S-72.2211 Mobile Communication Systems and Services

Exam 28.4. 2014

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. Provide short answers (at most a couple of sentences) to the questions below:

   a) What benefits would there be in a CDMA system if the UL users in a cell would be chip-synchronous?

   b) Is the UL in WCDMA synchronous?

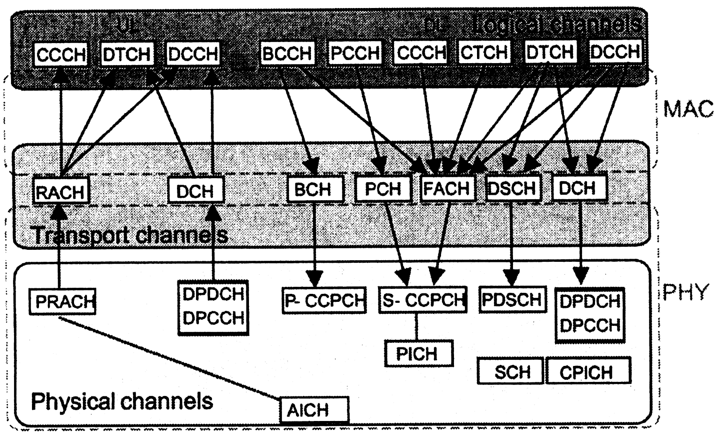
   c) Why is it necessary that the UL users within a cell of a TDMA system are synchronized?

   d) How is synchronicity of UL transmissions within a cell achieved?

   e) In GSM, the UL transmissions need not be perfectly synchronized. What sets the upper limit of acceptable asynchronizity in GSM?

   f) What reasons could there be to synchronize the cells in a cellular network so that all Base Stations use a common time reference?

2. The picture below shows the channel structure of WCDMA.



In logical channel names, the first letters stand for Common, Dedicated, Broadcast and Paging, the second letters stand for Control and Traffic. In four-letter transport channel names, the two first letters meaning either Random Access, Forward Access or Downlink Shared, in three-letter ones the first letter the same as one of the first letters in logical channel names. Some physical channels have obvious names, with P for "Physical" appended. Then we have Dedicated Physical Data and Control Channels, and Primary and Secondary Common Control Physical Channels.

   a) What determines a physical channel in WCDMA?

   b) What is the role of transport channels in WCDMA? What are the essential characteristics of the transport channels?

   c) A user has a dedicated connection for a WCDMA voice call. In addition to dedicated traffic, the Radio Resource Control protocol at the mobile station sends handover measurement data to the network. Over which physical channel is this data transmitted?

3. How many percents will the coverage area increase if a gain term in the radio link budget is improved with 6 dB, and the path loss exponent of the single slope average path loss model is i) 2.0, ii) 3.0, and iii) 4.0?

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 10 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.