Assignment 03

Chapter 03

Problem 1 (2pts)
List and explain all levels of virtualization implementation. For each level of virtualization, provide one or two example software or systems.

Answer 1
Implementing virtualization is not that simple. An operating system (OS) running on a computer is tailored to the specific hardware. On the same hardware, running a different OS is not quite possible.
A hypervisor exists to address this. The hypervisor functions as a link between the virtual OS and hardware to facilitate the instance's efficient operation.
The five degrees of virtualization that are most frequently utilized in the sector are accessible. These are listed below:

Instruction Set Architecture Level (ISA)

Virtualization in ISA operates via an ISA emulator. This is useful for running a ton of old code that was created for various hardware setups.
Through an ISA, these codes can be executed on the virtual machine.
Now, binary codes that previously required additional layers to execute can run on x86 computers or, with some modifications, even on x64 computers. This virtual machine is hardware-independent thanks to ISA.
However, the fundamental emulation needs an interpreter. This interpreter analyzes the source code and transforms it into a format that can be processed by hardware.

Hardware Abstraction Level (HAL)

The hardware level of virtualization is assisted by this level. In order to operate, it makes use of a simple hypervisor. This level aids in the creation of the virtual machine and utilizes virtualization to manage the hardware. Each piece of hardware, including I/O devices, processors, memory, etc., can be virtualized thanks to it.
In this manner, numerous virtualization instances can run concurrently on the same hardware while being used by multiple people.
This was initially used **by IBM in 1960 on the IBM VM/370**. For cloud-based infrastructure, it is more useful.
That Linux and other operating systems are currently being run on x86-based devices by Xen hypervisors using HAL is therefore not surprising.

Operating System Level

The virtualization paradigm establishes an amorphous layer between the OS and the applications at the operating system level. It uses hardware and software and functions as an isolated container on the physical server and operating system. These containers each perform the role of

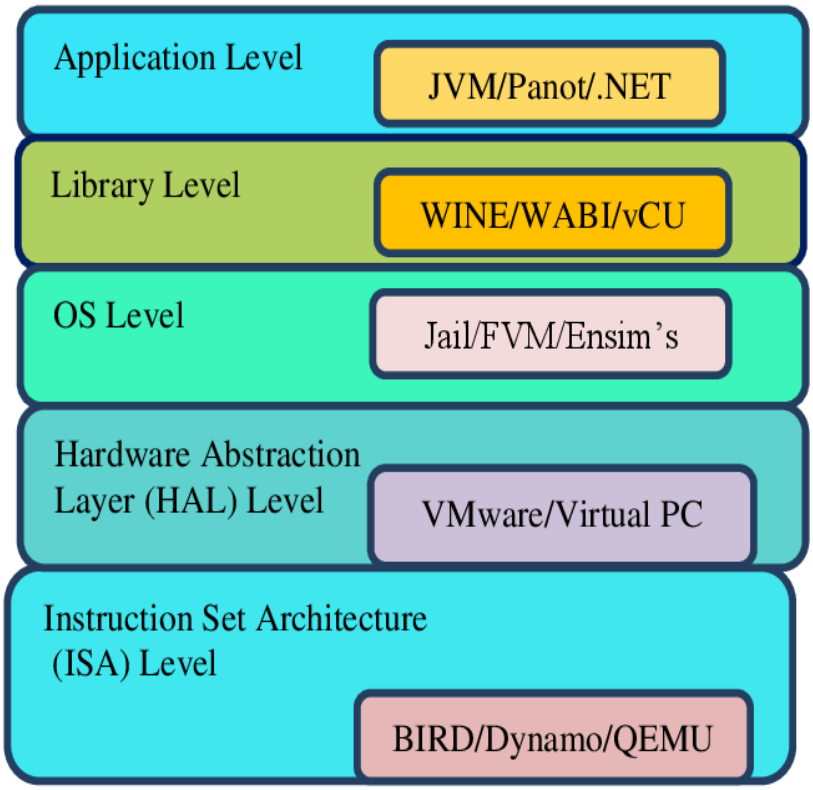
a server. This degree of virtualization is useful when there are a lot of users and nobody wants to share hardware. Each user in this situation has access to a unique virtual environment and virtual hardware resources. In this way, disputes never occur.

Library Level

OS system calls are laborious and time-consuming. Applications choose APIs from user-level libraries because of this. The majority of system APIs are rather well documented. Therefore, in these situations, library level virtualisation is desirable. API hooks enable virtualization of library interfaces. The communication channel between the system and the apps is managed by these API hooks.
This method has been successfully used with some current tools, including **vCUDA and WINE**.

Application Level

When you only want to virtualize one program, application-level virtualization is helpful. It does not virtualize a platform or environment in its entirety.
Applications operate as a single process on an operating system. As a result, it is often referred to as process-level virtualization.
When using high-level languages in virtual machines, it is often helpful. In this instance, the application program is positioned atop the virtualization layer.
The operating system itself houses the application program.



Implementation Levels of Virtualization

Problem 2 (3pts)
Answer the following questions:

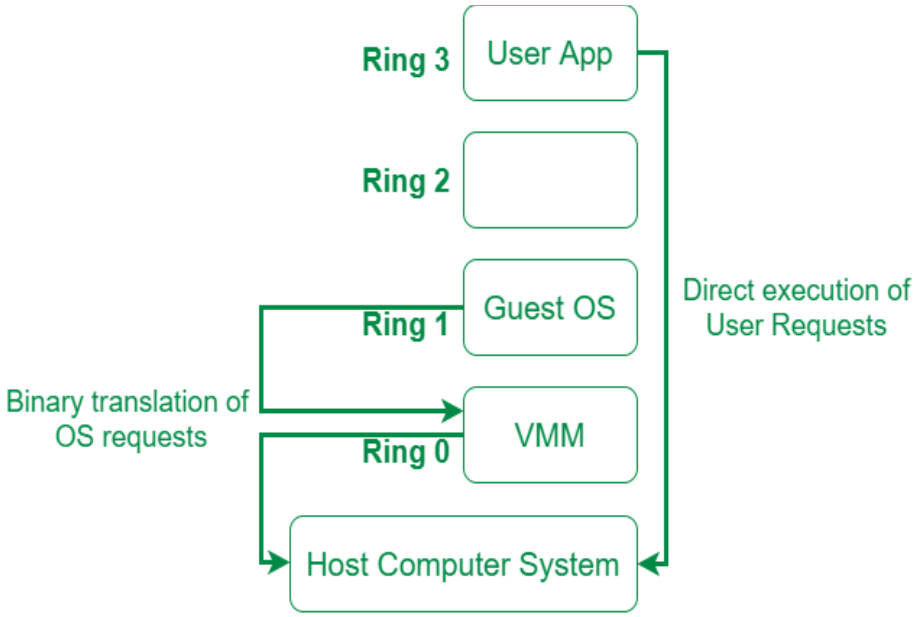
a. Explain full virtualization and provide an example hypervisor using this technique.
b. Explain para virtualization and provide an example hypervisor using this technique.
c. Compare the differences between full virtualization and para virtualization.

Answer 2

a. IBM first introduced full virtualization in 1966. It uses binary translation and direct approach techniques and is the first software solution for server virtualization. In full virtualization, the guest OS is totally segregated from the virtualization layer and hardware by the virtual machine. Systems from Microsoft and Parallels are two instances of complete virtualization.

Direct execution and binary translation are both used in full virtualization. Non-sensitive CPU instructions can now be executed directly, however sensitive CPU instructions must first be translated. The hypervisor keeps a cache of the most recently translated instructions to enhance performance.

This method is used by VMware's ESXi server to implement server virtualization.

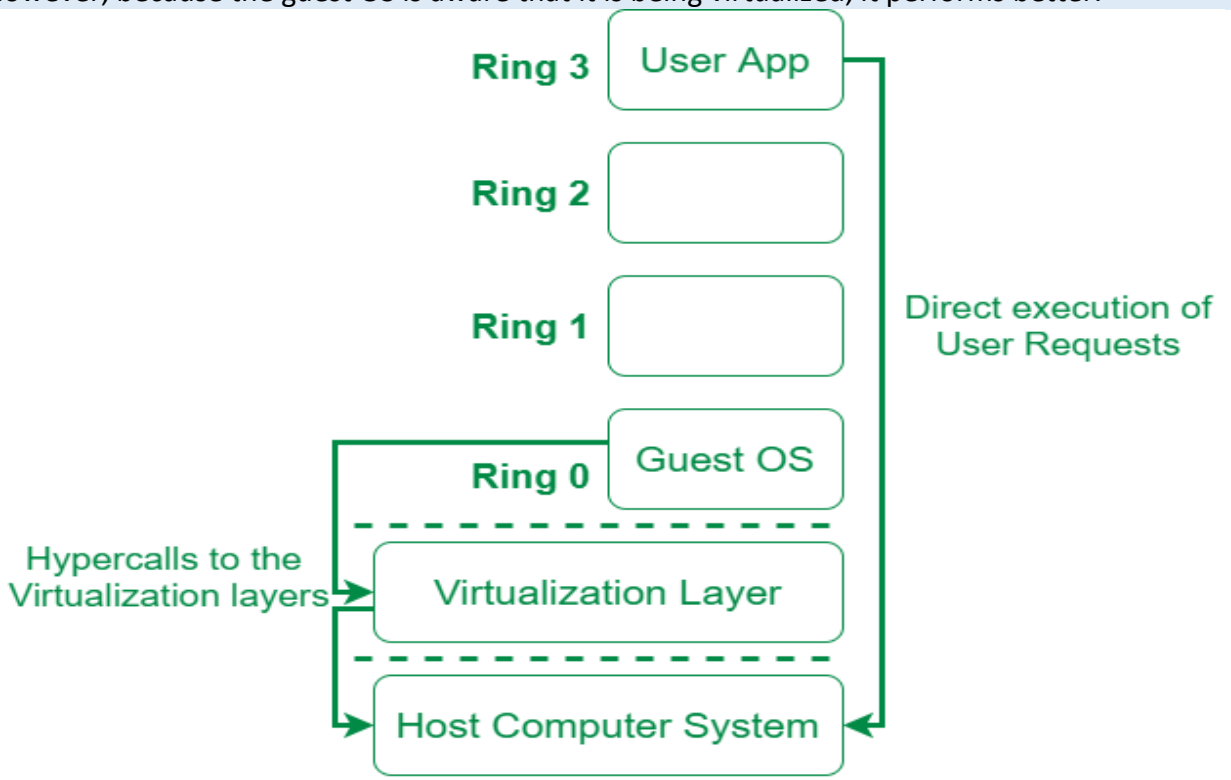


Full Virtualization

b. The type of CPU virtualization known as paravirtualization employs hypercalls for operations to manage instructions at compile time. In paravirtualization, the guest OS is

only partially insulated from the virtualization layer and hardware by the virtual machine. Some paravirtualization examples are VMware and Xen.

The hypervisor doesn't simulate the underlying hardware in paravirtualization. Hypercalls are instead made available. Hypercalls are used by the guest OS to carry out delicate CPU commands. Full virtualization is more portable than this method, which requires changing the guest OS. However, because the guest OS is aware that it is being virtualized, it performs better.



Paravirtualization

c. The following are the differences between full virtualization and paravirtualization:

S.No.	Full Virtualization	Paravirtualization
1.	Virtual machines in full virtualization allow for the isolated, unmodified OS to operate alongside the execution of instructions.	A virtual machine in paravirtualization offers a new API that is used when the OS is subjected to modification rather than implementing full OS isolation.
2.	Full Virtualization offers less security.	While being safer than full virtualization, paravirtualization.

3.	Binary translation and a direct approach are the techniques employed by Full Virtualization.	While Paravirtualization uses hypercalls at compile time for operations.
4.	Paravirtualization operates more quickly than full virtualization.	Paravirtualization is faster in operation as compared to full virtualization.
5.	Full virtualization is easier to use and more versatile.	Paravirtualization is less portable and compatible.
6.	Microsoft and Parallels systems are examples of full virtualization.	Examples of paravirtualization are Microsoft Hyper-V, Citrix Xen, etc.
7.	Without change, it supports all guest operating systems.	Only a select few operating systems support it, and the guest operating system must be updated.
8.	Hardware calls will be made by the guest operating system.	Using the drivers, the guest operating system will directly communicate with the hypervisor.
9.	When compared to para-virtualization, it is less streamlined.	It is more streamlined.
10.	It provides the best isolation.	It provides less isolation compared to full virtualization.

Chapter 04

Problem 1 (3pts)
Describe the following techniques or terminologies used in cloud computing and cloud services. Use a concrete example cloud or case study to explain the addressed technology.

a. Virtualized data center
b. Green information technology
c. Multitenant technique

Answer 2

a. **Virtualized data center:**

- It is a collection of cloud infrastructure resources made especially for the demands of large businesses. Memory, storage, bandwidth, and other resources are included here.
- It is the process of creating, planning, and setting up a data center using cloud computing and virtualization technologies.

- It primarily hinges on the virtualization of physical servers, together with storage, networking, and other infrastructure components, in a datacenter.

Advantages:

- It has two catalogs, public and private, so you can upload virtual machines that are currently operating in your internal environment or easily develop new ones. The biggest benefit is vApp, which lets you create virtual apps inside of your virtual datacenter.
- First, we need to understand vAapp. When an application needs more than one virtual machine and you wish to store it from a catalog, it is employed in those cases.
- It immediately makes it possible for you to access cloud infrastructure from the Blue Lock service provider.

b. **Green information technology:**

- Nothing more than reducing the damaging effects of IT activities on the environment through the development, production, use, and disposal of environmentally friendly computers and computer-related items.
- This drives other IT practices, such as cutting back on dangerous materials and boosting productivity over the course of a product's lifecycle.

Features:

- Introduces the idea of employing supply chain and green procurement strategies in the IT infrastructure.
- It illustrates how adopting large-scale shared infrastructure and cloud computing to consolidate corporate IT platforms has less of an impact on the environment and has fewer hazards.

c. **Multitenant technique:**

- Multi-tenancy in the context of the cloud refers to the practice of two or more customers using the same service or application that is offered by another in order to benefit from lower costs and improved performance.
- Take Infrastructure-as-a-Service (IaaS), for instance, where the customer has access to and control over the ability to store and network resources. But the point is that he is unable to control the underlying infrastructure, and while security experts view this as a vulnerability, software developers see it as an opportunity.

Benefits:

- In comparison to other programs, it provides less expensive services and makes better use of hardware resources.
- Ease of maintenance

Shared applications, distinct databases, and separate tables can all be used to create multitenancy. It belongs to various systems, programs, or data from various resources, databases, or businesses that are hosted on the same physical hardware. It is typical of the majority of cloud-based solutions.

Problem 2 (2pts)
Consider two cloud service systems: Google File System and Amazon S3. Explain how they achieve their design goals to secure data integrity and to maintain data consistency while facing the problems of hardware failure, especially concurrent hardware failures.

Answer 2
When creating these cloud services, a recovery and backup strategy is always included to ensure the data's consistency and integrity. They are regularly backup their data, and in the event of a hardware failure or simultaneous hardware failure, the backed-up data is used to restore the system. Because the backups that are saved are also encrypted, it doesn't affect the service to the users and also preserves the integrity and consistency of the data.

Amazon S3: Storage for the Internet is provided by Amazon Simple Storage Service. For developers, it is intended to make web-scale computing simpler. You may store and access any quantity of data from Amazon S3 at any time, from any location on the web, using the service's straightforward web services interface. Each object is duplicated by Amazon S3 across all Availability Zones in the relevant area. Replication duplicates changes across all Availability Zones where it maintains copies, but it does not offer protection against unintentional deletion or data integrity compromise. Replication can ensure data and service availability in the event of system failure.