Sri Lanka Institute of Information Technology

B.Sc. Special Honours Degree in Information Technology

Final Examination

Year 3, Semester 1 (2019)

SE3020 – Distributed Systems

Duration: 2 Hours

June, 2019

Instructions to Candidates:

- There is an additional 10 minute reading time provided.
- This paper has **four** questions. Answer for **all** Questions.
- Total Marks 100 (Contributes to 50% of the final grade).
- Each question is allocated **25 marks**.
- This paper contains **six** pages including the cover page.

Question 01 **(25 marks)**

a) You have been asked to develop a system where the student information of a University is managed and shared. **Briefly explain (using only 1-2 sentences each)** how Distributed System principles can be used to increase the **reliability** and the **accessibility** of the proposed system.

(4 Marks)

b) You have been asked to develop a cloud based Point of Sales (POS) system where multiple supermarkets can use to manage their sales. **Identify a specific challenge** that you expect in developing this system, under **Security, Heterogeneity and Concurrency**. **Briefly explain (using only 1-2 sentences each)**, how you can address each of those specific challenges.

(6 Marks)

c) Name a suitable **Software architectural style** and a **suitable System Architectural Style** to develop **each** of the following systems.

i) A cloud based POS (Point of Sales) system

ii) A mobile application that can share location updates among users.

iii) A version control system to share a codebase among developers. Note that the developers don't like to maintain a central server to avoid a situation where the system would crash if there's a server failure. Also, the developers should be notified when one developer commits code to the codebase.

(6 Marks)

d) You have been asked to develop a cloud based POS (Point of Sales) system that can be used by multiple supermarkets to manage their sales. The sales staff may add, update or remove sales items using the system. Each order may contain one or more sales items. The sales staff should be able to create/update and remove orders. The system may use a third party payment gateway to handle the credit card payments. Also, the system handles loyalty cards where loyalty points are maintained for customers. There should be an administrator interface to add/update/delete supermarkets in the system.

i) Using the Object/Component based Software Architectural style, draw a **Software Architecture diagram** for the system.

(5 Marks)

ii) Draw an appropriate **System Architecture diagram** for the above system.

(4 Marks)

Question 02 **(25 Marks)**

a) **Briefly explain (using 1-2 sentences)** the purpose of having a welcoming Socket in the Server side in Socket programming. **Briefly explain (using 1-2 sentences)**, how a Socket Server can communicate with multiple clients concurrently.

(3 Marks)

b) Assign the Distributed communication technologies; Socket programming, Java RMI blocking, Java RMI with asynchronous callback functions, Java RMI based polling, as the most appropriate communication method to solve each of the following problems. **One technology** may be most suitable for **only one of the problems** given. Briefly **justify (using 1-2 sentences each) each** answer.

i) To get an alert from the remote flight monitoring system, only when there is an unidentified flight in the airspace.

ii) To obtain the current value of the Euro, every one minute from the FOREX exchange.

iii) To make an only payment via a Credit card, where the card number and details have to be validated first, before the transaction can be processed.

iv) To implement application to obtain the temperature readings from a temperature sensor and store in a server application. The sensor doesn't have the JRE (Java Runtime environment) and is only capable of doing basic network communication.

(12 Marks)

c) This question also refers to the cloud based Point of Sales (POS) system mentioned in Question 1 part (d). The sales item code, name, quantity and price are maintained for each sales item in a supermarket. The supermarket name, code and location are maintained for each supermarket in the system. Loyalty card id, customer NIC and loyalty points are maintained for each loyalty card. The sales staff can add/update/remove items in a supermarket. The administrator can add/update/remove a supermarket from the system. An order may contain multiple sales items. For each order, the sales item code, name, quantity, payment method and price for each item needs to be stored. An asynchronous message is used to save the order information in the data repository. All other method calls in the system are synchronous. The client (sales person) state needs to be maintained over multiple method calls.

Based on the J2EE specification on Enterprise Java Beans, identify different EJBs that could be used to develop this system. For **each** EJB, write its type and its function. Use meaningful names for the EJB names.

(10 Marks)

Question 03 **(25 marks)**

a) **Briefly explain (using 1-2 sentences)** how message queues would improve the **maintainability** of a system by decoupling the components and message passing.

(2 Marks)

b) **Give two advantages and two disadvantages** of using Binary message formats over Open message formats.

(8 Marks)

c) This question also refers to the online supermarket mentioned in Question 1 (d). Assume that for each order, a list of sales items and the method of payment (text) are stored. Each sales item contains the item code (alphanumeric), name (text), quantity (number) and price (floating point number).

Based on the above information, write an XML schema to represent an order. Select the appropriate datatype for each property. You do not need to write the XML header information (such as namespaces)

(8 Marks)

d) For the above Order data structure, write a sample JSON object to represent an order.

(4 Marks)

e) **Briefly explain (using 1-2 sentences)** the following features of the Service Oriented Architecture (SOA) **promote reusability**.

i). Using Open standards
ii). Loose coupling
iii). Well defined service interfaces

(3 Marks)

Question 04 **(25 marks)**

a) In the cloud based Point of Sales (POS) system mentioned in Question 1 (d), assume that there are select, select all, create, update and delete remote operations to be performed on a Supermarket object. For each supermarket, the supermarket code, name and location are maintained. Write sample RESTful service URLs that can be used to perform these operations. Indicate the appropriate HTTP method to use with the URL.

(10 Marks)

b) **Briefly explain** how the Microservices architecture can provide scaling up or down individual services (without scaling up or down the entire application/system). You may use an example to explain your answer (do not use more than **3-5 sentences** for the entire answer).

(3 Marks)

c) For each of the following scenarios, **name the** appropriate type of Cloud computing service used, out of Public cloud, Private cloud and Hybrid cloud.

i) The cloud based Point of Sales (POS) system will be hosted in the Virtual machines provided by a commonly known cloud service such as Amazon EC2 cloud or Google cloud.

ii) You have a web application that's hosted on premise (internally hosted). However, you want to direct the additional traffic during the peak hours to a cloud based Virtual machine.

iii) A government organization wants to provide its employees the ability to create Virtual machines and share data and services, but is not allowed by law to host their data or system at a data center in a foreign country

(6 Marks)

d) For each of the following scenarios, **name the** appropriate type of Cloud computing service used, out of Software As a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS).

iv) You have developed a machine learning algorithm and need to train it in a high performance computer with a GPU (graphics processing unit), which is fairly expensive. You have decided to create a Virtual Machine with a GPU in a cloud and use it to train your algorithm. You will be installing all the libraries and Software that you need manually.

v) Using a cloud based POS (Point of Sales) system to manage the transactions in a supermarket, instead of using an internally hosted POS system.

vi) You are planning to deploy your Enterprise web application in an application server that's hosted in the cloud.

(6 Marks)

END OF THE EXAMINATION PAPER