S-72.2211 Mobile Communication Systems and Services

Exam 25.10. 2012

All five tasks are evaluated and taken into account in the grading. The exam can be written in Finnish, Swedish or English. This is a closed book exam.

1. Channel structure in GSM

   a) What defines a physical channel in GSM?

   b) The logical channels are divided into control and traffic channels. Into which three sub-groups are the control channels divided? What is the logic of this division?

   c) How many TDMA-frames does a traffic channel multiframe consist of? What about a control channel multiframe?

   d) Why do traffic and control channel have different multiframe structure?

   e) Which control channel is multiplexed together with a full rate speech channel on a traffic channel?

   f) Why does this multiplexing make sense?

2. Explain shortly the following concepts:
   a) multiplexing, and the different multiplexing alternatives
   b) duplexing, and the different duplexing alternatives
   c) timing advance
   d) circuit switched Radio Access Network
   e) interference limited network
   f) spectral efficiency

3. A cell is being planned. Preliminary measurements show that the average path loss L_p in dB including system losses and antenna gains can be modelled by

$$L_p = 130 + 10\log_{10}(r^{\alpha})$$

   where α is the path loss exponent and r is the distance measured in kilometers.

   a) Determine the required transmit power level to obtain a 5 km cell radius when the receiver sensitivity is -104 dBm and the path loss exponent is 3.2.

   b) Later it turns out that the path loss exponent is 3.5. What would the required transmit power level be to preserve the cell radius?

   c) To which value is the cell radius reduced, if the transmit power remains unchanged?

4. The maximum spreading factor in the uplink direction of WCDMA is 256. Consider a single-cell network, where all interference is intra-cell interference. The fractional load in such a system is $\eta = \sum_j \frac{\rho_j \gamma_j}{G_j}$, where G_j is the processing gain of user j, ρ_j is his activity factor, and γ_j is his Signal-to-noise-plus-interfrence ratio (SINR) requirement.
   a) How many simultaneous SF=256 uplink users with the activity factor 0.4 can coexist in theory (according to the pole capacity), if the required SINR for such users is 3dB? Assume

ideal power control (all users received with same power at the base station).

b) Power control is malfunctioning for one user. This user is transmitting with constant power corresponding to the power required to meet the SINR requirement at the cell border. How near to the base station (measured in units of the cell radius) is this user, if he reduces the total number of uplink users to half the number found in sub-task a? The path loss exponent is 3, and slow and fast fading are not considered. Hint: the user with malfunctioning power control causes fractional load 1/2.

5. Assume that in a cellular system the co-channel Carrier-to-Interference Ratio (CIR) must be 15 dB at least 50% of the time. The path loss exponent is $\alpha = 4$. Estimate the minimum frequency reuse factor M in an ideal hexagonal cellular layout. Consider an uplink situation, where the carrier power and interference power are measured by an omni-directional base station at the centre of a cell. The normalized reuse distance is $\frac{D}{R} = \sqrt{3M}$ where the reuse factor $M = i^2 + ij + j^2$ for any pair of non-negative integers i, j. You may use the aproximation that the interfering users are as close as possible to the receiving base transceiver station, see the picture below.