S-72.620 Radio Network Planning Methods

Examination 14.5.2004. Part A. Closed book tasks (2 tasks)

The examination consists of two parts. When you have done the tasks in Part A (closed book) you should give the answers to the exam supervisor, and then you will get Part B (open book) including 3 problems which may be done with any literature. You can decide yourself the time you spend with each part, and the total exam duration is 3 h. You can leave the exam room 1 hour after the exam start.

1. Answer the following questions with one or a few sentences. Use figures when appropriate.

a) Which are the main properties describing macro- and microcells?
b) How is the offered cell traffic obtained, when the average number of calls per time unit and the average call duration in the same time unit are known?
c) How can antenna feeder loss on the frequency f be determined, when the loss on a given frequency f_o is known?
d) Which Grade of Service measure is the basis for frequency planning in FDMA/TDMA based cellular networks?
e) Why is it impossible to reach the pole capacity in a CDMA-cell?

2. This task should be treated somewhat deeper than the previous one.

   List the elements of cellular network topology planning divided in to BS site configuration and BS antenna configuration, and explain shortly the meaning of the used terms.

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3. The Erlang B distributed traffic in a cellular network increases 20%/a (a=anno=year), $\rightarrow T(t) = T_o \cdot 1.2^t$. Network operation starts with 8 traffic channels/cell, and after 1 year the blocking probability achieves the target value of 2%, and a second set of 8 traffic channel must be taken into use.

a) Determine the traffic value at the start of network operation, T_o.
b) When must a 3rd and 4th traffic channel set, each comprising 8 traffic channels, be taken into use to maintain the 2% blocking probability target?
c) If no more traffic channels can be allocated to the cells, what is then your advice to the operator to do for maintaining the grade of service with the increasing traffic?

4. A cell is designed for a 95% outdoor coverage probability. In the actual environment the path loss exponent is 4 and the log-normal shadow fading standard deviation is 8 dB. When indoor coverage is considered, the wall penetration loss is also log-normal with a 10 dB average and a 6 dB standard deviation, and it is independent of outdoor shadow fading.

a) Determine the needed shadow fading margin to obtain the outdoor coverage probability target.
b) Calculate the indoor fade margin and standard deviation of the total log-normal fading. Take into account a 6 dB reduction of the average outdoor path loss on the outdoor part of the radio path compared to the outdoor case due to higher indoor MS antenna height.
c) Determine the indoor coverage probability in the cell.

Hint: Only approximate values based on the graphs in the lecture material are expected in subtasks a) and b).

5. In the actual propagation environment the path loss exponent is 4 and the log-normal shadow fading standard deviation is 6 dB. The required co-channel protection ratio is 12 dB.

a) In a case of 6 interfering base stations with identical parameters, determine the required normalised frequency reuse distance to obtain 75%, 80%, 85%, 90%, 95%, 98%, and 99% service probability. Only approximate values based on graphs in the lecture material are expected.
b) Determine the corresponding reuse pattern sizes when i) a quadratic, and ii) a hexagonal cell structure is used.