

S-72.3226

Radio Communication Systems II, Examination, 11.5.2010

**Problem 1.**

- a) What are the main objectives of WCDMA Radio Resource Management (RRM)?
- b) Describe different WCDMA power control approaches. Why power control is important especially in WCDMA uplink?

**Problem 2.** Consider uplink of an isolated WCDMA cell. Give the formula for uplink load and solve the following problem: Assume that target noise rise of the cell is 3dB and there are two active 128kbps users in the cell. How many 12.2kbps speech users can be supported (in addition to those two 128kbps data users)? System chip rate is 3.84Mcps, activity factor is 0.67 for speech and 1 for data, and required  $E_b/N_0$  for speech is 5dB and for data 2.5dB.

**Problem 3.**

- a) Name and describe at least three important differences between WCDMA downlink and HSDPA.
- b) Explain the principle of Hybrid Automatic Repeat Request (HARQ) protocol and describe how Incremental Redundancy and Chase Combining algorithms work.
- c) Briefly explain in what way HSDPA two-antenna transmission methods (Closed-loop transmit diversity, open-loop transmit diversity and Multiple-Input Multiple-Output (MIMO) improve downlink performance.

**Problems 4 and 5 on the next page**

**Problem 4.** Calculate the allowed propagation loss in High-Speed Downlink Shared Channel (HS-DSCH). Give the missing numbers related to A-G in your answer and explain how the values were calculated. Are all the parameters in the link budget really needed?

HS-DSCH 512kbps		
<b>Transmitter characteristics</b>		
	Transmitter power on HS_DSCH	16 W
	Transmitter power on HS_DSCH	42.0412 dBm
	TX antenna gain	17.4 dBi
	TX cable loss	2 dB
A	<b>Transmitter EIRP</b>	<b>dBm</b>
<b>Receiver characteristics</b>		
	Thermal noise density	-173.975 dBm/Hz
	Receiver noise figure	8 dB
B	Receiver noise density	dB
C	Receiver noise power	dBm
D	Spreading gain	dB
	SINR	6 dB
E	Receiver sensitivity	dB
	Load factor	0.75
F	Interference margin	dB
	RX antenna gain	0 dBi
	RX Body loss	0 dB
	Diversity gain	0 dB
	Fast fading margin	0 dB
	Soft handover gain	0 dB
	Indoor penetration loss	20 dB
	Coverage probability (cell edge)	0.9
	Shadow fading std deviation	6 dB
	Shadow Fading Margin	0 dB
G	<b>Allowed propagation loss</b>	<b>dB</b>

**Problem 5.**

- Name elements of WCDMA and LTE Radio Access Networks (UTRAN and E-UTRAN elements). Where most of the Radio Resource Management (RRM) functions are carried out in WCDMA UTRAN? Where most of the RRM functions are carried out in LTE E-UTRAN?
- Briefly describe the purpose of X2 interface in LTE. Why it is important for E-UTRAN?
- Why was Single Carrier Frequency Division Multiple Access (SC-FDMA) selected for LTE uplink instead of OFDMA?
- Why is LTE scheduling usually more efficient than HSDPA scheduling?