IEEE 802.11, why are all nodes able to send synchronization packets, as opposed to one single node? Is this a strength or weakness when nodes are mobile? If all nodes try to transmit beacons simultaneously, collisions are likely – how is this problem addressed in 802.11?

Solution: This is a strength. It is necessary in ad hoc mode especially in mobile networks where nodes can move in and out of transmission range of other nodes. So having a designated node to transmit synchronization packets is not useful.

Collision probability is reduced by inserting random delays.

(b) (4 points) Describe briefly how direct sequence spread spectrum provides medium access control.

Solution: The main idea is that the use of orthogonal sequences allows multiple signals to be superposed in a way that each can be recovered. Thus different sessions can utilize a shared medium effectively.

5. (3 points) **Bonus question:** FHSS systems use pseudorandom numbers to decide the frequency hopping sequence. What are pseudorandom numbers? How would you test if a sequence is pseudorandom? ("I will run statistical tests for randomness" is not an acceptable answer - think of what those tests might be.)

Solution:

This is an open-ended question. One needs to check 2 essential aspects. First, are the frequencies of values the same as the probability distribution we assumed, over a long interval? For example, if we want to show that a sequence follows the uniform distribution, the probabilities of all values should be the same. This property is necessary but not sufficient, because the sequence $1, 2, \ldots, n, 1, 2, \ldots, n, \ldots$ satisfies this. Second, how predictable is the sequence? This can be tested by looking at the conditional distributions of values. For example, given that the last value was 3, are all the values equally likely for the next number generated? A better technique to use is to compare the autocorrelation function computed from a generated pseudorandom sequence and that computed analytically for a true random variable.