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THE NATIONAL UNIVERSITY OF IRELAND

NATIONAL UNIVERSITY OF IRELAND, GALWAY.

SEMESTER I EXAMINATIONS 2002/2003

B.E. Degree Examination in Electronic & Computer Engineering

CT414A Distributed Systems

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Answer any 4 questions
 All questions carry equal weight
 Time allowed: **two and a half hours**

- 1.a: Explain, using a suitable code example (e.g. a Shopping Cart), the operation of the Session Tracking mechanism available in the Java Servlet API. How would you support session tracking for users that access a servlet with a browser that does not support cookies, or that is set up to reject cookies?

10 MARKS

- b: Consider the following JSP script:

```
<%@page language="java" contentType="text/html" %>
<html><body>
  <jsp:useBean id="myaccount" class="AccountBean">
    <jsp:setProperty name="accl" property="number" />
    <ul><li> Account
      <%= request.getParameter("number") %>
      has a balance of €
      <jsp:getProperty name="accl" property="balance" />
    </ul>
  </body></html>
```

Explain the operation of the JSP code shown. In particular, describe the operation of the various JSP action and scripting elements used. Also, write the Java Code for the AccountBean class, this can be a simple implementation that obtains the account balance from a file. The file name used corresponds to the account number i.e. the balance for each account is stored in a separate file.

15 MARKS

- 2.a: Explain briefly what is meant by a *Distributed System*. Why do these often occur naturally in a typical computing environment? 5 MARKS
- b: What is meant by the *processor pool model* for Distributed Operating Systems? What types of servers are typically be used to support this model? Compare this model to a shared-memory multiprocessor. 10 MARKS
- c: Describe the semantics of a typical synchronous *Remote Procedure Call* operation. Based on this description, show how an RPC library might implement these semantics on top of a connection-less transport layer (like UDP). In particular, show how this supports *non-idempotent* operations. 10 MARKS
3. Using Java Remote Method Invocation, outline the design for an Internet based Expense Claim Processing System. The expense server allows the client to download an expense policy object. The policy object implements an interface that provides methods to retrieve the current expense policies e.g. how much may be claimed for mileage expenses or overnight subsistence. The policy object can also be used to validate an expense claim locally (within the client application). Once validated, the expense claim can then be submitted to the expense server for processing. The following interfaces and classes are required:
- *ExpenseServer* - this (remote) interface provides methods for downloading policy objects and submission of expense claims. Obviously expense policies can change over time, so client applications can download new policy objects as often as required.
 - *ExpensePolicy* - this (serializable) interface should provide methods for the retrieval of information about the current expense policies and also for checking the validity of expense claims before submission to the server.
 - *ExpenseClaim* - this (serializable) class should encapsulate a completed expense claim. It should provide accessor methods to retrieve the contents of the expense claim for validation or processing.

The design of the system should make it possible for new Policy implementation classes to be easily added to the system in the future, making the system very flexible. The design uses Java RMI and Object Serialisation to download objects that implement the *ExpensePolicy* interface i.e. these objects are passed by value from the server to the client. Validated *ExpenseClaim* objects are subsequently passed back to the server for processing. Full implementation classes are not required but the answer should include source code for the Java interfaces and the *ExpenseClaim* class outlined above. Also include the mainline server code to initialise the server and show how a simple client program might use or interact with the server. 25 MARKS

4.a: Outline briefly the main differences between server initiated and source initiated load balancing systems. Why are source initiated systems more common?

5 MARKS

b: Discuss the various policies that affect the design of a distributed load balancing algorithm. Consider the example of adding load balancing capabilities to a *Unix Shell*, which algorithm do you think would work best in this case? How might varying the load exchange period affect the results?

10 MARKS

c: Outline the design of the Secure Sockets Layer (SSL) Handshake Protocol. In particular, explain how the following issues are addressed within this protocol:

- Client and Server Authentication.
- Secure sharing of session keys.

10 MARKS

5.a: Explain briefly the functionality of the following CORBA Components:

- Proxy Objects
- Object Adapter
- Implementation Objects
- Interface Definition Language
- Dynamic Invocation Interface

10 MARKS

b: Using the example of a simple remote library service, outline the steps required to implement this as a CORBA based application. The following minimum rules should be adhered to:

- Service definition should include interfaces for *Library*, *Book*, *User* and *Administrator*.
- Users should be able to list the available books, retrieve details on books and request them for loan.
- Administrators should be able to set-up / modify user accounts as well as the books available.
- The Library interface is the top-level server interface to allow users and administrators to login to the system.

Include in your answer the *IDL* file definitions and the steps required to complete the application development. Also show how a simple client program might use or interact with the server. Full source code for the implementation classes is **not** required.

15 MARKS

6.a: Describe briefly some of issues that often arise in the design of Distributed File Services. 5 MARKS

b: Explain the function and operation of the Corba Name Service. Include in your description the main interfaces provided by this service. What kind of applications can benefit from using this service? 10 MARKS

c: Web services represent an evolution and convergence of a number of important areas of technology and business. Describe briefly these technology areas and explain how Web Services builds on previous capabilities. Include in your explanation an overview of the main enabling technologies used to provide Web Services. 10 MARKS