UNIVERSITY OF LEICESTER

School of Computing and Mathematical Sciences

Coursework Specification

CO3219/CO4219/CO7219 Internet and Cloud Computing	
Cloud System Design and Evaluation	
Convenor(s): **Prof Ashiq Anjum, Dr Wil Ward**	Weighting Towards Module Grade: **50%**
Date Set: **01 October 2024**	Hand-In Deadline Date: **12 December 2024**

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 will be required to write **an individual report** about the work in **their own words**.

You **must not collaborate on writing**, nor share your writing with your group members: this will be **considered as plagiarism**.

Learning Outcomes

The aims of this deliverable are:

1. to develop technological foundations in Cloud Systems; and
2. to develop expertise in designing and developing robust and scalable Cloud Systems

Guidance on use of Artificial Intelligence

Generative AI may be used in the development of this assignment. You should follow the guidance indicated in this assignment brief.

Contents

Assignment Brief

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, with each application's instance serving a different group of users. You should demonstrate that the distributed application running in your private cloud is consistent in a way that all users will see the same application state across different instances. The cloud and application should scale to support additional users, and offer an improved quality of service when compared to one running on a single machine.

The assignment is separated into a set of tasks, and there is a set of activities that should be undertaken for each task.

You are not restricted to a particular set of tools or technologies, but you must justify your choices when designing and implementing your architecture. 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 [20%]

Your group should design and produce an architecture of a 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 demonstrate 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.

As an *individual member* of your group, you will be required to *explain the design* of your group's private cloud and technological choices *in your own words*. You should also include an architecture diagram of your proposed system.

Task 2: Implement your Private Cloud [30%]

Your group should 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 identified in Task 1. You should be able to demonstrate 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.

Each group should set up the private cloud on a minimal 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.

As an *individual member* of your group, you should explain the implementation, including the environment, components and explanation of any code, *in your own words*.

Task 3: Develop and Deploy a Distributed Whiteboard Application [20%]

Your group will 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 be running the application. The whiteboard should support basic drawing features, such as lines and shapes, as well as allowing text to appear anywhere on 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 displayed to every active user.

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

As an *individual member* of your group should explain the design and implementation of your whiteboard application *in your own words*. This should include consistency, replication and state management, and how your group has implemented the application.

Task 4: Demonstrate your Private Cloud [10%, shared by all group members]

There are two aspects of demonstration.

Each group should produce a video. The video should highlight the functionality of your private cloud and their individual contributions in **Tasks 1, 2 and 3**.

The group 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 users and whiteboard application instances and vice versa.

As an *individual member* of your group, you should demonstrate a component of the private cloud that they have produced in **Task 2** by deploying the application that they have produced in **Task 3**.

As an *individual member* of your group you should produce maximum one page demonstrating your individual contributions.

Task 5: Critical Review of your System [20%]

As an *individual member* of your group, you should a critical review of your system, *in your own words*. This should be based on your own understanding and contributions.

You should have cover three areas in your critical review:

1. the architecture of your system and the choices made;
2. the weaknesses and strengths of your design and implementation;
3. suggestions to improve your system's design and implementation, including reasons for how the proposed changes will improve the functionality of your system.

Format of Deliverables

You must submit your report, covering the five tasks, to the Turnitin submission point as a **single PDF document**.

Your document must not exceed 10 pages, not including title page, references, or appendices. Please follow a referencing style (e.g., IEEE, ACM, etc.) to prepare your references and ensure your references are cited properly in the text. You may include screenshots and code snippets in an appendix, where referencing these in your report would take up too much space.

Marking and feedback is done anonymously. You should **not** include your name in your document.

For your video submission, *one member of your* group should upload a video demonstration to the relevant submission portal. Your group's video should contain all members of the group contributing to the demonstration.

Using Generative AI

The University has policies surrounding students' use of generative artificial intelligence (AI) in their assessments. The University neither fully endorses nor bans the use of AI tools, and discretion is left to the module convenor to outline the limits of their use in assessments. You can read more about the University's AI guidance, including how to use AI effectively, and the benefits and limitations of its use on SharePoint.

The current definition of Plagiarism within Senate Regulation 11 has been updated to constitute "submitting written work that contains material copied from the work of another person or using work written by another person, including published work and/or online sources without appropriate acknowledgement. This includes content generated via artificial intelligence".

In this assignment, **generative AI may be used in development** of this coursework, with the following guidance:

A. You must reference, or otherwise indicate, any part of your system, solution, or submissions where you have used generative AI; and indicate which parts comprise AI generated text or code;
B. You **may not** use generative AI content directly in the written component of your report; however, you may use it to
    a. help you get started with structure or topics to write about,
    b. check grammar and spelling, and general structure in a similar way to one might use tools such as Grammarly,
    c. explain terms in a simpler way to help you better understand it;
C. **Avoid relying on generative AI to help you deploy or implement your cloud system**, as its capabilities will likely be limited. You should use other resources, including APIs, documentation, and user forums for troubleshooting.

A general guide for use of generative AI in your studies is available from AI for Education at https://www.aiforeducation.io/ai-resources/student-guide-ai-use.

You may also read about the University's guidance for use of Artificial Intelligence on SharePoint at https://uniofleicester.sharepoint.com/sites/academic-skills-online/SitePages/AI-Guidance.aspx.

Marking Rubric

Below is an indicative rubric, with benchmarks against each task is assessed.

	a	*b*	*c*	*d*
Task 1 *Design of your private cloud*	There is some description of a design that offers a standalone private cloud architecture	The design presented offers consistency or scalability	There is a detailed description of a design that offers both consistency and scalability	The design offers a network topology and proposes measures for low latency communication between the nodes
Task 2 *Implementation of your private cloud*	There is evidence of a working implementation of the private cloud	The implementation demonstrates consistency or scalability	In line with the design, the implementation is evidenced to offer both consistency and scalability	There is an implementation of a cloud system that offers scalability, consistency and measures for low latency communication
Task 3 *Development of a distributed whiteboard application*	Some attempt has been made to deploy an application on the cloud	There is a standalone working whiteboard application deployed	The application is distributed on two different machines that communicate with each othe rand can support an increasing number of users than on a single machine	The application is distributed and the instances are consistent that state changes in one are automatically communicated and updated with the other instances.
Task 4 *Video Demo*	There is a good demo but individual contributions are not clear		There are strong individual contributions, and there is demonstration of a perfectly working system	
Task 5 *Critical review of your system*	There is minimal attempt to engage critically with the proposed solution	There is an attempt to critically review the system along all three stated areas	The review offers strong reasons behind the gaps in the design as well as presenting a quantified view of the strengths backed by suitable examples and references	The critical review presents a solid roadmap to address the gaps and shortcomings in the design and implementation through examples and references

General Guidance and Pointers

Completing Task 1

Some popular cloud stacks include

- Apache CloudStack,
- OpenStack,
- VMware vSphere,
- Microsoft Azure,
- Amazon Web Services,
- Nimbus,
- IBM Smart Cloud,
- Ubuntu Enterprise Cloud,
- Eucalyptus, and
- Open Nebula.

You may use a toolkit of your choice, as long as you can justify this in your architecture. Similarly, you may use a hypervisor of your choice. Examples of hypervisors include

- XEN,
- KVM,
- VMware ESX,
- Iguest,
- Hyper-V, and
- Oracle VirtualBox

Completing Task 2

A few examples of monitoring tools include

- Zabbix,
- Cloud Watch,
- Nagios,
- Grafana,
- Ganglia,
- NMS,
- OPNET, and
- Open Nebula

However, you are free to select a tool of your choice as far as you have good reasons behind your selection.

Completing Task 3

You do not need to create your whiteboard application from scratch: you may use open-source code as inspiration for your application. You may find examples of distributed whiteboards on web, including open-source repositories such as GitHub. Any third-party code you use **must be referenced appropriately**.

You should not rely on using a web server to deploy your application, as this will not be an example of a distributed system.

Plagiarism and Collusion

While much of this project involves group work, your report must be written based on your own understanding. You should avoid sharing your report with members of your group.

The University regards plagiarism and collusion as very serious offences and so they are subject to strict penalties. The penalties that schools are authorised to apply are defined in the Regulations governing student discipline, see https://le.ac.uk/policies/regulations/senate-regulations/senate-regulation-11/academic.