Unit 6

Virtualization (Approaches in Virtualization, Hypervisor and Its Role, Types of Virtualization)

1. Virtualization

Virtualization is the underlying core technology of cloud computing. It helps in creating a multitenant model for the cloud environment by optimizing the resource usage through sharing. Benefits of virtualization include the lower costs and extended life of the technology, which has made it a popular option with small- to medium-sized businesses. Using virtualization, the physical infrastructure owned by the service provider is shared among many users, increasing the resource utilization. Virtualization provides efficient resource utilization and increased return on investment (ROI). Ultimately, it results in low capital expenditures (CapEx) and operational expenditures (OpEx).

Some of the benefits of virtualization include better utilization rate of the resources of the service providers, increased ROI for both the service providers and the consumers, and promotes the green IT by reducing energy wastage. Virtualization technology has the drawbacks of the chance of a single point of failure of the software achieving the virtualization and the performance overhead of the entire system due to virtualization.

2. Approaches in Virtualization

There have been many approaches adopted in the implementation of virtualization technology. Some of the important approaches are discussed in the following subsections.

2.1 Full Virtualization

Full virtualization uses a special kind of software called a hypervisor. The hypervisor interacts directly with the physical server's hardware resources, such as the CPU and storage space, and acts as a platform for the virtual server's OSs. It helps to keep each virtual server completely independent and unaware of the other virtual servers running on the physical machine. Each guest server or the virtual machine (VM) is able to run its own OS. That means one virtual server could be running on Linux and the other one could be running on Windows. Examples include VMWare ESX and VirtualBox. In the full virtualization, the guest OS is unaware of the underlying hardware infrastructure. That means the guest OS is not aware of the fact that it is running on a virtualized platform and of the feeling that it is running on the real hardware. In this case, the guest OS cannot communicate directly to the underlying physical infrastructure. The OS needs the help of virtualization software hypervisors to communicate with the underlying infrastructure. The advantages of the full virtualization include isolation among the various VMs, isolation between the VMs and the hypervisor, concurrent execution of multiple

OSs, and no change required in the guest OS. A disadvantage is that the overall system performance may be affected due to binary translation.

2.2 Paravirtualization

In this case, VMs do not simulate the underlying hardware, and this uses a special API that a modified guest OS must use. Examples include Xen and VMWare ESX server. In this type of virtualization, partial simulation of the underlying hardware infrastructure is achieved. This is also known as partial virtualization or OS-assisted virtualization. This virtualization is different from the full virtualization in that, here, the guest OS is aware of the fact that it is running in a virtualized environment. In this case, hypercalls are used for the direct communication between the guest OS and the hypervisor. In paravirtualization, a modified or paravirtualized guest OS is required.

An advantage of this approach is that it improves the overall system performance by eliminating the overhead of binary translation. A disadvantage could be that a modification of the guest OS is required.

2.3 Hardware-Assisted Virtualization

In this type of virtualization, hardware products supporting the virtualization are used. Hardware vendors like Intel and AMD have developed processors supporting the virtualization through the hardware extension. Intel has released its processor with its virtualization technology VT-x, and AMD have released its processor with its virtualization technology AMD-v to support the virtualization. An advantage of this approach could be that it eliminates the overhead of binary translation and paravirtualization. A disadvantage includes the lack of support from all vendors.

3 Hypervisor and Its Role

The concept of using VMs increases the resource utilization in a cloud computing environment. Hypervisors are software tools used to create the VMs, and they produce the virtualization of various hardware resources such as CPU, storage, and networking devices. They are also called virtual machine monitor (VMM) or virtualization managers. They help in the virtualization of cloud data centers (DCs). The various hypervisors used are VMware, Xen, Hyper-V, KVM, etc. Hypervisors help to run multiple OSs concurrently on a physical system sharing its hardware. Thus, a hypervisor allows multiple OSs to share a single hardware host. In this case, every OS appears to have the host's processor, memory, and other resources allocated solely to it. However, the hypervisor is actually controlling the host processor and resources and in turn allocates what is needed to each OS. The hypervisor also makes sure that the

guest OSs (called VMs) do not interrupt each other. In virtualization technology, hypervisor manages multiple OSs or multiple instances of the same OS on a single physical computer system. Hypervisors are designed to suit a specific processor, and they are also called virtualization managers.

Hypervisors are of mainly two types:

1. Type 1 hypervisor: This type of hypervisor runs directly on the host computer's hardware in order to control the hardware resources and also to manage the guest OSs. This is also known as native or bare-metal hypervisors. Examples include VMware ESXi, Citrix XenServer, and Microsoft Hyper-V hypervisor.

2. Type 2 hypervisor: This type of hypervisor runs within a formal OS environment. In this type, the hypervisor runs as a distinct second layer while the guest OS runs as a third layer above the hardware. This is also known as the hosted hypervisors. Examples include VMware Workstation and VirtualBox.

4. Types of Virtualization

Depending on the resources virtualized, the process of virtualization can be classified into the following types.

4.1 OS Virtualization

In OS virtualization, a desktop's main OS is moved into a virtual environment. The computer that is used by the service consumers remains on their desk, but the OS is hosted on a server elsewhere.

4.2 Server Virtualization

In server virtualization, existing physical servers are moved into a virtual environment, which is then hosted on a physical server. Modern servers can host more than one server simultaneously, which allows the users to reduce the number of servers to be reserved for various purposes.

4.3 Memory Virtualization

In main memory virtualization, the virtual main memory that is abstracted from the physical memory is allocated to various VMs to meet their memory requirements. The mapping of physical to virtual memory is performed by the hypervisor software.

4.4Storage Virtualization

In storage virtualization, multiple physical hard drives are combined into a single virtualized storage environment. To various users, this is simply called

cloud storage, and it could be a private storage, such that it is hosted by a company, or a public storage, such that it is hosted outside of a company like DropBox, or a mixed approach of the two.

4.5 Network Virtualization

In network virtualization (NV), logical virtual networks are created from the underlying physical network. The physical networking components such as the router, switch, or network interface card could be virtualized by the hypervisor to create logical equivalent components.

5. Application Virtualization

In application virtualization, the single application installed on the central server is virtualized and the various virtualized components of the application will be given to the users requesting the services. In this case, the application is given its own copy of components such as own registry files and global objects that are not shared with others. The virtual environment prevents conflicts in the resource usage. An example is the Java Virtual Machine (JVM). In the cloud computing environment, the CSPs deliver the SaaS model through the application virtualization technology. In the case of application virtualization, the cloud users are not required to install the required applications on their individual systems. They can, in turn, get the virtualized copy of the application, and customize and use it for their own purposes.ailability and backup of the user’s data are achieved