UNIVERSITY OF CALIFORNIA, LOS ANGELES

CS M117

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Pre-laboratory Homework #1 (Due 10/04)
(HW must be typed)

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Data Transmission over 802.11b Wireless LAN
(Lecture 1 + Reading 1)

Section A
Wireless MAC, TCP

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

> No, it would be more efficient to just directly send the packet. RTS and CTS are better suited for situations where we are sending a large data frame. If it's a short packet we can just expect that there may be a collision and resend the data.

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

> Yes. The Contention Window and Binary Backoff are used to deal with collisions, which can happen whether the packet is large or small.

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") ?

> The contention window is designed to avoid collisions (multiple devices that have different packets sending at the same time). If the medium is idle, that means nothing is sending – so we don't have to worry about using the contention window to avoid collisions.

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 bytes * 8 bits/byte = 512 bit frames
$11*10^6$ bits per section/512 bits per frame = 21484.375 frames/sec
A frame is damaged when *any* bit in the frame fails
Probability that any bit in the frame fails is 1 – P(all succeed)
P(all succeed) = $(1 – 10^{-7})^{512}$ = 0.9999489
So on average, (1-0.999489)*21484.375 = 1.1 frame/sec damaged

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?

Slow start effectively doubles the segment size each roundtrip.
1^{st} roundtrip = 2KB, 2^{nd} roundtrip = 4KB (6KB sent so far), 3^{rd} roundtrip = 8KB (14Kb sent so far), 4^{th} roundtrip = 16KB (30KB sent)
It takes four round trips to reach 24KB, so 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?

Using Shannon's Law $\boxed{C = W \cdot \log_2\left[1 + \frac{S}{N}\right]}$
20 = 3 * $\log_2$[1 + ratio]
6.67 = $\log_2$[1 + ratio]
ratio = 100.59

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)
The first is reflection (a signal could be reflected from a building onto a receiver). A second mode is diffraction, where waves are obstructed by a surface with sharp irregular edges. The third mode is scattering, when you encounter objects smaller than the wavelengths of the propagating wave.

(b)
Diffraction and scattering result in small scale fading, while reflection results in 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 cause inter symbol interference at different waves. The delay spread limits the transmission rate of a wireless channel

(b)
The more multipath transmissions there are, the lower the transmission rate will be. It's an inverse relationship.

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 = $20 * \log\left(\frac{4\pi f d}{c}\right)$dB

This equation was taken from the free space isotropic loss equation given in the course reader.

b)

We know the maximum amount of power that can be lost is 15 – (-72) dBm = 87dBm. This means that the max istropic free space lost is 87 dBm. Using the above equation, we solve for d.

$$87\ dBm = 20 * \log\left(4\pi * 2.4 * \frac{10^9 Hz * d}{c}\right)$$

$$10^{\frac{87}{20}} = 4\pi * 2.4 * 10^9 * \frac{d}{c}$$

$$d = 222.69m$$

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

2.4 GHz – 2.484 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?

180 degrees out of phase is equivalent to half a wavelength. We just need to find the wavelength of this particular microwave.

$$c = f\lambda$$

$$\frac{3 * 10^8}{1 * 10^9} = \lambda$$

$$\lambda = 0.3m$$

Half of 0.3m is 0.15m – which is the path difference required.