

Radio Communication Systems II, Examination, 11.12.2014

Note: there are questions on both sides of the paper

Problem 1. Evolution from WCDMA (wideband code division multiple access) to HSPA (high speed packet access). Are the following statements true or false? Answer just T/F (True/False). No justification is required.

- a) Variable spreading factor is used in HSDPA (high speed downlink packet access) shared channel.
- b) Fast power control is used in both WCDMA uplink and HSUPA (high speed uplink packet access) dedicated channel.
- c) Adaptive modulation and coding was used in first WCDMA networks to achieve good downlink performance.
- d) WCDMA downlink and HSDPA can share the same (spreading) code tree - but not use same codes at the same time.
- e) HSDPA data rate can be increased by dual carrier operation (simultaneous transmission over two carriers) but carriers need to be at least 10MHz away from each other
- f) In HSUPA orthogonal spreading codes are used to separate different data streams
- g) All 16 orthogonal spreading codes of HSDPA (in 5MHz band) can be simultaneously used for user data transmission.

(Evaluation: 7 correct answers => 6 points, 6 correct answers => 5 points, 5 correct answers => 4 points, 4 correct answers => 3 points, 3 correct answers => 2 points, 2 correct answers => 1 point, less than 2 correct answers => 0 points)

Problem 2. Describe briefly the following concepts

- a) Hybrid Automatic Repeat reQuest (HARQ). Why so-called Stop-And-Wait structure is used in HARQ?
- b) Fast scheduling. Why fast scheduling is more effective in LTE than in HSPA? What are the main algorithmic approaches used in fast scheduling?

Problem 3. LTE (long term evolution). Are the following statements true or false? Answer just T/F (True/False). No justification is required.

- a) In LTE uplink cyclic prefix is added after each block of 6-7 symbols.
- b) In LTE downlink, the reference symbols are placed in the midmost symbols of the time slot.
- c) SC-FDMA (single carrier-frequency division multiple access) was selected for LTE uplink to minimize the transmitter Peak to Average Power Ratio (PAPR).
- d) In LTE uplink each user has its own dedicated data channel for user data transfer.
- e) In LTE downlink the Physical Downlink Control Channel (PDCCH) is used to inform the device which time-frequency resource blocks are allocated to it.
- f) In LTE uplink the user bandwidth is doubled if user data rate is doubled when modulation and coding scheme is kept fixed.
- g) In LTE the control information between eNodeB (evolved Node B) and MME (mobile management entity) is carried through the so-called X2 interface.

(Evaluation: 7 correct answers => 6 points, 6 correct answers => 5 points, 5 correct answers => 4 points, 4 correct answers => 3 points, 3 correct answers => 2 points, 2 correct answers => 1 point, less than 2 correct answers => 0 points)

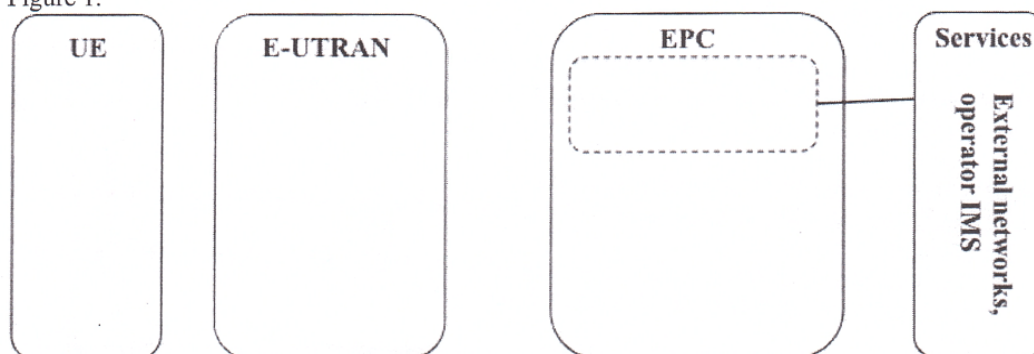
Problem 4. LTE downlink radio link budget:

- What margins/loss terms are used in Radio Link Budget and why?
- eNodeB (base station) transmission power is 30W, cable loss in eNodeB is 2dB and antenna gain 16dBi. Calculate the EIRP (Equivalent Isotropic Radiated Power) and dBm and in Watts.
- Assume the UE noise figure is 6dB and thermal noise is -104dBm (on 10 MHz band). What is the receiver noise floor in this case? If required SINR (for a certain data rate) is 2dB, how much then is receiver sensitivity if receiver noise floor in this case is -90dBm?

Problem 5. Place the elements of the LTE network architecture in right domains of the Figure 1. Then draw connections between network elements and name interfaces (Uu, X2, S1-U, S1-MME). Finally, describe functions of the elements and interfaces.

MME = Mobility Management Entity, S-GW = Service GateWay, P-GW = Packet data network GateWay, PCRF = Policy and Charging Resource Function, HSS = Home Subscription Server

Figure 1.



eNode B and MME: Describe main functions in details
 S-GW, P-GW, PCRF, HSS: Describe main functions briefly
 Uu, X2, S1-U, S1-MME: Describe main functions briefly