Queen Mary
University of London

BSc/BSc (Eng)/MSci Examination

Thursday 8th May 2014 10:00 - 12:30

ECS404U Computer Systems and Networks Duration: 2 hours 30 minutes

YOU ARE NOT PERMITTED TO READ THE CONTENTS OF THIS QUESTION PAPER UNTIL INSTRUCTED TO DO SO BY AN INVIGILATOR.

Answer ALL Questions

ONLY NON-PROGRAMMABLE CALCULATORS ARE PERMITTED IN THIS EXAMINATION. PLEASE STATE ON YOUR ANSWER BOOK THE NAME AND TYPE OF MACHINE USED.

COMPLETE ALL ROUGH WORKINGS IN THE ANSWER BOOK AND CROSS THROUGH ANY WORK WHICH IS NOT TO BE ASSESSED.

IMPORTANT NOTE:
THE ACADEMIC REGULATIONS STATE THAT POSSESSION OF UNAUTHORISED MATERIAL AT ANY TIME WHEN A STUDENT IS UNDER EXAMINATION CONDITIONS IS AN ASSESSMENT OFFENCE AND CAN LEAD TO EXPULSION FROM QMUL.

PLEASE CHECK NOW TO ENSURE YOU DO NOT HAVE ANY NOTES, MOBILE PHONES OR UNAUTHORISED ELECTRONIC DEVICES ON YOUR PERSON. IF YOU HAVE ANY THEN PLEASE RAISE YOUR HAND AND GIVE THEM TO AN INVIGILATOR IMMEDIATELY. PLEASE BE AWARE THAT IF YOU ARE FOUND TO HAVE HIDDEN UNAUTHORISED MATERIAL ELSEWHERE, INCLUDING TOILETS AND CLOAKROOMS IT WILL BE TREATED AS BEING FOUND IN YOUR POSSESSION. UNAUTHORISED MATERIAL FOUND ON YOUR MOBILE PHONE OR OTHER ELECTRONIC DEVICE WILL BE CONSIDERED THE SAME AS BEING IN POSSESSION OF PAPER NOTES. MOBILE PHONES CAUSING A DISRUPTION IS ALSO AN ASSESSMENT OFFENCE.
EXAM PAPERS CANNOT BE REMOVED FROM THE EXAM ROOM.

Examiners:
Prof E P Robinson and Dr G H White

Question 1

a) Describe the difference between the function and the implementation of a piece of hardware.

[5 marks]

b) Modern computers are *electronic*, *digital* devices. Explain what each of these terms means.

[5 marks]

c) Give an example of a computing device which is not digital, *or* of a computing device which is not electronic. If it is not digital, say whether it is electronic or not; if it is not electronic, say whether it is digital or not.

[5 marks]

d) Explain why computers are called *stored program devices*, and what advantage this gives them over special purpose devices such as calculators. Explain, in particular, why hardly anyone owns a calculator, but almost everyone owns a phone with a calculator on it.

[10 marks]

Question 2

This question is about digital representation

a) This part is about addition and multiplication in binary. Carry out the following long addition and multiplication in binary. Give the details of your calculation, including any carry. Do not convert numbers to decimal.

i) 101011
1001 +

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ii) 101011
1001 ∗

[5 marks]

b) This part is about conversion between binary and hexadecimal representations.

i) Convert the following *hexadecimal* numbers to bit sequences of length 12: $0A4$, $C2E$, 117.

ii) Convert the following 12-digit bit sequences to hexadecimal: 111101101110, 010000111001, 000011001010.

[5 marks]

c) This part is about the 2's complement representation of negative numbers, using 8-bit 2's complement.

i) Show how -25 is represented in 8-bit 2's complement. Give the details of your calculation.

ii) How do you know whether the eight-bit sequence 11101100 represents a positive or negative number in 8-bit 2's complement? Which is it, and what number does it represent? Give the details of your calculation. (Hint: if the number is negative, you can reverse the process you used in part i.)

[5 marks]

d) This part is about character sets.

i) In the ASCII character set letters are represented by binary sequences. How many bits does each sequence contain?

ii) The letter 'A' is represented by the bit sequence corresponding to the decimal number 65, while 'a' is represented by 97. Why is the difference of 32 between these significant?

iii) What are the ASCII representations of the following letters in terms of bit patterns: 'C', 'c', 'Z', 'z' (show reasoning).

[5 marks]

e) This part is about audio encoding.

i) Standard CD audio encoding uses two stereo channels each encoded at a 44.1kHz sample rate using 16 bits per sample. Approximately how many kilobytes does this require per second of audio? (Show your working) Why was MP3 audio encoding developed?

ii) What is *lossy* as opposed to non-lossy compression? Is MP3 audio encoding lossy or not?

iii) In the context of MP3 encoding, what is a *frame*? What (briefly) is the role of frames in the encoding algorithm?

[5 marks]

Question 3

a) Explain what a register is, and what a memory location is. Explain what the MIPS instruction

```
lw $t0 x
```

does, where $t0 is a register, x is a memory location, and where lw stands for load word: explain also what the MIPS instruction

```
sw $t1 y
```

does, where $t1 is a register, y is is a memory location, and where sw stands for store word.

[5 marks]

b) Explain what the MIPS instruction

```
add $t0 $t1 $t2
```

does, where $t0, $t1, and $t2 are registers, and where $t0 gets the result of the addition.

[5 marks]

c) Write a MIPS program that uses the instructions above to add the numbers in memory locations x and y together, and put the result in the memory location z.

[5 marks]

d) Now write a MIPS program that will add together the numbers in memory locations p, q, r, and s together, and put the result in p. You should be careful to use the minimum number of registers, and the minimum number of load and store instructions.

[10 marks]

Question 4

This question is about computer networks

The figure below shows the Wireshark program displaying a packet it has captured (14).

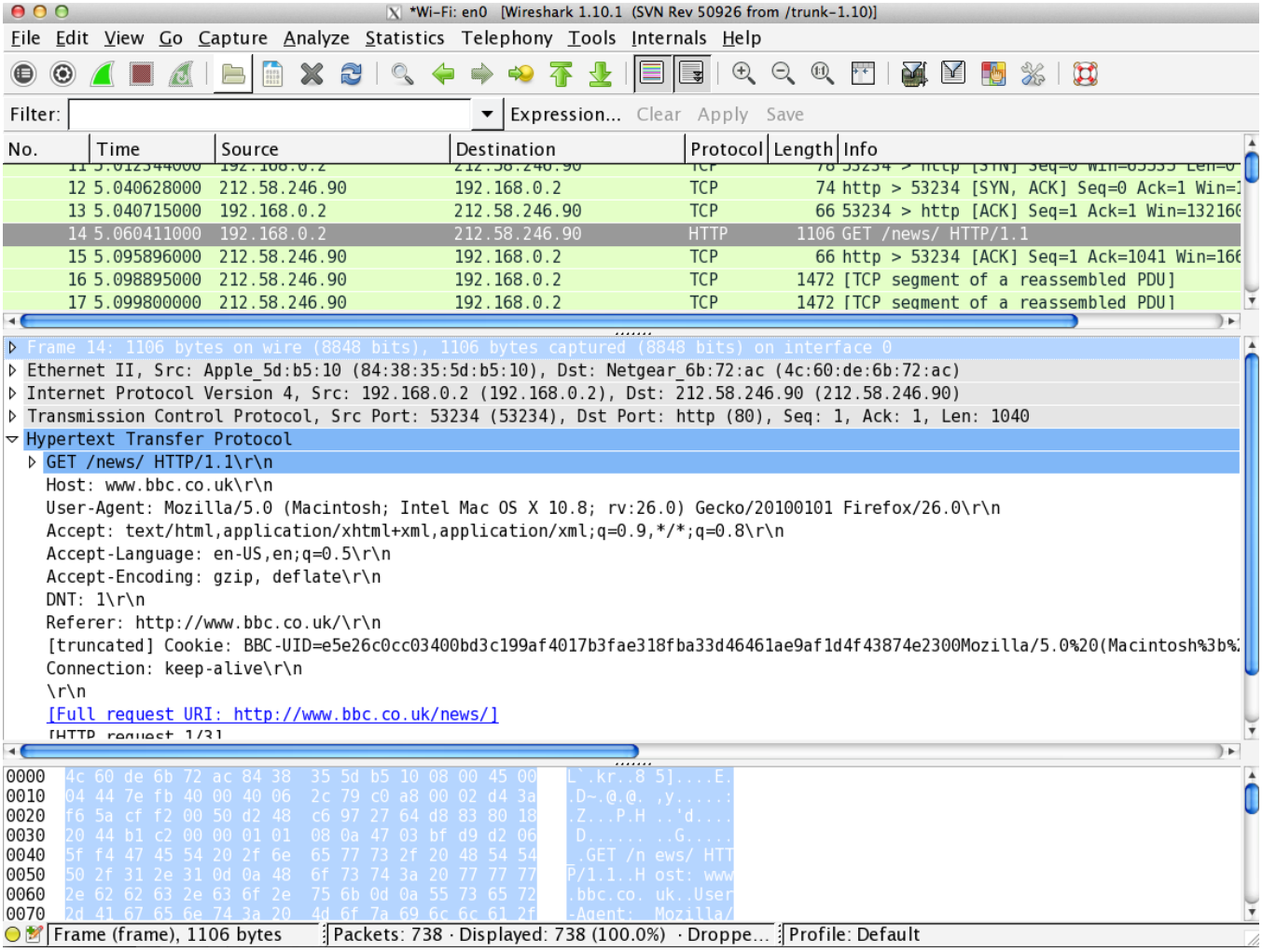

Figure 1: Wireshark display of packet 14

a) Which protocols are being used in the following layers:

   i) application

   ii) transport

   iii) internet

   iv) link

   In each case identify how you know the answer from the screenshot.

[5 marks]

b) Explain briefly who is sending the message contained in the packet (program and machine) to whom and what is being said in it.

[5 marks]

c) What is the name of the destination machine, its IP address and the port being used on it?

[3 marks]

d) Explain the function carried out by the "port" used on each machine.

[2 marks]

e) Draw a simple diagram of the structure of the packet being shown here, showing the various layers, headers, footers and bodies, but not detail of the fields.

[5 marks]

f) The two packets (12,13) preceding this one, and the one following (15) are marked as TCP packets. Explain the role of these packets in the interaction.

[5 marks]

End of Paper