COSC6397 Midterm

Date: Oct 21, 2013

Your Name: _____ Student ID: _____

2.5 pt each

Problem 1 (50 pt) Fill in the blanks:

1) CA stands for collision avoidance in CSMA/CA.

2) There are altogther 11 channels in IEEE 802.11abg PHY, out of which 3 are orthogonal to one another.

3) Dopler effects are caused by relative movement of transmitter & receiver.

4) Two cars are moving at a relative speed of 180Km/hr. The dopler shift at 2.5GHz is 416.6 Hz.

5) According to Shannon capacity, the capacity of a wireless channel with additive white Guassian noise doubles if the SNR doubles. This statement is false (true or false).

6) The maximum number of spatial streams in IEEE 802.11ac is 4.

7) Short interframe space is utilized before the transmission of ACK from the receiver upon the successful receiption of a data frame.

8) Name 3 types of management frame beacon, probe request, association request.

9) In passive scanning, the mobile devices select which AP to associate with based on probe request / beacon frames from the APs.

10) Name one security risk with the WEP protocol: replay attack / collision attack.

11) 4-way handshake authentication in 802.11i creates the pairwise transient key for key and data frame exchanges. This statement is true (true or false).

12) In wireless body area networks, the 400 M (Hz) band is primarily used for medical implant devices.

13) Prioritized medium access in CSMA/CA in wireless body area networks is achieved by different IFS & contention window.

14) Name one routing protol used in wireless sensor networks: Sink tree / direct diffusion.

15) 6LoWPAN reduces the size of IPv6 header through header compression.

16) IEEE 802.11p is the dominating MAC protocol in vehicle-to-vehicle and vehicle-to-roadside networks.

17) Name one key difference bewteen delay tolerance networks and typical wireless sensor networks: connectivity is rather unlikely in DTN.

18) The key function of directory repository in service discovery is to register / store device info.

19) In Bonjour, the mDNS protocol is used to discover services available.

20) Consider a device with home address 128.119.40.186 moving to a foreign address and obtaining a care-of-address 79.129.13.2. To communicate with the device, 128.119.40.186 is used as the destination IP by a corresponding host in mobile IP.

Problem 2 (25 pt) Propagation model: Consider a wireless transmitter with transmission power $P_t = 10W$. The carrier frequency is $f_c = 900MHz$. Assume free space propagation from the transmitter to distance d_0 ($d_0 = 1km$). Furthermore, the path loss between a wireless receiver and the transmitter is given by,

$$\overline{PL}(dB) = \overline{PL}(d_0) + 10(2.5)log(\frac{d_1}{d_0}) - X_\sigma, \ \sigma = 4dB. \tag{1}$$

The gain of the omnidirectional antenna for the transmitter and receiver are $G_t = 6dBi$ and $G_r = 0dBi$ respectively. Assume the noise level at the receiver is -89.5dBm. Determine the maximum distance between the transmitter and receiver with SNR ratio of at least 18dB at least 99.9% of the time.

TABLE I
TABULAR FOR $Q(z) = \frac{1}{\sqrt{2\pi}} \int_z^\infty exp(-x^2/2)dx$

z	$Q(z)$	z	$Q(z)$	z	$Q(z)$	z	$Q(z)$
0.0	0.5	1.0	0.15866	2.0	0.02275	3.0	0.00135
0.1	0.46017	1.1	0.13567	2.1	0.01786	3.1	0.00097
0.2	0.42074	1.2	0.11507	2.2	0.01390	3.2	0.00069
0.3	0.38209	1.3	0.09680	2.3	0.01072	3.3	0.00048
0.4	0.34458	1.4	0.08076	2.4	0.00820	3.4	0.00034
0.5	0.30854	1.5	0.06681	2.5	0.00621	3.5	0.00023
0.6	0.27425	1.6	0.05480	2.6	0.00466	3.6	0.00016
0.7	0.24196	1.7	0.04457	2.7	0.00347	3.7	0.00011
0.8	0.21118	1.8	0.03593	2.8	0.00256	3.8	0.00007
0.9	0.18406	1.9	0.02872	2.9	0.00187	3.9	0.00005

$$\lambda = \frac{c}{f} = \frac{3\times10^8}{900\times10^6} = \frac{1}{3}\ m$$

$$\overline{PL}(d_0) = -10\log\left(\frac{G_t G_r \lambda^2}{(4\pi)^2 d^2}\right)$$

$$= -6 - 20\log\frac{1}{3\times4\pi\times10^3} = 85.527\ dB$$

$$\overline{PL}(dB) = \overline{PL}(d_0) + 10\cdot2.5\log\left(\frac{d_1}{d_0}\right) - x_\sigma$$

$$= 10.527 + 25\log d_1 - x_\sigma$$

$$SNR = 10\log P_t - \overline{PL} - 10\log P_N$$

$$= 10 + 89.5 + 30 - 10.527 - 25\log d_1 + x_\sigma$$

$$= 118.973 - 25\log d_1 + x_\sigma$$

$$\sim N\left(\underbrace{118.973 - 25\log d_1}_{\mu},\ \underbrace{4}_{\sigma^2}\right)$$

Let $Z = \frac{SNR - \mu}{\sigma} \sim N(0,1)$

From the table,

$$P(Z > -3.1) \simeq 99.9\%$$

$$SNR > -3.1\sigma + \mu = 18$$

$$\Rightarrow -14.4 + 118.973 - 25\log d_1 = 18$$

$$\Rightarrow d_1 = 290.4\ m$$

Problem 3 (25 pt) IEEE 802.11 DCF: A pair of nodes A and B are sending packets to node C using IEEE 802.11 DCF. Both nodes A and B have many packets pending for node C. Show on a timing diagram the sequence of events that occurs *until each of nodes A and B has received ACK for their first packet sent to C*, assuming that they pick their successive backoff intervals as follows:
Node A: 4, 7, 3, 4
Node B: 4, 4, 5, 8

Assume that the propagation delay is negligible, and that the two nodes choose their initial backoff exactly at time t0, and that at time t0 channel changes status from busy to idle. In your timing diagram, show one timeline each for hosts A, B and C (Fig. 1). In the timeline, show the various packets sent by the hosts, and backoff slots counted by the hosts and inter-frame spacing. Also, if a packet transmission results in a collision, indicate that as well. Assume that no RTS/CTS are sent prior to Data and ACK, and that in the absence of a collision, all transmissions are received reliably.

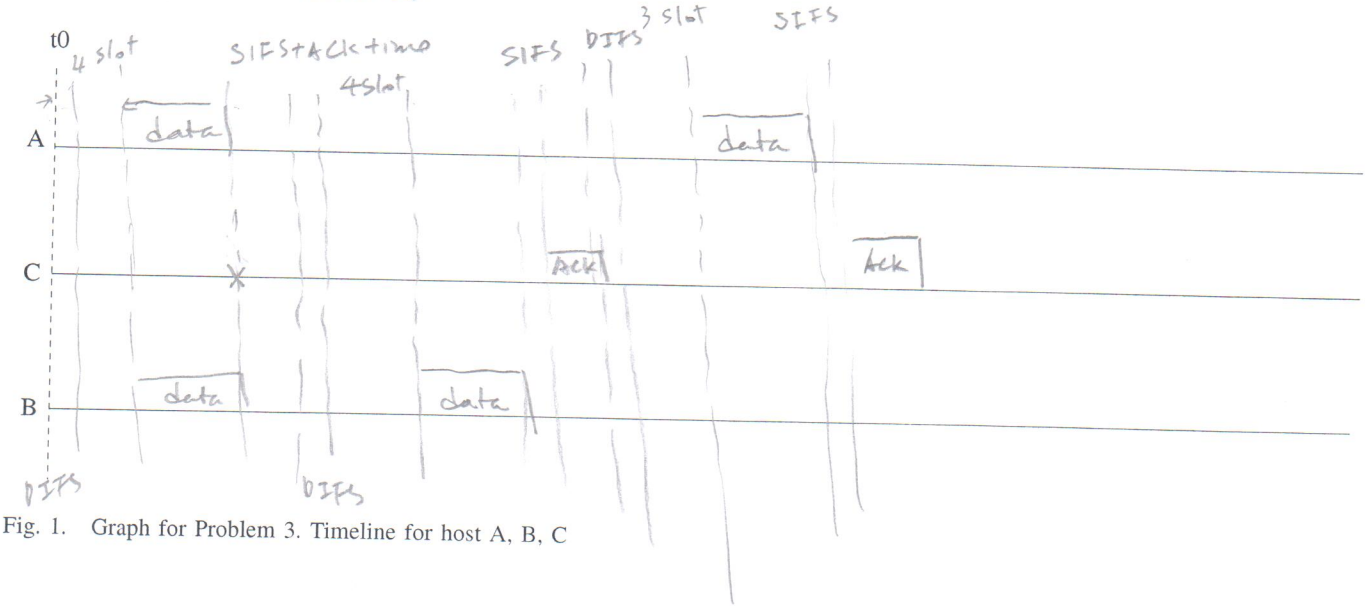

Fig. 1. Graph for Problem 3. Timeline for host A, B, C