University of Leicester
School of Computing and Mathematical Sciences

In-course Assignment Specification

Module Code and Title: CO4219/CO7219 Internet and Cloud Computing	
Assignment No. and Title: #1 –Cloud System Design and Evaluation	
Assessment Tutor: Prof Ashiq Anjum	**Weighting Towards Module Grade:** 50%
Date Set: October 16, 2022	**Hand-In Deadline Date:** December 5, 2022

Level of Collaboration

This is a group assignment; however, each group member has to write their understanding and contributions in each task in their own words. Each group should work together to design and develop the system, and then each member within the group should write the work in their own words.

Learning Outcomes covered in this Assignment:

The aim of this deliverable is twofold: Firstly, to develop technological foundations in Distributed and Cloud Systems and secondly, to develop expertise in designing and developing robust and scalable Cloud Systems.

Assignment: You have to design and document the architecture of a private cloud, implement it, and then deploy on it a whiteboard application. The whiteboard application should run on at least two separate machines/nodes within your private cloud, each applications instance serving a different group of users. You have to demonstrate that the distributed application running in your private cloud is consistent in a way that all the users will see the same application state across different instances. The application should scale to support a number of additional users and offer an improved quality of service as compared to the one if it was running on a single machine.

The assignment has a set of tasks and there is a set of activities that need to be performed in each task.

Note 1: You will work in groups (average group size is 4) for this assignment, however, the evaluation will be based upon individual performance. You are free to select your group members and make sure that you work as a team and share your understanding, expertise and skills with other members of your group.

Note 2: We will not restrict you to a particular set of tools or technologies as far as you can justify your choices in your architecture and implementation. You should critically assess your options before you

propose your architecture and carefully evaluate the tools and technologies to implement your architecture.

Task 1: Produce a Design of your Private Cloud (10 % of the total module grade)

Each group should produce an architecture of your own private cloud. You should evaluate available cloud computing technologies and architectures before you propose a suitable architecture of your private cloud. You should put in place mechanisms to achieve consistency, scalability, agility and quality of service. You should also propose a suitable network topology for your private cloud to manage traffic and provide fault tolerance. In this task, you should also have a clear understanding of the tools and technologies that you will use to implement the design of your private cloud. You should have convincing reasons to justify the technology choices that you have made for the implementation of your architecture.

Each member of the group should explain the design of their private cloud and technological choices in their own words (two pages max). This should also include an architecture diagram of your proposed system.

Note 3: For your information, some of the popular cloud stacks include Apache CloudStack, OpenStack, Vsphere, MS Azure, AWS, Nimbus, IBM Smart Cloud, Ubuntu Enterprise Cloud, Eucalyptus and OpenNebula. You may use a toolkit of your choice as far as you can justify this in your architecture. Similarly, you may use a hypervisor of your choice, such as XEN, KVM, VMware ESX, lguest, Hyper-V or virtual box, to virtualize system resources.

Task 2: Implement the Private Cloud (15 % of the total module grade)

Each group will implement the architecture for the private cloud that has been proposed in Task 1. To implement your private cloud, you should use the set of tools and technologies that you have shortlisted in Task 1. You should be able to show a working implementation of the private cloud in this task. Your implementation should enable the private cloud to provide a consistent, scalable and low latency access to your whiteboard application. This should also enable new virtual machines to be provisioned and decommissioned with minimal human intervention.

Note 4: Zabbix, Cloud Watch, Nagios, Grafana, Ganglia, NMS, OPNET, Open Nebula are a few examples of monitoring tools. However, you are free to select a tool of your choice as far as you have good reasons behind your selection.

Note 5: Each group should set up the private cloud on a minimum number of nodes possible. You should deploy the whiteboard application in each virtual machine. However, the distributed application should offer consistency and should look like a single application to outside users. There are no additional marks for setting up a higher number of nodes in your private cloud.

Each group member should explain in their own words the implementation, including the environment, components and explanation of your code in no more than two pages.

Task 3: Development of a Distributed whiteboard Application (10% of the total module grade)

You need to design and develop a whiteboard application that can be shared between multiple nodes of the private cloud. You need to run this whiteboard in a distributed environment (at least two nodes should run the application) and the whiteboard should support basic drawing features such as line, circle, and rectangle as well as text anywhere in the whiteboard.

The whiteboard should allow multiple users to draw simultaneously on a shared interactive canvas.

When a new user joins the system, the user should obtain the current state of the whiteboard so that the same objects are always displayed to every active user.

At least two virtual machines within the cloud should host two instances of the whiteboard. However, all the users should see the same state of the whiteboard and should have the privilege of doing all the drawing operations.

Each group member should explain the design and implementation of your whiteboard application. This should include consistency, replication and state management and how they have implemented the application in no more than two pages.

Task 4: Demonstrate the Private Cloud (5 % of the total module grade)

There are two aspects of demonstration: Group as well as individual demonstration.

4.1 Each group member will demonstrate the private cloud that they have produced in Task 2 by deploying the application that they have produced in task 3.

Each group member should produce maximum 1 page demonstrating your individual contributions

4.2 Each group should produce a combined group video that all group members will submit as a part of their individual submissions. The video (max 10 minutes) should highlight the functionality of your private cloud and their individual contributions in Tasks 1, 2 and 3.

All team members have to validate the contributions of their colleagues. You should highlight how you are monitoring the computing, storage and network resources in your private cloud and should provide information about consistency, performance, availability and scalability of resources. The cloud resource consumption (performance numbers) should go up/down with more number of users using the whiteboard application instances and vice versa.

Task 5: Critical review of your system (10 % of total module grade)

Each student will submit an individual critical review of your system in no more than 2 pages. This should be based on your own understanding and contributions. You should have two sections in this task. **5.1**. Present a critical analysis of the weaknesses and strengths of your system. **5.2.** You should present alternative models to improve your system and give reasons on how the proposed changes will improve the functionality of your system if you have been given another chance.

Each student will submit 1 single document (in pdf) that should include the following:

1. Task 1: Design and Technological choices for your private cloud (2 pages max)
2. Task 2: Implementation details of your private cloud (2 pages max)
3. Task 3: Distributed Whiteboard Application design and development (2 pages max)
4. Task 4: Individual Contributions and URL of the group video (1 page max)
5. Task 5: Critical review of your system (2 pages max)

Please ensure that you have put a cover page showing your name and student number.

Marking Scheme

Tasks and Total Marks	Break down of Marks
Task 1: Design of your private cloud (10)	a. The design offers a standalone private cloud architecture but does not offer scalability, consistency or network topology **(4)** b. The design offers consistency **(2)** c. The design offers scalability **(2)** d. The design offers a network topology and proposes measures for low latency communication between the nodes **(2)**
Task 2: Implementation of your private cloud (15)	a. The private cloud implementation is not distributed and does not offer scalability, consistency or network topology **(6)** b. The implementation offers consistency **(3)** c. The implementation offers scalability **(3)** d. The implementation offers a network topology and implements measures for low latency communication **(3)**
Task 3: Development of a Distributed whiteboard Application (10)	a. A standalone whiteboard application that does not offer a distributed functionality **(4)** b. The distributed application instances on two different machines communicate with each other and can support an increasing number of users than on a single machine **(3)** c. The distributed application instances are consistent that state changes in one are automatically communicated and updated with the other instances **(3)**
Task 4: Demonstrate your Private Cloud (5)	a. There is a good group contribution but individual contribution is not impressive **(2)** b. There is a strong individual as well as group contribution. The system works perfectly fine. **(3)**
Task 5: Critical Review of your system (10)	a. The critical review of the strengths and weaknesses in the proposed design does not take into consideration the state of the art, is not objective and is not substantiated through suitable examples and references. **(4)** b. The critical review offers strong reasons behind the gaps in the design as well as presents a quantified view of the strengths backed by suitable examples and references. **(3)** c. The critical review presents a solid roadmap to address the gaps and shortcomings in the design and implementation through examples and references **(3)**