This question paper consists of 5 printed pages, each of which is identified by the Code Number COMP5850M.

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School of Computing

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COMP5850M

Cloud Computing

Answer all 3 questions

Time allowed: 2 hours

TURN OVER FOR QUESTIONS

Question 1

(a) Four different cloud companies provide Storage as a Service capabilities: Company A stores user data in its primary data centre in Manchester and replicates the data to a backup data centre also in Manchester. Company B stores user data in its primary data centre in London and replicates it to a data centre in Edinburgh. Company C stores user data in its primary data centre in Swansea and stores replicas in the same data centre. Company D stores user data in its primary data centre in Glasgow and does not replicate the data. Which company is likely to provide the highest availability? **[2 marks]**

- Company A
- Company B
- Company C
- Company D

(b) A company delivers Software as a Service that allows users to fill out and submit tax forms on line. What should the company do to accommodate the spike in demand on the date when the tax forms are due? **[2 marks]**

- A. Build the system according to peak demand requirements.
- B. Build the system with high end hardware to ensure system performance.
- C. Monitor the system and lease additional hardware during the peak tax season.
- D. Design a robust load balancing architecture that monitors application performance and routes request to application instances appropriately.

(c) 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? **[2 marks]**

- 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.

(d) 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.) **[2 marks]**

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

(e) What is a common mechanism of communications among Virtual Machines (VM) running in a cloud environment? **[2 marks]**

- A. A public IP address for each instance that is connected to a virtual private bridge.
- B. A private IP address for each instance that is connected to a virtual private bridge.
- C. A public IP address for each instance that attaches to the Operating System software Ethernet bridge.
- D. A private IP address for each instance that attaches to the Operating System software Ethernet bridge.

(f) Which statement is true about a bare metal hypervisor? **[2 marks]**

- A. It can only be hosted on an existing operating system.
- B. It requires a separate license for the native operating system.
- C. It has minimum functionality to support only one type of operating system.
- D. It runs directly on server hardware to provide Virtual Machines with time-sharing resources.

(g) In Hadoop, when is the earliest point at which the reduce method of a given Reducer can be called? **[2 marks]**

- A. As soon as at least one mapper has finished processing its input split.
- B. As soon as a mapper has emitted at least one record.
- C. Not until all mappers have finished processing all records.
- D. It depends on the Input Format used for the job.

(h) A company is interested in enterprise cloud computing adoption and is considering the following scenarios:

(i) The company has peak customer demand for its IT services in the month of April. It has enough IT resources to handle off peak demand but not peak load. Explain briefly what is the best approach for handling this situation. **[2 marks]**

(ii) The company wants to build a test environment to test software updates and new solutions. The test environment should mirror the production environment, be secure and inaccessible from outside the company network. The company does not want to invest in infrastructure that may be idle for a significant amount of time. Which cloud computing model will satisfy all these requirements? **[2 marks]**

(iii) State two advantages of adopting a hybrid cloud model for the company. **[2 marks]**

[question 1 total: 20 marks]

Question 2

(a) 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. **[3 marks]**

(b) A Virtual Infrastructure Manager can be used to deploy virtualised services on both a local pool of resources and on external IaaS. Compare OpenStack with OpenNebula using five criteria of your choice. **[5 marks]**

(c) There is a large text file of computer science bibliography data held in an HDFS over a number of machines. Each line of this file describes the details of one paper in the following format:
`authors | title | conference | year`
The different fields are separated by the | character, and the list of authors are separated by commas. An example line is given below:
`R Kavanagh, D Armstrong, K Djemame | Towards an Energy-Aware Architecture for Smart Grids | GECON | 2015`
You can assume that there are no duplicate records, and each distinct author or conference has a different name.
You are asked to calculate for each conference the average number of authors per paper. Describe how you would solve this problem using a MapReduce. **[6 marks]**

(d) The cloud is a distributed, multi-tiered platform onto which layered, modular software application architectures are mapped.

- Explain why the cloud can be viewed as an adaptive system. **[2 marks]**
- An auto-scaling system can reconfigure cloud-based services and applications. Give an example of overhead incurred in such system. **[2 marks]**

(e) Explain briefly how Mobile Edge Computing can support an Autonomous Vehicle-to-Infrastructure use case. **[2 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 greater advocacy of green computing and energy efficiency.

(i) Propose a DVFS-based VM allocation mechanism to use in order to minimise the power consumed in the data centre **[4 marks]**.

(ii) 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? **[1 mark]**
- If the amount of energy used to perform the task in the V_{max} case is E, what is it in the case described above? **[2 marks]**

(b) A cloud provider is setting up a Service Level Agreement (SLA) framework for Quality of Service provision for its customers. The infrastructure management supports multi-tenancy as well as availability, confidentiality and integrity. To fulfil the SLA the cloud provider needs to ensure that the acceptable level of Virtual CPU utilisation allocated for each VM does not exceed 90%.

(i) Propose a high-level design of the SLA framework including any information that you feel is relevant to back it up. **[4 marks]**

(ii) What issues would you consider if the cloud provider were a member of a federation? **[2 marks]**

(c) Strawberries growing in greenhouses are very susceptible to two main factors: air temperature (significant from the coverage of the greenhouse up to harvest) and water irrigation amount (very important both during the first few months after planting and before harvest). Propose a cloud computing-based solution that allows to instantly check environmental and production parameters and generate notifications when urgent corrections are needed. Discuss how to deploy your solution and include any information that you feel is relevant to back it up. **[7 marks]**

[question 3 total: 20 marks]

[grand total: 60 marks]

END