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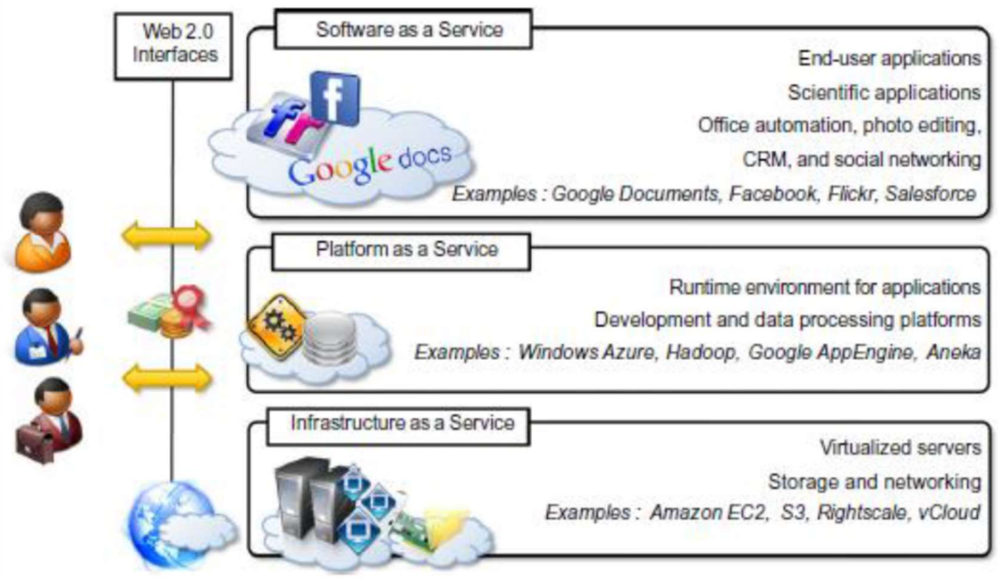
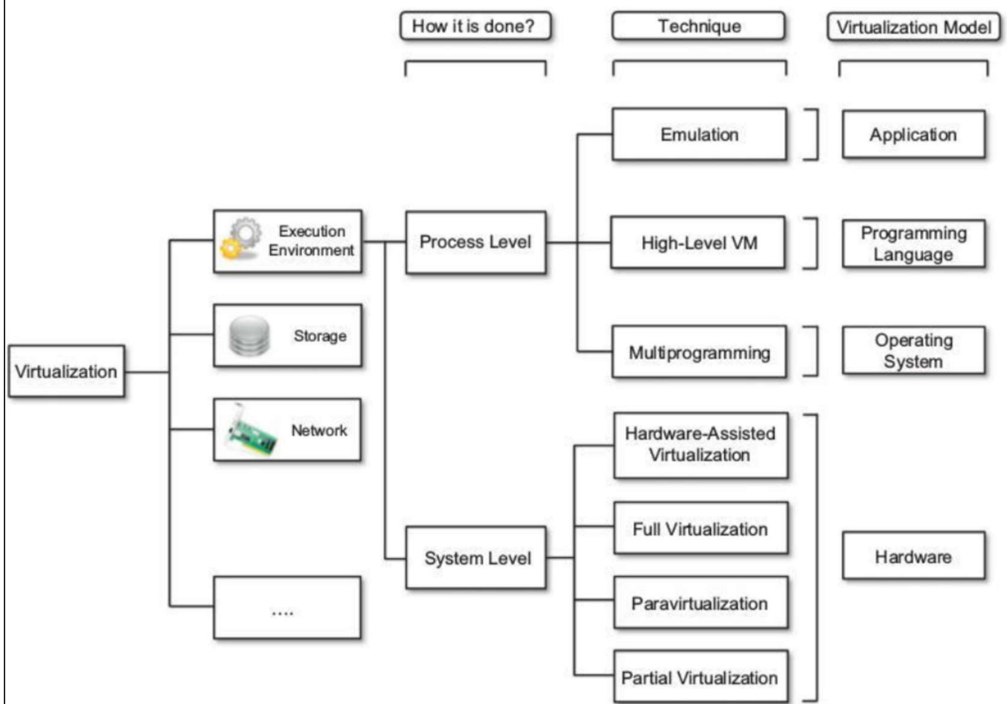
Internal Assessment Test 1 – Set 3 – May 2022									
Sub:	Cloud Computing and its Applications				Sub Code:	18CS643	Branch	ISE	
Date:	10/05/2022	Duration:	90 min's	Max Marks: 50	Sem/Sec:	VI / A, B and C		OBE	
Answer any FIVE questions							MARKS	CO	RBT

1	Briefly explain the concept of Cloud Computing? The term cloud has historically been used in the telecommunications industry as an abstraction of the network in system diagrams. It then became the symbol of the most popular computer network, the Internet. This meaning also applies to cloud computing, which refers to an Internet-centric way of computing. The Internet plays a fundamental role in cloud computing, since it represents either the medium or the platform through which many cloud computing services are delivered and made accessible. This aspect is also reflected in the definition given by Armbrust et al.: "Cloud computing refers to both the applications delivered as services over the Internet and the hardware and system software in the datacenters that provide those services." Explain the Cloud Computing reference model with a neat diagram. 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 the below figure, 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.	10	CO1	L1

				
2	What is Virtualization? Virtualization is another core technology for cloud computing. It encompasses a collection of solutions allowing the abstraction of some of the fundamental elements for computing, such as hardware, runtime environments, storage, and networking. Virtualization has been around for more than 40 years, but its application has always been limited by technologies that did not allow an efficient use of virtualization solutions. Virtualization is essentially a technology that allows creation of different computing environments. These environments are called virtual because they simulate the interface that is expected by a guest. The most common example of virtualization is hardware virtualization. Virtualization technologies are also used to replicate runtime environments for programs. Applications in the case of process virtual machines (which include the foundation of technologies such as Java or .NET), instead of being executed by the operating system, are run by a specific program called a virtual machine. This technique allows isolating the execution of applications and providing a finer control on the resource they access. Explain the taxonomy of Virtualization. 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 below Figure). The first classification discriminates against the service or entity that is being emulated. Execution Virtualization Execution virtualization includes all techniques that aim to emulate an execution environment that is separate from the one hosting the virtualization layer. All these techniques concentrate their interest on providing support for the execution of programs, whether these are the operating system, a binary specification of a program compiled against an abstract machine model, or an application. 1. Machine reference model 2. Hardware-level virtualization a. Hypervisors b. Hardware virtualization techniques c. Operating system-level virtualization 3. Programming language-level virtualization	10	CO1	L1

	4. Application-level virtualization Explanation for the different types: 			
3	What are the major distributed computing technologies that led to cloud computing? Briefly explain. The idea of renting computing services by leveraging large distributed computing facilities has been around for long time. It dates back to the days of the mainframes in the early 1950s. Figure below provides an overview of the evolution of the distributed computing technologies that have influenced cloud computing. In tracking the historical evolution, we briefly review five core technologies that played an important role in the realization of cloud computing. These technologies are distributed systems, virtualization, Web 2.0, service orientation, and utility computing.	10	CO1	L2

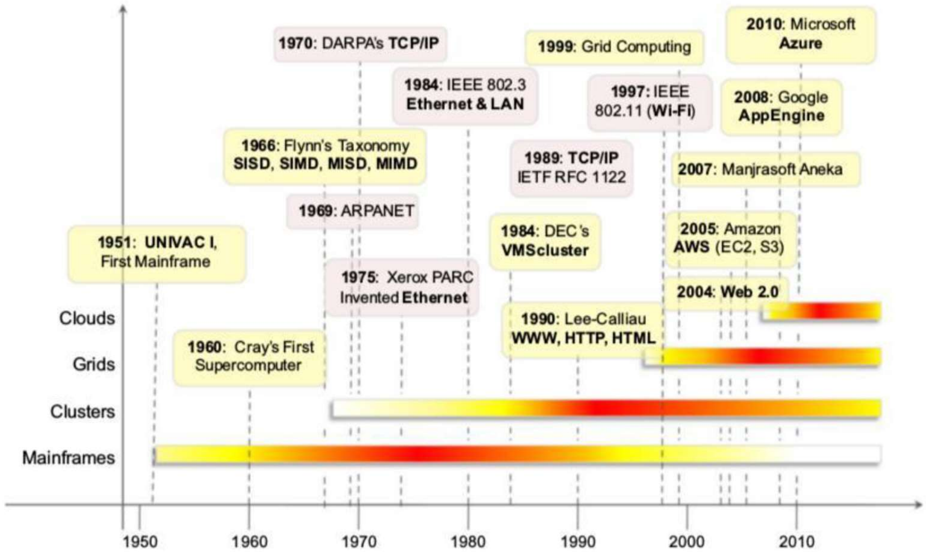


FIGURE 1.6

The evolution of distributed computing technologies, 1950s–2010s.

1. Distributed Systems

Clouds are essentially large distributed computing facilities that make available their services to third parties on demand. As a reference, we consider the characterization of a distributed system proposed by Tanenbaum et al.:

"A distributed system is a collection of independent computers that appears to its users as a single coherent system."

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

a) 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.

b) 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 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.			
4	What is service orientation? 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. A service is an abstraction representing a self-describing and platform-agnostic component that can perform any function—anything from a simple function to a complex business process. Describe the important characteristics of service orientation. A service is supposed to be loosely coupled, reusable, programming language independent, and location transparent. Loose coupling allows services to serve different scenarios more easily and makes them reusable. Independence from a specific platform increases services accessibility. Thus, a wider range of clients, which can look up services in global registries and consume them in a location-transparent manner, can be served. Service-oriented computing introduces and diffuses two important concepts, which are also fundamental to cloud computing: quality of service (QoS) and Software-as-a-Service (SaaS). • **Quality of service (QoS)** identifies a set of functional and nonfunctional attributes that can be used to evaluate the behavior of a service from different perspectives. These could be performance metrics such as response time, or security attributes, transactional integrity, reliability, scalability, and availability. • The concept of Software-as-a-Service introduces a new delivery model for applications. The term has been inherited from the world of application service providers (ASPs), which deliver software services-based solutions across the wide area network from a central datacenter and make them available on a subscription or rental basis.	10	CO1	L2
5	What is virtualization and briefly explain its benefits. Virtualization is another core technology for cloud computing. It encompasses a collection of solutions allowing the abstraction of some of the fundamental elements for computing, such as hardware, runtime environments, storage, and networking. Virtualization has been around for more than 40 years, but its application has always been limited by technologies that did not allow an efficient use of virtualization solutions. Virtualization is essentially a technology that allows creation of different computing environments. These environments are called virtual because they simulate the interface that is expected by a guest. The most common example of virtualization is hardware virtualization. Virtualization technologies are also used to replicate runtime environments for programs. Applications in the case of process virtual machines (which include the foundation of technologies such as Java or .NET), instead of being executed by the operating system, are run by a specific program called a virtual machine. This technique allows isolating the execution of applications and providing a finer control on the resource they access.	10	CO1	L2

Virtualization technologies have gained renewed interested recently due to the confluence of several phenomena:

• Increased performance and computing capacity.

The high-end side of the PC market, where supercomputers can provide immense compute power that can accommodate the execution of hundreds or thousands of virtual machines.

• Underutilized hardware and software resources.

Hardware and software underutilization is occurring due to (1) increased performance and computing capacity, and (2) the effect of limited or sporadic use of resources.

Computers today are so powerful that in most cases only a fraction of their capacity is used by an application or the system. Using these resources for other purposes after hours could improve the efficiency of the IT infrastructure.

• Lack of space.

Companies such as Google and Microsoft expand their infrastructures by building data centers as large as football fields that are able to host thousands of nodes. Although this is viable for IT giants, in most cases enterprises cannot afford to build another data center to accommodate additional resource capacity. This condition, along with hardware underutilization, has led to the diffusion of a technique called server consolidation

• Greening initiatives.

Maintaining a data center operation not only involves keeping servers on, but a great deal of energy is also consumed in keeping them cool. Infrastructures for cooling have a significant impact on the carbon footprint of a data center. Hence, reducing the number of servers through server consolidation will definitely reduce the impact of cooling and power consumption of a data center. Virtualization technologies can provide an efficient way of consolidating servers.

• Rise of administrative costs.

The increased demand for additional capacity, which translates into more servers in a data center, is also responsible for a significant increment in administrative costs. Computers—in particular, servers—do not operate all on their own, but they require care and feeding from system administrators.

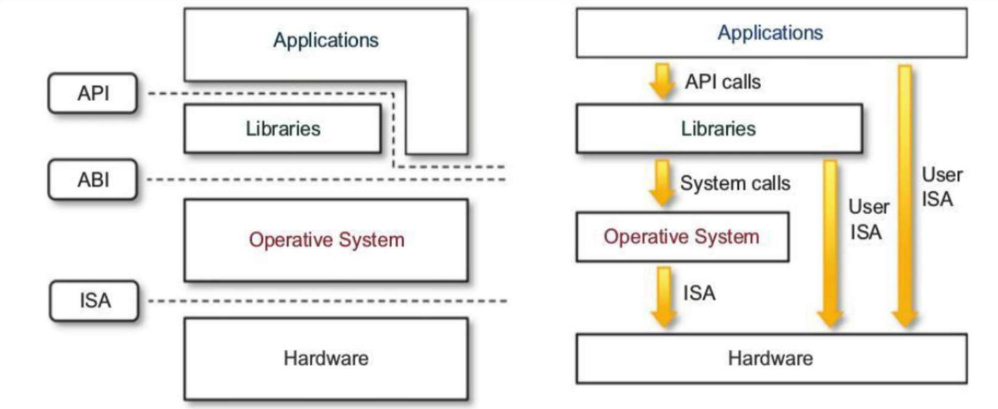
These are labor-intensive operations, and the higher the number of servers that have to be managed, the higher the administrative costs. Virtualization can help reduce the number of required servers for a given workload, thus reducing the cost of the administrative personnel.

Explain the reference model for virtualization

Modern computing systems can be expressed in terms of the reference model described in below Figure. At the bottom layer, the model for the hardware is expressed in terms of the Instruction Set

Architecture (ISA), which defines the instruction set for the processor, registers, memory, and interrupt management. ISA is the interface between hardware and software, and it is important to the operating system (OS) developer (System ISA) and developers of applications that directly manage the underlying hardware (User ISA). The application binary interface (ABI) separates the operating system layer from the applications and libraries, which are managed by the OS. ABI covers details such as low-level data types, alignment, and call conventions and defines a format for executable programs.

The highest level of abstraction is represented by the application programming interface (API), which interfaces applications to libraries and/or the underlying operating system.

	 **FIGURE 3.4** A machine reference model. For this purpose, the instruction set exposed by the hardware has been divided into different security classes that define who can operate with them. The first distinction can be made between privileged and nonprivileged instructions. Nonprivileged instructions are those instructions that can be used without interfering with other tasks because they do not access shared resources. This category contains, for example, all the floating, fixed-point, and arithmetic instructions. Privileged instructions are those that are executed under specific restrictions and are mostly used for sensitive operations, which expose (behavior-sensitive) or modify (control-sensitive) the privileged state.			
6	What are the characteristics of the Virtualization environment? 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. The guest represents the system component that interacts with the virtualization layer rather than with the host, as would normally happen. The host represents the original environment where the guest is supposed to be managed. The virtualization layer is responsible for recreating the same or a different environment where the guest will operate (see below Figure). 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 (see below Figure).	10	CO1	L1

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.

Explain the different types of managed execution in cloud virtualization.

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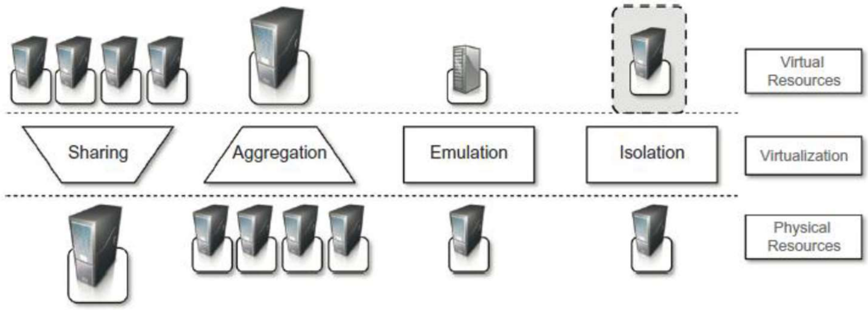 **FIGURE 3.2** Functions enabled by managed execution.			

Faculty In-Charge

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