Homework 3

From Rapport's book

4.1: If P_t= 10 W, G_t= 0 dB, G_r=0 dB, and f_c=900 MHz, find P_r in Watts at a free space distance of 1 km.

4.27: A transmitter provides 16 W to an antenna having 12 dB gain. The receiver antenna has a gain of 3 dB and the receiver bandwidth is 30 kHz. If the receiver system noise figure is 8 dB and the carrier frequency is 1800 MHz, find the maximum T-R separation that will ensure that a SNR of 20 dB is provided for 95% of the time. Assume n=4, σ=8 dB, and d_0 = 1 km.

4.34 Consider seven-cell frequency reuse. Cell B1 is the desired cell and B2 is a co-channel cell as shown in Figure P4.34(a). For a mobile located in cell B1, find the minimum cell radius R to give a forward link C/I ratio of at least 18 dB at least 99% of the time. Assume the following:

Co-channel interference is due to base B2 only.
Carrier frequency, f_c = 890 MHz.
Reference distance, d_0 = 1 km (assume free space propagation from the transmitter to d_0).
Assume omnidirectional antennas for both transmitter and receiver, where G_{base} = 6 dBi and G_{mobile} = 3 dBi.
Transmitter power, P_t = 10 W (assume equal power for all base stations).
PL(dB) between the mobile and base B1 is given as

$$\overline{PL}(\mathrm{dB}) = \overline{PL}(d_0) + 10(2.5)\log\left(\frac{d_1}{d_0}\right) - X_\sigma \quad \sigma = 0\ \mathrm{dB}.$$

PL(dB) between the mobile and base B2 is given as

$$\overline{PL}(\mathrm{dB}) = \overline{PL}(d_0) + 10(4.0)\log\left(\frac{d_2}{d_0}\right) - X_\sigma \quad \sigma = 7\ \mathrm{dB}.$$

Cell boundaries are shown in the Figure P4.34(b).

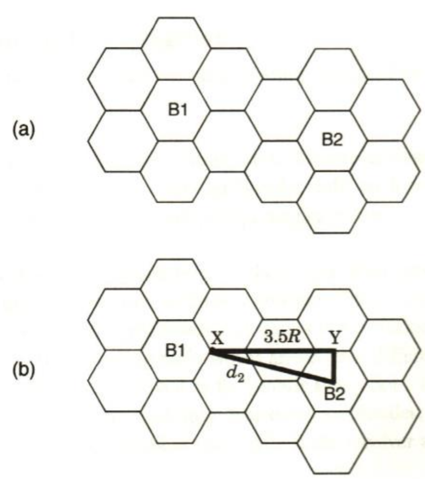

Figure P4.34 (a) Seven-cell reuse structure; (b) co-channel interference geometry between B1 and B2.

Remarks:
(1). Hints on problem 4.27: Given the noise figure in the problem F=8 dB, which translates into F=6.3 in decimal form, with the receiving BW B, the noise power density N=kBFT, where k=$1.38*10^{-23}$, the Boltzman constant, T=290 degree in Kelvin, and B is the receiving bandwidth (for details, please see

Appendix B on page 612). Use this noise power and the required SNR, find the desired received power level.
(2). In 4.34, although there is a well-defined notation for dBi, in this exercise, just treat it as dB when you do the conversion.

Additional problems:

1. What causes the long-term fading? Why do we need the path-loss model for the design of wireless cellular networks?

2. List at least three factors leading to the small-scale fading. How do you overcome the small-scale fading in reliable communications?

3. In communications systems, electro-magnetic (EM) wave is used to carry information. Where do we place the information in an EM wave for the information transfer?

4. Is CSMA/CD suitable for wireless LANs? Why or why not?

5. Suppose that the ALOHA protocol is used to share a 56 kbps satellite channel. Suppose that packets are 1000 bits long. Find the maximum throughput of the system in packets/second.

6. Let G be the total rate at which packets are transmitted in a slotted ALOHA system. What portion of slots goes empty in this system? What portion of slots goes empty when the system is operating at its maximum throughput? Can observations about channel activity be used to determine when stations shoudl transmit?

7: What is the advantage that the pure Aloha gives you over the slotted Aloha in addition to the synchronization requirement?

8: Only in certain scenario, the CSMA/CD outperforms slotted Aloha, what is the scenario?