Wireless Networking: Fundamentals and Applications

Homework #1

Due: 1pm, Thursday, November 10, 2011

=== Homework submission instructions ===

- Submit the answers for writing problems (including your programming report) through the CEIBA system (electronic copy) or to the TA in R432 (hard copy). Please write down your name and school ID in the header of your documents.
- Each student may only choose to submit the homework in one way; either all as hard copies or all through CEIBA except the programming assignment. If you submit your homework partially in one way and partially in the other way, you might only get the score of the part submitted as hard copies or the part submitted through CEIBA (the part that the TA chooses).
- If you choose to submit the answers of the writing problems through CEIBA, please combine the answers of all writing problems into only one file in the doc/docx or pdf format, with the file name in the format of "hw1_[student ID].{pdf,docx,doc}" (e.g. "hw1_b97902001.pdf"); otherwise, you might only get the score of one of the files (the one that the TA chooses).

Problem 1. For each power delay profiles in Figure 1, estimate the 90% correlation and 50% correlation coherence bandwidths.

Problem 2. Table 1 lists a set of empirical path loss measurements.

1. Find the parameters of a simplified path-loss model plus log-normal shadowing that best fit this data.
2. Find the path loss at 2km based on this model.
3. Find the outage probability at a distance d assuming the received power at d due to path loss alone is 10 dB above the required power for non-outage.

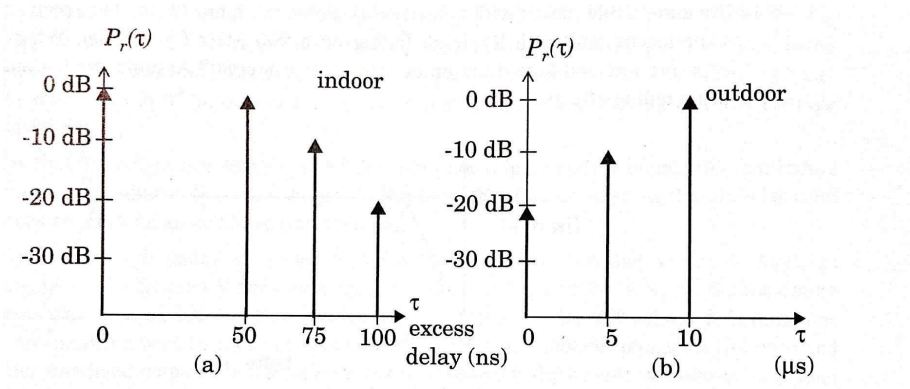

Figure 1: Power delay profiles

Table 1: Path-loss measurements

Distance from transmitter	P_r/P_t
5 m	-60 dB
25 m	-80 dB
65 m	-105 dB
110 m	-115 dB
400 m	-135 dB
1000 m	-150 dB

Problem 3. In this problem, we ask you to estimate the coverage of 802.11b/g/n wireless access points on the 2F of the CSIE building. The question we are trying to answer in this problem is, if we place one access point at "point 68" in Figure 2, what are the rooms which will be covered by the access point?
Please answer the following questions.

1. What is the typical receive sensitivity for a 802.11b/g/n device? Please look for this information on the Internet and list your reference. Note that the sensitivity for different link speed is different. In this problem, let's use the lowest link speed for 802.11b/g/n - 1 Mbps.

2. What is the typical transmission power for a 802.11b/g/n wireless access point? Please look for this information on the Internet and list your reference.

3. What are the typical antenna gains for a 802.11b/g/n wireless access point and a client (a laptop built-in antenna, or a external wireless adapter)? Please provide your reference or explanations. Note that the antennas that come with the zigduinos have a peak gain of 2 dBi.

4. We say that a room is *covered* by the access point when the received power of a receiver at *any* location in the room is larger than the receive sensitivity. Using this definition, together with the above information and the path loss exponent you estimated from lab2, answer the initial question we have for this problem. Assume that when the signal passes through a wall, it will get an additional 13 dB of loss (this is the typical value for a concrete wall).

5. Prof. Dumbledor observed that we have way too much interference in the 2.4 GHz frequency band (probably because all the students in our class is using the zigduinos to blast out signals carelessly XD). He suggests that we instead deploy a 802.11a wireless access point, which operates at 5-6 GHz (let's use 5.8 GHz for this problem), since there is not that many devices operating at that frequency band. Assuming that the path loss model, the receive sensitivity, the transmission power, and the

Figure 2: The floor plan of the 2F of the CSIE building

antenna gains stay the same, answer the same question again. Based on your new result, convince him that this might not be a good idea.

(The floor plan does not have all the dimensions of the 2F. Feel free to specify your own estimations and use those estimations to calculate your results.)

Problem 4. Consider a cellular system where (a) path loss follows the simplified model with path loss exponent $\gamma = 6$ and (b) there is also log-normal shadowing with $\sigma = 8$ dB. If the received power at the cell boundary due to path loss is 20 dB higher than the minimum required received power for non-outage, find the cell coverage area.