UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2001

MSc in Computing Science
MSc in Computing for Industry
BSc Honours Degree in Mathematics and Computer Science Part III
MSci Honours Degree in Mathematics and Computer Science Part III
MSci Honours Degree in Mathematics and Computer Science Part IV
for Internal Students of the Imperial College of Science, Technology and Medicine

*This paper is also taken for the relevant examinations for the
Associateship of the Royal College of Science*

PAPER M313

COMPUTER NETWORKS AND DISTRIBUTED SYSTEMS

Friday 4 May 2001, 10:00
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions
Calculators not required

1a Define the terms baud rate, bit rate and data rate. Briefly explain how they are related.

Give an example of a communications channel where

i)   The bit rate is lower than the baud rate

ii)   The bit rate is higher than the baud rate

explaining why in each case.

b   Consider a (non-Ethernet) CSMA/CD based network running at 1 Gigabit per second over a 1 km cable with no repeaters. The signal speed in the cable is 200,000 km per second. Discuss the requirements for

i)   Minimum frame size

ii)   Maximum frame size

compared to 10Base5/10Base2 Ethernet. Justify any conclusions you make.

c   With reference to other Medium Access Control methods with which you are familiar, or otherwise:

i)   Suggest how IEEE 802.3 (Ethernet) might be enhanced to provide higher priority nodes preferred access over normal nodes using standard contention-based access.

ii)   How would priority-enabled nodes on the network need to be altered?

iii) How would non-priority-enabled nodes on the network need to be altered?

iv)   Is priority access to your enhanced network probabilistic or deterministic?

The three parts carry, respectively, 30%, 30%, 40% of the marks.

2a   Give an example of a network service or application that uses

     i)   UDP

     ii)   TCP

     iii)   UDP *or* TCP.

     Include in each case why the transport protocol used is appropriate for the requirements.

  b   In "Computer Networks", when discussing the allocation of IP address space and the problem of shortage of IP addresses, Andrew Tanenbaum says:

     "In particular, the real villain is the class B network".

     i)   Do you agree with Professor Tanenbaum's opinion? Justify your answer.

     ii)   How might the classes of network have been better defined and allocated?

     iii)   Would this have led to any other problems?

  c   A small business has been allocated the class C TCP/IP Network address 195.32.0.0. Each office in its building has an Ethernet network with up to 12 nodes. The intention is to join these LANs up as subnets of the class C network.

     i)   What connection devices will they use?

     ii)   How many subnets will the organisation have?

     iii)   What will the subnet mask be?

     iv)   Discuss how best to incorporate the company's other office, 200 miles away, into the network. Include what factors would influence the choice.

The three parts carry, respectively, 30%, 30%, 40% of the marks.

3   A building security system has a controller for every room with integrated switch and display. Each room also has a motion detector. The switch can be used to enable or disable alarms being generated from the local motion detector. The display indicates *disabled, enabled* or *alarm* condition. Each room-controller communicates with the motion detector and a centralised operator via a network. The current state of every room is indicated on the operator's display. The operator has a keyboard to enter room numbers and commands to clear an alarm for a particular room. The room-controller sends state information every 5 seconds to the operator, and receives a return value to indicate whether an alarm condition has been cleared.

a   Assuming a Java RMI object invocation system for implementation, produce a diagram indicating all the objects needed to model this security system and the operation invocations between objects (only a single room system plus the operator need be shown). Assume that normal Java input-output is used by the room-controller to interact with its switch and display and by the operator to interact with its keyboard and display. Use the following interface specification.

```
package securitySystem;
import java.rmi.*;

public interface MotionDetector extends Remote {
        public boolean detect ( ); } // assume detect resets motion detector

public interface iOperator extends Remote {
        public boolean  report  (int room, int status);  // true response clears alarm

int  disabled = 0; enabled =1; alarm = 2; // status values
```

b   Give a *pseudocode* outline for the *room-controller* as a client, which is created with a parameter indicating room number, and the *operator* as a server. Strict Java syntax is not required.

The two parts carry, respectively, 20%, 80% of the marks.

4   The department wishes to implement a system whereby all assessed work is submitted by email. Students send coursework by email to a central office server which acknowledges receipt and forwards the coursework to the relevant lecturer who also acknowledges receipt to the office.

There is no need for encryption of the coursework.

Using the notation below, describe a protocol between a student S, central office O, and lecturer L to give non-repudiation of submission and delivery. Explain how your protocol works, how it supports non-repudiation and justify the need for each field in a message.

L   lecturer name
S   student name
cwid   course work identifier (course and coursework number)
cw   actual coursework
H(cw)   hash digest of coursework
Tx   timestamp generated by X
Kxy   a secret key known to X and Y
Kso{m}   indicates encryption of a message m with a key known to S and O
Klo{m}   indicates encryption of a message m with a key known to L and O.

Assume the central office is trusted; each student and lecturer has a secret key known only to themselves and the central office; and the office does not hold coursework after sending it to a lecturer.