UNIVERSITY OF CALIFORNIA, LOS ANGELES
CS M117

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Pre-laboratory Homework #1 (Due 07/05)
(HW must be typed)

Data Transmission over 802.11b Wireless LAN
(Lecture 2 + Reading 2 & 3)

Section A
Wireless MAC, TCP

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

No. Even with a hidden terminal solution, the overhead associated with RTS and CTS is costlier than the occasional packet collision with a short packet.

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

Yes. Contention Window and Binary Backoff with short packets can reduce the number of collisions by resending a packet after a collision instead of notifying the receiver of the initial collision.

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") ?

A new packet does not need a Contention Window to sense an idle medium because the only condition to sense an idle medium is that the medium is not currently being used to transfer information. The Contention Window only deals with the time to resend a packet.

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?

$$\frac{11\ Mbps}{64\ bytes} = \frac{11000000\ bps}{512\ bits} = 21484.375\ fps$$
$$P(FAILURE) = (10^{-7})^{512} = 0.00005$$
$$21484.375\ fps * 0.00005 = 1.07422\ damaged\ fps$$

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?

$$time = \lfloor \log_2 24 \rfloor * 10 = 4 * 10 = 40\ ms$$

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?

$$C = B \log_2\left(1 + \frac{S}{N}\right)$$
$$20\ Mbps = 3\ Mhz * \log_2\left(1 + \frac{S}{N}\right)$$
$$\frac{S}{N} = 2^{\frac{20}{3}} - 1 = 100.5937$$

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)

- **Scattering:** wave bounces off object with smaller wavelength
- **Diffraction:** wave bounces off sharp surface
- **Reflection:** wave bounces off object with larger wavelength or a smooth surface

(b)

- **Scattering:** small-scale fading
- **Diffraction:** small-scale fading
- **Reflection:** large-scale fading

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) Multipath signals affect signal reception by reducing the transmission rate. The signals contain noise and can cause interference.

(b) $R = \frac{1}{2}\tau_d$

The multipath transmission rate is inversely related to the data transmission rate.

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)

$$P_{received} = P_{transmitted}\left(\frac{c}{4\pi f_c d}\right)^2$$

$$L_{ISO} = 20\log\left(\frac{c}{4\pi f_c d}\right)$$

b)

$$P_{received} = -72\ dBm$$
$$P_{transmitted} = 15\ dBm$$
$$f_c = 2.4\ GHz$$
$$P_{received} = P_{transmitted} - L_{ISO}$$
$$-72\ dBm = 15\ dBm - 20\log\left(\frac{4\pi d * 2.4 * 10^9}{3 * 10^8}\right)$$
$$10^{\log\left(\frac{4\pi d*2.4*10^9}{3*10^8}\right)} = 2^{\frac{87}{20}}\ dBm$$
$$d = 10^{\frac{87}{20}} * \left(\frac{3 * 10^8}{4\pi * 2.4 * 10^9}\right) = 222.69\ m$$

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

2.4 GHz 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?

$$\lambda = \frac{C}{f} = \frac{3 * 10^8 \frac{m}{s}}{1 * 10^9 \frac{1}{s}} = 0.3m = 30\ cm$$

$$path\ difference = \frac{\lambda}{2} = 15\ cm = 0.15\ m$$