COMP 61242

Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Mobile Communications

Date: Thursday 17th May 2018

Time: 14:00 - 16:00

Please answer any THREE Questions from the FIVE Questions provided

Each Question is worth 20 marks.

This is a CLOSED book examination

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

[PTO]

1. (a) Explain how the TCP/IP protocol stack introduces and uses each of the following types of addresses to identify applications, users and mobile devices:

   (i) IP addresses
   (ii) Physical (or MAC) addresses
   (iii) Port numbers (6 marks)

   (b) Explain why IP addresses rather than physical (MAC) addresses are used for communications globally over computer networks? What might happen if two mobile communication devices were manufactured and released with the same physical address? (6 marks)

   (c) What is the purpose and functionality of the 'home agent' and the 'foreign agent' in the context of 'mobile IP'? (4 marks)

   (d) What is meant by 'quality of service' (QoS) and how does the required QoS differ between email (or text messaging), voice telephony and streaming media (speech, music and video) applications? (4 marks)

2. (a) What is the main difference between circuit switched and packet switched network channels? Highlight the advantages and disadvantages of each of these two types of channel when used for mobile voice communications. Which generations of cellular mobile technology use circuit switched channels? (7 marks)

(b) What are the main goals of '4G–IMT Advanced' as proposed by ITU-R for the 4th generation of cellular wireless standards (4G)? To what extent has 3GPP-LTE technology met the '4G-IMT Advanced' goals and how are speech services being provided by this technology? (7 marks)

(c) Why is run-length coding and Huffman coding used by JPEG image coders? Symbols A, B, C, D, E, F, representing quantisation levels for non-zero DCT coefficients, have probabilities: 0.08, 0.2, 0.5, 0.05, 0.07, 0.1 respectively. Devise a Huffman code for these symbols. (6 marks)

[PTO]

3. (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 is WEP 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:

C1 = 1 0 0 1 0 1 0 0
C2 = 1 0 0 1 1 1 0 0
C3 = 1 0 0 0 0 1 0 1

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? (8 marks)

Character	Ascii code
0	0 0 1 1 0 0 0 0
1	0.0.1 1 0 0 0 1
2	0 0 1 1 0 0 1 0
3	0 0 1 1 0 0 1 1
4	0 0 1 1 0 1 0 0
5	0 0 1 1 0 1 0 1
6	0 0 1 1 0 1 1 0
7	0 0 1 1 0 1 1 1
8	0 0 1 1 1 0 0 0
9	0 0 1 1 1 0 0 1
space	0 0 1 0 0 0 0 0

Table 1: ASCII codes for decimal digits 0 to 9 and space

4. (a) Explain the mechanism of a cyclic redundancy check (CRC) for a sequence of N message bits and a generator polynomial G(x) of order 8. Under what circumstances would a CRC check fail to detect a combination of bit-errors in a transmission? (5 marks)

   (b) What are the essential differences between block codes and convolutional codes for forward error correction (FEC)? A convolutional coder of constraint length 4 has two generator functions expressed in octal as (13) and (11). Why is this described as a 'half rate' coder? Draw a diagram for the coder and calculate the first 10 bits of its output when the first 5 bits of the input are '1 1 0 1 1'. (6 marks)

   (c) Explain why error detection and forward error correction (FEC) are used simultaneously at the data-link layer on IEEE802.11 WLAN networks, whereas only error detection is generally used on wired networks. (4 marks)

   (d) How does the use of forward error correction (FEC) in cellular networks for mobile communications increase their energy efficiency and the effectiveness of space division multiplexing by frequency re-use? (3 marks)

   (e) What is meant by interleaving as applied when transmitting a sequence of ASCII characters over a radio channel. Why is it beneficial when using forward error correction (FEC)? (2 marks)

[PTO]

5. (a) Explain how the 'code division multiple access' (CDMA) multiplexing mechanism used by third generation of cellular mobile telephony (3G) is able to share a radio spectral band in any given cell among many users. What do you consider to be the three main advantages of CDMA over the mechanism used by 2G-GSM telephony. What do you consider to be the main disadvantage of CDMA? (8 marks)

(b) A mobile device receives a 20 MHz bandwidth radio transmission from a WLAN access point 1000 metres away. The reception is affected by 'additive white Gaussian noise' (AWGN) and has a signal to noise ratio of 18 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. Assuming that the received power decreases with increasing distance from the access-point according to an 'inverse square law', i.e. $P(d_1) = (d_2/d_1)^2 P(d_2)$ where $P(d_1)$ and $P(d_2)$ denote the received power at distances d_1 and d_2 respectively, how much nearer must the mobile computer move towards the access-point if the maximum possible bit-rate is to be doubled. (6 marks)

(c) In principle, why are pulses of finite duration not used for data transmission over radio channels 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 with binary signalling? (6 marks)

END OF EXAMINATION PAPER