Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

M.Sc. in Advanced Computer Science

Mobile Computing

Date: Tuesday 26th May 2009

Time: 09:45 – 11:45

Please answer any THREE Questions from the FIVE questions provided

Please use a separate answer book for each Section.

For full marks your answers should be concise as well as accurate.
In order to achieve full marks you should show your working for any calculations

This is a CLOSED book examination

The use of electronic calculators is permitted provided
they are not programmable and do not store text
Section A

1. a) Contrast how new processes are created by:
   - The operating system for a desktop computer running Microsoft Windows or Linux and
   - The operating system for a Personal Digital Assistant (PDA) or mobile telephone. (5 marks)

b) Referring to question 1 a) above, what similar and different operations tend to be provided by the operating system in these two different classes of environment? (5 marks)

c) How do the characteristics of computer networks differ from those of traditional telephone networks? (3 marks)

d) As observed at the network layer, what are the fundamental differences between the quality of service offered by wireless computer networks as compared with that of wired computer networks. Explain why IEEE802.11b and IEEE802.11g wireless local area (Wi-Fi) networks are not ideal for providing mobile access to voice over IP (VoIP) telephone services. What problems can ‘contention mode access’ (CSMA) cause when battery powered mobile equipment is used for voice over WI-FI? What features of more recent IEE802.11 standards could, in principle, be employed to reduce these problems? (7 marks)
Section B

2. a) Why does an IEEE 802.11a system using RTS/CTS have lower throughput than an equivalent system using IEEE 802.11bg? How might the IEEE 802.11a system be modified to correct this issue?  

   (4 marks)

b) Using the example IEEE 802.11g wireless computer nodes A, B, X and Y in the picture below, explain why even when RTS/CTS is successfully used some data transfers will still fail?  

   (7 marks)

c) Explain how transmit power adaptation can be used to maximise the throughput of a wireless network using RTS/CTS? For the example in the picture below, how might the power adaptation change the behaviour of node A sending data to node B when at the same time node X is trying to send data, also using RTS/CTS, to node Y.  

   (5 marks)

d) i) Is power adaptation like 2.c) above provided for in the IEEE 802.11 standards?  

   ii) If IEEE 802.11 does provide power adaption, how does it work?  

   iii) If IEEE 802.11 does not provide power adaptation, explain how it might be implemented?  

   (4 marks)
3. a) For what types of application and environment would you choose IEEE 802.11 (WiFi) for the interconnection of a mesh of wireless sensor nodes? What features of WiFi guided your choice of applications and environments?

For what wireless sensor network applications and environments would WiFi be a bad choice? In each case explain why? (7 marks)

b) A mesh topology battery powered wireless sensor network (WSN) is deployed in a location that is a long way from any infrastructure networks. The wireless sensor network is assumed to have a few nodes that are capable of passing on captured sensor data to the Internet and thereby to a database where the data can be analysed and monitored.

If the wireless sensor network nodes are deployed by dropping them from an aircraft resulting in a random layout of nodes, describe what the nodes need to do to establish a reliable network to forward sensor data to the Internet? (10 marks)

c) How does the wireless sensor network deal with issues such as clock drift at wireless nodes and eventual failure of the nodes as they run out of power? (3 marks)
Section C

4. a) A block diagram of the ‘wired equivalent privacy’ (WEP) encryption method proposed by the IEEE802.11 standards is given in figure 1. Explain the function of each block and then explain why WEP is now considered to be a weak security method for wireless LANs. (8 marks)

b) Explain the mechanism of a ‘cyclic redundancy check’ as used for error detection. If a CRC has generator polynomial \( G(x) = x^4 + x^3 + 1 \), calculate the CRC of the short bit stream 1 0 1 0 1 1. (6 marks)

c) Why are convolutional rather than block codes currently used for forward error correction (FEC) in wireless networks? If a convolutional coder has two generator functions expressed in octal as (11) and (13) draw a diagram for the coder and calculate the first 8 bits of its output when the first 4 bits of the input are ‘1 0 1 1’. (6 marks)
5. a) Explain why ‘sinc-like’ base-band pulse-shaping is necessary when pulses representing binary data are to be transmitted by single carrier modulation. In theory, what is the maximum achievable band-width efficiency, at base-band, if inter-symbol interference (ISI) is to be eliminated? Why is this maximum bandwidth efficiency difficult to achieve in practice? (6 marks)

b) Explain the principle of a vector-modulator and ‘complex base-band’. How does the vector modulator achieve the same the bandwidth efficiency as would be obtained with base-band transmission? (4 marks)

c) According to the Shannon-Hartley law, what ‘signal-to-noise ratio’ (SNR) must be achieved to convey 128 Mb/s with an arbitrarily small bit-error probability (PB) over a radio channel with bandwidth 20 MHz where the reception is affected by ‘additive white Gaussian noise’ (AWGN)? (2 marks)

d) What causes ‘frequency selective fading’ in a radio channel? Compared with single carrier modulation, what are the advantages and disadvantages of ‘orthogonal frequency division multiplexing’ (OFDM) for radio communications over frequency selective fading channels? (8 marks)