UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2004

MSc in Computing Science
MSc in Computing for Industry
MSci Honours Degree in Mathematics and Computer Science Part IV
BSc Honours Degree in Mathematics and Computer Science Part III
MSci Honours Degree in Mathematics and Computer Science Part III
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 26 April 2004, 14:30
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions
Calculators required

Section A *(Use a separate answer book for this Section)*

1a Describe how source routing finds a route between two stations in a LAN. Highlight two advantages or disadvantages of this method compared with transparent bridges.

b A system "x" has a buffer of 4kB allocated for holding TCP packets. It processes incoming data at a rate of 1kB (or whatever is in the buffer if smaller) every 20ms. A second system "y" has 7kB of data to send. It uses an initial window size of 1kB and at most doubles this with each message. It takes 10ms to send each kilobyte of data from "y" or 1ms to send a control message in either direction. Draw a message sequence chart illustrating the times packets are sent (including any to set up the connection), size of data sent (if any) or the control message and values of TCP SEQ and WIN fields. Also indicate when data is processed at Y. Assume that SEQ starts at zero, for simplicity.

c A racetrack has 40 sensors, each of which tries to send 1000B of data (including all headers) describing events on the track to a single server at least once every 10ms. In order to provide commentators up to date race information it is important that the data being received arrives quickly. Currently a single 100Mb/s Ethernet bus network provides the network. The track owners have found that much of the data is being lost or is slow to arrive and so frustrates the commentators.

Describe, with the aid of diagrams and calculations where appropriate, two possible changes to the network which will improve matters. Note which layer(s) in the Internet model are changed. Assume that collision / congestion becomes significant in CSMA/CD networks once the network is carrying 10% of its theoretical capacity. Extra servers can be deployed if necessary, but in this case the racetrack owners would like to achieve some redundancy to justify the extra cost – so that race data could continue to flow without causing network problems if any one server failed.

The three parts carry, respectively, 20%, 50% and 30% of the marks.

2a You are a consultant designing a network for a factory and warehouse. The site is 1km long. They have suggested that an RS232 (serial line, TTL signals) may be best way of interconnecting systems because it is cheap. Cost and fragility mean that fiber optics are not a suitable solution. Considering the problems of long cable runs, electrical noise and temperature variations affecting system clocks give a reasoned suggestion for a network with a different signaling system. Discuss the advantages of this signaling system over RS232.

b This factory has some equipment which is widely spaced. The host to host network you have chosen has a maximum segment length of 200m and a data rate of 100Mb/s and a signal propagation speed of 200,000,000m/s. A repeater gives a delay of 2μs. In order to achieve a 500m segment length what is the theoretical minimum frame size for CSMA/CD to operate?

c In order to get production reports back to the head office data must be sent over the Internet. Packets are sent between two hosts, say A and B. At the factory, A is on LAN X and B is on LAN Z at the head office. The packet must traverse the Internet Service Provider's LAN, Y, between these two. LANs X and Y have a maximum transfer unit (MTU) of 4Kb. LAN Z has an MTU of 1Kb. Draw a diagram of the network layer devices which will process the packet. At what device in which network will the destination LAN's MTU be taken into account and what changes will be made to headers in achieving this?

d The factory equipment includes machines which must send a combination of status and production logs to servers. Suppose that you have been asked to design an application layer protocol to encode these so that both types of data are sent together in packets for quality control purposes. It should have minimum practical overheads both from the protocol itself and any transport layer protocols it assumes are present. Error, loss or out of order delivery should be detectable, but there is no need to acknowledge delivery or provide for flow control.

i) What transport layer protocol would you use as the basis for your protocol?

ii) What fields would your protocol header have?

iii) What other information about the data would you need in order to complete the header specification for your design?

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

Section B *(Use a separate answer book for this Section)*

3 A trading system consists of a terminal, for a human user, connected to a share monitoring agent running on a network server and uses the services of a stock-broker. The terminal is implemented by a Java RMI server which holds adapter objects for the display and the keyboard of the trader. For simplicity, assume that the share monitoring agent monitors the shares of a single company on behalf of the user and is initialised with the share name, the number of shares held and a 'stop-loss' value for the shares. If the share price falls below the 'stop-loss' value, the shares should be sold. The monitoring agent must then display an alarm on the user's screen and request keyboard confirmation to sell the shares. The monitoring agent sells the shares through the stock-broker and displays the value at which the shares have been sold on the trader's screen. The stockbroker also confirms the share price from the quote server when executing the sale. Every five seconds the monitoring agent polls a quote server to find the latest quote for the monitored share and displays the returned values on the user's screen. The quotes obtained from the quote server contain the share name, opening value and the current value.

Use the following specifications:

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

public class Quote implements java.io.Serializable
    { public String shareName;
    public float open;
    public float current; }

public interface iKeyboard extends java.rmi.Remote {
    public boolean confirmSale(String name, long quantity) throws RemoteException;}

public interface iDisplay extends java.rmi.Remote {
    public void display(String shareName, float current, float open, float change) throws
    RemoteException;
    public void alarm(String shareName) throws RemoteException;
    public void sold(String shareName, float value) throws RemoteException;}

public interface iStockbroker extends Remote {
    public float sell(String shareName, long quantity) throws RemoteException;}

public interface iQuoteServer extends Remote {
    public Quote getQuote(String sharename) throws RemoteException;}
```

The 5 second delay can implemented using `Thread.sleep (millseconds)`

a Assuming a Java RMI invocation system for implementation, produce a diagram indicating all the objects needed and the *method invocations* between objects with an arrow from client to server, indicating each method which can be invoked.

b Give the Java class for the *share monitoring agent*, as a client, which is created with parameters for share name, number of shares and stop loss value.

c Give the Java class for the *terminal server* which implements the keyboard and display remote objects.

Implementations for the StockBroker and QuoteServer remote objects are not needed – assume they have been created. Strict Java syntax is not required but your solution should indicate what is needed for instantiating remote objects, remote reference registration, binding and security etc.

The three parts carry, respectively, 25%, 35%, 40% of the marks.

4a Briefly describe a smartcard based authentication system and indicate what the advantages are compared to a login system where a user provides *user-id* and *password*.

b A stockbroker accepts instructions via email, but insists all messages are sent via a notarisation service trusted by the firm's client and by the stockbroker.
The following protocol is used for message exchange between the client (C), notary (N) and stockbroker (S).

i) C to N: C, Kcs{m}, Kcn{C, S, Tc, H(Kcs{m}) }

ii) N to S: N, Ksn {C, Tc,Tn}, Kcs{m}, Kcn{C, Tc, Tn, H(Kcs{m}) }

m is the instructions from client to stockbroker,
Kxy is a secret encryption key known only to X and Y,
H(z) is a hash digest over a file z,
Tx is a timestamp generated by X.

Explain how the above protocol works, justifying the fields in each message and why fields are encrypted with particular keys.

c Assume the notary provides no long-term storage. Explain how the notary can be used by the stockbroker to prove that the client did send a particular message.

The three parts carry, respectively, 35%, 40%, 25% of the marks.