PRINCE OF SONGKLA UNIVERSITY FACULTY OF ENGINEERING

Final Examination: Semester 1 Date: 12 December 2015 Subject Number: 242-548 Academic Year: 2015 Time: 13.30 - 16.30 (3 hours) Room: A202

Subject Title: Cloud Computing Principles and Paradigms

Exam Duration: 3 hours

This paper has 15 pages, 4 questions and 165 marks (35%).

Authorised Materials:

- Writing instruments (e.g. pens, pencils).
- Textbooks, a notebook, handouts, and dictionaries are permitted.

Instructions to Students:

- Scan all the questions before answering so that you can manage your time better.
- Answers **must** be written in **Thai**.
- Write your name and ID on every page.
- Any unreadable parts will be considered wrong.

When drawing diagrams or coding, use good layout, and short comments; marks will not be deducted for minor syntax errors.

Cheating in this examination

Lowest punishment: Failed in this subject and courses dropped for two semesters.

Highest punishment: Expelled.

NO	Time (Min)	Marks	Collected	NO	Time (Min)	Marks	Collected
1	90	87		3	15	15	
2	60	50	<u> </u>	4	15	13	
Total	180	165	Collected:		35%		

Question 1 Virtual Machines and Virtualization of Clusters and Data Centers (87 marks; 90 minutes)

a) Compare the following emulation methods: Static Translation (one-by-one code interpretation) and Dynamic Binary Translation in the emulation method. (6 marks)

b) In Trace Scheduling, explain basic blocks, superblocks and repair blocks. Briefly illustrate and explain the concept. (10 marks)



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c) Explain the differences between hypervisor and para-virtualization and give one example VMM (virtual machine monitor), that was built in each of the two categories. (6 marks)

d) What are *Three Critical Instructions* in virtualization? Also explain how to deal with them. (6 marks) e) According to Hardware Virtualization, tell whether the following statements are

- According to Hardware Virtualization, tell whether the following statements are True (T) or False (F). (8 marks)
 - 1) _____ All CPU architectures are virtualizable.
 - 2) Binary translation of full virtualization is needed in Hardware-Assisted CPU Virtualization.
 - 3) In Hardware-Assisted CPU Virtualization, the operating system run in VMs without modification.
 - 4) In Hardware-Assisted CPU Virtualization, operating systems run at Ring 0 and the hypervisor at Ring -1, and all the privileged and sensitive instructions are trapped in the hypervisor automatically.
 - 5) In Memory Virtualization, it needs more than one stage of memory mapping.

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- 6) In Memory Virtualization, the guest OS can directly access the actual machine memory.
- 7) <u>I/O virtualization involves managing the routing of I/O requests</u> between virtual devices and the shared physical hardware.
- 8) In full I/O virtualization, software device emulation runs much faster than the hardware it emulates.
- 9) _____ Copy-on-write in I/O virtualization induces disk space consumption.
- 10) Para-I/O-virtualization achieves better device performance than full device emulation and it can achieve close-to-native performance.
- 11) _____ Direct I/O virtualization lets the VM access devices directly but it comes with a higher CPU overhead.
- 12) _____ In Self-Virtualized I/O, it utilizes a multicore processor and defines one virtual interface (VIF) for every kind of virtualized I/O devices.
- 13) ______ virtualized I/O devices include virtual network interfaces, virtual block devices (disk), virtual camera devices, and others.
- 14) _____ CPU virtualization demands hardware-assisted traps of sensitive instructions by the hypervisor.
- 15) Memory virtualization demands special hardware support to help translate virtual address into physical address and machine memory.
- 16) I/O virtualization is the easiest one to realize.
- f) Use the following figures to explain and illustrate the concept of Virtual Hierarchy. (8 marks)



(a) Mapping of VMs into adjacent cores

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g) The below picture shows another VIOLIN adaptation scenario for changes in virtual environments. There are four VIOLIN applications running in two cluster domains. Trace the three steps of VIOLIN job execution and discuss the gains in resource utilization after live migration of the virtual execution. (6 marks)



- h) Tell whether the following statements concerning a *Virtual Cluster* are True (T) or False (F). (5 marks)
 - 1) _____ The virtual cluster nodes must be virtual machines.
 - 2) _____ Multiple VMs running with different OSs can be deployed on the same physical node.
 - 3) _____ The purpose of using VMs is to consolidate multiple functionalities on the same server so that it will greatly enhance the server utilization and application flexibility.
 - 4) _____ VMs can be replicated in multiple servers.
 - 5) _____ The number of nodes of a virtual cluster can grow or shrink dynamically, similarly to the way an overlay network varies in size in a P2P network.
 - 6) _____ The boundary of a virtual cluster can change as VM nodes are added, removed, or migrated dynamically over time.
 - 7) In a Virtual Cluster, the failure of any physical nodes will not disable VMs installed on the failing nodes.
 - 8) In a Virtual Cluster, the failure of VMs will affect the entire host system.
 - 9) In a Virtual Cluster, VMs can be installed on remote servers or replicated on multiple servers belonging to the same or different physical clusters.
 - 10) In a Virtual Cluster, the host and guest systems must run with different operating systems.
- i) Explain and illustrate the concept of *Shadow Page Table* in Memory Virtualization. (6 marks)

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j) Explain how *Virtualized Data Centers* benefit from virtualization technology in the security issues: trust management, key reuse and intrusion detection. (10 marks)

k) From the below figures, explain the following keywords of Life Migration: *Dirty Pages/Bitmaps, and Context-based Compression (CBC) algorithm.* (8 marks).



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VM running normally on Host A	Stage 0: Pre-Migration Active VM on Host A Alternate physical host may be preselected for migration Block devices mirrored and free resources maintained * Stage 1: Reservation Initialize a container on the target host					
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Overhead due to copying	Stage 2: Iterative pre-copy Enable shadow paging Copy dirty pages in successive rounds.					
Downtime (VM out of service)	Stage 3: Stop and copy Suspend VM on host A Generate ARP to redirect traffic to Host B Synchronize all remaining VM state to Host B Stage 4: Commitment					
VM running normally on Host B	VM state on Host A is released ▼ Stage 5: Activation VM starts on Host B Connects to local devices					
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Question 2 Cloud Platform Architecture over Virtualized Datacenters (50 marks; 60 minutes)

a) From the below picture, explain the *Cost-Effectiveness* in *Cloud Computing*. (3 marks)



b) Tell differences of Warehouse-Scale Computer (WSC) with High Performance Computing Clusters and conventional data centers. (6 marks)



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c) What are the design considerations in Warehouse-Scale Computer (WSC). (5 marks) d) Compare black box, white box and gray box testing. (6 marks) e) Explain ACID properties for Megastore Architecture. (8 marks) -----____

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Feature	How-to Techniques/Enabling technologies
Fast platform deployment	
Virtual cluster on demand	
Multitenant techniques	
Massive data processing	
Web-scale communication	
Distributed Storage	

f) List the following enabling technologies for the Clouds. (6 marks)

g) List at least 4 *Challenges* for Cloud Platform Architecture and Computing. (8 marks)

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h) Suppose that you are building a Cloud/Data center, list *Physical and Cyber Security Protection* schemes you are applying and explain why. (8 marks)

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Question 3 Cloud Programming and Software Environments (15 marks; 15 minutes)

Choose to give an example and explain the algorithm of one of the following MapReduce Applications.

- 1) Map Only processing
- 2) Filtering and accumulation
- 3) Database join
- 4) Reversing graph edges
- 5) Producing inverted index for web search
- 6) PageRank graph processing



Question 4 Ubiquitous Clouds and the Internet of Things (13 marks; 15 minutes)

a) What are the differences between active RFID and passive RFID? Comment on their advantages and limitations. (5 marks)

b) The IoT differs from the traditional Internet in many ways. Identify their differences and describe their distinctions in connecting entities, infrastructure and networking, and application domains. (8 marks)

----End of Examination----

Pichaya Tandayya Lecturer

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