

DUBLIN INSTITUTE OF TECHNOLOGY
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BSc APPLIED SCIENCES & COMPUTING

YEAR 4

SUPPLEMENTAL EXAMINATIONS 2004

COMPUTER NETWORKS AND DISTRIBUTED SYSTEMS

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3 ½ HOURS (TO BE REPLACED WITH DATE/TIME)

Answer **FOUR** questions, **TWO** from each section.

All questions carry equal marks

Section A

1. (a) Describe the different states that a Java thread can be in, identifying clearly how it can enter and leave each state. You must use code samples in your answer.

(10 marks)

The following code will be used for the remaining parts of this question.

```
public class Q1b {
    public static void main(String argv[]) {
        MyData data = new MyData();
        new Thread(new Producer(data)).start();
        new Thread(new Consumer(data)).start();
    }
}
class Producer implements Runnable {
    MyData data;
    public Producer(MyData data) {
        this.data = data;
    }
    public void run() {
        int i;
        for (i = 0; ; i++) {
            data.store(i);
            System.out.println ("P: " + i);
        }
    }
}
class Consumer implements Runnable {
    MyData data;
    public Consumer(MyData data) {
        this.data = data;
    }
    public void run() {
        for (;;) {
            System.out.println ("C: " + data.load());
        }
    }
}
class MyData {
    private int d;
    public void store(int d) { this.d = d; }
    public int load() { return this.d; }
}
```

- (b) The correct behaviour of a Producer-Consumer pair, is the production of data by the producer, and the consumption of that same data by the consumer. Each piece of data can only be consumed once, and new data shouldn't be produced until the previous data has been consumed.

What output would you expect when the above code is compiled and the program Q1b is run? Explain your answer.

(4 marks)

- (c) Rewrite the above code using the inbuilt waiting queues associated with Java objects to ensure that its behaviour is correct. Explain all your code fully.

(11 marks)

2. (a) Give an outline of the operation of the IP protocol. Include in your answer a description of the addressing scheme, and the headers used in IP packets.

(6 marks)

- (b) “TCP and UDP both use the underlying IP facility, but they each provide a different service to application layer protocols.”

Discuss this statement, clearly identifying the key differences between the services offered by each TCP and UDP.

(7 marks)

- (c) Using three clear examples, show how it is possible to build client-server applications in Java using
- i. TCP
 - ii. UDP
 - iii. IP Multicast

(12 marks)

3. (a) Discuss what is meant by each of the following terms in relation to distributed systems:
- i. Heterogeneity
 - ii. Openness
 - iii. Scalability

In your answer you should explain why each of these issues makes the development of large distributed systems considerably more difficult than localised, isolated systems. You should use real world examples in your answer.

(8 marks)

- (b) Contrast the traditional *client-server* model of distributed computing with the more modern *mobile code* model employed in agent systems and Java applet environments. In your answer you should discuss situations where one model is preferable to the other.

(7 marks)

- (c) You are required to design a distributed chat room application. The chat room is based on a server and a variable number of clients.
- i. Specify the architecture of the application i.e. structure/function of server/client.
 - ii. Design a complete application layer protocol that the components can use to communicate.
- Clearly specify any assumptions you make.

(10 marks)

4. (a) Alice has just written a Java application that scans her hard disk searching for certain files and backs them up by copying them onto a CD. Bob is a friend of Alice's, and wishes to use the application, so Alice agrees to e-mail the compiled code to him. However, Alice and Bob have a common enemy, Mallory, who they both suspect is interfering with their electronic communications. They fear that she could intercept the e-mail containing the application code and replace it with code that will destroy, rather than back up the files.

Clearly demonstrate how Alice and Bob can use the Java security tools to ensure that if Mallory interferes with their e-mail it will be detected.

(10 marks)

- (b) The RSA algorithm provides encryption using asymmetric cryptography. Describe fully the principles upon which this algorithm is based, and show, using examples where appropriate, how to:
- i. Generate the required keys for RSA
 - ii. Encrypt data using RSA
 - iii. Decrypt data using RSA

(8 marks)

- (c) You and your friend want to secretly communicate by passing paper notes during an exam. It is imperative that if you are caught the contents of the notes cannot be read by the examiner, as this would constitute serious evidence against you. You meet before the exam and devise a symmetric algorithm that you could use to encrypt the message you will pass. Describe your algorithm, and show how it could be used to pass the following message:

ANSWER TO ONE IS B

Give one approach that your examiner could take in trying to decrypt your messages, should they be intercepted.

(7 marks)

Section B

5. (a) Explain what *Enterprise Java Beans* are, and the functions they could serve in a large enterprise application.

(5 marks)

- (b) Using examples, describe precisely what is meant by the term *transaction* in relation to distributed systems. In your answer you should:

- i. Identify and describe the four main properties of transactions
- ii. Define and distinguish between *flat* and *nested* transactions.

(10 marks)

- (c) A *distributed transaction* involves many transaction managers, each of whom has a say in the state of the transaction as a whole. Managing such transactions is made difficult by virtue of the fact that the state of one system can change suddenly, unknown to the other participants in the transaction. One way of addressing this problem is by using the *two phase commit* protocol. Show how this protocol addresses the difficulty outlined here. Use examples in your answer.

(10 marks)

6. (a) Explain precisely what is meant by the term *middleware*, in relation to distributed systems.

(3 marks)

- (b) In distributed object systems, methods are invoked on objects located in different spaces, usually on different hosts across a network. In this case, execution of a method is not necessarily guaranteed, as it would be in a localised system.

As a result, distributed object systems must provide guarantees in relation to the invocation of remote methods, referred to as the *invocation semantics*.

Describe the three main invocation semantics, and explain how they provide the appropriate guarantees.

(10 marks)

Continued overleaf.

- (c) In Java, there are a number of key differences between the invocation of a local method and the invocation of a remote method.

Using an example, clearly identify and describe the primary differences between localised object systems and distributed object systems, both in terms of identifying and locating objects, and actually proceeding to invoke a remote method in an object.

Your answer should identify the main components of a Java RMI system, and should use examples from Java RMI.

(12 marks)

- 7 (a) Define the term *client callback*, as used in distributed object systems. Show how it could be implemented in Java RMI.

(6 marks)

- (b) Show how the *publish-subscribe* paradigm, as used in distributed event based systems requires the use of client callbacks.

(6 marks)

- (c) Provide the code for the classes/interfaces that would be needed to develop a distributed chatroom using Java RMI. The chatroom should allow various clients register with the system and send text messages to eachother.

You should state any assumptions you make, and clearly explain all your code.

(13 marks)

8. (a) Remote interfaces are of crucial importance in a distributed object system. Show how CORBA and Web Services allow for the definition of interfaces for heterogeneous object systems.

(10 marks)

- (b) “The Semantic Web uses XML based languages to change the content of the World-Wide-Web in order to make it not just machine *readable*, but machine *understandable*.”

Discuss the above statement, contrasting the existing World-Wide-Web with the emerging Semantic Web.

(8 marks)

- (c) Do you believe *Web Services* and *Semantic Web Services* will replace common standards such as CORBA or distributed Java? Justify your opinion.

(7 marks)

