Data Provided: None

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Spring Semester 2006-2007 (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 is not defined it can be assumed to have its usual meaning, with which candidates should be familiar.*

1.   **a.**   Show that the uplink load factor of a 3G WCDMA cell can be written

$$\eta_{UL} = (1+i)\sum_{j=1}^{N}\left(\frac{1}{1 + \dfrac{W}{(E_b/N_o)_j R_j \nu_j}} \right) \quad (1.1)$$

and explain its significance.   **(10)**

   b.   Hence calculate the noise rise caused by *9* users each uploading data to the cell at *144kbps*, assuming an E_b/N_o requirement of *1.5dB*, and *i=0.65*.   **(6)**

   c.   Estimate the uplink pole capacity of the cell.   **(4)**

2.   **a.**   Briefly explain each of the parameters relevant to estimating a link budget for a 3G WCDMA *12.2kbps* voice service, assuming the mobile handset is being used in a moving car, and using typical values for each parameter hence estimate an allowed propagation loss within a cell.   **(10)**

b. A plane wave with an average power density of $10^{-10} W / m^2$ from a transmitting 3G mobile handset is incident on a BTS antenna, in the direction of its main lobe. Estimate the power induced at the BTS receiver terminal, clearly stating all assumptions made. **(5)**

c. A mobile network is considering installing super-cooled mast-head receive pre-amplifiers at some of its BTS sites. Discuss the rationale behind this. **(5)**

3. a. Explain how and why Time Division Duplex is used in the GSM system. **(4)**

b. Sketch the bit sequences as a function of time for the following bursts in the GSM protocol:

    i)   A normal burst

    ii)   A random access burst

and explain what each is used for. **(10)**

c. A GSM handset with an engineering 'Field Test' menu displays a time advance of *30* during a phone call, and shows that timeslot *4* is being used. Estimate the elapsed time:

    (i)   From the beginning of the BTS downlink traffic frame to the beginning of the received handset uplink burst as measured at the BTS

    (ii)   From the beginning of the received BTS downlink traffic frame to the beginning of the handset uplink burst as measured at the handset.

(Assume $c = 3 \times 10^8 \, ms^{-1}$). **(6)**

4. a. Describe with the aid of area coverage sketches the following mobile phone network cell types, and the circumstances in which they would typically be deployed:

    (i)   A macro cell

    (ii)   A micro cell

    (iii)   A pico cell

    (iv)   An umbrella cell

    (v)   A sectored cell. **(14)**

b. Explain why bit cancellation due to multi-path propagation may be more of a problem with 3G WCDMA micro cells in city centres than with their GSM counterparts, and briefly describe how 3G systems can overcome this problem. (Assume $c = 3 \times 10^8\, ms^{-1}$). **(6)**

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