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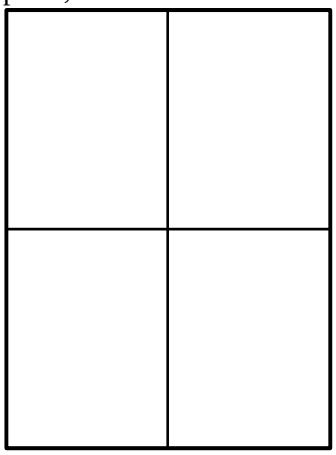
Seminar 3: Radio Networks

Problems

1. The ratio between reuse distance and cell radius, $\frac{D}{R}$,is equal to 4. Determine the minimum cluster size and sketch the pattern of cells.
2. A NMT 450 system requires a SIR of at least 20 dB. The path loss exponent is $\alpha = 3.5$. If you consider only the first tier of interferers, what is the minimum cluster size?
3. Assume that a radio system has base stations built along a straight highway. The distance between the base stations are given by $2R$, where are R is the radius of the circular coverage area (cell) for each base station. All base stations are identical except for the transmission frequency. The path loss exponent is 3. Consider the worst case user (located between two base stations) and determine the capacity of the system if there are 100 channels.
4. A city covers an area of 400 km^2. How many cells, each with a radius of 2 km, are needed to get coverage over the whole city? If the path loss exponent is 4, how many channel groups are needed if a minimum of γ_t =23 dB is required at the cell border? Assume that 490 channels are available and determine the area capacity.
5. You are going to set up a WLAN network in a building. You have access to 802.11n WLAN access points that transmitts on the 2.4 GHz band. The access points transmit power is 20 mW. The sensitivity (minimum received power for corresponding data rate) of the station is assumed to be as follows:
   Sensitivity:
   72.2 Mb/s -73 dBm
   65 Mb/s -74 dBm
   57.8 Mb/s -75 dBm
   43.3 Mb/s -80 dBm
   28.9 Mb/s -83 dBm
   21.7 Mb/s -84 dBm
   14.4 Mb/s -85 dBm
   7.2 Mb/s -86 dBm
   The path loss can be modelled as
   L_p=43+26 $\log_{10}$(r) [dB]
   Assume that the signal is attenuated on average by 10 dB for walls and furthermore a 10 dB fade margin is needed. Calculate how many access points are needed to provide 72.2 Mbit / s across the floor below. The house dimensions are 15m by 20 m. If you only have one access point, what will be the minimum speed in the house?



6. A cellular mobile phone system needs 17 dB in signal to interference ratio. The number of channel groups is currently 7, but you want to increase the capacity. Which capacity can be achieved if 60-degree sector antennas are used? Assume the sector antennas reduce the number of interfering base stations to 2. Assume that the propagation loss is proportional to r^4.
7. A cellular mobile telephone system has an area capacity of η_A channels/km^2. The operator has decided that they need to uppgrade the capacity of the system. Assume hexagonal shaped cells and that the base stations have omni-directional antennas. Estimate the increase of the area capacity using the following methods:
   a) Exchange the omnidirectional antennas to 120 degrees sector antennas in the base stations.
   b) Halv the cell radius.
   c) The required SIR level is reduced by 3 dB.
   Assume that the path loss is proportional to the power of 4 and use suitable simplifications.
8. You are going to set up a WLAN network in a building. You have access to 802.11n WLAN access points that broadcast on the 2.4 GHz band. Access points transmit at 20 mW. The sensitivity of the station is assumed to be as follows:
   Sensitivity:

72.2 Mb/s	-73 dBm
65 Mb/s	-74 dBm
57.8 Mb/s	-75 dBm
43.3 Mb/s	-80 dBm
28.9 Mb/s	-83 dBm
21.7 Mb/s	-84 dBm
14.4 Mb/s	-85 dBm
7.2 Mb/s	-86 dBm

   The path loss can be modelled as free space propagation, but with a loss of 20 dB floors and a loss of 10 dB for each wall and assume at least 10 dB in fade margin. Below is a drawing of an office on two floors. The office is 10m wide and 25m long and the dimension of each office is 4m x 4m (except the boss who is 8m x 4m and upstairs). It is 4 m between the floors and 2.5 m ceiling height.
   You should place as few access points as possible so that the entire office gets at least 14.4 Mb / s and that the manager's room (marked with a cross) gets 72.2 Mb / s.