Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

M.Sc. in Advanced Computer Science

Mobile Computing

Date: Thursday 3rd June 2010
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

[PTO]
Section A

1. a) Using appropriate examples and diagrams briefly compare and contrast:

   i) an operating environment for battery powered hand held wireless enabled mobile computers (e.g. a smart mobile phone) with

   ii) an operating environment for mains powered mainly static desktop devices.  

      (6 marks)

b) Using the Error Correction laboratory for COMP60242 (Mobile Computing) as an example. Compare and contrast a laboratory solution designed for desktop (including laptop) computers with a solution designed to run on (so called) ‘smart’ mobile telephones.  

      (4 marks)

c) Explain how bit-error detection and forward error correction (FEC) are achieved at the data-link layer with IEEE802.11 WLAN networks. How do these two error-control mechanisms work together? 

      (5 marks)

d) Explain what happens to packets with bit-errors that cannot be corrected. How would it be possible for the receiver to fail to detect uncorrected bit-errors within a packet? If this did happen with a packet conveying email, what problems would then occur? 

      (5 marks)

2. Using examples where appropriate, briefly discuss the issues and problems that wireless enabled mobile computers face initiating, and maintaining high data rate communications in different situations. You should assume that most mobile computers can communicate using several different protocol stacks.

[Note: For maximum marks, you should outline/plan your answer carefully and ensure that the examiners can read your outline/plan as well as your answer.]

      (20 marks)
3. A transport protocol is required to support a sensor network to monitor the storage environment for fresh produce (fruit and vegetables) from farm field through to sale in a shop. Sensors will monitor and return location, physical movement, temperature, light and humidity readings on a regular basis.

a) Why might there be issues using TCP as the network transport protocol for this application? (6 marks)

b) Assuming neither TCP nor UDP is ideal, giving reasons, suggest features an appropriate transport protocol should have and justify each feature. (8 marks)

c) Briefly outline how the network layer for this application should work. (6 marks)
Section B

4.  a) How does ‘wired equivalent privacy’ (WEP) aim to provide confidentiality, integrity and authentication in IEEE802.11 wireless LANs? What are the functions of the ‘integrity check vector’ (ICV), the ‘RC4’ cipher stream generator, the ‘initialisation vector’ (IV) and the WEP key. (7 marks)

b) Explain why WEP is not considered a good security solution for wireless LANs. In giving your answer, explain how its confidentiality, integrity and authentication mechanisms may be compromised. (5 marks)

c) Three ASCII characters are believed to have been encrypted by the same 8-bit RC4 stream producing the cipher-text bytes:

\[
\begin{align*}
C_1 &= 1 0 0 1 0 1 0 0 \\
C_2 &= 1 0 0 1 1 1 0 0 \\
C_3 &= 1 0 0 0 0 1 0 1 
\end{align*}
\]

If they are all assumed to be decimal digits 0 to 9 or a space as listed in table 1, what are the three digits and what is the 8-bit RC4 stream?

What does this example illustrate about the requirements for achieving good security?

<table>
<thead>
<tr>
<th>Character</th>
<th>Ascii code</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>0 0 1 1 0 0 0 0</td>
</tr>
<tr>
<td>1</td>
<td>0 0 1 1 0 0 0 1</td>
</tr>
<tr>
<td>2</td>
<td>0 0 1 1 0 0 1 0</td>
</tr>
<tr>
<td>3</td>
<td>0 0 1 1 0 0 1 1</td>
</tr>
<tr>
<td>4</td>
<td>0 0 1 1 0 1 0 0</td>
</tr>
<tr>
<td>5</td>
<td>0 0 1 1 0 1 0 1</td>
</tr>
<tr>
<td>6</td>
<td>0 0 1 1 0 1 1 0</td>
</tr>
<tr>
<td>7</td>
<td>0 0 1 1 0 1 1 1</td>
</tr>
<tr>
<td>8</td>
<td>0 0 1 1 1 0 0 0</td>
</tr>
<tr>
<td>9</td>
<td>0 0 1 1 1 0 0 1</td>
</tr>
<tr>
<td>space</td>
<td>0 0 1 0 0 0 0 0</td>
</tr>
</tbody>
</table>

Table 1: ASCII codes for decimal digits 0 to 9 and space (8 marks)
5. a) In principle, why are pulses of finite duration, such as rectangular pulses, not used for data transmission with single-carrier modulation? With the aid of a sketch or sketches, indicate what pulses-shapes are generally used and state their main properties. What limitation does the use of such pulses impose on the maximum achievable bandwidth efficiency? What function is performed by the ‘equaliser’ in a single carrier receiver? (8 marks)

b) What are the main advantages and disadvantages of the multi-carrier modulation technique ‘orthogonal frequency division multiplexing’ (OFDM) as compared with single carrier modulation? Explain why single carrier modulation is currently preferred for cellular mobile telephony whereas multi-carrier modulation is preferred for wireless LANs (9 marks)

c) A single carrier receiver receives a 2 MHz bandwidth radio transmission from a transmitter. The reception is affected by ‘additive white Gaussian noise’ (AWGN) and has a signal to noise ratio of 30 dB. According to the Shannon-Hartley law, what is the maximum possible bit-rate that can be received with an arbitrarily small bit-error probability? How would this maximum achievable bit-rate change if the single carrier transmission were replaced by a 2 MHz OFDM transmission? (3 marks)