

Written Exam – June 27, 2017

Surname	
Name	
ID	

Time available for the exam: 1:45 hours

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Question 1 (6 points)

- a) Describe the traffic model for calculating the call blocking probability and call drop probability in a mobile system with guard channels for handovers and given traffic (call arrival rate), topology (cell size), and mobility (user speed) parameters.
- b) Calculate the blocking probability and the call drop probability due to handover failure for a mobile radio system with $n=15$ channels per cell assuming that: Users move with an average speed of 5.5 km/h and random direction; Cells are hexagonal with ray $r=400$ m; Arrival frequency of new calls λ_i is equal to 3 calls/min; Average call duration $\tau = 1/\mu$ equal to 3 min. Assume that channel holding time and call duration are exponentially distributed and the call arrival process and the handover requests process are Poisson processes.

Question 2 (6 points)

- a) Describe the logical to physical channel mapping in GSM and the TDMA scheme used.
- b) Design the multiplexing scheme of a TDMA mobile radio system similar to GSM. The system has radio carriers with a net rate of 210 Kb/s and it requires the following logical channels: Traffic channels TCH (uplink and downlink) with rate 15 Kb/s; Associated control channels SACCH (uplink and downlink) with rate 5 Kb/s; Broadcast channel BCCH (only downlink) with rate 12 Kb/s; Frequency channel FCCH (only downlink) with rate 12 Kb/s; Synchronization channel SCH (only downlink) with rate 10 Kb/s; Paging channel PCH (only downlink) with rate 14 Kb/s; Access grant channel AGCH (only downlink) with rate 8 Kb/s; Random access channel RACH (only uplink) with rate 54 Kb/s. On the carrier, you have to multiplex 5 TCHs and their 5 SACCHs and one signaling channel for each of the types indicated above. Design the multiplexing scheme indicating the frame and multi-frame structure for both uplink and downlink (solutions similar to GSM will get a higher score).

Question 3 (6 points)

Define the maximum cell size of a TDMA system in order to guarantee coverage (power above minimum threshold) and a maximum call blocking probability of 2%. Assume: hexagonal cells, minimum threshold for received power P_{th} equal to -90 dBm, minimum SIR equal to 13 dB, propagation factor equal to 4, number of carriers equal to 9 with 5 time slots per TDMA frame (one call per time slot), received power at reference distance $d_0=10$ m equal to -20 dBm, shadowing margin 5.9 dB. Consider the two cases:

- a) rural area with traffic density of 5 Erlang/km²,
- b) dense urban area with traffic density of 35 Erlang/km².

Question 4 (6 points)

Describe into detail the signaling procedure for a inter MSC handover.

Question 5 (6 points)

Describe the main characteristics of data service in terms of multiple access scheme resource management strategies in UMTS R.99, and HSPA (considering separately HSDPA and HSUPA).

Additional topics (2 points)

It is possible to present here topics directly related to those of the course but not discussed during lectures, including those in the suggested readings available on the web page.