Module Title: Cloud Computing © **UNIVERSITY OF LEEDS**

School of Computing Semester 2 2021/2022

Examination Information

- The submission deadline for this assessment is .

- Submit your answers via the **Gradescope** submission point.

- Support for the assessment is available via the module **Microsoft Teams** group.

- You are permitted to use your lecture notes while completing this assessment.

- There are **2 hours** to complete the examination.

- There are **4** pages to this assessment.

- Answer **all 3** questions.

- The number in brackets **[ ]** indicates the marks available for each question or part question.

- You are reminded of the need for clear presentation in your answers.

- The total number of marks for this assessment paper is **60**.

Question 1

(a) When building data centre clouds, certain network performance characteristics should be closely evaluated so that users are not negatively impacted. What are the two most important characteristics that should be examined? (Choose two).

- A. network security
- B. network latency
- C. network packet loss rate
- D. network buffer overflow rate

[2 marks]

(b) A large infrastructure as a service provider wants to allow users to provision new server capacity from a variety of different interface technologies. Which Web technology should the service provider use to build an interface that users can leverage?

- A. The company should provide an HTTP REST API.
- B. The company should provide an XML RPC service.
- C. The company should provide a command line interface.
- D. The company should provide a proprietary remote API.

[3 marks]

(c) You are designing an application that requires both data acquisition and pre-processing of raw data for event filtering on the cloud. Moreover, you have the freedom to describe the underlying hardware to perform the pre-processing. Which hardware architecture would you choose for such an application? Justify your answer.

[5 marks]

(d) Consider an application deployment scenario on a cloud infrastructure where the aspect of *migration* is key. Which type of virtualisation mechanism would you choose, Virtual Machines or Containers? Explain your answer.

[5 marks]

(e) You are required to develop a cloud application that uses publish-subscribe to communicate between entities developed in different languages. Producers should be written in C++ and consumers should be in Java. Distributed components communicate with one another using AMQP. Explain how to develop such application.

[5 marks]

[Question 1 Total: 20 marks]

Question 2

(a) Consider an application deployment scenario on a cloud virtualised infrastructure. You have the choice of using Openstack or Kubernetes to deploy virtualised services. Compare Openstack and Kubernetes considering five criteria of your choice. **[5 marks]**

(b) A company called Flixnet specialising in video streaming is about to provide its service on the cloud. This requires re-engineering their core application, which makes use of thousands of files that get changed and modified on a daily basis. The validity and integrity of the files get checked before they are finally backed up. Both serverless computing and containers will enable the company to deploy its application. Considering the following factors, which solution should Flixnet adopt, serverless computing or containers?

- scalability

- cost

- maintenance

- time of deployment

[6 marks]

(c) A student is overheard saying the following regarding a large Mapreduce job with m mappers and r reducers:

(i) Each mapper must generate the same number of key/value pairs as its input had.

(ii) The number of output jobs you get at the end of the job is m.

(iii) There will be m × r distinct copy operations in the sort/shuffle phase.

(iv) The earliest point at which the reduce method of a given reducer can be called is as soon as a mapper has emitted at least one record.

(v) A reducer is applied to all values associated with the same key.

Comment briefly on these statements, correcting any inaccuracies or omissions in them. **[5 marks]**

(d) Consider the issue of multitenancy in a public cloud. Explain how can a cloud customer ensure that certain Virtual Machine workloads are physically isolated from workloads being run by other customers? **[4 marks]**

[Question 2 Total: 20 marks]

Question 3

(a) There is an explosive growth of energy consumption in cloud data centres. This explosion has led to advocacy of energy efficiency and green computing.

  (i) Consider the scenario where a DVFS-enabled server running at its maximum voltage of V_{max} finishes a particular task in $T/2$ seconds. What voltage should the server run at if it is to finish the task in T seconds?

  (ii) Propose a DVFS-based VM allocation mechanism to minimise the power consumed in the data centre.

  (iii) You are asked to schedule 3 Virtual Machines on 3 physical servers. The power consumption of the servers is shown in Table 1. What allocation mechanism would minimise the total power consumption? Justify your answer.

Table 1: Servers' Power Consumption

	Server 1	Server 2	Server 3
Idle power (W)	105	80	95
Power per VM (W)	10	15	20

[8 marks]

(b) You are required to design a cloud security solution. The cloud as a multi-user distributed environment brings unique security challenges, dependent on the level at which the user operates: application, virtual or physical. For each level propose one security requirement and one associated threat. **[6 marks]**

(c) Nowadays, the highest percentage of air pollution comes directly from road traffic. Road traffic is considered to be responsible for 25% of all emissions in Europe. Moreover, 90% of all transport emissions are due to road traffic. Loss of environmental quality is one of the biggest threats to health and human well-being, together with environmental impacts.

As an expert in cloud computing, you have been contacted by Leeds City Council to lead a project on monitoring environmental parameters in the city. The main goal of the project is to achieve sustainable management of the traffic in the city by using two key-elements: a pervasive air-quality sensors network connected to the cloud as well as prediction models.

Propose a cloud computing-based solution and discuss how to deploy it. Include any information that you feel is relevant to justify your recommendation. **[6 marks]**

[Question 3 Total: 20 marks]

[Grand Total: 60 marks]