# Seventh Semester B.E. Degree Examination, June/July 2019
## Cloud Computing and its Applications

Time: 3 hrs. Max. Marks: 80

**Note: Answer any FIVE full questions, choosing ONE full question from each module.**

### Module-1

1 a. Describe cloud computing reference model. List any four characteristics and benefits of cloud computing. (08 Marks)
b. Describe the three major milestones which have led to cloud computing. (06 Marks)
c. Define service oriented computing and utility oriented computing. (02 Marks)

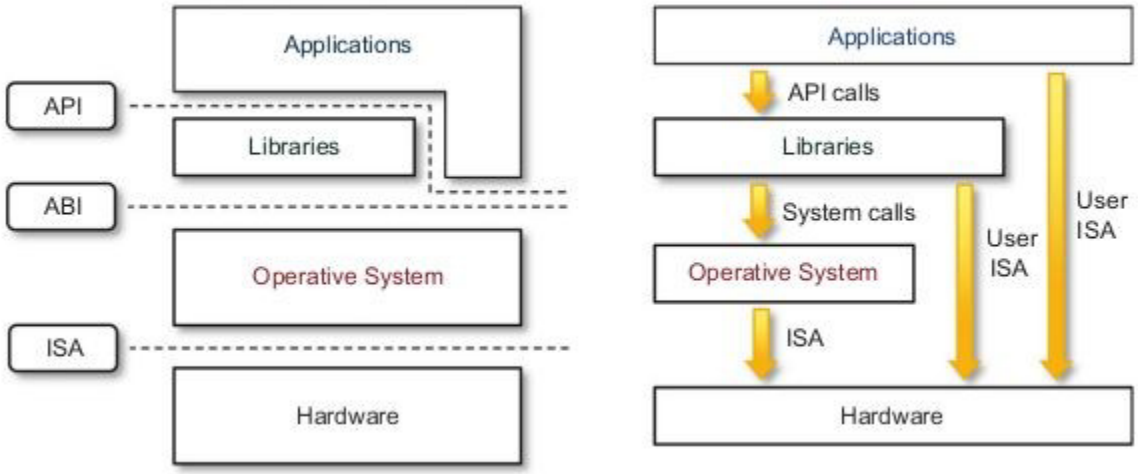
**OR**

2 a. What is virtualization? What are the characteristics of virtualized environments? (08 Marks)
b. What is an Hypervisor? Explain how hardware virtualization can be achieved. (08 Marks)



1A)

**The cloud computing reference model**




- A fundamental characteristic of cloud computing is the capability to deliver, on demand, a variety of IT services that are quite diverse from each other.
- cloud computing services offerings into three major categories:
- Infrastructure-as-a-Service (IaaS)
- Platform-as-a-Service (PaaS)
- Software-as-a- Service (SaaS).
- These categories are related to each other as described in Figure 1.5, which provides an organic view of cloud computing.
- At the base of the stack, Infrastructure-as-a-Service solutions deliver infrastructure on demand in
the form of virtual hardware, storage, and networking.
- Virtual hardware is utilized to provide compute on demand in the form of virtual machine instances.
- Platform-as-a-Service solutions are the next step in the stack.
- They deliver scalable and elastic runtime environments on demand and host the execution of applications. These services are backed by a core middleware platform that is responsible for creating the abstract environment where applications are deployed and executed.
- At the top of the stack, Software-as-a-Service solutions provide applications and services on demand.
- Most of the common functionalities of desktop applications. Each layer provides a different service to users.

- IaaS solutions are sought by users who want to leverage cloud computing from building dynamically scalable computing systems requiring a specific software stack.
- IaaS services are therefore used to develop scalable Websites or for back- ground processing

**Characteristics and benefits**

Cloud computing has some interesting characteristics that bring benefits to both cloud service consumers (CSCs) and cloud service providers (CSPs). These characteristics are:

- No up-front commitments
- On-demand access
- Nice pricing
- Simplified application acceleration and scalability
- Efficient resource allocation
- Energy efficiency
- Seamless creation and use of third-party services

**BENIFITS**

- The most evident benefit from the use of cloud computing systems and technologies is the increased
  economical return due to the reduced maintenance costs and operational costs related to IT software
  and infrastructure.
- This is mainly because IT assets, namely software and infrastructure, are turned into utility costs,
  which are paid for as long as they are used, not paid for up front.
- IT infrastructure and software generated capital costs, since they were paid up front so that business
  start-ups could afford a computing infrastructure, enabling the business activities of the organization.
- The revenue of the business is then utilized to compensate over time for these costs. End users can benefit from cloud computing by having their data and the capability of operating on it always available, from anywhere, at any time, and through multiple devices.
- Information and services stored in the cloud are exposed to users by Web-based interfaces that make them accessible from portable devices as well as desktops at home.

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1B) Three major milestones have led to cloud computing: mainframe computing, cluster computing, and
grid computing.

- **Mainframes.** These were the first examples of large computational facilities leveraging multiple

processing units. Mainframes were powerful, highly reliable computers specialized for large data movement and massive input/output (I/O) operations. They were mostly used by large organizations for bulk data processing tasks such as online transactions, enterprise resource planning, and other operations involving the processing of significant amounts of data.

- **Clusters.** Cluster computing started as a low-cost alternative to the use of mainframes and supercomputers. The technology advancement that created faster and more powerful mainframes and supercomputers eventually generated an increased availability of cheap commodity machines as a side effect. These machines could then be connected by a high-bandwidth network and controlled by specific software tools that manage them as a single system. Starting in the 1980s.

Cluster technology contributed considerably to the evolution of tools and frameworks for distributed computing, including Condor, Parallel Virtual Machine (PVM), and Message Passing Interface (MPI).

- **Grid computing** appeared in the early 1990s as an evolution of cluster computing. In an analogy to

the power grid, grid computing proposed a new approach to access large computational power, huge B storage facilities, and a variety of services.
A computing grid was a dynamic aggregation of heterogeneous computing nodes, and its scale was nationwide or even worldwide. Several developments made possible the diffusion of computing grids:
(a) clusters became quite common resources;
(b) they were often underutilized;
(c) new problems were requiring computational power that went beyond the capability of single clusters; and
(d) the improvements in networking and the diffusion of the Internet made possible long-distance, high-bandwidth connectivity.

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1C) **Service-oriented computing**
Service orientation is the core reference model for cloud computing systems. This approach adopts the concept of services as the main building blocks of application and system development. Service-oriented computing (SOC) supports the development of rapid, low-cost, flexible, interoperable, and evolvable applications and systems.

**Utility-oriented computing**
Utility computing is a vision of computing that defines a service-provisioning model for compute services in which resources such as storage, compute power, applications, and infrastructure are packaged and offered on a pay-per-use basis. The idea of providing computing as a utility like natural gas, water, power, and telephone connection has a long history but has become a reality today with the advent of cloud computing.

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2A) **Virtualization**
Virtualization technology is one of the fundamental components of cloud computing, especially in regard to infrastructure-based services. Virtualization allows the creation of a secure, customizable, and isolated execution environment for running applications, even if they are untrusted, without affecting other users' applications. The basis of this technology is the ability of a computer program—
or a combination of software and hardware—to emulate an executing environment separate from the one that hosts such programs.

**Characteristics of virtualized environments**
Virtualization is a broad concept that refers to the creation of a virtual version of something, whether hardware, a software environment, storage, or a network. In a virtualized environment there are three major components: guest, host, and virtualization layer.

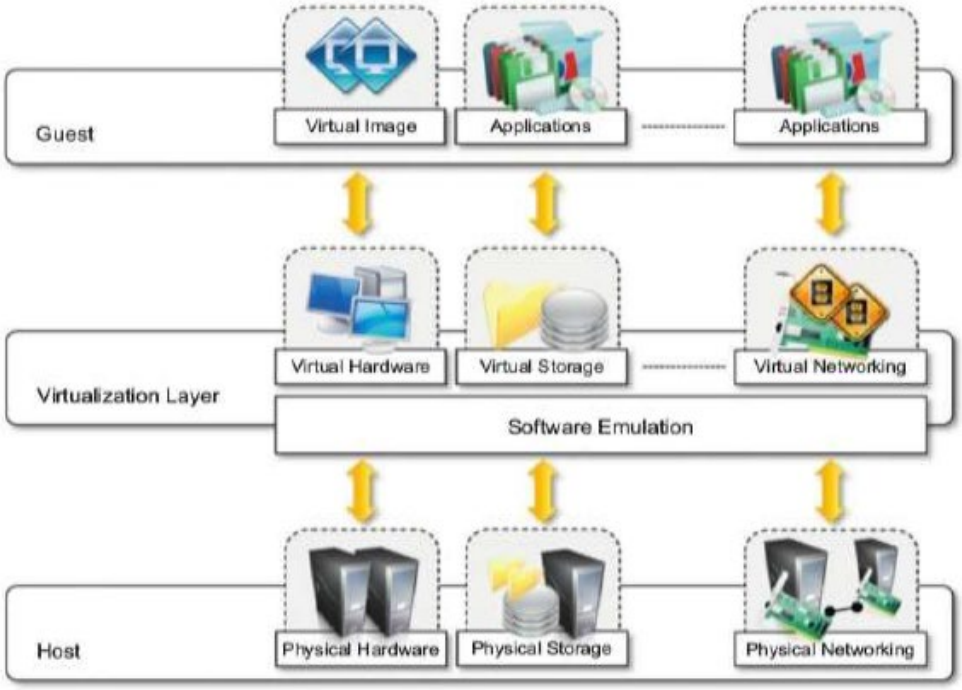


**FIGURE 3.1**

The virtualization reference model.

**The characteristics of virtualized solutions are:**

**1 Increased security**

**2 Managed execution**

**3 Portability**

**1. Increased security**

- The virtual machine represents an emulated environment in which the guest is executed.
- All the operations of the guest are generally performed against the virtual machine, which then translates

and applies them to the host. This level of indirection allows the virtual machine manager to control

and filter the activity of the guest, thus preventing some harmful operations from being performed.

- For example, applets downloaded from the Internet run in a sandboxed 3 version of the Java Virtual Machine (JVM), which provides them with limited access to the hosting operating system resources.
- Both the JVM and the .NET runtime provide extensive security policies for customizing the execution environment of applications.

**2 Managed execution.**

- Virtualization of the execution environment not only allows increased security, but a wider range of

features also can be implemented.

- In particular, sharing, aggregation, emulation, and isolation are

the most relevant features

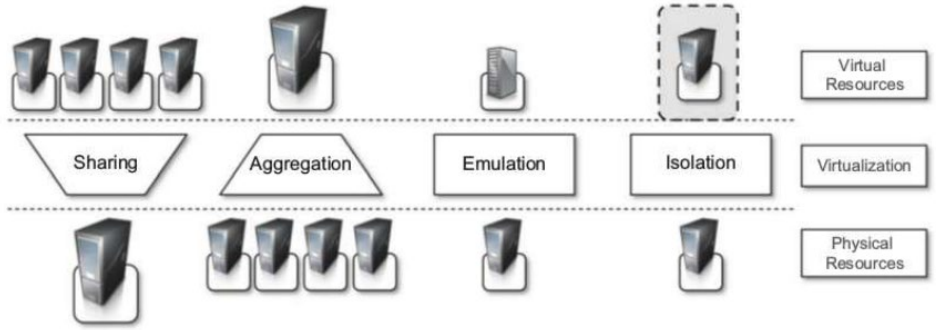


**FIGURE 3.2**
Functions enabled by managed execution.

**Sharing.** Virtualization allows the creation of a separate computing environments within the same host. In this way it is possible to fully exploit the capabilities of a powerful guest, which would otherwise be underutilized.
**Aggregation.** Not only is it possible to share physical resource among several guests, but virtualization also allows aggregation, which is the opposite process. A group of separate hosts can be tied together and represented to guests as a single virtual host.
**Emulation.** Guest programs are executed within an environment that is controlled by the virtualization layer, which ultimately is a program. This allows for controlling and tuning the environment that is exposed to guests. For instance, a completely different environment with respect to the host can be emulated, thus allowing the execution of guest programs requiring specific characteristics that are not present in the physical host.
**Isolation.** Virtualization allows providing guests—whether they are operating systems, applications, or other entities—with a completely separate environment, in which they are executed. The guest program performs its activity by interacting with an abstraction layer, which provides access to the underlying resources.

**3 Portability**

- The concept of portability applies in different ways according to the specific type of virtualization
  considered. In the case of a hardware virtualization solution, the guest is packaged into a virtual
  image that, in most cases, can be safely moved and executed on top of different virtual machines.
- In the case of programming-level virtualization, as implemented by the JVM or the .NET runtime,
  the binary code representing application components (jars or assemblies) can be run without any
  recompilation on any implementation of the corresponding virtual machine.
- This makes the application development cycle more flexible and application deployment very straightforward: One version of the application, in most cases, is able to run on different platforms with no changes.

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2B) **Hypervisors**
A fundamental element of hardware virtualization is the hypervisor, or virtual machine manager (VMM). It recreates a hardware environment in which guest operating systems are installed. There are two major types of hypervisor: Type I and Type II

**Type I hypervisors** run directly on top of the hardware. Therefore, they take the place of the operating systems and interact directly with the ISA interface exposed by the underlying hardware, and they emulate this interface in order to allow the management of guest operating systems. This type of hypervisor is also called a native virtual machine since it runs natively on hardware.

**Type II hypervisors** require the support of an operating system to provide virtualization services. This means that they are programs managed by the operating system, which interact with it through the ABI and emulate the ISA of virtual hardware for guest operating systems. This type of hypervisor is also called a hosted virtual machine since it is hosted within an operating system.

**b. Hardware virtualization techniques**

**Hardware-assisted virtualization.**

- This term refers to a scenario in which the hardware provides architectural support for building a virtual machine manager able to run a guest operating system in complete isolation.
- This technique was originally introduced in the IBM System/370. At present, examples of hardware-assisted virtualization are the extensions to the x86-64 bit architecture introduced with Intel VT (formerly known as Vanderpool) and AMD V (formerly known as Pacifica). Intel and AMD introduced processor extensions, and a wide range of virtualization solutions took advantage of them: Kernel-based Virtual Machine (KVM), VirtualBox, Xen, VMware, Hyper-V, Sun xVM, Parallels, and others.

**Full virtualization.**

- Full virtualization refers to the ability to run a program, most likely an operating system, directly on top of a virtual machine and without any modification, as though it were run on the raw hardware.
- To make this possible, virtual machine managers are required to provide a complete emulation of the entire underlying hardware.
- The principal advantage of full virtualization is complete isolation, which leads to enhanced security, ease of emulation of different architectures, and coexistence of different systems on the same platform.

**Paravirtualization.**

- This is a not-transparent virtualization solution that allows implementing thin virtual machine managers.
- Paravirtualization techniques expose a software interface to the virtual machine that is slightly modified from the host and, as a consequence, guests need to be modified.
- The aim of paravirtualization is to provide the capability to demand the execution of performancecritical
  operations directly on the host, thus preventing performance losses that would otherwise be experienced in managed execution.

**Partial virtualization.**

- Partial virtualization provides a partial emulation of the underlying hardware, thus not allowing the complete execution of the guest operating system in complete isolation.
- Partial virtualization allows many applications to run transparently, but not all the features of the
  operating system can be supported.

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**Seventh Semester B.E. Degree Examination, Dec.2019/Jan.2020**

**Cloud Computing and its Applications**

Time: 3 hrs. Max. Marks: 80

***Note: Answer any FIVE full questions, choosing ONE full question from each module.***



**Module-1**

| | | | |
|---|---|---|---|
| 1 | a. | Describe the main characteristics and benefits of cloud computing. | (04 Marks) |
| | b. | With neat diagram, explain the cloud computing reference model. | (06 Marks) |
| | c. | Explain the technologies on which cloud computing relies. | (06 Marks) |

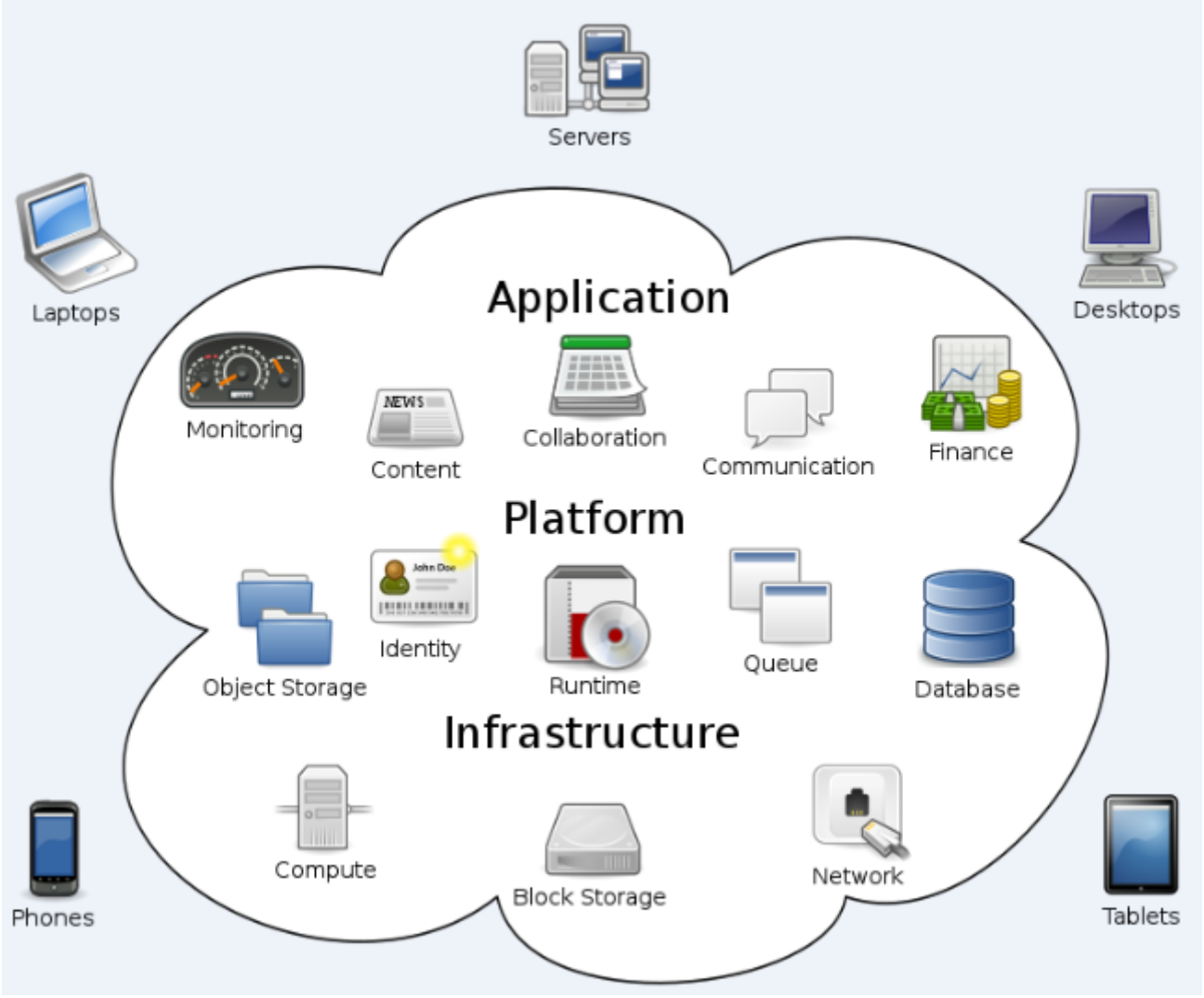
**OR**

| | | | |
|---|---|---|---|
| 2 | a. | Discuss classification or taxonomy of virtualization at different levels. | (08 Marks) |
| | b. | Explain the architecture of Hyper-V and discuss its use in cloud computing. | (08 Marks) |

1A) REPEATED

**The cloud computing reference model**

- 1B) A fundamental characteristic of cloud computing is the capability to deliver, on demand, a variety of IT services that are quite diverse from each other. cloud computing services offerings into three major categories: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as- a-Service (SaaS). These categories are related to each other as described in Figure below , which provides an organic view of cloud computing.
- At the base of the stack, Infrastructure-as-a-Service solutions deliver infrastructure on demand in the form of virtual hardware, storage, and networking. Virtual hardware is utilized to provide compute on demand in the form of virtual machine instances.
- Platform-as-a-Service solutions are the next step in the stack. They deliver scalable and elastic runtime environments on demand and host the execution of applications. These services are backed by a core middleware platform that is responsible for creating the abstract environment where applications are deployed and executed.
- At the top of the stack, Software-as-a-Service solutions provide applications and services on demand. Most of the common functionalities of desktop applications. Each layer provides a different service to users. IaaS solutions are sought by users who want to leverage cloud computing from building dynamically scalable computing systems requiring a spe- cific software stack. IaaS services are therefore used to develop scalable Websites or for back- ground processing.

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1c)

**Computing platforms and technologies**

Development of a cloud computing application happens by leveraging platforms and frameworks that provide different types of services, from the bare-metal infrastructure to customizable applications serving specific purposes.

**1 Amazon web services (AWS)**
**2 Google AppEngine**
**3 Microsoft Azure**
**4 Hadoop**
**5 Force.com and Salesforce.com**
**6 Manjrasoft Aneka**

**1 Amazon web services (AWS)**

- AWS offers comprehensive cloud IaaS services ranging from virtual compute, storage, and networking to complete computing stacks.
- AWS is mostly known for its compute and storage-ondemand services, namely Elastic Compute Cloud (EC2) and Simple Storage Service (S3).
- EC2 provides users with customizable virtual hardware that can be used as the base infrastructure for
  deploying computing systems on the cloud.
- It is possible to choose from a large variety of virtual hardware configurations, including GPU and cluster instances.

- EC2 also provides the capability to save a specific running instance as an image, thus allowing users to create their own templates for deploying systems.'
- These templates are stored into S3 that delivers persistent storage on demand.
- S3 is organized into buckets; these are containers of objects that are stored in binary form and can be enriched with attributes.
- Users can store objects of any size, from simple files to entire disk images, and have them accessible from everywhere.

**2 Google AppEngine**

- Google AppEngine is a scalable runtime environment mostly devoted to executing Web applications.
- These take advantage of the large computing infrastructure of Google to dynamically scale as the demand varies over time.
- AppEngine provides both a secure execution environment and a collection of services that simplify the development of scalable and high-performance Web applications.
- These services include in-memory caching, scalable data store, job queues, messaging, and cron tasks.
- Developers can build and test applications on their own machines using the AppEngine software development kit (SDK). Once development is complete, developers can easily migrate their application to AppEngine, set quotas to contain the costs generated, and make the application available to the world.
  The languages currently supported are Python, Java, and Go.

**3 Microsoft Azure**

- Microsoft Azure is a cloud operating system and a platform for developing applications in the cloud.
- Applications in Azure are organized around the concept of roles, which identify a distribution unit for applications and embody the application's logic.
- Currently, there are three types ofrole: Web role, worker role, and virtual machine role.
- The Web role is designed to host a Web application, the worker role is a more generic container of applications and can be used to perform workload processing, and the virtual machine role provides a virtual environment in which the computing stack can be fully customized, including the operating systems.

**4 Hadoop**

- Apache Hadoop is an open-source framework that is suited for processing large data sets on commodity hardware.
- Hadoop is an implementation of MapReduce, an application programming model developed by Google, which provides two fundamental operations for data processing: map and reduce.
- The former transforms and synthesizes the input data provided by the user; the latter naggragates the output obtained by the map operations.
- Hadoop provides the runtime environment, and developers need only provide the input data and specify the map and reduce functions that need to be executed.

**5 Force.com and Salesforce.com**

- Force.com is a cloud computing platform for developing social enterprise applications.
- The platform is the basis for SalesForce.com, a Software-as-a-Service solution for customer relationship management. Force.com allows developers to create applications by composing ready-to-use blocks; a complete set of components supporting all the activities of an enterprise are available.
- The platform provides complete support for developing applications, from the design of the data layout

to the definition of business rules and workflows and the definition of the user interface.

**6 Manjrasoft Aneka**

- Manjrasoft Aneka is a cloud application platform for rapid creation of scalable applications and
  their deployment on various types of clouds in a seamless and elastic manner.
- It supports a collection of programming abstractions for developing applications and a distributed runtime
  environment that can be deployed on heterogeneous hardware (clusters, networked desktop computers, and cloud resources).
- Developers can choose different abstractions to design their application: tasks, distributed threads,
  and map-reduce.
- These applications are then executed on the distributed service-oriented runtimeenvironment, which can dynamically integrate additional resource on demand.

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**2a) taxonomy of virtualisation at different level**

**Taxonomy of virtualization techniques**

- Virtualization covers a wide range of emulation techniques that are applied to different areas of computing.
- A classification of these techniques helps us better understand their characteristics and use (see Figure 3.3).
  The first classification discriminates against the service or entity that is being emulated.
- Virtualization is mainly used to emulate execution environments, storage, and networks.
- Among these categories, execution virtualization constitutes the oldest, most popular, and most developed
  area. Therefore, it deserves major investigation and a further categorization.

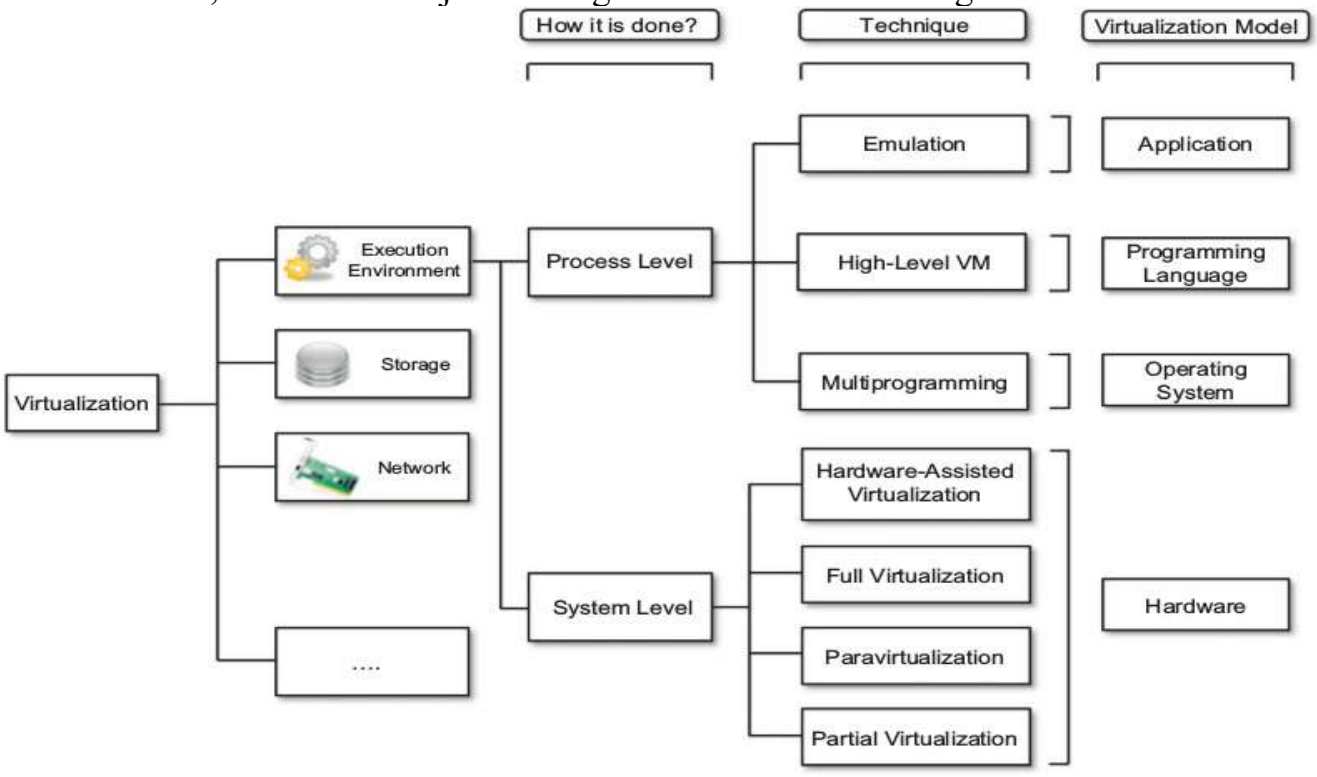
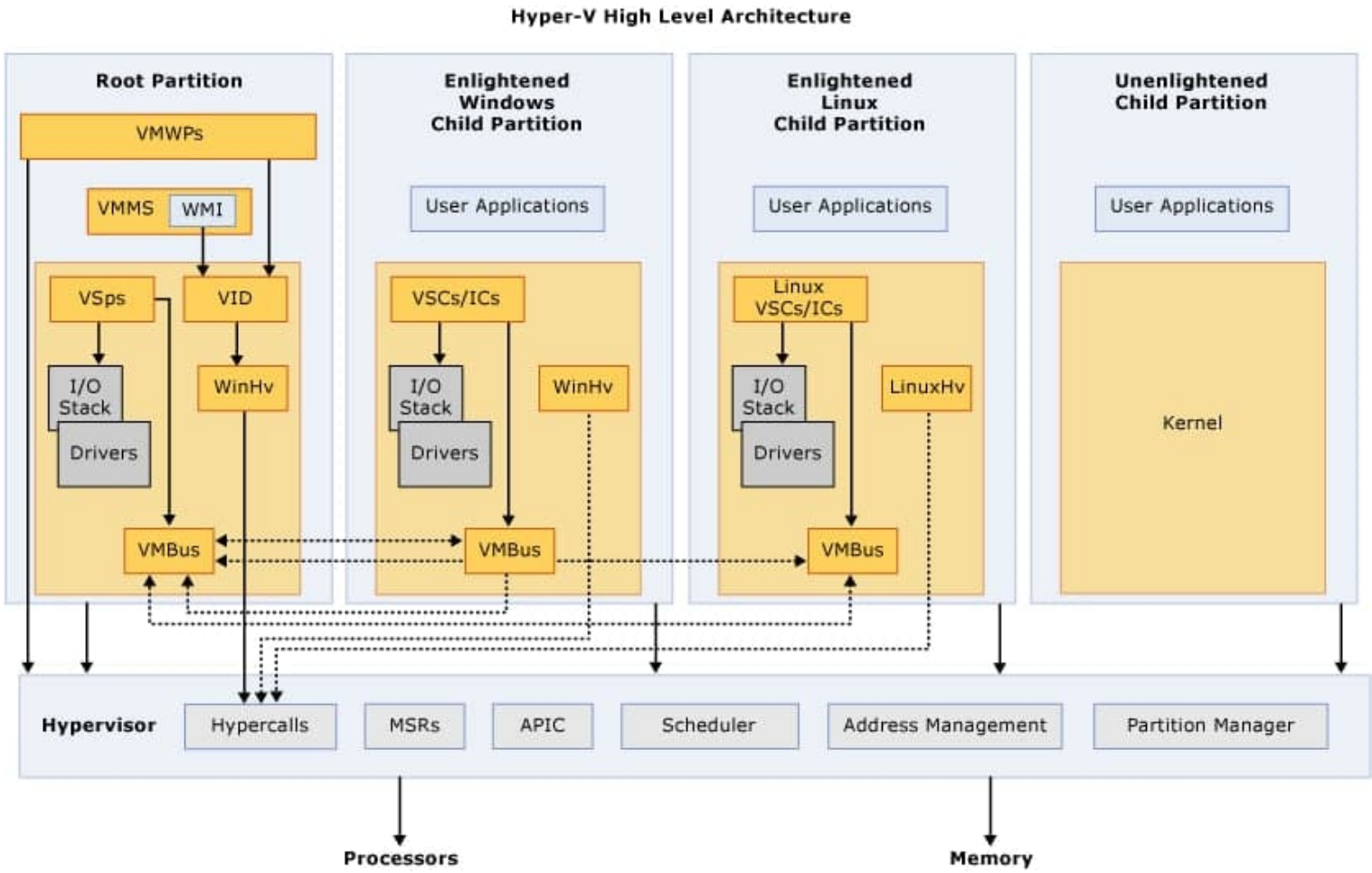



**FIGURE 3.3**

A taxonomy of virtualization techniques.

2B) **Explain the architecture of Hyper V and discuss its use in cloud computing.**




- Hyper-V supports isolation in terms of a partition. A partition is a logical unit of isolation, supported by the hypervisor, in which operating systems execute.
- The Microsoft hypervisor must have at least one parent, or root, partition, running Windows.
- The virtualization management stack runs in the parent partition and has direct access to hardware devices.
- The root partition then creates the child partitions which host the guest operating systems.
- A root partition creates child partitions using the hypercall application programming interface
- Partitions do not have access to the physical processor, nor do they handle the processor interrupts.
- Instead, they have a virtual view of the processor and run in a virtual memory address region that is private to each guest partition.
- The hypervisor handles the interrupts to the processor, and redirects them to the respective partition. Hyper-V can also hardware accelerate the address translation between various guest virtual address spaces by using an Input Output Memory Management Unit (IOMMU) which operates independent of the memory management hardware used by the CPU.
- An IOMMU is used to remap physical memory addresses to the addresses that are used by the child partitions.
- Child partitions also do not have direct access to other hardware resources and are presented a virtual view of the resources, as virtual devices (VDevs).
- Requests to the virtual devices are redirected either via the VMBus or the hypervisor to the devices in the parent partition, which handles the requests.
- The VMBus is a logical interpartition communication channel. The parent partition hosts Virtualization Service Providers (VSPs) which communicate over the VMBus to handle device access requests from child
partitions.

- Child partitions host Virtualization Service Consumers (VSCs) which redirect device requests to VSPs in the parent partition via the VMBus.
- This entire process is transparent to the guest operating system.Virtual Devices can also take advantage of a Windows Server
- Virtualization feature, named Enlightened I/O, for storage, networking, graphics, and input subsystems.
- Enlightened I/O is a specialized virtualization-aware implementation of high level communication protocols (such as SCSI) that utilize the VMBus directly, bypassing any device emulation layer. This makes the communication more efficient but requires an enlightened guest that is hypervisor and VMBus aware.
- Hyper-V enlightened I/O and a hypervisor aware kernel is provided via installation of Hyper-V integration services.

**Seventh Semester B.E. Degree Examination, Dec.2018/Jan.2019**

**Cloud Computing and Its Applications**

Time: 3 hrs. Max. Marks: 80

***Note: Answer any FIVE full questions, choosing ONE full question from each module.***

**Module-1**

| | | | |
|---|---|---|---|
| 1 | a. | Explain cloud computing reference model with neat diagram. | (10 Marks) |
| | b. | Write a note on the challenges in cloud computing. | (06 Marks) |
| | | **OR** | |
| 2 | a. | Explain Microsoft Hyper V architecture. | (10 Marks) |
| | b. | Explain pros and cons of virtualization. | (06 Marks) |

**1a )1b) REPEATED**

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**2a) Pros and cons of virtualization**

Virtualization has now become extremely popular and widely used, especially in cloud computing. Today, the capillary diffusion of the Internet connection and the advancements in computing technology have made virtualization an interesting opportunity to deliver on-demand IT infrastructure and services.

**Advantages of virtualization**

1. Managed execution and isolation are perhaps the most important advantages of virtualization. In the case of techniques supporting the creation of virtualized execution environments, these two characteristics allow building secure and controllable computing environments.
2. Portability is another advantage of virtualization, especially for execution virtualization techniques.

Virtual machine instances are normally represented by one or more files that can be easily transported with respect to physical systems.

3. Portability and self-containment also contribute to reducing the costs of maintenance, since the number of hosts is expected to be lower than the number of virtual machine instances. Since the guest program is executed in a virtual environment, there is very limited opportunity for the guest program to damage the underlying hardware.
4. Finally, by means of virtualization it is possible to achieve a more efficient use of resources.

Multiple systems can securely coexist and share the resources of the underlying host, without interfering
with each other.

**The other side of the coin: disadvantages**

**1.Performance degradation**

Performance is definitely one of the major concerns in using virtualization technology. Since virtualization interposes an abstraction layer between the guest and the host, the guest can experience increased latencies (delays).

For instance, in the case of hardware virtualization, where the intermediate emulates a bare machine on top of which an entire system can be installed, the causes of performance degradation can be traced back to the overhead introduced by the following activities:

- Maintaining the status of virtual processors
- Support of privileged instructions (trap and simulate privileged instructions)
- Support of paging within VM
- Console functions

**2 Inefficiency and degraded user experience**

Virtualization can sometime lead to an inefficient use of the host. In particular, some of the specific features of the host cannot be exposed by the abstraction layer and then become inaccessible. In the case of hardware virtualization, this could happen for device drivers: The virtual machine can sometime simply provide a default graphic card that maps only a subset of the features available in the host. In the case of programming-level virtual machines, some of the features of the underlying operating systems may become inaccessible unless specific libraries are used.

**3 Security holes and new threats**

Virtualization opens the door to a new and unexpected form of phishing. The capability of emulating a host in a completely transparent manner led the way to malicious programs that are designed to extract sensitive information from the guest.

The same considerations can be made for programming-level virtual machines: Modified ver- sions of the runtime environment can access sensitive information or monitor the memory locations utilized by guest applications while these are executed.