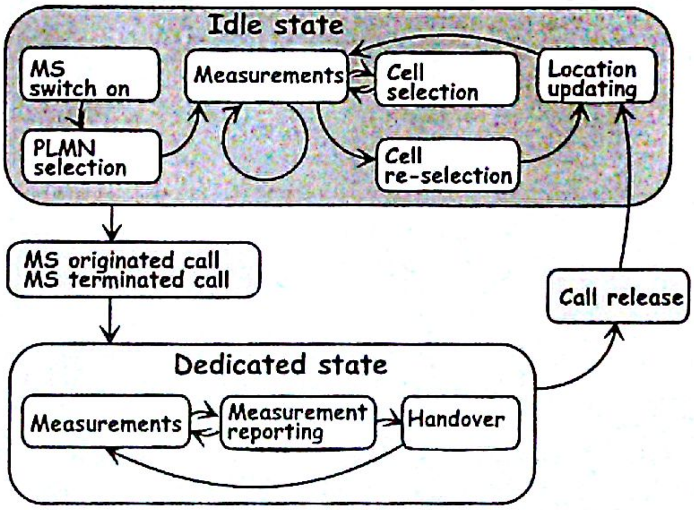
S-72.2211 Mobile Communication Systems and Services

Exam 5.3. 2013

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. In the figure below, a state machine for GSM mobility management is depicted.



a) Why does an idle state mobile station perform cell re-selection?

b) What does an idle state mobile station measure for cell re-selection?

c) When is a location update initiated?

d) What does an idle state mobile station do in order to be able to know if he has a MS terminated call coming?

e) What does an idle state mobile station do when initiating an MS originated call?

f) What core network elements are involved in location updating?

(Short answers to the six questions above are expected, at most a couple of sentences.)

2. WCDMA radio resource management.

a) Why is the near-far effect a problem particularly in the WCDMA uplink?

b) How is the near-far effect avoided in the WCDMA system? What are the consequences of the speed of the mobile station for avoiding the near-far effect?

c) Why is frequency reuse 1 possible in WCDMA but not in GSM? What are the advantages of having frequency reuse 1?

(An expected answer to each of the three questions above would consist of a few sentences.)

3. Calculate the impact of load on coverage in a Direct Sequence CDMA system. Assume the path loss model $L_p = L_0 + 30\log(r)$, fast fading and shadow fading are not taken into account. Consider a service with a given data rate, and a corresponding receiver sensitivity S. When the fractional load $\eta = 0$ (and correspondingly the interference margin $IM = 0$), denote the area of coverage of this service with A. What would the coverage area of this service be in the cases and $\eta = 0.5$ and $\eta = 1$?

4. Assume a system with reuse factor 1, with base stations in a hexagonal cellular lattice. Calculate an approximate expression of the downlink carrier-to-interference ratio (C/I) along a line connecting the serving base station with one of the neighboring base stations. All base stations transmit with the same power. An accepted approximation is to take into account only the six base stations surrounding the serving base station, and to assume that the interference from each of these cells equals the interference from the nearest interfering base station. Fast fading and shadow fading are not taken into account. Path loss is assumed to follow an $d^{-\alpha}$ law, the distance between the base stations is denoted by D, and the distance from the serving base station by r. Assuming that the path loss exponent is 4, tabulate the numeric C/I-values for $r = 0.1D$, $r = 0.2D$, $r = 0.3D$, $r = 0.4D$, $r = 0.5D$.

5. Consider Hybrid ARQ (HARQ) with Chase combining and at most one retransmission. If a coded transmission is erroneously received, the packet is retransmitted. If there is a retransmission, the receiver combines the received signals from the two transmissions, so that after combining, he obtains a packet with an equivalent SNR being the sum of the SNRs of the two transmissions. We use a modulation/coding scheme(MCS) with transmission rate k, and an exponential packet error rate (PER) function

$$P_e(\gamma) = 10^{-\gamma/\gamma_c}, \qquad (1)$$

where γ denotes the SNR of the packet, and γ_c is a constant which characterizes the MCS. Note that if the first transmission was in error, the probability of error for the combined first and second transmission is given by (1) with the sum SNR. We have a channel with a fixed per-transmission SNR γ.

a) Calculate the residual packet error probability, i.e. the probability that a packet is in error after the two possible HARQ transmissions.

b) Calculate the expected number of transmissions used per packet.

c) Calculate the expected throughput.

d) Consider the case $\gamma = \gamma_c/3$. How much larger is the expected throughput for HARQ with at most $T = 2$ transmissions, compared to a single transmission without HARQ using the same MCS?