The University Of Sheffield.

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DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Spring Semester 2010-2011 (2 hours)

Mobile Networks and Low Level Protocols 6

Answer **THREE** questions. **No marks will be awarded for solutions to a fourth question.** Solutions will be considered in the order that they are presented in the answer book. Trial answers will be ignored if they are clearly crossed out. The numbers given after each section of a question indicate the relative weighting of that section. **Where a symbol or abbreviation is not defined it can be assumed to have its usual meaning, with which candidates should be familiar**.

1. **a.** Show using a diagram the bit sequence of a normal burst in the GSM protocol, and hence describe the logical control channels that map onto it (multi-frame combinations are not required). **(10)**

b. A BTS communicates with a GSM mobile handset on a normal burst in a particular timeslot, and has instructed the mobile to use a time advance of *TA=63*. Estimate:

(i) From the mobile's perspective: The elapsed time between the start of the received BTS burst and the start of the mobile's transmit burst

(ii) From the BTS's perspective: The elapsed time between the start of the BTS transmit burst and the start of the received mobile burst. **(6)**

c. Estimate the distance between the BTS and mobile handset. What is the significance of this particular value? Assume $c = 3 \times 10^8 m/s$. **(4)**

2. **a.** Compare the GSM and TETRA standards for mobile communications in the following aspects:

(i) TDMA multi-frame structure (excluding logical channels)

(ii) Modulation and bandwidth

(iii) What type of usage they are designed for. **(10)**

b. Assuming a TETRA handset transmits in one timeslot per frame on a carrier frequency of *390MHz*, and all bits are set to *1*, draw a calibrated sketch of the signal spectrum, stating any analysis techniques used or assumptions made. **(8)**

c. Comment on possible implications of the spacing of the spectral harmonics. **(2)**

3. a. Explain why fast closed loop power control is used in 3G WCDMA networks, but not in GSM networks, and describe how it is implemented in 3G. **(6)**

b. Compare the effects of multi-path propagation on GSM and 3G signals, and describe briefly techniques used to maximise the signal. **(6)**

c. A mobile phone user makes a call in a city centre whilst standing close to a BTS. If the uplink signal frequency is *2GHz* and it reaches the BTS via a direct path and a reflected path, with a time delay of *0.52025us* between the two paths, comment on how the resultant uplink signal would be managed to maintain optimum quality of service assuming

(i) The call is made on a 3G network

(ii) The call is made on a GSM network.

Assume $c = 3 \times 10^8 m/s$. **(4)**

d. What happens in cases **c**(i) and **c**(ii) if the user then starts walking away from the BTS? **(4)**

4. a. Explain what is meant by the processing gain G_p of a WCDMA signal. **(2)**

b. Show that the uplink load factor due to *N* users accessing a 3G WCDMA cell can be written in terms of the received energy per bit to noise ratio E_j as

$$\eta_{ul} = \sum_{j=1}^{N} \frac{E_j}{E_j + G_{pj}} \qquad (4.1).$$

and explain its significance. Assume there is no interference from adjacent cells. **(9)**

c. If *N=10* users are simultaneously uploading data (not speech) to the cell at *96kbps* each, calculate

(i) The uplink load factor

(ii) The noise rise above thermal (P_t / P_n) due to this user activity

(iii) The pole capacity of the cell.

Assume $E_j = 1.5dB$ for all users, and again that there is no interference from adjacent cells. **(9)**

GGC