UNIVERSITY OF CALIFORNIA, LOS ANGELES

CS M117

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Discussion Section: 1B

Data Transmission over 802.11b Wireless LAN

Pre-laboratory Homework #2 (Due 04/13)
(HW must be typed)

Section A
Wireless MAC, TCP

1. (1) Are RTS and CTS used with short packets, even if there is a hidden terminal situation?

> We don't want to use RTS and CTS with short packets, because the overhead incurred would be more detrimental. Essentially if the packet is shorter than the RTS then it would be better to send the packet and expect some collision even if there is a hidden terminal situation.

2. (2) Should we still use the Contention Window and Binary Backoff with short packets? Explain?

> Short packets don't rid us of collisions, and so we should still use Binary Backoff with the Contention Window in order to retransmit the data with fair timing with respect to the amount of traffic. So yes we should still use the two in conjunction.

3. (2) Why can a new packet that senses the medium idle go off without using the Contention Window ("direct access if medium is free") ?

> If the medium is idle, then by definition it is free for communication and thus will grant direct access to the new packet without the need for the Contention Window. This avoids the unnecessary delays that the Contention Window can create.

4. (2) 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?

64 byte frame = 64*8 bit frames = 516 bits/frame
P(frame damaged) = 1 – P(frame not damaged) = $1-(1-10^{-7})^{512}=0.000051199$
11 Mbps = $11\cdot\frac{10^6}{512}$= 21484.375 frames/sec
⇨ 21484.375 * P(frame damaged) = 1.1 damaged frames/second

5. (2) Consider the effect of using slow start on a line with a 10-msec round-trip time and no congestion. The receive window is 24 KB and the maximum segment size is 2 KB. How long does it take before the first full window can be sent?

With slow start, we start by sending 2KB. This continues with round trip times of 2 segments with 4KB, 4 segments with 8KB ... until we have 16 segments with 32 KB. This means we have gone through 4 round trip times and thus we send the first full window after 4*10msec = 40 msec.

6. (1) Given a cannel with an intended capacity of 20 Mbps. The bandwidth of the channel is 3 MHz. What signal-to-noise ratio is required in order to achieve this capacity?

Shannon's Capacity Theorem, C = $B\cdot\log_2\left(1+\frac{S}{N}\right)$

$$\rightarrow 20=3\cdot\log_2\left(1+\frac{S}{N}\right)$$

$$\rightarrow 2^{\frac{20}{3}}-1=\frac{S}{N}=100.6$$

Thus the signal to noise ratio is 100.6

Section B

Data Transmission over 802.11b Wireless LAN

1) (a) (1) List the three different modes of multipath signal propagation (besides direct signal) and the cause for each of these modes.

(b) (1) What kind of signal reception problems these different modes cause?

a.) Signal propagation modes are:

1. Reflection – caused by surfaces larger than wavelength.
2. Diffraction – when the waves are obstructed by sharp edged surfaces.
3. Scattering – caused by objects smaller than the wavelength.

b.) The problems from the modes are:

1. Reflection – large scale fading
2. Diffraction – small scale fading
3. Scattering – small scale fading

Other problems include weakening or dispersion of a signal.

2) (a) (1) How do multipath signals effect signal reception? This effect limits the transmission rate of wireless channel.

(b) (1) Give relation between transmission rate and this "effect" in part (a).

a.) When the multipath signal is time delayed then we can cause inter-symbol interference or distortion of the signals which then can reduce the transmission rate of the wireless channel, because they arrive at the receiver at different times or lengths.

b.) $R = \frac{1}{2\tau_d}$ This is an inverse relation between the multipath transmission and the transmission rate (increase of this causes decrease of the multipath transmission or vice-versa).

3) (a) (2) How much power you expect to receive if your receiver is at distance *d* away from the transmitter and the transmitter transmits at frequency f_c. Assume isotropic receiver/transmitter antennas and isotropic free *space* loss. Give path loss in dB.

(b) (1) Assume your WLAN system has transmission power of 15 dBm and the received power must be at least –72 dBm. WLAN radio frequency is 2.4 GHz. Assuming isotropic antennas and no obstructions (i.e. isotropic free space loss), what is the maximum distance you can communicate over.

a) $Isotropic\ free\ space\ loss\ (dB) = L_{ISO} = 20 \cdot \log\left(\frac{4\pi f_c d}{c}\right)$

$$From\ the\ course\ reader\ we\ see\ P_{received} = P_{transmitted} \cdot \left(\frac{c}{4\pi f_c d}\right)^2$$

b) $P_{transmission} = 15dBm; P_{received} = -72\ dBm; f_c = 2.4GHz$

$$P_{received} = P_{transmission} - L_{ISO} \rightarrow -72 = 15 - 20 \cdot \log\left(4\pi \cdot 3 \cdot \frac{d}{3 \cdot 10^8}\right)$$

$$10^{\frac{87}{20}} = 4\pi \cdot 3 \cdot \frac{d}{3 \cdot 10^8}$$

$$d = 222.69\ m$$

4) (1) What is frequency range of 802.11b Wireless Channel?

$$2.4\ to\ 2.4835\ GHz$$

5). (2) Multipath fading is maximized when the two beams arrive 180 degrees out of phase. How much of a path difference is required to maximize the fading for a 50-km-long 1-GHz microwave link?

$$\lambda = \frac{c}{f} = \frac{3 \cdot 10^8}{1 \cdot 10^9} = 0.3m = 30\ cm$$

The path difference is defined as half the wavelength if we want 180 degrees out of phase and thus is 15cm.