Written Exam - June 29, 2011

Surname	
Name	
ID	

Time available: 2:20 hours

1	2	3	4	5	6	A

Question 1 (6 points)

Optimize the coverage and plan the frequencies of a mobile radio system with 7 candidate sites, 3 of which have 2 possible configurations each (denoted with a parenthesis in the matrix below), and 25 test points considering the matrix V reported below where $v_{ij}=1$ if the test point j is covered by site i and 0 otherwise. Installation costs are all equal.

a) Find an admissible solution to the coverage problem using the greedy algorithm (in case you have equal cost coefficients take the side with the minimum index). Note: you can use directly the matrix reported below but you need to indicate for each step i the vector Π_i of the cost factors used.

b) Is it possible to show if the solution found is optimal? Why?

c) Assign frequencies using the greedy algorithm with the goal of minimizing the number of frequencies used. Define the compatibility matrix with $c_{ii}=2$ for all i, for $i \neq j$ $c_{ij}=1$ if the number of test point covered by both i and j is equal to 2 ($\sum_k v_{ki}v_{kj} = 2$), $c_{ij}=2$ if it is greater or equal 3 ($\sum_k v_{ki}v_{kj} \geq 3$), and $c_{ij}=0$ otherwise. The number of frequencies to be assigned is equal to 2 for the first base station and equal to 1 for all the others.

$$V = \begin{bmatrix}
1 & 1 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 \\
0 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 1 & 1 & 0 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 1 & 0 \\
1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 1
\end{bmatrix}$$

Question 2 (4.5 points)

a) Describe into detail the signaling procedure for a basic call from a mobile radio user to another mobile radio user of the same operator indicating the protocols used at each step.

b) Describe how the procedure changes when the two users are in roaming in the network of a foreign mobile operator.

Continues on the back …

Question 3 (punti 4.5)

Design the multiplexing scheme of a TDMA mobile radio system similar to GSM. The system has radio carriers with a net rate of 320 Kb/s and it requires the following logical channels:

- ✓ Traffic channels TCH (uplink and downlink) with rate 35 Kb/s
- ✓ Associated control channels SACCH (uplink and downlink) with rate 5 Kb/s
- ✓ Broadcast channel BCCH (only downlink) with rate 10 Kb/s
- ✓ Frequency channel FCCH (only downlink) with rate 2 Kb/s
- ✓ Synchronization channel SCH (only downlink) with rate 4 Kb/s
- ✓ Paging channel PCH (only downlink) with rate 14 Kb/s
- ✓ Access grant channel AGCH (only downlink) with rate 6 Kb/s
- ✓ Random access channel RACH (only uplink) with rate 38 Kb/s

On a carrier you have to multiplex 7 TCHs and their 7 SACCHs and one signaling channel for each of the types indicated above. Design the multiplexing scheme indicating the frame and multiframe structure for both uplink and downlink (solutions similar to GSM will get a higher score).

Question 4 (3 points)

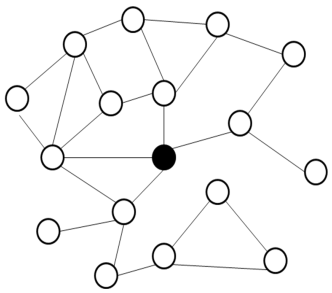
Describe in detail the analytical model for the computation of the throughput in 802.11 systems, considering the case of: a) broadcast transmission; b) point-to-point transmission with RTS-CTS-DATA-ACK. Assume the channel is fully broadcast (no hidden terminals).

Question 5 (4.5 points)

a) Describe the model for the computation of the queuing time in polling systems with round-robin service policy (present the formula derivation step by step).
b) Show how it is possible to modify the model for taking into account the specific characteristics of Bluetooth in the case (1) of 1-slot packets only and in the case (2) of packets of 1, 3 and 5-slots.
c) For case (1) calculate the average waiting time assuming: a piconet with 5 slaves, arrival frequency per queue equal to 500 packets per second.

Question 6 (4.5 points)

a) Describe the main characteristics of reactive and proactive routing in ad hoc networks
b) Describe the operation of AODV protocol. Indicate which nodes during the route discovery procedure can cache routes and for which destinations.
c) Describe the operation of OLSR protocol. Indicate a possible set of multipoint relays that starting from the black node in the figure can forward the packet in the whole network.



Further 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.