The University Of Sheffield.

Data Provided: None

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Spring Semester 2009-2010 (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.** Explain briefly the different strategies that may be adopted by a mobile cellular network to cover

(i) Rural areas

(ii) City centres

(iii) Motorways

(iv) Buildings. **(4)**

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

c. Estimate the allowed propagation loss for a 3G cell assuming the following:

mobile transmit power = 0.1W into dipole antenna,

body loss = 2dB,

base station receiver sensitivity = -120 *dBm,*

base station antenna directivity = 18dBi,

base station feeder loss = 2dB.

Hence calculate the range of the cell.

The following formula may be of use:

$$L = 137.4 + 35.2 \log_{10} R \qquad (1.1).$$

(10)

2. **a.** Describe each of the following physical channels and their associated transport channels used for transmitting higher layer signalling messages and physical layer control data over the 3G WCDMA cellular mobile air interface:

(i) The Common PIlot CHannel (CPICH)

(ii) The Synchronisation CHannel (SCH)

(iii) The primary and secondary Common Control Physical Channels (CCPCH)

(iv) The Paging Indicator CHannel (PICH) **(10)**

b. The downlink Acquisition Indicator CHannel (AICH) transmits over *4096* chips in every timeslot of a *20ms* frame structure, as shown in Fig 2.1. If a spreading factor of *256* is used, calculate

(i) The AICH instantaneous bit rate

(ii) The AICH average data rate assuming half rate coding.

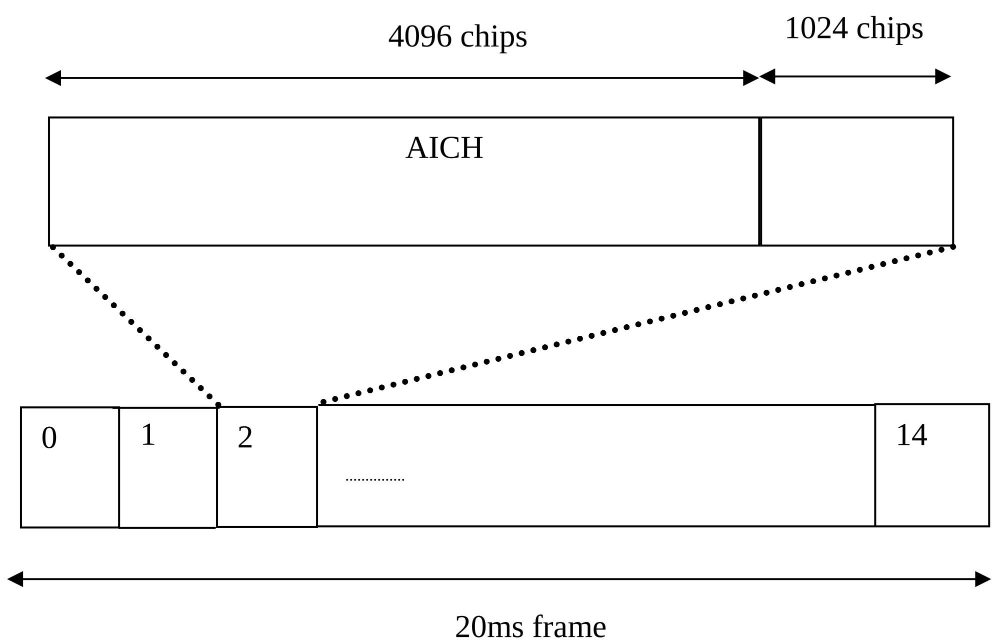

Fig 2.1 **(6)**

c. If the AICH only transmitted in timeslot *2* of every *20ms* frame, what would the average data rate then be? **(2)**

d. Suggest a use for the remaining *1024* chips in each timeslot. **(2)**

3. **a.** Explain how convolution coding is used to provide FEC when sending speech over the GSM air interface. Use *10110* as example data. **(8)**

b. Describe how the speech bits are mapped onto a full rate traffic channel. **(8)**

c. A half rate speech traffic channel is coded using 228 bits per 20ms speech block.

(i) Calculate the channel bit rate

(ii) Estimate the actual speech data rate. **(4)**

4. **a.** A BTS located in a residential street uses an antenna with a gain of *17dBi* to serve a cell, with *10W* of transmit power fed to the antenna. Estimate the minimum safe distance from the antenna in the direction of the (horizontal) main lobe so that the radiated power density level is within the ICNIRP safety limit of $100Wm^{-2}$. **(5)**

b. One of the sidelobes of the *BTS* array has a level of *-27dB* with respect to the main lobe at an angle of 60^{o} from the horizontal towards the ground. Assuming the antenna height is *8.5m*, calculate the power density on a pedestrian's head due to this sidelobe (assume pedestrian is *1.75m* tall). **(5)**

c. Make an approximate estimation of the power density incident on a person's head whilst using a mobile handset, assuming it is held *10cm* from the head and the transmit power is *0.1W* into a *2dBi* antenna. **(3)**

d. Hence discuss the health concerns of residents who complain about a BTS being located in their street. **(7)**

GGC