The University of Melbourne

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Computing and Information Systems

COMP 90024   Cluster and Cloud Computing

Reading Time 15 minutes Writing

Time   2 hours

Open Book Status   Closed   Book

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                                         form

Question 1:

A) Explain what is meant by the terms:
    "Grid Computing [l]
    '"Cluster Computing [l]
    '"Cloud Computing [1]

Grid Computing: Grid Computing is a technology that build a distributed system for organizations to collaborate, compute and share data resources on demand.

Cluster Computing: Cluster Computing is when two or more computer serve a single resource.This improves performance and provides redundancy; typically a collection of smaller computers strapped together with a collection of smaller computers strapped together with a high-speed local network.

Cloud computing: Cloud Computing is a colloquial expression used to describe a variety of different types of computing concepts that involve a large number of computers that are connected through a real-time communication network (internet).

B) Current Cloud Computing systems do not solve many key challenges of large-scale distributed systems. Discuss. [7]

Data and data heterogeneity

Scalability and issue of fixed hardware system

Fault tolerance not solved

Results in software "stacks"

General Assumptions that do not hold in real life.

(往年答案）

Single point failure
Dependence analysis is hard for core that uses pointers, recursion, ...;
Access to global resources (e.g. Shared variables)

Question 2 ：

A) Define Amdahl's law and discuss the challenges of its practical implementation. [2]

Amdahl's law declares that If 95% of the program can be parallelized, the theoretical maximum speedup using parallel computing would be 20×, no matter how many processors are used. Amdahl's law assumed a computation problem of fixed dataset size. Also includes overheads required to deal with parallelism (loops, variables, comms etc)

B) The actual performance as experienced by users of shared-access HPC facilities such as the Edward cluster at the University of Melbourne can vary - where here performance can be considered as the throughput of jobs, i.e. from the time of first job submission to the time of last job completion.
    Explain why this can happen. [2]

Stuck in queue; Overall usage of facility, e.g. I/O or node load; not all nodes identical; the way code is written; the nature of the application itself

Explain how the Edward cluster has been set up to minimize this. [2]

Multiple quotes dedicated to certain types of jobs.

Queueing system to only schedule jobs when resources free (avoid starvation/blocking of system by users with large reservation demands for their job) Modules set up with main libraries installed etc.

Explain what users can do to optimize their throughput (use) of the Edward cluster. [2]
Load right modules; wall time choices (minimal necessary); benchmark small data then scale up to appropriately large value; avoid demanding large scale resources.

Describe some of the challenges with application benchmarking on HPC facilities. [2]
Shared facility not just for user that can't guarantee runs same; benchmarking apps hard anyways; Linpack is a fixed set of algorithm that don't reflect real word apps e.g. twitter analytics etc

Question 3:

A) Explain the consequences of Brewer's CAP theorem on distributed databases. [4]
Consistency: every client receiving an answer receives the same answer from all nodes in the cluster
Availability: every client receives an answer from any node in the cluster
Partition-tolerance: the cluster keeps on operating when one or more nodes cannot communicate with the rest of the cluster
The DBMS can have no more than two of the three characteristics.
Two phase commit for consistency availability
Paxos for consistency and partition-tolerance
MVCC for availability and partition-tolerance

B) Describe which aspects of the CAP theorem are supported by the following database technologies: " non-SQL (unstructured) databases such as CouchDB. [2]
MVCC support nonSQL database. MVCC (multi-version concurrency control) is a method to ensure availability and some sort of recovery from a partition by reconciling the single databases with revisions (data are not replaced, they are just given a new revision number)

'''   relational databases such as PostGreSQL. [2]
Two phase commit. It enforces consistency by: locking data that are within the transaction scope, performing transactions on write-ahead logs, completing transactions (commit) only when all nodes in the cluster have performed the transaction, aborts transactions when a partition is detected.

Describe the advantages of MapReduce compared to other more traditional data processing approaches. [2]
Apart from parallelism, its advantage lies in moving the process to where data are, greatly reducing network traffic.
往年答案
MapReduce Algorithms:
Map: Distributes data across machines
Reduce: Summarize the mapped data until the result is obtained
Advantages:
1. Scaling: can achieve scalability.

2. Lower cost: open source framework such as Hadoop is free.
3. Volume of data: large amount of data.
4. Types of data: can apply on semi-structured and unstructured data.

Question 4:

A) Compare and contrast Representational State Transfer (ReST) based web services and Simple Object Access Protocol (SOAP)-based web services for implementing service-oriented architectures. [8]

Two patterns to call service over HTTP

SOAP/WS is build upon the Remote Procedure Call paradigm: A language independent function call that spans another system

ReST is centred around resources, and the way they can be manipulated remotely. ReST is more of a style to use HTTP than a separate protocol

SOAP/WS is a stack of protocols that covers every aspect of using a remote service, from service discovery, to service description, to the actual request/response.

B) Explain the differences between ReST-based PUT and POST methods and explain when one should be used over another. [2]
PUT should be used when the target resource URL is known by the client.
POST should be used when the target resource URL is server generated.

Question 5:

A) Explain what is meant by the following terms:
Virtual Machine Monitor/Hypervisor [1]

The virtualisation layer between the underling hardware (e.g. the physical server) and the virtual machines and guest operating systems it supports.

Full Virtualization [l]

allow an unmodified guest OS to run in isolation by simulating full hardware (e.g. VMWare)

Para-virtualization [l]

VMM/Hypervisor exposes special interface to guest OS for better performance. Requires modified/hypervisor-aware Guest OS (e.g. Xen)

Shadow page tables [I]

• VMM maintains shadow page tables in lock-step with the page tables

Explain how hardware virtualization and software virtualization can differ in their treatment of shadow page tables. [2]
- hardware virtualization has less performance overheads
- the ability to trap various sensitive calls and different software solutions to do that

Explain the advantages and disadvantages of virtual machines.
Advantages:
1) Application Containment
2) Horizontal Scalability
3) Personal VM can be created on demand.

4) Server Consolidation (Increased utilization, Reduced energy consumption)
5) Security/Isolation
6) Hardware Independence

Disadvantages:
1) Guest OS and binaries can give rise to duplications between VM's wasting server processor, memory and disk space.
2) Small overhead when instructions are translated from guest os to host os.
3) Startup time is slower than containers.

Describe the typical steps that are required to support live migration of virtual machine instances using a Cloud facility such as the NeCTAR Research Cloud. [2]

Stage 0: Pre-Migration
Stage 1: Reservation
Stage 2: Iterative Pre-copy
Stage 3: Stop and copy
Stage 4: Commitment
Stage 5: Activation

Question 6:

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A) Explain what is meant by the following security terms:
- single sign-on [1]
- public key infrastructures [1]
- .. certification authority [1]
- .. registration authority [1]
- .. identity provider (IdP) [l]

single sign-on:
Single sign-on (SSO, also often referred to as reduced sign-on) is the name for a group of technologies that allows you to access a variety of web applications without entering your username and password each time.
public key infrastructures:
Public Key Infrastructure is a technology for authenticating users and devices in the digital world. The basic idea is to have one or more trusted parties digitally sign documents certifying that a particular cryptographic key belongs to a particular user or device.
certification authority:
a certificate authority or certification authority (CA) is an entity that issues digital certificates. A digital certificate certifies the ownership of a public key by the named subject of the certificate.
registration authority:
A registration authority (RA) is an authority in a network that verifies user requests for a digital certificate and tells the certificate authority (CA) to issue it.
identity provider (IdP):
An identity provider stores and manages users' digital identities.

B) Discuss the challenges in supporting fine-grained security in Cloud environments. You may refer to the importance and/or role of (some of) the terms in part A) of this question. [5]

- Authentication
- Authorisation
- Audit/accounting
- Confidentiality
- Privacy
- Fabric management
- Trust

Question 7:

A) Many research domains are facing "big data" challenges. Big data is not just related to the size of the data sets. Explain. [5]
Volume : size of the data (Giga, peta …)
Velocity: frequency of data being analysed
Variety: variety of data add complexity to the data schema
Veracity: accuracy of data: the more diverse source you have, the more unstructured they are, the less veracity you will have.

B) What capabilities are currently offered or will be required for Cloud Computing infrastructures such as the NeCTAR Research Cloud to tackle these "big data" challenges. [5]
You may refer to specific research disciplines, e.g. life sciences, astrophysics, urban research (or others!) in your answer to part A) and B) of this question.
有人会吗？

--- END OF EXAMINATION ---

Student Number   _

2014

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Number of pages (including this page) 3

Authorised Materials: None

Instructions to Students: This examination is worth 50% of your final mark

Answer 5 out of any 7 questions. Please note that only the first 5 questions will be marked.

Each question carries 10 marks.

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Instructions to Invigilators: Please provide students with standard script books

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Yes   **X**   No   D

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Question 1:

A) Discuss the major trends in research and research computing over the last 20 years that have led to the emergence of Cloud computing. [6]

– On-demand self-service. A consumer can provision computing capabilities as needed without requiring human interaction with each service provider.
– Networked access. Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous client platforms.
– Resource pooling. The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model potentially with different physical and virtual resources that can be dynamically assigned and reassigned according to consumer demand.
– Rapid elasticity. Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly upon demand.
– Measured service. Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service.

B) How has the evolution of service-oriented architectures supported Cloud computing? [2]

C) A HTTP method can be *idempotent.*
   • What is meant by this italicized term? [1]
     Effect of repeating a call is equivalent to making a single call.
   • Give an example of an idempotent ReST method. [1]
     PUT

Question 2:

A) According to Wikipedia *"Cloud Computing is a colloquial expression used to describe a variety of different types of computing concepts that involve a large number of computers that are connected through a real-time communication network (typically the Internet). Cloud computing is ajargon term without a commonly accepted non-ambiguous scientific or technical definition".*
   a. Is this justified? Your answer should cover:
      i. public, private and hybrid Cloud computing models and their advantages and disadvantages; [4]

Public Clouds
- Pros
  • Utility computing
  • Can focus on core business
  • Cost-effective
  • "Right-sizing"
  • Democratisation of computing
- Cons
  • Security
  • Loss of control
  • Possible lock-in
  • Dependency of Cloud provider continued existence
Private Clouds
- Pros
  • Control
  • Consolidation of resources
  • Easier to secure

- • More trust
- - Cons
- • Relevance to core business
- • Staff/management overheads
- • Hardware obsolescence
- • Over/under utilisation challenges

Hybrid Clouds
- - Example
- • Eucalyptus, VMWare, vCloud Hybrid Service
- - Pros
- • Cloud-bursting
- - Use private cloud, but burst into public cloud when needed
- - Cons
- • How do you move data/resources when needed?
- • How to decide (in real time?) what data can go to public cloud?
- • Is the public cloud compliant with PCI-DSS (payment card industry – data security standard)?

11. the different flavours of *"X as a Service (XaaS)"* models including their associated advantages and disadvantages. [4]

The SoA provides the implementation of API such as REST and SOAP Web service to interact between the Clouds.

SOAP allows object(information) exchange among different servers, SOAP uses XML based communication requests, and HTTP based responses.

From a developer perspective, nothing really changes due to SOAP taking care of information exchange.

1. Standardized service contract allows all servers being able to communicate in a standard protocol

2. Loose coupling ensures the communication is effective by minimising the dependencies among components, as these components might spread out on different cloud servers

3. Service dissolvability allows remote users to use the service from the cloud with 3 minimum effort as the service itself comes with metadata.

b. Outline some of the practical challenges in supporting Cloud interoperability? [2]
（往年答案）

1. Setting up the network in the target cloud to give the application the support that it had in its original cloud.

2. Setting up security to match the capabilities provided by the source cloud.

3. Managing the application running in the target cloud.

4. Handling data movement and the encryption of data while it is in transit and when it gets to the target cloud.

Question 3:
A) What is Flynn's Taxonomy? [2]
    a. What have been the implications of Flynn's taxonomy on modern computer architectures? Give examples of its consequences on modern multi-core servers and clusters of servers such as the University of Melbourne Edward HPC facility. [4]

Single Instruction, Single Data Stream(SISD)

Single Instruction, Multiple Data Stream (SISD)

Multiple Instruction, Single Data Stream (MISD)

Multiple Instruction, Multiple Data Stream (MIMD)

Modern computers use SIMD instructions to improve performance of multimedia use such as for image processing. Multiple processing elements that perform the same operation on multiple data points simultaneously.

HPC uses MIMD, a number of processors that function asynchronously and independently. At any time, different processors may be executing different instructions on different pieces of data

B) What features does the Edward HPC facility offer to allow utilization of multiple servers (nodes)? [2]

Hardware Parallel ?

(往年答案）

With a cluster architecture, applications can be more easily parallelised across them. Parallel computing refers to the submission
of jobs or processes over multiple processors and by splitting up the data or tasks between them (random number generation as
data parallel, driving a vehicle as task parallel).
Research computing is the software applications used by a research community to aid research. This skills gap is a major problem
and must be addressed because as the volume, velocity, and variety of datasets increases then researchers will need to be able to
process this data.

C) Why is the accuracy of the wall time estimate important to Edward end users? [2]

If your job is big and the wall time is short, then your job may be terminated before it is finished. If your job is small, then the job may stay in the queue longer than it should be.

Question 4:

A) Define Gustafson-Barsis' law for scaled speed-up of parallel programs. [2]

Speed up S using N processes is given as a linear formula dependent on the number of processes and the fraction of time to run sequential parts.
Gustafson's Law proposes that programmers tend to set the size of problems to use the available equipment to solve problems within a practical fixed time.
Faster (more parallel) equipment available, larger problems can be solved at the same time.

B) A parallel program takes 128 seconds to run on 32 processors. The total time spent in the sequential part of the program is 12 seconds. What is the scaled speedup? [2]

$$\alpha = \frac{12}{128} = \frac{3}{32}$$

$$S(32) = 32 - \frac{3}{32} \times (32 - 1) = 29\frac{3}{32}$$

C) According to Gustafson-Barsis' law, how much faster could tho.! application *theoretically* run if it ran across all 32 processors compared to running on a single processor? [3]

$29\frac{3}{32}$ times faster

D) Why is theoretically italicized in the above? [3]

Because in real life we need to consider extra overhead as more processors are added in. The overheads are created by the communication interaction between the parallel programming such as MPI.
Consider a program that executes a single loop, where all iterations can be computed independently, i.e. code can be parallelized. By splitting the loop into several parts, e.g. one loop iteration per processor, each processor now has to deal with loop overheads such as calculation of bounds, test for loop completion etc. This overhead is replicated as many times

as there are processors. In effect, loop overhead acts as a further (serial) overhead in running
the code. Also getting data to/from many processor overheads?

Question 5:

A) Discuss the advantages and disadvantages of unstructured (noSQL) databases such as CouchDB for dealing with "big data" compared to more traditional databases, e.g. relational databases such as MySQL. Your answer should cover challenges with data distribution, traditional database ACID properties, heterogeneity of data and large-scale data processing. [6]

NoSQL advantages:
- Easily handle big data
- Document-oriented DBMS stores data as structured documents, usually expressed as XML or JSON.
- NoSQL saves documents which can contain various kinds of data (heterogeneity of data), it can restore images or other types of data.
- Fast data retrieval for large datasets using views and MapReduce - Big Data Applications

Disadvantages:
- NoSQL databases don't have the reliability functions which Relational Databases have (basically don't support ACID).

B) Apache Hadoop is a software framework that enables processing of large data sets.

   a. Explain the role of Hadoop Distributed File System (HDFS) in supporting the Apache Hadoop framework. [2]

   HDFS is a fault tolerant file system that has been explicitly designed to span many nodes. A HDFS file is a collection of blocks stored in *datanodes*, with metadata (such as the position of those blocks) that is stored in *namenodes*

   b. Describe the process by which Apache Hadoop supports fault tolerant data processing. [2]

   The file system replicates, or copies, each piece of data multiple times and distributes the copies to individual nodes, placing at least one copy on a different server rack than the others. As a result, the data on nodes that crash can be found elsewhere within a cluster. This ensures that processing can continue while data is recovered.

Continued on next page

Question 6:

A) The Internet2 Shibboleth technology as currently supported by the Australia Access Federation provides *federated authentication* and *single sign-on.*

    a.   Explain what is meant by the italicized terms [2].

single sign-on
Single sign-on (SSO, also often referred to as reduced sign-on) is the name for a group of technologies that allows you to access a variety of web applications without entering your username and password each time.

federated authentication
Federated identity is related to single sign-on (SSO), in which a user's single authentication ticket, or token, is trusted across multiple IT systems or even organizations. SSO is a subset of federated identity management, as it relates only to authentication and is understood on the level of technical interoperability and it would not be possible without some sort of federation.

    b.   Explain the role of *trust* and *public key infrastructures* in supporting the Internet2 Shibboleth model. [2]

    c.   What are the advantages and disadvantages of the Shibboleth approach for security? [4]
        Shibboleth is a single sign-on log-in system for computer networks and the Internet. It allows people to sign in using just one
        identity to various systems run by federations of different organizations or institutions. The federations are often universities or
        public service organizations.

    d.   Why isn't Shibboleth used to access Cloud-based systems more generally? [2]

Question 7:

A) Define the following terms and their relevance to Cloud Computing:

    a.   Hypervisor [1]
        The virtualization layer between the underlying hardware (e.g. the physical server) and the virtual machines and guest operating systems it supports.

    b.   Virtual machine [1]
        A representation of a real machine using hardware or software that can host a guest operating system.

    c.   Machine image [1]
        An image of a virtual machine is (in simple words) a copy of the VM, which may contain an OS, data files, and applications (just like your personal computer)

    d.   Object Store [1]
        A simple storage system like Amazon S3 Bucket. A system designed for more static data that can be retrieved, leveraged and then updated if necessary. It is independent of a particular VM and can be updated and use without any VM running.

    e.   Volume Store [1]
        Volume store is disks that can be attached to certain VMs. Contents that has been written to the disk can be seen as persistent. Volumes can be mounted or used to launch VM from.

    f.   Key-pair [1]
        Public-key cryptography
        A key pair contains a public key and private key. The mechanism is for both authentication

and encryption: where public key verifies a holder of the paired private key, and only with the private key, the message can be decrypted.

B) Applications can be deployed across Clouds either through creation and deployment of virtual images (snapshots) or through scripting the installation and configuration of software applications.

    a.   What are the benefits and drawbacks of these approaches? [2]

Using Ansible or scripting languages is more flexible; can reestablish/upgrade/configure applications; mount new volumes etc etc. Snapshots don't give history of how instance got to that state etc

    b.   Discuss the mechanisms used to support these approaches. You may refer to specific tools used to support these processes. [2]

Snapshot: NeCTAR Cloud support image service that users can create their own snapshots or use existing snapshots of virtual images.

Automation: Ansible - An automation tool for configuring and managing computers. Finer grained setup and configuration of software packages

--- END OF EXAMINATION ---

THE UNIVERSITY OF

MELBOURNE

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Question 1:

D) Discuss the major trends in research and research computing over the last 20 years that have led to the emergence of Cloud computing. [6]

Flexibility :

1.Scalability

Cloud infrastructure scales on demand to support fluctuating workloads.

2.Storage options

Users can choose public, private or hybrid storage offerings, depending on security needs and other considerations.

3.Control choices

Organizations can determine their level of control with as-a-service options.

These include software as a service (SaaS), platform as a service (PaaS) and infrastructure as a service (IaaS).

4.Tool selection

Users can select from a menu of prebuilt tools and features to build a solution that fits their specific needs.

5.Security features

Virtual private cloud, encryption and API keys help keep data secure.

Efficiency :

1.Accessibility

Cloud-based applications and data are accessible from virtually any internet-connected device.

2.Speed to market

Developing in the cloud enables users to get their applications to market quickly.

3.Data security

Hardware failures do not result in data loss because of networked backups.

4.Savings on equipment

Cloud computing uses remote resources, saving organizations the cost of servers and other equipment.

5.Pay structure

A "utility" pay structure means users only pay for the resources they use.

Strategic value:

1.Streamlined work

Cloud service providers (CSPs) manage underlying infrastructure, enabling organizations to focus on application development and other priorities.

2.Regular updates

Service providers regularly update offerings to give users the most up-to-date technology.

3.Collaboration

Worldwide access means teams can collaborate from widespread locations.

4.Competitive edge

Organizations can move more nimbly than competitors who must devote IT resources to managing infrastructure.

答案来源：https://www.ibm.com/cloud/learn/benefits-of-cloud-computing

E) How has the evolution of service-oriented architectures supported Cloud computing? [2]

1.SOA has a set of architectural principles, patterns and criteria that support modularity, encapsulation, loose coupling, separation of concerns, reuse and composability. It helps different modules communicate well.

2.SOA focuses on service, meaning every module can concentrate on its own job high effectively.

答案来源：https://www.oracle.com/technical-resources/articles/middleware/soa-ind-soa-cloud.html

F) A HTTP method can be *idempotent*.

- What is meant by this italicized term? [1]

Effect of repeating a call is equivalent to making a single call.

- Give an example of an idempotent ReST method. [1]

PUT and DELETE

Question 2:

B) According to Wikipedia *"Cloud Computing is a colloquial expression used to describe a variety of different types of computing concepts that involve a large number of computers that are connected through a real-time communication network (typically the Internet). Cloud computing is a jargon term without a commonly accepted non-ambiguous scientific or technical definition".*

    a.   Is this justified? Your answer should cover:

        i.   public, private and hybrid Cloud computing models and their advantages and disadvantages; [4]

public cloud:

Pros: Utility computing, Can focus on core business, Cost-effective, "Right-sizing", Democratisation of computing

Cons: Security, Loss of control, Possible lock-in, Dependency of Cloud provider continued existence

private cloud:

Pros: Control, Consolidation of resources, Easier to secure, More trust

Cons: – Relevance to core business, Staff/management overheads, Hardware obsolescence, Over/under utilisation challenges

hybrid cloud:

Pros: Cloud-bursting (Use private cloud, but burst into public cloud when needed)

Cons: Need to move data/resources when needed, Need to decide (in real time?) What data can go to the public cloud? Not sure whether the public cloud compliant with PCI-DSS (Payment Card Industry – Data Security Standard)?

        11.   the different flavours of *"X as a Service (XaaS)"* models including their associated advantages and disadvantages. [4]

IaaS:

Pros: flexible, Highly scalable, purchase resources as needed, full control of their infrastructure,

Cons: high deploy difficulty, resource maybe wasted due to wrong operation

PaaS:

Pros: Make application development and deployment simple and cost-effective, Allows easy migration to mixed models, Significantly reduced the amount of coding, Enable developers to create custom applications without maintaining software

Cons: low autonomy and flexibility, high price

SaaS :

Pros: greatly reducing the time and money spent on cumbersome tasks such as installing, managing, and upgrading software.

Cons: low degree of freedom, resource and infrastructure are limited

答案来源：https://houbb.github.io/2019/12/21/sass-pass-daas

    b.   Outline some of the practical challenges in supporting Cloud interoperability? [2]

1. Rebuilding the application and application stack in the target cloud.
2. Setting up the network in the target cloud to give the application the support that it had in its original cloud.
3. Setting up security to match the capabilities provided by the source cloud.
4. Managing the application running in the target cloud.
5. Handling data movement and the encryption of data while it is in transit and when it gets to the target cloud.

答案来源：
https://www.computerworld.com/article/2508726/cloud-interoperability--problems-and-best-practices.html

Question 3:

D) What is Flynn's Taxonomy? [2]

Flynn's Taxonomy:
Single Instruction, Single Data stream (SISD)
Single Instruction, Multiple Data streams (SIMD)
Multiple Instruction, Single Data stream (MISD)
Multiple Instruction, Multiple Data streams (MIMD)

a. What have been the implications of Flynn's taxonomy on modern computer architectures? Give examples of its consequences on modern multi-core servers and clusters of servers such as the University of Melbourne Edward HPC facility. [4]

Giving theory help to achieve structure of different number of data and instructor work together.
multi-processor, multi-core, and even multi-threaded and multi-node systems are possible, such as GPGPU, Spartan, couchdb.

E) What features does the Edward HPC facility offer to allow utilization of multiple servers (nodes)? [2]
我认为就是在说Spartan
good cluster structure and load balancing manager makes multiple server work efficiently.
(往年答案)

F) Why is the accuracy of the wall time estimate important to Edward end users? [2]
Wall time: Wall clock time consumed by the start and end of the process, also called real time.
Process time, also known as CPU time, is used to measure the CPU resources used by the process. The process time is calculated by the clock and is divided into user time (user), system time (sys), and total time (total): user time and system time are the CPU time used by a specific process, and the total time is equal to the sum of user time and system time.

Wall time <total, the process is computationally intensive (CPU bound), we can take advantage of the parallel execution of multi-core processors
wall time ≈ total, the process is computationally intensive and not executed in parallel
wall time> total, the process is I/O bound (I/O bound), and the advantages of multi-core parallel execution are not obvious

Question 4:

E) Define Gustafson-Barsis' law for scaled speed-up of parallel programs. [2]

Gustafson-Barsis's Law

• Gives the "scaled speed-up"

$$T(1) = \sigma + N\pi \quad \text{and} \quad T(N) = \sigma + \pi$$

$$S(N) = \frac{T(1)}{T(N)} = \frac{\sigma + N\pi}{\sigma + \pi} = \frac{\sigma}{\sigma + \pi} + \frac{N\pi}{\sigma + \pi}$$

π Fixed parallel time per process
α Fraction of running time sequential program spends on parallel parts $\pi/\sigma = \frac{1-\alpha}{\alpha}$

$$S(N) = \alpha + N(1 - \alpha) = N - \alpha(N - 1)$$

Speed up S using N processes is given as a linear formula dependent on the number of processes and the fraction of time to run sequential parts. Gustafson's Law proposes that programmers tend to set the size of problems to use the available equipment to solve problems within a practical fixed time. Faster (more parallel) equipment available, larger problems can be solved in the same time.

F) A parallel program takes 128 seconds to run on 32 processors. The total time spent in the sequential part of the program is 12 seconds. What is the scaled speedup? [2]

S(N)=T(1)/T(N)=32-(12/128)(32-1)=29.09

G) According lo Gustafson-Barsis' law, how much faster could tho.! application *theoretically* run if it ran across all 32 processors compared to running on a single processor? [3]
128*29.09-128=3595.5s

H) Why is theoretically italicized in the above? [3]
when processors are added, more jobs such as communication between processors , making schedule and locks problems appear. It should be a point worth thinking in parallelized programming.

Question 5:

C) Discuss the advantages and disadvantages of unstructured (noSQL) databases such as CouchDB for dealing with "big data" compared to more traditional databases, e.g. relational databases such as MySQL. Your answer should cover challenges with data distribution, traditional database ACID properties, heterogeneity of data and large-scale data processing. [6]
challenges with data distribution: high quantity of data, many kinds of data format, data should be accessed from many different nodes or servers

traditional database ACID properties:
Atomicity
Atomicity means that the transaction is an inseparable unit of work, and the operations in the transaction either occur or do not occur.
Consistency
The integrity of the data before and after the transaction must be consistent.
Isolation
The isolation of transactions is that when multiple users access the database concurrently, the transactions initiated by the database for each user cannot be disturbed by the operation data of other transactions, and multiple concurrent transactions must be isolated from each other.
Durability
Persistence means that once a transaction is committed, it changes the data in the database permanently, and then there should be no impact on it even if the database fails

heterogeneity of data: for relationship chart is not enough to store data, key-value, big tables and documents are used to store.

large-scale data processing: nosql is faster to operate and data can be distributed stored.

D) Apache Hadoop is a software framework that enables processing of large data sets.
   a. Explain the role of Hadoop Distributed File System (HDFS) in supporting the Apache Hadoop framework. [2]
      Reduced need for memory to store information about where the blocks are (metadata)
      More efficient use of the network (with a large block, a reduced number network connections needs to be kept open)
      Reduced need for seek operations on big files
      Efficient when most data of a block have to be processed
      low cost and high fault-tolerance

   b. Describe the process by which Apache Hadoop supports fault tolerant data processing. [2]

The core of Hadoop is a fault tolerant file system that has been explicitly designed to span many nodes

always monitoring all nodes in case of node fails

Continued on next page

The core of Hadoop is a fault tolerant file system that has been explicitly designed to span many nodes

always monitoring all nodes in case of node fails

Question 6:

B) The Internet2 Shibboleth technology as currently supported by the Australia Access Federation provides *federated authentication* and *single sign-on.*

    a.   Explain what is meant by the italicized terms [2].

        federated authentication:Implement an authentication mechanism that can use federated identity. Separating user authentication from the application code, and delegating authentication to a trusted identity provider, can considerably simplify development and allow users to authenticate using a wider range of identity providers (IdPs) while minimizing the administrative overhead.

        single sign-on：means that in an environment where multiple systems coexist, users only need to log in once to access other authorized systems.

    b.   Explain the role of *trust* and *public key infrastructures* in supporting the Internet2 Shibboleth model. [2]

        In this model, once you enter a private key(like password), the system will check it with a public key then offer you trust from all systems or resources you are admitted to, if the private key is right.

    c.   What are the advantages and disadvantages of the Shibboleth approach for security? [4]

        advantages: convenient, once login user doesn't need to login again

                easy to equip in cluster,

                Transmission encryption, supports a variety of symmetric and asymmetric encryption algorithms to ensure that user information is not stolen and tampered with during transmission

                Scalability, good compatibility with subsequent business system expansion and expansion

        disadvantages: information maybe leaked because no auditing after logining

                Not conducive to reconstruction, because many systems are involved, it must be compatible with all systems to refactor, which may be time-consuming

    d.   Why isn't Shibboleth used to access Cloud-based systems more generally? [2]

        Auditing：

        logging, intrusion detection, auditing of security in external computer facilities well established in theory but not in practice and for local systems

        Deletion: Data deletion with no direct hard disk,   scale of data is also a problem

        Liability

        Licensing, it's difficult to delivery license model on cloud

        workflow(其实不太明白这个在说什么)

        The Ever Changing Technical/Legal Landscape

Question 7:

C) Define the following terms and their relevance to Cloud Computing:

    a.   Hypervisor [1]

        The virtualization layer between the underlying hardware (e.g. the physical server) and the virtual machines and guest operating systems it supports.

    b.   Virtual machine [1]

        A representation of a real machine using hardware or software that can host a guest operating system.

    c.   Machine image [1]

        An image of a virtual machine is (in simple words) a copy of the VM, which may contain an OS, data files, and applications (just like your personal computer)

    d.   Object Store [1]

        Store data as an object

e. Volume Store [1]
Create, terminate, attach and backup

f. Key-pair [1]
Public-key cryptography
A key pair contains a public key and private key. The mechanism is for both authentication and encryption: where the public key verifies a holder of the paired private key, and only with the private key, the message can be decrypted.

D) Applications can be deployed across Clouds either through creation and deployment of virtual images (snapshots) or through scripting the installation and configuration of software applications.
   a. What are the benefits and drawbacks of these approaches? [2]

   b. Discuss the mechanisms used to support these approaches. You may refer to specific tools used to support these processes. [2]

--- END OF EXAMINATION ---

THE UNIVERSITY OF
MELBOURNE

Student Number

2015

Faculty/Dept.   Computing and Information Systems

Subject Number   COMP90024

Subject Name   Cluster and Cloud Computing

Writing Time   **2**   hours

Reading Time   **15**   minutes

Open Book Status   Closed Book

Number of pages (including this page)   3

Authorised Materials: None

Instructions to Students: This examination is worth 50% of your final mark

Answer 5 out of any 7 questions. Please note that only the first 5 questions will be marked.

Each question carries 10 marks.

The number in square brackets after each sub--question represents the marks allocated to it.

Instructions to Invigilators: Please provide students with standard script books

No calculators are allowed

Paper to be held by Baillieu Library: Indicate whether the paper is to be held with the Baillieu Library. Yes

X   No   ☐

Extra Materials required (please tick & supply)

Graph Paper   ☐   Multiple Choice form   ☐

Question 1:

A) Describe some of the erroneous assumptions that are often made in designing large-scale distributed systems. [5]

B) Cloud Computing systems do not solve many key challenges of large-scale distributed systems. Discuss. [5]

2013Q1

Question 2:

A) Explain the general principles that should underlie the design of Service-Oriented Architectures (SOA). [7]

Standardized service contract: Services adhere to a communications agreement, as defined collectively by one or more service-description documents.

Service loose coupling: Services maintain a relationship that minimizes dependencies and only requires that they maintain an awareness of each other.

Service abstraction: Beyond descriptions in the service contract, services hide logic from the outside world.

Service reusability: Logic is divided into services with the intention of promoting reuse.

Service autonomy: Services have control over the logic they encapsulate.

Service statelessness: Services minimize resource consumption by deferring the management of state information when necessary.

Service discoverability: Services are supplemented with communicative meta data by which they can be effectively discovered and interpreted.

Service composability: Services are effective composition participants, regardless of the size and complexity of the composition.

Service granularity: a design consideration to provide optimal scope at the right granular level of the business functionality in a service operation.

Service normalization: services are decomposed and/or consolidated to a level that minimizes redundancy, for performance optimization, access, and aggregation.

Service optimization: high-quality services that serve specific functions are generally preferable to general purpose low-quality ones.

Service relevance: functionality is presented at a level of granularity recognized by the user as a meaningful service.

Service encapsulation: many services are consolidated for use under a SOA and their inner workings hidden.

Service location transparency: the ability of a service consumer to invoke a service regardless of its actual location in the network.

B) Explain why and how Cloud infrastructures have benefited from SOA. [3]

Standardized service contract: service adhere to a single communication agreement, as defined collectively by one or more service description documents

Loose coupling: service's components maintain a relationship that minimize the dependencies to the other components. As above, minimise the dependency as other components

Service dissolvability allows remote user be able to use the service from the cloud with minimum effort as the service itself comes with metadata.

Question 3:

A) *SOAP is dead; ReST is the future*! Explain this statement with regards to Representational State Transfer (ReST) based web services compared to Simple Object Access Protocol (SOAP)-based web services for implementing service-oriented architectures. [5]

16年Q4, advantages and disadvantages of SOPA and REST

B) HTTP methods can be *safe* or *idempotent*.

    a.   What is meant by a *safe* HTTP method? [1]

    b.   Give an example of a *safe* HTTP method. [1]

    c.   What is meant by an *idempotent* HTTP method? [1]

    d.   Give an example of an *idempotent* HTTP method. [1]

    e.   Give an example of a HTTP method that is neither safe nor idempotent? [1]
       POST

Question 4:

A) Explain the following terms in the context of high performance computing.

    a.   *Data parallelization* [1]
       Break the whole data into different parts and execute them in multiple processors in parallel. Example: Cache.

    b.   *Compute parallelization* [1]
       Parallel computing is a type of computation in which many calculations or the execution processes are carried out concurrently. Large problems can often be divided into smaller ones, which can then be solved at the same time. Example: threads

    c.   *Wall-time* [1]
       wall time of a program is how long the program should use on the HPC resource

B) Explain the role of a job scheduler on a high performance computing system like the University of Melbourne *Edward* cluster. What commands can be used to influence the behavior of the job scheduler in supporting parallel jobs running on single or multiple nodes (servers)? [3]
The job scheduler runs itself to determine when it runs your job by arranging the running properties like cores number, node number, wall times etc. Slurm language can be used.

C) Why is the accuracy of the wall-time important to users? [1]

D) Compute parallelization of an application can be achieved through a variety of paradigms including *task farming* and *single program multiple* data. Describe these approaches and explain when they might best be applied. [3]
Task farming: Master decomposes the problem into small tasks, distributed to workers and gathers partial results to produce the final result

Single-Program Multiple-Data:

 Each process executes the same piece of code, but on different parts of the data

 Data is typically split among the available processors

 Data splitting and analysis can be done in many ways

    Task farming: like divide and conquer with master doing both split and join operation

  Single program multiple data:

      Commonly exploited model – Bioinformatics, MapReduce, …

      Each process executes the same piece of code, but on different parts of the data

      Data is typically split among the available processors

      Data splitting and analysis can be done in many ways

Question 5:

A) There are many open challenges in delivering secure Clouds. Describe some of the technical and non-technical issues that currently exist for development and delivery of security-oriented Clouds. [4]
non-technical issues:

- Grids and Clouds (IaaS) allow users to compile codes that do stuff on physical/virtual machines

- Should try to develop generic security solutions

- Clouds allow scenarios that stretch inter-organization security

technical issues:

- Authentication

- Authorisation

- Audit/accounting

- Confidentiality

- Privacy

- Fabric management

- Trust

B) The Internet2 Shibboleth technology as currently supported by the Australia Access Federation provides *federated authentication*.
   a. Explain what is meant by this italicized term and discuss the advantages and disadvantages of the Shibboleth approach for security. [3]

federated authentication
Federated identity is related to single sign-on (SSO), in which a user's single authentication ticket, or token, is trusted across multiple IT systems or even organizations. SSO is a subset of federated identity management, as it relates only to authentication and is understood on the level of technical interoperability and it would not be possible without some sort of federation.

   b. Why isn't Shibboleth used to access Cloud-based systems more generally? [3]

Question 6:

A) Describe the terms Cloud-based IaaS, PaaS and SaaS and give examples for each. [3]
Infrastructure as a Service, examples Amazon Web Services, Oracle Public Cloud, Rackspace Cloud, NeCTAR/Openstack Research Cloud
Platform as a Service , example: google map engine, microsoft azure
Software as a Service, example: Gmail, Sharepoint, on-live, Gaikai, Microsoft Office 365, Public PaaS Examples

B) What are the advantages/disadvantages of public, private and hybrid clouds? [5]
14年Q2A

C) Describe some of the challenges in delivering hybrid Clouds? [2]
Security when moving from private to public
Cannot be sure of what data to migrate to public and what should be private, at runtime.

Question 7:

A) Applications can be deployed across Clouds either through creation and deployment of virtual images (snapshots) or through scripting the installation and configuration of software applications.
   a. What are the benefits and drawbacks of these approaches? [4]
      14年Q7b
      Snapshot: NeCTAR Cloud support image service that users can create their own snapshots or use existing snapshots of virtual images.
      Automation: Ansible - An automation tool for configuring and managing computers. Finer grained setup and configuration of software packages
      using Ansible or scripting languages is more flexible; can reestablish/upgrade/configure applications; mount new volumes etc etc. Snapshots don't give history of how instance got to that state etc
   b. Discuss the mechanisms used to support these approaches. You may refer to specific tools used to support these processes on the NeCTAR Research Cloud. [3]
      Glance and other key openStack services, eg keystone

   c. Describe the typical steps that are required to support live migration of virtual machine instances using a Cloud facility such as the NeCTAR Research Cloud. [3]
      Stage 0: Pre-Migration - Active VM on Host A
      Stage 1: Reservation - Initialize a container on the host B
      Stage 2: Iterative Pre-copy - Enable shadow paging, copy dirty pages in successive rounds
      Stage 3: Stop and copy - Suspend VM on host A, generate ARP to redirect traffic to host B, sync all remaining VM state to host B
      Stage 4: Commitment - VM state on host A is released
      Stage 5: Activation - VM starts on Host B, connects to local devices, resumes normal operation

--- END OF EXAMINATION ---

THE UNIVERSITY OF
MELBOURNE

Student Number

2016

Faculty/Dept.   Computing and Information Systems

Subject Number   COMP90024

Subject Name   Cluster and Cloud Computing

Writing Time   **2**   hours

Reading Time   **15**   minutes

Open Book Status   Closed Book

Number of pages (including this page)   3

Authorised Materials: None

Instructions to Students: This examination is worth 50% of your final mark

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☐   No   X

Extra Materials required (please tick & supply)

Graph Paper   ☐   Multiple Choice form   ☐

Question 1:

A) Cloud computing does not solve the fundamental challenges associated with large-scale distributed systems. Discuss. [8]

Data and data heterogeneity

Scalability and issue of fixed hardware system

Fault tolerance not solved

Results in software "stacks"

Need to face the CAP Theorem which the Distributed System have.

Security cannot be guaranteed

Bandwidth is finite.

Network is not reliable.

B) How has the evolution of service-oriented architectures supported Cloud computing? [2]

The SoA provides the implementation of API such as REST and SOAP Web service to interact between the Clouds.

SOAP allows object(information) exchange among different servers, SOAP uses XML based communication requests, and HTTP based responses. From a developer perspective, nothing really changes due to SOAP taking care of information exchange.

1. Standardized service contract allows all servers being able to communicate in a standard protocol

2. Loose coupling ensures the communication is effective by minimising the dependencies among components, as these components might spread out on different cloud servers

3. Service dissolvability allows remote users to use the service from the cloud with 3 minimum effort as the service itself comes with metadata.

Question 2:

A) Define Gustafson-Barsis' law for scaled speed-up of parallel programs. [2]

Speed up S using N processes is given as a linear formula dependent on the number of processes and the fraction of time to run sequential parts. Gustafson's Law proposes that programmers tend to set the size of problems to use the available equipment to solve problems within a practical fixed time. Faster (more parallel) equipment available, larger problems can be solved at the same time.
S (N) = N - alpha*(N-1)   alpha: Fraction of running time sequential program spends on parallel parts

B) A parallel program takes 120 seconds to run on 8 processors. The total time spent in the sequential part of the program is 12 seconds. What is the scaled speedup? [2]

Alpha = 12/120 = 1/10

$$S(8) = 8 - \frac{1}{10} \times (8-1) \ = \ 7.3$$

C) According to Gustafson-Barsis' law, how much faster could the application *theoretically* run if it ran across all 8 processors compared to running on a single processor? [2]

7.3 times faster

we know from b/ that it (theoretically) runs 7.3 times faster using 8 processors compared to running on a single processor. If it takes 120 seconds with the 8 processor case then it would (theoretically) take 7.3*120 in the single processor case. Note I would have accepted two answers here (7.3 times faster or plugging in the actual numbers to get (7.3*120) - 120 = 6.3*120 = 756 seconds longer).

Question 1:

Alpha = 12/120 = 1/10

pi = 9/10

s（n）=1/(0.1+0.9/8)=4.7

D) Why is theoretically italicized in the above? [4]

Because in real life we need to consider extra overhead as more processors are added in. The overheads are created by the communication interaction between the parallel programming such as MPI.

Consider a program that executes a single loop, where all iterations can be computed independently, i.e. code can be parallelized. By splitting the loop into several parts, e.g. one loop iteration per processor, each processor now has to deal with loop overheads such as calculation of bounds, test for loop completion etc. This overhead is replicated as many times as there are processors. In effect, loop overhead acts as a further (serial) overhead in running the code. Also getting data to/from many processor overheads?

Question 3:

A) *Big data* is often associated with data having a range of properties including high volume, high velocity and high variety (heterogeneity). Discuss the advantages, disadvantages and suitability more generally of the following data solutions with regards to these big data properties:

    a. CouchDB [3]

Compared with Relational DBMS, NoSQL DBMSs like CouchDB and can grant variety and veracity in the base of keeping great volume and velocity. All nodes answer requests at the same time; nodes can be added/removed easily, and their shards are re-balanced automatically upon addition/deletion of nodes. By using MVCC, CouchDB also keeps availability and partition-tolerance.

Mapreduce

- 不擅长实时计算

  - Mapreduce无法做到像Mysql那样做到毫秒或者秒级的返回结果

- 不擅长流式计算（stream computing）

  - 流式计算的输入数据是动态的，而Mapreduce的输入数据集是静态的，不能流态变化。这是Mapreduce自身的设计特点决定了数据源必须是静态的。

- 不擅长DAG(有向图)计算

  - 多个应用程序存在依赖关系，后一个应用程序的输入为前一个应用程序的输出，在这种情况下，Mapreduce并不是不能做，而是使用后每个Mapreduce作业的输出结果都会写入到磁盘，会造成大量的磁盘IO，导致性能非常低下。

    b. Apache Hadoop Distributed File System (HDFS) [3]

The core of Hadoop is a fault tolerant file system that has been explicitly designed to span many nodes.

Adv:

    1. The file system replicates, or copies, each piece of data multiple times and distributes the copies to individual nodes, placing at least one copy on a different server rack than the others. As a result, the data on nodes that crash can be found elsewhere within a cluster. This ensures that processing can continue while data is recovered.

    2. 数据规模可以达到 PB

DIS:

    1. 不适合低延迟数据访问（毫秒级）

    2. 无法高效的对大量小文件进行存储

    3. 只支持数据增加，不支持数据修改

    4. 一个文件不支持多线程同时写

    c. Apache Spark [3]

Question 1:

Apache Spark was designed to reduce the latency inherent in the Hadoop approach for the execution of MapReduce jobs.
Spark Streaming cannot dynamically adjust the parallelism

Your answer should include the way in which these solutions implement MapReduce. What

other data properties can be associated with big data challenges? [1]

Veracity: the level of trust in the data accuracy (provenance); the more

diverse sources you have, the more unstructured they are, the less veracity

you have.

Question 4:

A) Representational State Transfer (ReST) based web services are often used for creating *Resource-oriented Architectures* (ROA) whilst Simple Object Access Protocol (SOAP)-based web services are often used to implement *Service-oriented Architectures* (SOA). Discuss the similarities and differences between a ROA and a SOA. [3]
The communication interaction and call resource/service are over HTTP.
17年Q3

B) Discuss the advantages and disadvantages of ReST vs SOAP for web services more generally. [5]

	adv	disadv
ReST	Separation of front and rear ends to reduce flow Security issues are concentrated on the interface, because the json format is accepted, preventing injection and other security issues The front-end is irrelevant, the back-end is only responsible for data processing, and the front-end representation can be any front-end language (android, ios, html5) Front-end and back-end personnel are more focused on their own development, and only front-end and back-end interactions can be completed by interface documents without too much mutual understanding Server performance optimization: Since the front end is a static page, it can be obtained through nginx, and the main pressure of the server is placed on the interface	不支持acid 安全性差
SOAP	1.web services 安全	1.速度较慢：SOAP 使用 XML 作

Question 1:

	2.web services 原子性事务 3.web services 消息可靠性, SOAP 具备内置的成功/重试逻辑并通过 SOAP 中介来提供端对端的可靠性。 4. 语言平台独立	为数据传输的格式，web 服务每次读取数据时都需要对 XML 进行解析，速度较慢。另外，SOAP 规定了 web 服务需要遵循的许多规范，这导致在传输过程中消耗较多的网络带宽。 2.依赖于 WSDL：除了使用 WSDL 外，SOAP 并不提供其他的机制来让其他应用程序发现服务。

C) HTTP methods can be *safe* or *idempotent*. What is meant by the italicized terms, and give an example of each? [2]

Safe methods

Do not change repeating a call is equivalent to not making a call at all.

ET, OPTIONS, HEAD – Safe

Idempotent methods

Effect of repeating a call is equivalent to making a single call

PUT, DELETE – Idempotent

Question 5:

A) Popek and Goldberg laid down the foundations for computer virtualization in their 1974 paper, *Formal Requirements for Third Generation Architectures*.

    a. Identify and explain the different types of classification of instruction sets for virtualization to occur according to the theorem of Popek and Goldberg. You should include the relationships between the instruction sets. [3]

Privileged Instructions： instructions that trap if the processor is in user mode and do not trap in kernel mode

Sensitive Instructions： instructions whose behavior depends on the mode or configuration of the hardware

Innocuous Instructions： instructions that are neither privileged nor sensitive

For any conventional third generation computer, a virtual machine monitor may be constructed if the set of sensitive instructions for that computer is a subset of the set of privileged instructions

    b. Describe how these principles are realized by modern virtual machine monitors/hypervisors. [2]

VMM emulates the effect on system/hardware resources of privileged instructions whose execution traps into the VMM aka trap-and-emulate

Typically achieved by running GuestOS at a lower hardware priority level than the VMM

Problematic on some architectures where privileged instructions do not trap when executed at de-privileged level

Fidelity: Software on the VMM executes behaviour identical to that demonstrated when running on the machine directly, barring timing effects–

Performance: An overwhelming majority of guest instructions executed by hardware without VMM intervention–

Safety: The VMM manages all hardware resources

Question 1:

   c. Explain the differences between full virtualization and para-virtualisation. Give an example of a hypervisor that uses full virtualization and an example of a hypervisor that uses para-virtualisation. [2]

full : Allow an unmodified guest OS to run in isolation by simulating full hardware (e.g. VMWare)
Guest OS has no idea it is not on physical machine
PARA : VMM/Hypervisor exposes special interfaces to guest OS for better performance.
Requires a modified/hypervisor-aware Guest OS (e.g. Xen)
Can optimism systems to use this interface since not all instructions need to be trapped/dealt with

   d. Describe the role of a virtual machine manager/hypervisor with regards to memory management and shadow page tables. [3]

The virtualization layer between the underlying hardware (e.g. the physical server) and the virtual machines and guest operating systems it supports.
The environment of the VM should appear to be the same as the physical machine
VMM maintains "shadow" copies of critical structures whose "primary" versions are manipulated by the GuestOS,
Primary copies needed to insure correct versions are visible to GuestOS

Please Turn Over

Question 6:

A) Explain what is meant by the following security terms:
  - single sign-on [1]
  - Single sign-on (SSO, also often referred to as reduced sign-on) is the name for a group of technologies that allows you to access a variety of web applications without entering your username and password each time.

  - federated authentication [1]
  - Federated identity is related to single sign-on (SSO), in which a user's single authentication ticket, or token, is trusted across multiple IT systems or even organizations.[2][3][4] SSO is a subset of federated identity management, as it relates only to authentication and is understood on the level of technical interoperability and it would not be possible without some sort of federation.[5]

  - authorization [1]
  - Authentication is the establishment and propagation of a user's identity in the system.

  - certification authority [1]
  - A certificate authority or certification authority (CA) is an entity that issues digital certificates. A digital certificate certifies the ownership of a public key by the named subject of the certificate.

  - identity provider [1]
  - An identity provider (IdP or IDP) stores and manages users' digital identities. Think of an IdP as being like a guest list, but for digital and cloud-hosted applications instead of an event. An IdP may check user identities via username-password combinations and other factors, or it may simply provide a list of user identities that another service provider (like an SSO) checks.

B) Discuss the challenges in supporting finer-grained security in *hybrid* Cloud environments. You may refer to the importance and/or role of (some of) the terms in part A) of this question. [5]
  - Authentication: Authentication is the establishment and propagation of a user's identity in the system.
  - Authorisation: Authorisation is concerned with controlling access to resources based on policy
  - Audit/accounting
  - Confidentiality
  - Privacy
  - Fabric management
  - Trust

Question 7:

A) The NeCTAR Research Cloud is based on the openStack technology.
  a. Describe the role and features of the following openStack components:
   i. Nova   [1]

   Manages the lifecycle of compute instances in an OpenStack environment.

      Responsibilities include spawning, scheduling and decommissioning of virtual machines on demand

Question 6:

- Manages the **lifecycle** of compute instances in an OpenStack environment

- Responsibilities include **spawning, scheduling and decommissioning** of virtual machines on demand

- Virtualization agnostic

  - Libvirt 虚拟机管理软件
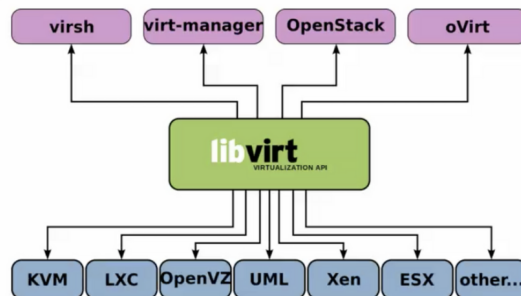
  - open source API, daemon and tools for managing platform virtualization including **support for Kernel based virtual machine (KVM), Quick Emulator (QEMU), Xen, Lightweight Linux Container System (LXC)**

  - openStack 通过 libvirt 提供的接口 管理虚拟化软件

- XenAPI, Hyper-V, VMWare ESX,

  - Docker (more later from Luca)

ii. Swift [1]

Stores and retrieves arbitrary unstructured data object via RESTful API

iii. Glance [1]

Accepts request for disk or serve images and their associated metadata (from Swift) and retrieves / installs (through Nova)

iv. Keystone [1]

- Provides an authentication and authorization* service for OpenStack services Tracks users/permissions

- Provides a catalog of endpoints for all OpenStack services

b. Describe the interplay between these components that allows a researcher to create an instance of a virtual machine through a pre-existing snapshot. [3]
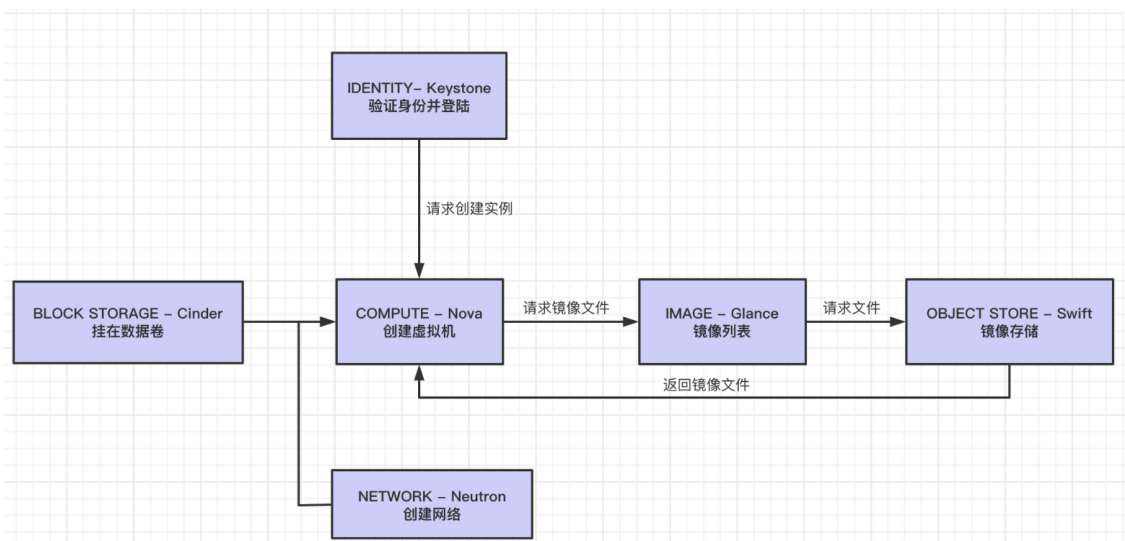
B) The NeCTAR Research Cloud has multiple *availability zones*.

a. What is meant by the term: availability zone? [1]

An availability zone is a logical data center in a region available for use by any

Question 6:

customer. Each zone in a region has redundant and separate power, networking and connectivity to reduce the likelihood of two zones failing simultaneously. A common misconception is that a single zone equals a single data center.
Locations of data centres used to provide logical view of cloud

b. What are the implications of availability zones with regards to virtual machine instance creation and data volumes offered by NeCTAR? [2]

--- END OF EXAMINATION ---

THE UNIVERSITY OF
MELBOURNE

Student Number_____

2017

Faculty/Dept.   Computing and Information Systems

Subject Number COMP90024

Subject Name   Cluster and Cloud Computing

Writing Time   **2**   hours

Reading Time   **15**   minutes

Open Book Status   Closed Book

Number of pages (including this page)   4

Authorised Materials: None

Instructions to Students: This examination is worth 50% of your final mark

Answer 5 out of any 7 questions. Please note that only the first 5 questions will be marked.

Each question carries 10 marks.

The number in square brackets after each sub-question represents the marks allocated to it.

Instructions to Invigilators: Please provide students with standard script books

No calculators are allowed

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Graph Paper   ☐   Multiple Choice form   ☐

Question 1:

A) Define Gustafson-Barsis' law for scaled speed-up of parallel programs. [1]

B) A parallel program takes 240 seconds to run on 24 processors. The total time spent in the sequential part of the program is 12 seconds. What is the scaled speedup? [2]

C) According to Gustafson-Barsis' law, how much faster could the application *theoretically* run if it ran across all 24 processors compared to running on a single processor? [2]

D) Why is *theoretically* italicized in Part C)? [2]

E) The message-passing interface (MPI) is often used for parallel programming on high performance computing systems. Describe four methods that are commonly found in MPI programs and explain their functionality. [3]

Question 2:

A) *Big data* is often associated with data having a range of properties including high volume, high velocity and high variety (heterogeneity). Discuss the advantages, disadvantages and suitability more generally of the following data solutions with regards to these big data properties:

    a. CouchDB [2]

    b. Apache Hadoop Distributed File System (HDFS) [2]

    c. Apache Spark [2]

B) What is the Apache Hadoop Resilient Distributed Dataset (RDD) operation type that triggers RDD evaluations? Which operation type does *not* trigger RDD evaluations? [2]

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Question 3:

A) Representational State Transfer (ReST) based web services are often used for creating *Resource-oriented Architectures* (ROA) whilst Simple Object Access Protocol (SOAP)-based web services are often used to implement *Service- oriented Architectures* (SOA). Discuss the similarities and differences between a ROA and a SOA. [3]

B) Discuss the advantages and disadvantages of ReST vs SOAP for web services more generally. [5]

C) HTTP methods can be *safe* or *idempotent*. What is meant by the italicized terms, and give an example of each? [2]

Please Turn Over

Question 4:

   A) Popek and Goldberg laid down the foundations for computer virtualization in their 1974 paper, *Formal Requirements for Third Generation Architectures*.

      a. Identify and explain the different types of classification of instruction sets for virtualization to occur according to Popek and Goldberg. You should include the relationships between the instruction sets. [2]

      b. Describe how these principles are realized by modern hypervisors. [2]

      c. Explain the differences between *full virtualization* and *para-virtualisation*. Give an example of a hypervisor that uses full virtualization and an example of a hypervisor that uses para-virtualisation. [2]

      d. Container-based solutions such as Docker offer a lighter-weight approach to virtualization.

         i. Describe the advantages and disadvantages of using Docker over other full virtualization technologies. [3]

         ii. What is the relationship between a Docker Image and a Docker Container? [1]

Question 5:

   A) Code versioning systems are frequently used in collaborative software development activities. Name three types of architectures that code versioning systems have adopted and give one example of a solution for each with their respective advantages and disadvantages. [3]

   B) Give a short explanation for the following terms that are often used in a code versioning context:

      a. Commit [1]

      b. Checkout [1]

      c. Branch [1]

      d. Tag [1]

      e. Rebase [1]

   C) What is the main difference between the *clone* and *checkout* commands? [2]

Question 6:

   A) The NeCTAR Research Cloud is based on the openStack technology.

      a. Describe the role and features of the following openStack components:

         i. Nova   [1]

         ii. Swift   [1]

         iii. Glance   [1]

         iv. Keystone [1]

      b. Describe the interplay between these components that allows a researcher to create an instance of a virtual machine through a pre-existing snapshot. [3]

   B) The NeCTAR Research Cloud has multiple *availability zones.*

      a. What is meant by the term: availability zone? [1]

      b. What are the implications of availability zones with regards to virtual machine instance creation and data volumes offered by NeCTAR? [2]

Please Turn Over

Question 7:

A) The NeCTAR Research Cloud focuses primarily on offering Infrastructure-as-a-Service (*IaaS*) capabilities, however many research communities require Software-as-a-Service (*SaaS*).

  a. Discuss the relationship between the italicized terms: *IaaS* and *SaaS*. [3]
  b. Applications can be deployed across Clouds either through creation and deployment of virtual images (snapshots) or through scripting the installation and configuration of software applications. What are the benefits and drawbacks of these approaches? [3]
  c. Describe the approach that would be taken using Ansible for scripted deployment of SaaS solutions onto the Cloud. [2]
  d. Describe the approach that would be taken using the openStack Heat service for deployment of SaaS solutions onto the Cloud. [2]

--- END OF EXAMINATION ---

THE UNIVERSITY OF **MELBOURNE**

Student

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2017-1

Faculty/Dept.   Computing and Information Systems

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Question 1:

F) Define Gustafson-Barsis' law for scaled speed-up of parallel programs. [1]

G) A parallel program takes 240 seconds to run on 24 processors. The total time spent in the sequential part of the program is 12 seconds. What is the scaled speedup? [2]

H) According to Gustafson-Barsis' law, how much faster could the application *theoretically* run if it ran across all 24 processors compared to running on a single processor? [2]

I) Why is *theoretically* italicized in Part C)? [2]

J) The message-passing interface (MPI) is often used for parallel programming on high performance computing systems. Describe four methods that are commonly found in MPI programs and explain their functionality. [3]

Q1F
With more computing nodes, larger problems can be solved in almost the same time. (if sequential part remains relatively the same)
Q1G
T_s = 12s, T_p = 240 - 12 = 228s
T_total = 12 + 228*24
S(24) = (12+228*24) / 240 = 22.85
Or S(24) = (1-228/240) + 228/240*24 = 22.85
Q1H
22.85
Q1I
Latency + Bandwidth
Response Time
System Throughput
Load Balancing (same amount of computation per node)
Concurrency
Q1J
MPI_Barrier: to sync all processes
MPI_Bcast: broadcast message to all processes
MPI_Scatter: divide a givus parts and send to nodes respectively
MPI_Gather: collect small arrays in different nodes into the root node.en array in to equal contiguo

Question 2:

D) *Big data* is often associated with data having a range of properties including high volume, high velocity and high variety (heterogeneity). Discuss the **advantages**, **disadvantages** and **suitability** more generally of the following data solutions with regards to these big data properties:

    a. CouchDB [2]

    b. Apache Hadoop Distributed File System (HDFS) [2]

    c. Apache Spark [2]

CouchDB
- stores JSON format documents. Good in variety.
- limited built-in data analyzing tool. (MapReduce)
HDFS
- supports various data format, good for variety
- stores data in large blocks, good for high volume
- batch processing high volume of data, but cannot handle real-time data, high latency computing -> not good for velocity
Spark
- supports various data format, good for variety
- can process stream of data, good for velocity

E) What is the Apache Hadoop Resilient Distributed Dataset (**RDD**) operation type

that triggers RDD evaluations? Which operation type does *not* trigger RDD evaluations? [2]

RDDs support two types of operations:

transformations, which create a new dataset from an existing one

actions, which return a value to the driver program after running a computation on the dataset.

For example, map is a transformation that passes each dataset element through a function and returns a new RDD representing the results.

reduce is an action that aggregates all the elements of the RDD using some function and returns the final result to the driver program (although there is also parallel reduce ByKey that returns a distributed dataset).

the evaluation process happens only when data cannot be kept in an RDD, as when the number of objects in an RDD has to be computed, or an RDD has to be written to a file (these are called actions), but not when an RDD are transformed into another RDD (these are called transformations)

F) CouchDB views whose map part is defined using a composite key can be used to aggregate data at different levels: how can a user request different aggregation levels via the CouchDB HTTP API? [2]

curl -X GET http://localhost:5984/db/_design/{ddoc}/_view/{view}/?reduce=true &group_level="aggregation level"

Question 3:
D) Representational State Transfer (ReST) based web services are often used for creating *Resource-oriented Architectures* (ROA) whilst Simple Object Access Protocol (SOAP)-based web services are often used to implement *Service- oriented Architectures* (SOA). Discuss the **similarities** and **differences** between a ROA and a SOA. [3]

Similarities:

Can work overs HTTP protocol?

SOA using REST services is similar to ROA?

Differences:

SOA:

combinations and commonality of services can be used to form a Service-oriented Architecture (SoA).

SOA is service oriented architecture. Therefore, the whole system is made up of services that typically perform some operations. The architecture is based on this. Imagine a cloud of servers where each one holds at least one service, for instance WeatherPredictor, ForexCalculator, etc.

SOA is used a bit everywhere. In SOA you commonly find the SOAP over HTTP,

SOAP over JMS, etc.

ROA:

ROA, where the system is made up of resources. ROA is typically used in big, open systems, because of the advantages it brings. In ROA architectures you would typically find RESTful services.

SOA(Service-oriented architecture): 软件的主要元素是服务。

ROA(Resource-oriented architecture): 软件的主要元素是资源。

这其实有点像面向过程编程和面向对象编程的区别。SOA视角中，软件就是由各种松耦合的服务组成的,一切都可以服务化。而在ROA视角中，软件是由资源组成的，一切软件都可以通过对资源的操作(CRUD)来完成。

E) Discuss the advantages and disadvantages of ReST vs SOAP for web services more generally. [5]

ReST Pros:

REST allows a greater variety of data formats, whereas SOAP only allows XML.

Coupled with JSON (which typically works better with data and offers faster parsing), REST is generally considered easier to work with.

Thanks to JSON, REST offers better support for browser clients.

REST provides superior performance, particularly through caching for information that's not altered and not dynamic.

It is the protocol used most often for major services such as Yahoo, Ebay, Amazon, and even Google.

REST is generally faster and uses less bandwidth. It's also easier to integrate with existing websites with no need to refactor site infrastructure. This enables developers to work faster rather than spend time rewriting a site from scratch. Instead, they can simply add additional functionality.

SOAP Pros:

SOAP's support for WS-Security can come in handy. It offers some additional assurances for data privacy and integrity. It also provides support for identity verification through intermediaries rather than just point-to-point, as provided by SSL (which is supported by both SOAP and REST).

Another advantage of SOAP is that it offers built-in retry logic to compensate for failed communications. REST, on the other hand, doesn't have a built-in messaging system. If a communication fails, the clients have to deal with it by retrying. There's also no standard set of rules for REST. This means that both parties (the service and the consumer) need to understand both content and context.

SOAP's standard HTTP protocol makes it easier for it to operate across firewalls and proxies without modifications to the SOAP protocol itself. But, because it uses the complex XML format, it tends to be slower compared to middleware such as ICE and COBRA.

Additionally, while it's rarely needed, some use cases require greater transactional reliability than what can be achieved with HTTP (which limits

REST in this capacity). If you need ACID-compliant transactions, SOAP is the way to go.

In some cases, designing SOAP services can actually be less complex compared to REST. For web services that support complex operations, requiring content and context to be maintained, designing a SOAP service requires less coding in the application layer for transactions, security, trust, and other elements.

SOAP is highly extensible through other protocols and technologies. In addition to WS-Security, SOAP supports WS-Addressing, WS-Coordination, WS-ReliableMessaging, and a host of other web services standards etc

F) HTTP methods can be *safe* or *idempotent*. What is meant by the italicized terms, and give an example of each? [2]

Safe methods: Do not change repeating a call is equivalent to not making a call at all.
Example: GET, HEADER
Idempotent methods: Effect of repeating a call is equivalent to making a single call
Example: PUT, DELETE

Question 4:

B) Popek and Goldberg laid down the foundations for computer virtualization in their 1974 paper, *Formal Requirements for Third Generation Architectures*.

    a. Identify and explain the different types of classification of instruction sets for virtualization to occur according to Popek and Goldberg. You should include the relationships between the instruction sets. [2]

Classification of Instructions

- **Privileged Instructions**: instructions that trap if the processor is in user mode and do not trap in kernel mode
- **Sensitive Instructions**: instructions whose behaviour depends on the mode or configuration of the hardware
  - Different behaviours depending on whether in user or kernel mode
    - e.g. POPF interrupt (for interrupt flag handling)
- **Innocuous Instructions**: instructions that are neither privileged nor sensitive
  - Read data, add numbers etc

For any conventional third generation computer, a virtual machine monitor may be constructed if the set of sensitive instructions for that computer is a subset of the set of privileged instructions

    b. Describe how these principles are realized by modern hypervisors. [2]

VMM emulates the effect on system/hardware resources of privileged instructions whose execution traps into the VMM aka trap-and-emulate

Typically achieved by running GuestOS at a lower hardware priority level than the VMM

Problematic on some architectures where privileged instructions do not trap when executed at de-privileged level

Fidelity: Software on the VMM executes behaviour identical to that demonstrated when running on the machine directly, barring timing effects–

Performance: An overwhelming majority of guest instructions executed by hardware without VMM intervention–

Safety: The VMM manages all hardware resources

    c. Explain the differences between *full virtualization* and *para-virtualisation*. Give an example of a hypervisor that uses full virtualization and an example of a hypervisor that uses para-virtualisation. [2]

Full virtualisation – allow an unmodified guest OS to run in isolation by simulating full hardware (e.g. VMWare)

        Guest OS has no idea it is not on physical machine

Para-virtualisation – VMM/Hypervisor exposes special interface to guest OS for better performance. Requires a modified/hypervisor-aware Guest OS (e.g. Xen)

Can optimise systems to use this interface since not all
instructions need to be trapped/dealt with

d. Container-based solutions such as Docker offer a lighter-weight
approach to virtualization.
i. Describe the advantages and disadvantages of using Docker over
other full virtualization technologies. [3]

Advantages
Lightweight
Many more VMs on same hardware
Can be used to package applications and all OS dependencies
into container
Disadvantages
Can only run apps designed for the same OS
Cannot host a different guest OS
Can only use native file systems
Uses same resources as other containers

ii. What is the relationship between a Docker Image and a Docker
Container? [1]

A running instance of the image is the container.

Question 5:

D) Code versioning systems are frequently used in collaborative software
development activities. Name three types of architectures that code versioning
systems have adopted and give one example of a solution for each with their
respective advantages and disadvantages. [3]

Local (Revision Control System (RCS))

Centralised (Concurrent Versions System (CVS), Subversion (SVN), Vesta)

Decentralised (Git, Mercurial, Bitbucket)

E) Give a short explanation for the following terms that are often used in a code
versioning context:
a. Commit [1]

To commit (check in, ci or, more rarely, install, submit or record) is to write or merge
the changes made in the working copy back to the repository.

b. Checkout [1]

To check out (or co) is to create a local working copy from the repository. A user may
specify a specific revision or obtain the latest.

c. Branch [1]

A set of files under version control may be branched or forked at a point in time so
that, from that time forward, two copies of those files may develop at different speeds

or in different ways independently of each other.

    d.   Tag [1]

       A tag or label refers to an important snapshot in time, consistent across many files.

    e.   Rebase [1]
       Move the entire branch to the tip of the branch being rebased. Only one branch left after
       rebase

F)   What is the main difference between the *clone* and *checkout* commands? [2]

A "checkout" is the act of switching between different versions of a
target entity, so that the repository should pre-exist before checkout.
A clone is copying the whole repository from another repository which
the local repository should not be pre-existing.

Question 6:

C)   The NeCTAR Research Cloud is based on the openStack technology.

    a.   Describe the role and features of the following openStack components:

       i.   Nova   [1]

          Compute Service
          Manages the lifecycle of compute instances in an OpenStack environment
          Responsibilities include spawning, scheduling and decommissioning of
          virtual machines on demand

       ii.   Swift   [1]

          Object Storage Service
          Stores and retrieves arbitrary unstructured data objects via RESTful API
          Fault tolerant with data replication and scale-out architecture
          Can be used with/without Nova/compute

       iii.   Glance   [1]

          Image Service
          Accepts requests for disk or server images and their associated metadata
          (from Swift) and retrieves / installs (through Nova)

       iv.   Keystone [1]

          Security Management
          Provides an authentication and authorization service for OpenStack services
          Provides a catalog of endpoints for all OpenStack services
          Generic authorization system for openStack

    b.   Describe the interplay between these components that allows a
       researcher to create an instance of a virtual machine through a pre-
       existing snapshot. [3]

16年第7题

D) The NeCTAR Research Cloud has multiple *availability zones.*

16年第7题

    a. What is meant by the term: availability zone? [1]

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Please Turn Over

Question 7:

B) The NeCTAR Research Cloud focuses primarily on offering Infrastructure-as-a-Service (*IaaS*) capabilities, however many research communities require Software-as-a-Service (*SaaS*).

    a.   Discuss the relationship between the italicized terms: *IaaS* and *SaaS*. [3]

       IaaS: Infrastructure as a service
       SaaS: Software as a service

    b.   Applications can be deployed across Clouds either through creation and deployment of virtual images (snapshots) or through scripting the installation and configuration of software applications. What are the benefits and drawbacks of these approaches? [3]

       Snapshot

       Benefits: easy to create snapshot and copy the state of one VM to another, no need to write script, easy to operate when deploying small number of VMs

       Drawbacks: Requires mass labor work when have hundreds of instances to deploy. Deploying complex cloud systems requires a lot of moving parts. Easy to forget what software you installed, and what steps you took to configure the system

       Automation

       Benefits: Provides a record of what you did, Codifies knowledge about the system, Makes process repeatable and programmable

       Drawbacks: Have to program and test the scripts manually. More labor work when the cloud is small.

    c.   Describe the approach that would be taken using Ansible for scripted deployment of SaaS solutions onto the Cloud. [2]

    d.   Describe the approach that would be taken using the openStack Heat service for deployment of SaaS solutions onto the Cloud. [2]

--- END OF EXAMINATION ---

THE UNIVERSITY OF
MELBOURNE **Student**

Number_____

2017-2

Faculty/Dept.   Computing and Information Systems

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O) The message-passing interface (MPI) is often used for parallel programming on high performance computing systems. Describe four methods that are commonly found in MPI programs and explain their functionality. [3]

Q1K

Gustafson estimated the speedup S gained by using N processors (instead of just one) for a task with a serial fraction s (which does not benefit from parallelism) as follows:[2]

$$S = N + (1 - N)s$$

Using different variables, Gustafson's law can be formulated the following way:[citation needed]

$$S_{\text{latency}}(s) = 1 - p + sp,$$

where

- S_{latency} is the theoretical speedup in latency of the execution of the whole task;
- s is the speedup in latency of the execution of the part of the task that benefits from the improvement of the resources of the system;
- p is the percentage of the execution workload of the whole task concerning the part that benefits from the improvement of the resources of the system *before the improvement*.

or

- Gives the "scaled speed-up"

$$T(1) = \sigma + N\pi \quad \text{and} \quad T(N) = \sigma + \pi$$

$$S(N) = \frac{T(1)}{T(N)} = \frac{\sigma + N\pi}{\sigma + \pi} = \frac{\sigma}{\sigma + \pi} + \frac{N\pi}{\sigma + \pi}$$

π — Fixed parallel time per process

α — Fraction of running time sequential program spends on parallel parts

$$\pi/\sigma = \frac{1 - \alpha}{\alpha}$$

$$S(N) = \alpha + N(1 - \alpha) = N - \alpha(N - 1)$$

Q1L

N=24

Q1M

Q1N

Because it can't reach the result in Part C.

Q1O

MPI_Init : initiate MPI computation

MPI_Finalize: terminate computation

MPI_COMM_SIZE: determine number of processors

MPI_COMM_RANK: determine my process identifier

Question 2:

G) *Big data* is often associated with data having a range of properties including high volume, high velocity and high variety (heterogeneity). Discuss the advantages, disadvantages and suitability more generally of the following data solutions with regards to these big data properties:
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   c. Apache Spark [2]

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I) CouchDB views whose map part is defined using a composite key can be used to aggregate data at different levels: how can a user request different aggregation levels via the CouchDB HTTP API? [2]

Q2G

a. CouchDB
b. HDFS:
   ● Reduced need for memory to store information about where the blocks are (metadata)
   ● More efficient use of the network (with a large block, a reduced number network connections needs to be kept open)
   ● Reduced need for seek operations on big files
   ● Efficient when most data of a block have to be processed
c. Apache Spark:
   ● While Hadoop MapReduce works well, it is geared towards performing relatively simple jobs on large datasets.
   ● However, when complex jobs are performed (say, machine learning or graph-based algorithms), there is a strong incentive for caching data in memory and in having finer-grained control on the execution of jobs.
   ● Apache Spark was designed to reduce the latency inherent in the Hadoop approach for the execution of MapReduce jobs.
   ● Spark can operate within the Hadoop architecture, using YARN and Zookeeper to manage computing resources, and storing data on HDFS.

Question 3:

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Q3G

Please Turn Over

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      i. Describe the advantages and disadvantages of using Docker over other full virtualization technologies. [3]

      ii. What is the relationship between a Docker Image and a Docker Container? [1]

Q4C

a. sensitive instructions. privileged instructions. innocuous instructions. The set of sensitive instructions for that computer is a subset of the set of privileged instructions

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   b. Checkout [1]

   c. Branch [1]

   d. Tag [1]

   e. Rebase [1]

I) What is the main difference between the *clone* and *checkout* commands? [2]

Q5G
-Local (Revision Control System (RCS))
-Centralised (Concurrent Versions System (CVS), Subversion (SVN), Vesta)
-Decentralised (Git, Mercurial, Bitbucket)
Q5H

a. Commit: To commit (check in, ci or, more rarely, install, submit or record) is to write or merge the changes made in the working copy back to the repository.

b. Checkout: To check out (or co) is to create a local working copy from the repository. A user may specify a specific revision or obtain the latest.

c. Branch: A set of files under version control may be branched or forked at a point in time so that, from that time forward, two copies of those files may develop at different speeds or in different ways independently of each other.

d. Tag: A tag or label refers to an important snapshot in time, consistent across many files.

e. Rebase: use another feature to change the main branch.

Q5I?

The main difference is that clone is to create a repository but checkout is to create a local working copy.

Question 6:

 E) The NeCTAR Research Cloud is based on the openStack technology.

   a. Describe the role and features of the following openStack components:

     i. Nova [1]

     ii. Swift [1]

     iii. Glance [1]

     iv. Keystone [1]

   b. Describe the interplay between these components that allows a researcher to create an instance of a virtual machine through a pre-existing snapshot. [3]

 F) The NeCTAR Research Cloud has multiple *availability zones.*

   a. What is meant by the term: availability zone? [1]

   b. What are the implications of availability zones with regards to virtual machine instance creation and data volumes offered by NeCTAR? [2]

Q6E

 a. i. Nova:

  Compute:

  1)Manages the lifecycle of compute instances in an OpenStack environment

  2)Responsibilities include spawning, scheduling and decommissioning of virtual machines on demand

  3)Virtualisation agnostic

  ii. Swift:

  Object storage:

  1)Stores and retrieves arbitrary unstructured data objects via RESTful API, e.g. VM images and data

  2)Fault tolerant with data replication and scale-out architecture.

  3)Can be used with/without Nova/compute

  4)Client; admin support

  iii. Glance:

  Image Service:

  1)Accepts requests for disk or server images and their associated metadata (from Swift) and retrieves / installs (through Nova)

  iv. Keystone:

  Identity service:

  1)Provides an authentication and authorization* service for OpenStack services

  2)Provides a catalog of endpoints for all OpenStack services

  3)Generic authorization system for openStack

 b. 1)Create the template file according to your requirements

  2)Provide environment details (name of key file, image id, etc)

  3)Select a name for your stack and confirm the parameters

  4)Make sure rollback checkbox is marked, so if anything goes wrong, all partially

created resources get dumped too

Q6F

a. which can make the physical servers run the programs in the zones.
b. the larger the availability zones, faster the virtual machine instance be created, the larger data volumes

Please Turn Over

Question 7:

    C) The NeCTAR Research Cloud focuses primarily on offering Infrastructure-as-a-Service (*IaaS*) capabilities, however many research communities require Software-as-a-Service (*SaaS*).

        a. Discuss the relationship between the italicized terms: *IaaS* and *SaaS*. [3]

        b. Applications can be deployed across Clouds either through creation and deployment of virtual images (snapshots) or through scripting the installation and configuration of software applications. What are the benefits and drawbacks of these approaches? [3]

        c. Describe the approach that would be taken using Ansible for scripted deployment of SaaS solutions onto the Cloud. [2]

        d. Describe the approach that would be taken using the openStack Heat service for deployment of SaaS solutions onto the Cloud. [2]

Q7C

    a. In IaaS, the client manages several parts: application, data, runtime, middleware, O/S. But in Saas, the client is not responsible for any project.

    b. Disadvantages of through creation of virtual images:
        Easy to forget what software you installed, and what steps you took to configure the system
        Manual process is error-prone, can be non-repeatable
        Snapshots are monolithic – provides no record of what has changed
        Advantages of through scripting the installation:
        Provides a record of what you did
        Codifies knowledge about the system
        Makes process repeatable
        Makes it programmable – "Infrastructure as Code"（不知道对不对）

    c. Create a playbook that contains YAML files. Typical contents include variables, inventories and roles/tasks/templates. Inventories will include the servers/database used for the software etc etc. Then say how you would run the script using openrc.sh etc. Note 2 points so massive amounts of detail not needed.

--- END OF EXAMINATION ---