

ENGINEERING TRIPOS PART IIB

Friday 23 April 2004 9 to 10:30

Module 4F5

DIGITAL COMMUNICATIONS

Answer not more than three questions.

All questions carry the same number of marks.

The approximate percentage of marks allocated to each part of a question is indicated in the right margin

There are no attachments.

You may not start to read the questions printed on the subsequent pages of this question paper until instructed that you may do so by the Invigilator

(TURN OVER

1 (a) Briefly describe the following multiple access techniques:

FDMA
TDMA
SSMA

and give their advantages and disadvantages.

[70%]

(b) The downlink of a typical third generation (3G) mobile radio system uses SSMA-DS to support multiple users. Data and code generators both employ BPSK modulation at bit and chip rates of R_b and R_c respectively. Half rate error correction coding is employed and the minimum value of E_b/N_0 is 4.77dB. If the channel bandwidth is 3.84MHz and all frequency components of the power spectral density out to the first null must be received intact, determine the maximum bit rate per user (assume all have equal bit rate) with 43 users per cell. Note the available spreading ratios are 256, 128, 64, 32, 16, 8 and 4.

[30%]

2 (a) Imagine the many possible location-based services that could be offered to users of mobile phones. Describe the three you would consider most useful.

[30%]

(b) For each of the three services you presented in step (a), discuss whether it can be provided anonymously and to what extent. If so, how could this be done technically? What parts of the system would the user need to trust? (Solutions that minimize the Trusted Computing Base are obviously better.)

[50%]

(c) Mechanical locks that can be operated by different keys, with each key opening a particular subset of the deployed locks, are common in large buildings. Nowadays, though, this functionality can also be provided by electronic entry cards. Discuss the security aspects involved in the replacement of locks with entry cards, including location privacy and ways to preserve it.

[20%]

3 We are interested in a “digital cash” protocol for anonymous payments over the Internet.

- (a) What does such a protocol achieve? Who are the participants? In what way is the payment anonymous? [20%]
- (b) Describe the inner workings of such a protocol. [20%]
- (c) What are the security goals of the participants of such a protocol? (HINT: They may be different for different participants.) How is your protocol protecting them? [20%]
- (d) Discuss the properties of your protocol compared with standard “Internet Banking”. [20%]
- (e) Discuss the properties of your protocol compared with real (physical) cash. [20%]

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4 Sensor-driven or “Sentient” computing makes possible many new applications of computer and communication systems. It is potentially useful for in-building environments.

- (a) Outline the major hardware and software components used to implement an in-building “Sentient Computing System” based on location information. [25%]
- (b) Give a software architecture and describe the most important components of the middleware. [25%]
- (c) What is a spatial monitor and how can it be designed to handle a very high rate of indexing events. [25%]
- (d) Give three potential applications of location-aware systems. [25%]

END OF PAPER