The University Of Sheffield.

Data Provided: None EEE6430

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Spring Semester 2012-2013 (2 hours)

EEE6430 Mobile Networks and Low Level Protocols

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.** Describe the random access (RA) burst and its payload in the GSM protocol, and why a time advance (TA) is necessary. What is the maximum TA allowed and why? **(6)**

b. A GSM mobile sends repeated RA bursts in successive frames on an uplink frequency of 900MHz. Assuming all RA bits are set high, calculate:

(i) The width of the signal spectrum envelope to the –6dB points if $\text{sinc}(1.895) = 0.5$

(ii) The height and position of the spectrum envelope first sidelobes

(iii) The separation of individual frequency components in the spectrum

and show these parameters on a calibrated sketch of the signal spectrum, explaining any Fourier analysis methods used. **(12)**

c. Why might you hear ‘buzzing’ type interference if the handset was held close to audio equipment? **(2)**

2. **a.** Explain why fast closed loop power control is required in 3G WCDMA cellular mobile networks, and how it is implemented. **(5)**

b. Calculate the allowed propagation loss between a 3G WCDMA mobile station used outdoors and the serving cell base station for a 120kbps data service given the following parameters:

Mobile transmit power $= 0.05W$ into a half wave dipole antenna

Base station receiver noise spectral density $= -174\text{dBm/Hz}$

Base station receiver noise figure $= 5\text{dB}$

Interference margin $= 3\text{dB}$

Required bit/noise power ratio $= 5\text{dB}$

Base station antenna directivity $= 14\text{dBi}$

Fading margin $= 7\text{dB}$

Soft handover gain $= 3\text{dB}$

Any parameters not given above but considered relevant should also be included in the calculation with typical values. **(10)**

c. Estimate the range of the cell using the formula

$$L = 137.4 + 35.2\log_{10} R$$

and comment on how this range may be affected if the mobile were used

(i) Indoors

(ii) In a direction away from the main beam of the serving cell antenna

(iii) On high ground **(5)**

3. **a.** Describe the Common Control Physical Channels (CCPCH) and Synchronisation Channels (SCH) in the 3G WCDMA physical layer. Your answer should include their associated transport channels and a sketch of the primary CCPCH and SCH timeslot and frame structures. **(10)**

b. If a transport channel occupies the entire primary CCPCH, calculate

(i) The transport channel symbol rate

(ii) The transport channel instantaneous bit rate

(iii) The transport channel average data rate assuming 2/3 rate coding.

Assume a spreading factor of 256. **(6)**

c. If two channels each equally occupy the remaining 10% of the time slot, what are their

(i) symbol rates

(ii) instantaneous bit rates

(iii) average bit rates?

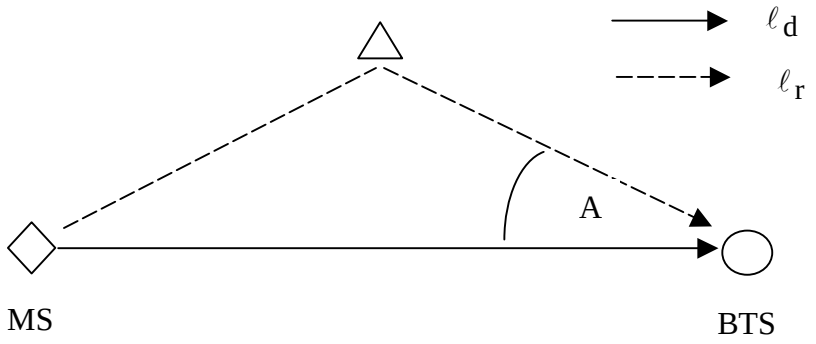
Assume a spreading factor of 256. **(4)**

4. a. Briefly describe the various methods of diversity gain that may be employed over a mobile network physical layer radio link between a mobile station and BTS to enhance the signal, and say whether each is used in GSM and/or 3G networks. **(10)**

b. A GSM BTS with a single antenna receives an uplink signal from a mobile station on a frequency of 1710.2MHz, via a direct path ℓ_d and an indirect reflected path ℓ_r, where

$$\ell_r - \ell_d = 175.5057\text{m}$$

measured between the mobile and BTS antenna as shown in the figure.



Using appropriate calculations,

(i) comment on the combined received signal strength at the BTS

(ii) if the mobile then frequency hops to 1719.6MHz, comment on the new combined received signal strength at the BTS.

Assume $c = 3\times10^8\,\text{m/s}$. **(6)**

c. If $\ell_d = 500\text{m}$ and the reflecting object is mid-way between the mobile and BTS, calculate the angle A subtended by the reflected path, and explain its significance. **(4)**