UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2003

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

Monday 12 May 2003, 10:00
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions
Calculators required

1a Widget Corp. has five departments: marketing, research, development, testing and management. Research are in a separate building 2km away from the other departments. It also has two classes of server: those providing internal services (intranet web, email, file-store, printing etc.) and those providing external services (web, email etc.). All staff have a desktop PC and some also have a laptop.

i) Using standard interconnection devices and 100BaseT, 1000BaseF and IEEE802.11 wireless networks as media provide a diagram to illustrate how the various users' systems might be interconnected. Assume that none of these media can transmit 2km in one segment. Describe why the devices and network media chosen are appropriate for their purpose, noting which OSI stack layer they operate at and how they affect scalability.

ii) In order to manage their internal network, they wish to have sub-networks within the company's C-class network. This should allow them to assign desktops for various departments, servers and laptops to separate sub-networks. Describe a sub-networking strategy, indicating how many subnets can be assigned, the network mask for the subnets and how many hosts each subnet can support.

b When closing a connection formed at the transport layer, a "three way handshake" is used to ensure all messages have been delivered to the satisfaction of both parties in the connection. Describe, with the aid of a diagram, how the loss of each of the messages in the handshake protocol is accommodated or recovered from (only one loss in each of the three cases). You should use TCP as the basis for your answer, but any reasonable behaviour is acceptable.

The two parts carry, respectively, 75%, 25% of the marks.

2 a Describe the difference between *circuit* and *packet* switched networks. Indicate how they relate to *connectionless* and *connection-oriented* network services.

b You are to design the CSMA/CD data link protocol for a new network. The design requirements and fixed parameters are:

- Network speed 100Mb/s
- Propagation speed in the wire is 200,000,000m/s
- Addressing 8 million nodes or more, messages should indicate sender and receiver.
- 8 bytes required for timing (as for Ethernet)
- 1 byte check seq for every 8 bytes of variable header data
- 1 byte check seq for every 64 bytes of payload data
- Messages are quite short: the typical range of payload is 16 to 200 bytes
- Each field should be a whole number of bytes

i) Illustrate the framing you choose and briefly justify the sizes of the various fields.

ii) What is the maximum segment length?

iii) What impact would your design decisions have if the protocol was later used to transmit messages of up to 4kBytes?

iv) What impact would changing the maximum message length in the requirements to 64kBytes have on the operation of your protocol?

c In the world wide web it is normal for caches to be maintained at both browsers and Internet service providers. Each of these has advantages and disadvantages. Discuss why the combination of the two gives a greater benefit than either one on its own.

The three parts carry, respectively, 25%, 60%, 15% of the marks.

3 A hotel air-cooling system has a microcomputer for every room connected to a central operator's workstation via a network. Each room has a temperature sensor and a local control panel with a switch to enable/disable the room air-cooler and a dial to set the desired temperature. The current state (cooler on/off and local temperature) of every room is indicated on the operator's display. The room controller sends state information every 30 seconds to the operator. The operator has a display to indicate status information for all rooms in the hotel.

A Java RMI object invocation system is used for implementation. Use the following interface specification:

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

public interface iSensor extends Remote {
        public int sensread ( ) throws RemoteException;  } // read temperature

public interface iDial extends Remote {
        public int dialread ( ) throws RemoteException;  }  // read temperature dial

public interface iSwitch extends Remote {
        public boolean getswitch ( ) throws RemoteException;  }  // true = enabled

public interface iCooler extends Remote {
        public void setcooler ( boolean cmd ) throws RemoteException;  }
        //true = on, false = off

public interface iOperator extends Remote {
       public void  report  (int  temp, boolean coolerOn, string roomNumber)
              throws RemoteException; }
```

a Produce a diagram indicating all the objects needed to model the cooling system and show named *operation invocations* between objects (only a single room system plus the operator need be shown).

b Give the Java class for the *room-controller* as a client, which is created with a parameter indicating room number. Use a URL of the form rmi://roomNumber/objectName for binding to local objects.

c Give the Java class for the *operator* as a remote object i.e. a server. Assume that a procedure which uses normal Java I/O to write to the display is available

```
update (int  temp, boolean coolerOn, int room)
```

Implementations for the remote objects Sensor, Dial, Switch and Cooler are not needed. Strict Java syntax is not required but your solution should indicate what is needed for implementing remote objects, remote reference registration, binding and security, and holding room state information in the operator etc.

The three parts carry, respectively, 20%, 40% and 40% of the marks.

4a Briefly describe, with the aid of a diagram, the Bell-LaPadula security model for military security. Give the conditions for both reading and writing target objects

b A firm of accountants has 2 branches in the UK with 20 employees at one branch and 10 at the other. Each branch has a server holding client data. They want to allow all employees access to both servers via the internet. A new systems programmer suggest that a solution would be to hold the user passwords on both servers and to manually distribute an encryption key to each workstation and server. Users can then login to either server, using ordinary login but sending the user's password encrypted with the key held on each workstation. The server can decrypt the password and check its validity against the passwords which are stored in a file on the server, encrypted with the same key

i) Discuss the security risks in the above design

ii) Describe a suitable centralised authentication service protocol, *optimised for the small size of the firm*, which can be installed at the larger branch to serve the firm of accountants. Use the format Kxy{M} for encryption of a message M using a key known to X and Y. Your solution must describe the messages exchanges, and the reasons for each item in the message.

The two parts carry, respectively, 30% and 60% of the marks.