Friday, 4 May 2012
9.30 am - 11.00 am
(1 hour 30 minutes)

DEGREES OF MSci, MEng, BEng, BSc, MA and MA (Social Sciences)

COMPUTING SCIENCE 3T: NETWORKED SYSTEMS 3

Answer all 3 questions

This examination paper is worth a total of 60 marks.

You must not leave the examination room within the first half hour or the last fifteen minutes of the examination.

INSTRUCTIONS TO INVIGILATORS
Please collect all exam question papers and return to School together with exam answer scripts

1. **(a)** When making a TCP connection, it is necessary to specify both an IP address and a TCP port number. Describe the purpose of these two parameters, and explain why both are needed. [3]

(b) Outline how IP addresses and TCP port numbers are assigned. Your answer should discuss the extent to which the choice of IP address and TCP port is a local matter, and when it requires wider coordination between users of the network. [11]

(c) A TCP connection offers a byte stream abstraction that delivers data in order, but doesn't preserve record boundaries. This complicates protocol implementations, since they must explicitly scan the data read from a TCP socket to find the end of the protocol data unit (PDU) that they are processing (e.g., when reading an HTTP request, an implementation must call `read()` in a loop, accumulating data into a buffer, until it sees the blank line signifying the end of request). With reference to the packet-level dynamics of a TCP connection, explain why record boundaries are not preserved. [6]

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2. (a) Many network protocols send binary data directly, rather than encoding it in some textual format. This binary data is usually sent in network byte order. Explain what is network byte order, and discuss why it is needed. [4]

(b) Other network protocols are structured using a textual encoding, and indeed many older protocols are defined using the US ASCII character set. Such protocols cannot directly transfer binary data, forcing the binary content to be encoded using, for example, base-64 before it can be transmitted. Explain why these protocols do not support binary data, then describe how base-64 encoding works and solves this problem. [9]

(c) Many modern network protocols use Unicode in UTF-8 format to encode textual values. Outline what is UTF-8, and explain why it is the preferred representation of Unicode text. [7]

3. **(a)** The Open Systems Interconnection (OSI) reference model can be used to describe layered networked systems. What are the seven layers of the OSI reference model, in order from lowest to highest? [4]

(b) The lower three layers of the OSI reference model operate in a hop-by-hop manner, while the upper four layers operate end-to-end. With references to the roles of the different layers, explain what is meant by this, and why the distinction arises. [9]

(c) The layered protocol stack is a good model for explaining conceptually how a networked system works, and is useful when writing protocol specifications. Discuss whether it is also a good way of implementing a networked system, or whether an alternative software architecture would be more suitable. Outline the trade-offs involved in developing software to implement a network protocol stack, giving examples of possible design decisions and their impact if appropriate. [7]

END OF QUESTION PAPER