Semester 2 Examinations 2016 / 2017

Exam Code(s)	4BCT, 4BP
Exam(s)	Fourth Year Computer Science and Information Technology
	Fourth Year Electronic and Computer Engineering
Module Code(s)	CT414
Module(s)	Distributed Systems
Paper No.	1
External Examiner(s)	Dr. J. Power
Internal Examiner(s)	Dr. M. Schukat
	*Dr. D. Chambers

Instructions:	Answer any 4 out of the 5 questions.
	All questions carry equal marks.

Duration	2 hrs
No. of Pages	5
Department(s)	Information Technology
Requirements	None

1. Assume that you have been contracted to implement a Distributed Banking System that consists of a server and some Automated Teller Machine (ATM) clients. The server manages all users' account information. A customer can invoke operations at an ATM that are then accessed, and implemented, on a server using Java RMI. Full implementation classes are not required for the server based remote objects but the answer should include the following:

   Write a Java interface called *BankServer* that provides provide methods for user login / authentication, deposit and withdrawal of funds, balance lookup and downloading a *Statement*. The user authentication will be based on using a unique session ID that acts as an authentication token that must be passed to the other methods.   7 MARKS

   Write a Java interface called *Statement* that provide methods for the retrieval of the transactions done on a particular bank account over a specified time period. Each individual transaction should be returned in a separate *Transaction* class that encapsulates details about each transaction. Include the source code for the *Transaction* class in your answer.   7 MARKS

   Provide the mainline server code required to fully initialise the server and then register an instance of the *BankServer* implementation class in the RMI Registry.
                                                                            5 MARKS

   Provide a simple command line client program that will interact with the server as follows: (i) Login to the server. (ii) Deposit €100 to an account. (iii) Print the balance of an account. (iv) Download a Statement object for an account and print out the associated transactions.   6 MARKS

2.a: Outline the main differences between a *two-tier* and a *three-tier* Client-Server architecture. When would you recommend using a *three-tier* architecture?
                                                                            5 MARKS

   b: Web services represent an evolution and convergence of a number of important areas of technology and business. Describe 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

   c: You have been asked to develop a commercial online bookstore using J2EE-based technologies. The bookstore architecture and design should be able to support different types of client browsers and should use a three-tier application model i.e. a client tier to support different clients, a middle tier that implements the application business logic and an information tier to persist the application state. Based on these requirements, describe the top-level application architecture. Identify the technologies that will be used and explain the role each of these technologies plays in the overall system architecture.   10 MARKS

3.a: What is *message oriented middleware* and what types of messaging models are available in the Java Messaging Service?   5 MARKS

  b: You have been asked to design an application that allows weather updates on specific areas to be retrieved from a central web server and then forwarded periodically to interested client applications. Describe a suitable architecture and design for a distributed application that uses the Java Messaging Service (JMS) to handle the distribution of the weather update messages. Full Java source code is not required but your answer should provide a full description of how the JMS could be used within the application. Also describe how the application might use the Java Naming and Directory Interface (JNDI) as part of this solution.   10 MARKS

  c: Assume that you have been contracted by a large multinational company to develop an enterprise class client / server application that may be accessed by a large number of clients concurrently. You will therefore need to employ some form of load balancing in the design of the application. What type of load balancing algorithm would you recommend? Are there any alternatives available? Provide technical justification and rationale for your recommendations.
                10 MARKS

4.a: What types of services are typically available from commercial Cloud Computing providers? Provide some examples of each of these services in your answer.
                5 MARKS

  b: Suppose you work for a social media company that has very large unstructured data sets e.g. web logs or other application related data that needs to be stored and analysed. Also assume that the company has access to large scale computing resources based in multiple data centres. Explain how using the Apache Hadoop Distributed File System and its related facilities might help in solving this problem. Why is this a better solution than using traditional database systems?
                8 MARKS

  c: Describe in detail the MapReduce programming model. Outline the architecture for a MapReduce application that could be used to index a large number of text files by the individual words present in each file. Full source code for the application is not required but your answer should include the data structures that could be used and also clearly explain the purpose and functionality of the map() and reduce() functions in solving this problem.   12 MARKS

Question 5

Consider the example network shown in Figure 1 below:
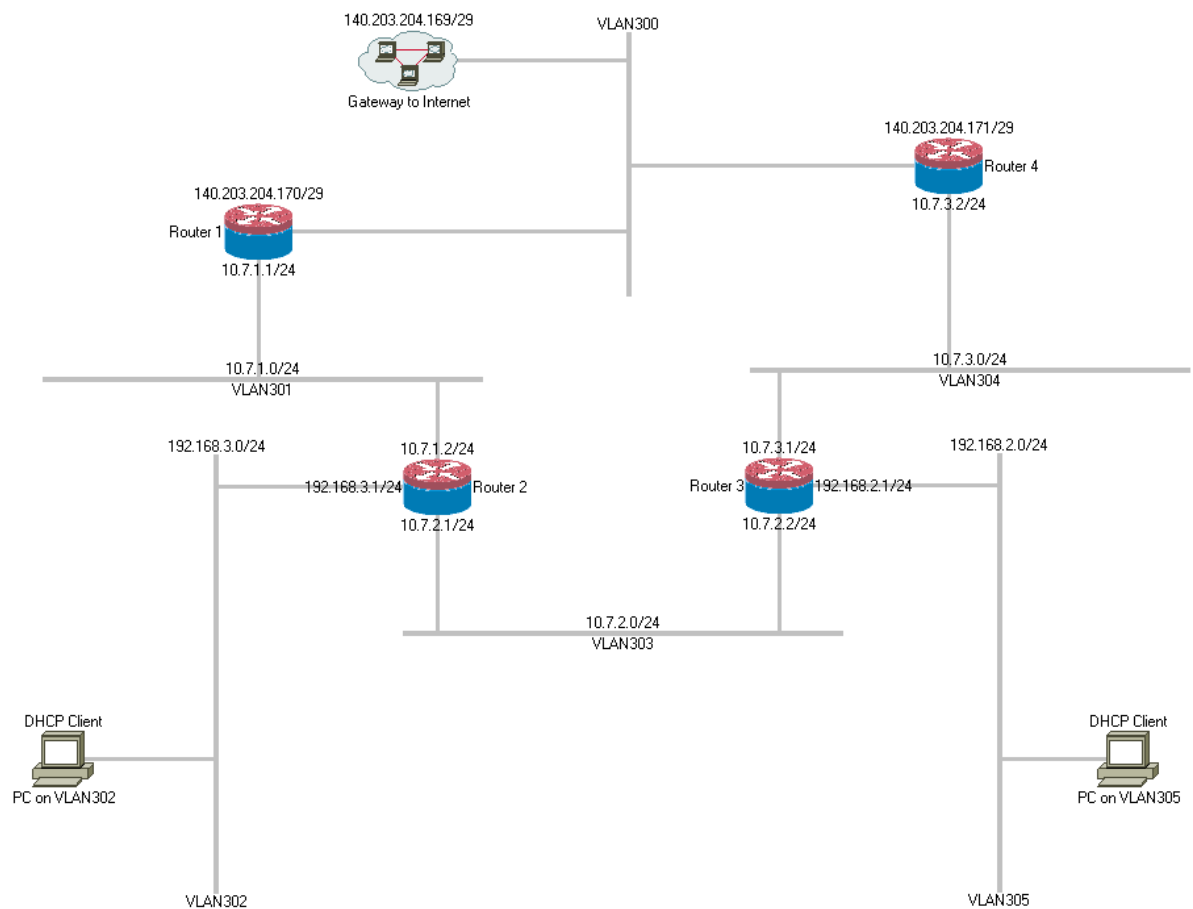
Figure 1 - Example Network

Router 1 has two connected interfaces with the IP addresses shown in Figure 1. It has a Network Address Translation (NAT) firewall rule for internal traffic routed to the internet via this router, as well as a default route to the internet via gateway 140.203.204.169. It has the Open Shortest Path First (OSPF) protocol enabled on the interface connected to Router 2 and it redistributes its default route to other routers via OSPF. The OSPF cost of the interface linking to Router 2 uses the default value of 10.

Router 2 has three connected interfaces with the IP addresses shown in Figure 1. It acts as a DHCP Server for subnet 192.168.3.0/24 and has OSPF enabled on the interfaces connected to Router 1 and Router 3. It also redistributes connected networks so that other OSPF routers will have a route for the 192.168.3.0/24 subnet. The OSPF cost of the interfaces linking to Router 1 and Router 2 both use the default value of 10.

Router 3 has three connected interfaces with the IP addresses shown in Figure 1. It acts as a DHCP Server for subnet 192.168.2.0/24 and has OSPF enabled on the interfaces connected to Router 2 and Router 4. It also redistributes connected networks so that

[Q5 continued overleaf]

other OSPF routers will have a route for the 192.168.2.0/24 subnet. The OSPF cost of the interfaces linking to Router 2 uses the default value of 10. However, the OSPF cost on the interface connecting to Router 4 has been set to 300.

Router 4 has two connected interfaces with the IP addresses shown in Figure 1. It has a NAT firewall rule for internal traffic routed to the internet via this router, as well as a default route to the internet via gateway 140.203.204.169. It has OSPF enabled on the interface connected to Router 3 and it redistributes its default route to other routers via OSPF. The OSPF cost on the interface linking to Router 3 has been set to 300.

Answer the following questions in relation to this network:

a: Describe the operation and purpose of the OSPF protocol in the network shown. What is the Link State Database and how is Dijkstra's Algorithm used by OSPF in this context?   8 MARKS

b: What route will a PC attached to VLAN302 and VLAN305 normally take to get to the internet? What would happen with OSPF if the interface between Router 1 and Router 2 became unavailable for some reason? How would the resulting Link State Announcements be disseminated throughout the network?
                                                                        7 MARKS

c: What is an Autonomous System? In this context explain the purpose of the Border Gateway Protocol (BGP).   5 MARKS

d: Suppose a company was using the RIP dynamic routing protocol on its routers, what reasons would you give to persuade them to change to OSPF instead?
                                                                        5 MARKS