UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2004

BEng Honours Degree in Computing Part III
BEng Honours Degree in Information Systems Engineering Part III
MEng Honours Degree in Information Systems Engineering 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 City and Guilds of London Institute

PAPER C335=I3.14

DISTRIBUTED SYSTEMS

Monday 26 April 2004, 14:30
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions
Calculators not required

1 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 stockbroker. 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 stockbroker 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.

2a Define *binding*. Explain and compare *First-party* and *Third-party* binding, indicating how they work, where they would be used.

b What are explicit type tags in an external representation syntax for a presentation layer? Describe a means of representing variable length numbers in a message which minimises the number of bits used.

c Explain what type checking can be achieved at bind time and run-time for remote procedure call and message passing systems.

d A video server uses a pool of 100 video processes to serve videos to up to 100 users. A user process sends a start message with video name to the video server and then receives video frames to display. Assume synchronous message communication, mailbox based addressing, that mailbox identifies can be included in the message and the following message primitives:

SEND message TO mailboxid

RECIEVE message FROM mailboxid

i) Identify all the mailboxes required in the system.

ii) Give outline code for the video and user processes showing the messages needed to initiate and play videos. Assume reliable communication so ignore errors.

The four parts carry, respectively, 25%, 15%, 20% and 40% of the marks.

3a 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{i}, Kcn{C, Tc, Tn, H(Kcs{i}) }

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.

4a Briefly discuss why global time is needed and why it is difficult to achieve.

b A clock is reading 15:00:05 (hours:min:secs) and is 5 seconds fast. Explain why it should not be reset to 15:00:00 and how it can be adjusted over a period of 10 seconds. Assume a timer interrupt is generated every 50ms to update the clock.

c Outline Cristian's algorithm for clock synchronisation and discuss its disadvantages and assumptions.

d A workstation uses Cristian's algorithm in order to synchronise with a time server. The times at which the messages are sent (T0) and received (T1) are outlined below.

T0	**T1**
16:32:04.220	16:32.04.234
16:32:04:250	16:32:04.262
16:32:04:275	16:32:04.307

Assuming the server takes less than 2 ms to reply to any time synchronisation message, calculate in each case the clock offset of the workstation with respect to the server.

Explain what correction should be applied to the clock justifying which of the pairs (T0, T1) you take into account.

e An airline traffic control system has a dedicated time server receiving the Universal Coordinated Time (UTC) from Geostationary Satellites with an accuracy of ± 5 milliseconds (ms) and a set of operator workstations. The workstations and the server are interconnected by a LAN.

i) Assume a clock drift of the operator workstations with respect to the server of 2 ms/1000 seconds. How often must the workstations synchronise with the time server to ensure a time difference of less than 6 ms ?

ii) A private jet has a cruising speed of 720 Km/h. It receives UTC directly from the satellites with an accuracy of ± 5ms. The plane communicates its precise position to the operator workstation via radio which incurs a 10ms propagation delay. Assume the workstation is synchronised to within 5ms with the time server. What is the inaccuracy of the position of the plane as given by an air traffic control workstation due to propagation delay and time synchronisation ?

Note: Calculators are not needed for this question and will not be given.

The five parts carry, respectively, 20%,10%, 25%, 15% and 30% of the marks.