What is Virtualization?

Virtualization is a process that allows for more efficient utilization of physical computer hardware and is the foundation of cloud computing.

Virtualization uses software to create an abstraction layer over computer hardware that allows the hardware elements of a single computer—processors, memory, storage and more—to be divided into multiple virtual computers, commonly called virtual machines (VMs). Each VM runs its own operating system (OS) and behaves like an independent computer, even though it is running on just a portion of the actual underlying computer hardware.

Need for Virtualization

- Eliminates inflexibilities.
- Allows for better manageability.
- Better utilization of the resources.
- Trade- off between performance and flexibility.
- Emulates the system.

Benefits of Virtualization

- Instant Provisioning.
- Pooling hardware resources.
- Backup & Restore.
- Cost Management.
- Monitoring.
- Dynamic Resource Sharing.
- Security & Fault Isolation.
- Sizing.
- Optimization.

Comparison with traditional IT infrastructure

Parameter	Traditional IT	Virtualization
Utilization	0-20%	Typically 60-70%
Provisioning	Typically takes 6-8 weeks	1 day
Monitoring	Usage of monitoring tools. However, need manual intervention to take care of any hardware failures	Comparative ease in monitoring using automated tools. However, need manual intervention to take care of any failures
Sizing	Sizing needs to be completed before deployment. Re-sizing involves procuring new hardware and planned downtimes	Easier to resize. However, manual intervention required to resize
Staff for Administration	Require larger number of Full Time employees to manage the infrastructure	Reduced number of Full Time employees
Cost	Upfront costs involved in outright purchase of hardware	Initial hardware cost reduced due to sharing of hardware assets and increased utilization. There is a typical reduction of 40% in hardware
Optimization	Difficult to do as there is no easy way to monitor and load balance across machines	Easy to share resources and re-balance loads on the virtual machines on the same host. However, re-balancing across physical hosts require advanced features and planned downtime

Hypervisor

A hypervisor is the software layer that coordinates VMs. It serves as an interface between the VM and the underlying physical hardware, ensuring that each has access to the physical resources it needs to execute. It also ensures that the VMs don't interfere with each other by impinging on each other's memory space or compute cycles.

There are two types of hypervisors:

TYPE-1 Hypervisor:

The hypervisor runs directly on the underlying host system. It is also known as a "Native Hypervisor" or "Bare metal hypervisor". It does not require any base server operating system. It has direct access to hardware resources. Examples of Type 1 hypervisors include VMware ESXi, Citrix XenServer, and Microsoft Hyper-V hypervisor.

Pros & Cons of Type-1 Hypervisor:

Pros: Such kinds of hypervisors are very efficient because they have direct access to the physical hardware resources (like Cpu, Memory, Network, and Physical storage). This causes the empowerment of the security because there is nothing any kind of the third party resource so that attacker couldn't compromise with anything.

Cons: One problem with Type-1 hypervisors is that they usually need a dedicated separate machine to perform their operation and to instruct different VMs and control the host hardware resources.

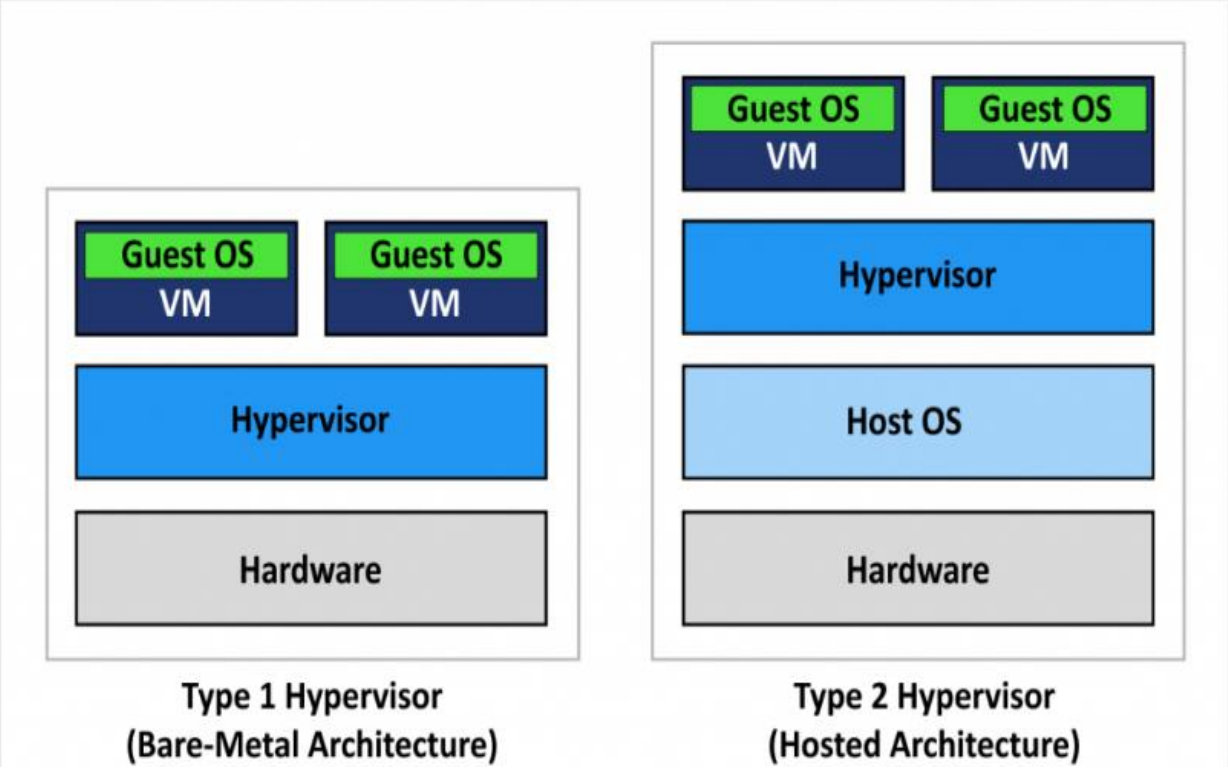
TYPE-2 Hypervisor:

A Host operating system runs on the underlying host system. It is also known as 'Hosted Hypervisor". Such kind of hypervisors doesn't run directly over the underlying hardware rather they run as an application in a Host system (physical machine). Basically, the software is installed on an operating system. Hypervisor asks the operating system to make hardware calls. An example of a Type 2 hypervisor includes VMware Player or Parallels Desktop. Hosted hypervisors are often found on endpoints like PCs. The type-2 hypervisor is very useful for engineers, and security analysts (for checking malware, or malicious source code and newly developed applications).

Pros & Cons of Type-2 Hypervisor:

Pros: Such kind of hypervisors allows quick and easy access to a guest Operating System alongside the host machine running.

Cons: Here there is no direct access to the physical hardware resources so the efficiency of these hypervisors lags in performance as compared to the type-1 hypervisors, and potential security risks are also there an attacker can compromise the security weakness if there is access to the host operating system so he can also access the guest operating system.



Types of Virtualization

1. Hardware Virtualization
2. Network Virtualization
3. Storage Virtualization
4. O S Virtualization
5. Desktop Virtualization
6. Application Virtualization

1. Hardware Virtualization

In hardware virtualization, software called hypervisor is used. With the help of hypervisor virtual machine, software embedded into the hardware component of the server. The work of hypervisor is that it manages the physical hardware resource which is shared between the customer and the provider.

Hardware virtualization can be done by extracting the physical hardware with the help of the virtual machine monitor (VVM).

Types of Hardware Virtualization

This is the list of hardware virtualization in Cloud Computing:

1. Full Virtualization
2. Partial Virtualization
3. Para-Virtualization

1. Full Virtualization

In full virtualization, there is no need for any modification to run any application. In addition, the hardware architecture completely simulates, which benefits the guest software. There is an environment, quite similar to an operating system in a server.

With the help of full virtualizations, the administrators allow running a virtual environment change to its physical counterpart. With the help of full virtualization, the administrators can combine the new and the existing system for something efficient. So, it should be compatible with the newer system.

2. Partial Virtualization

When entire operating systems cannot run in the virtual machine, but some or many applications can, it is known as Partial Virtualization. Basically, it partially simulates the physical hardware of a system.

This type of virtualization is far easier to execute than full virtualization. This is very successful when computer resources are shared among-st multiple users.

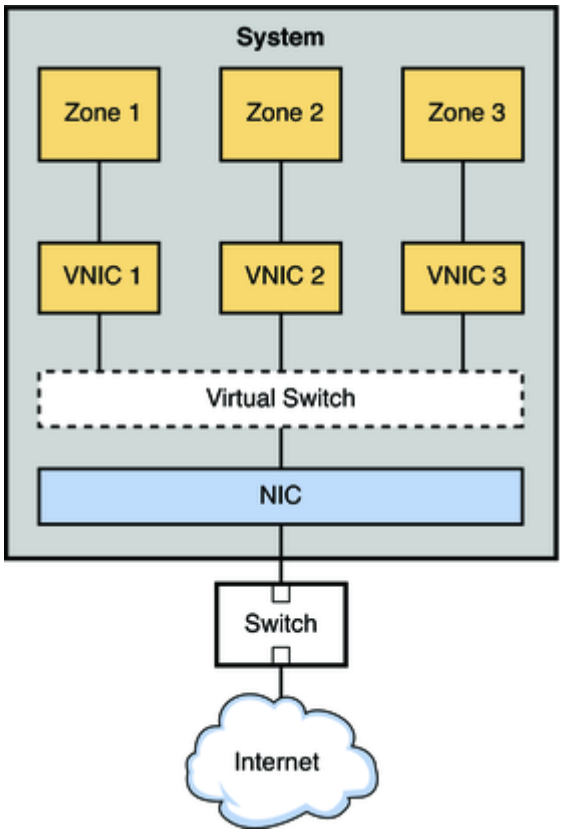
3. Para Virtualization

- Virtual guests aware that it has been virtualized, unlike the full virtualization.
- Guest source codes will be modified with sensitive information to communicate with the host.
- Guest Operating systems require extensions to make API calls to the hypervisor.
- In full virtualization, guests will issue a hardware calls but in para virtualization, guests will directly communicate with the host (hypervisor)

using the drivers. Xen, IBM LPAR, Oracle VM for SPARC (LDOM), Oracle VM for X86 (OVM), Citrix.

2. **Network Virtualization**

Network virtualization is the process of combining hardware and software network resources and network functionality into a single, software-based administrative entity, a virtual network. Network virtualization involves platform virtualization, often combined with resource virtualization. All network servers and services are considered as one pool of resources, which can be used independently of the physical elements.



3. **Storage Virtualization**

Storage virtualization is when you group several physical resource and make it look like a single storage. It makes managing storage from multiple sources to be managed and utilized as a single repository. Storage virtualization software maintains smooth operations, consistent performance.

Types of Storage Virtualization

1. Block level virtualization: Block virtualization used in this context refers to the abstraction (separation) of logical storage (partition) from physical storage so that it may be accessed without regard to physical storage or heterogeneous structure. This separation allows the administrators of the storage system greater flexibility in how they manage storage for end users.

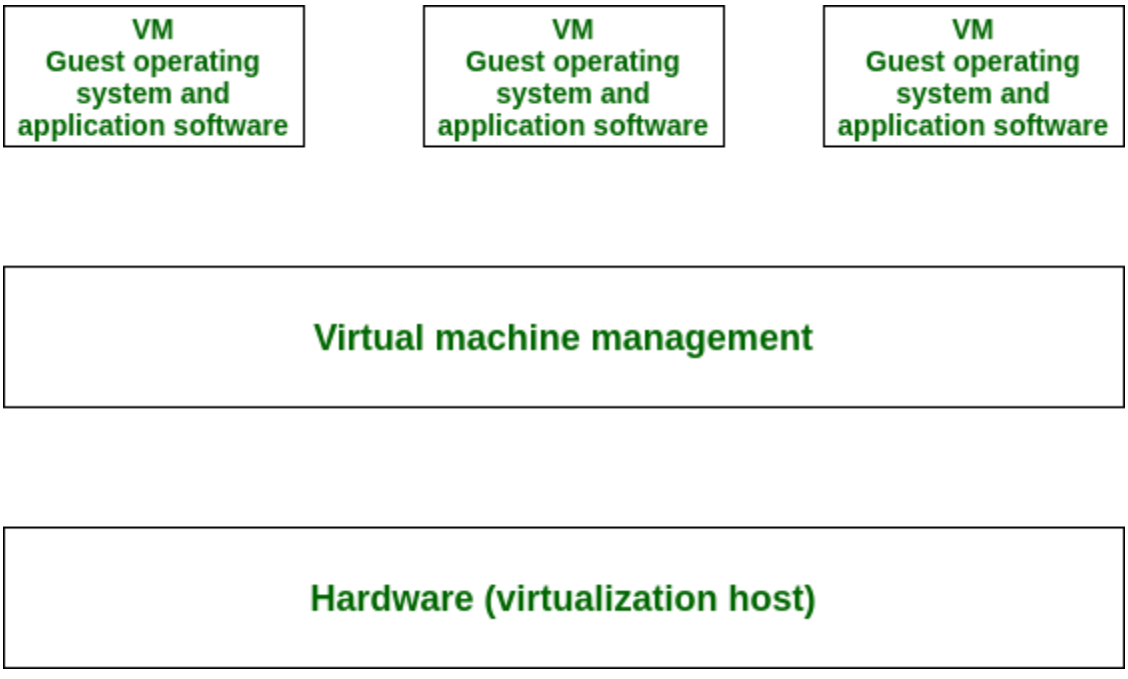
2. File level virtualization: File virtualization addresses the NAS (Network-attached storage) challenges by eliminating the dependencies between the data accessed at the file level and the location where the files are physically stored. This provides opportunities to optimize storage use and server consolidation and to perform non-disruptive file migrations.

4. OPERATING SYSTEM VIRTUALIZATION

When the virtual machine manager (VMM) is installed on the Host operating system instead of directly on the hardware system is known as operating system virtualization.

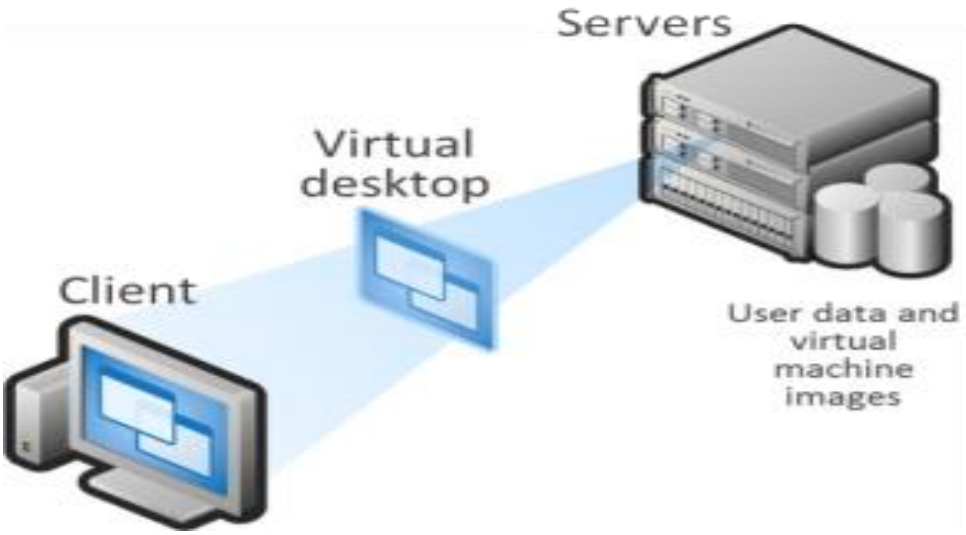
Usage:

Operating System Virtualization is mainly used for testing the applications on different platforms of OS.

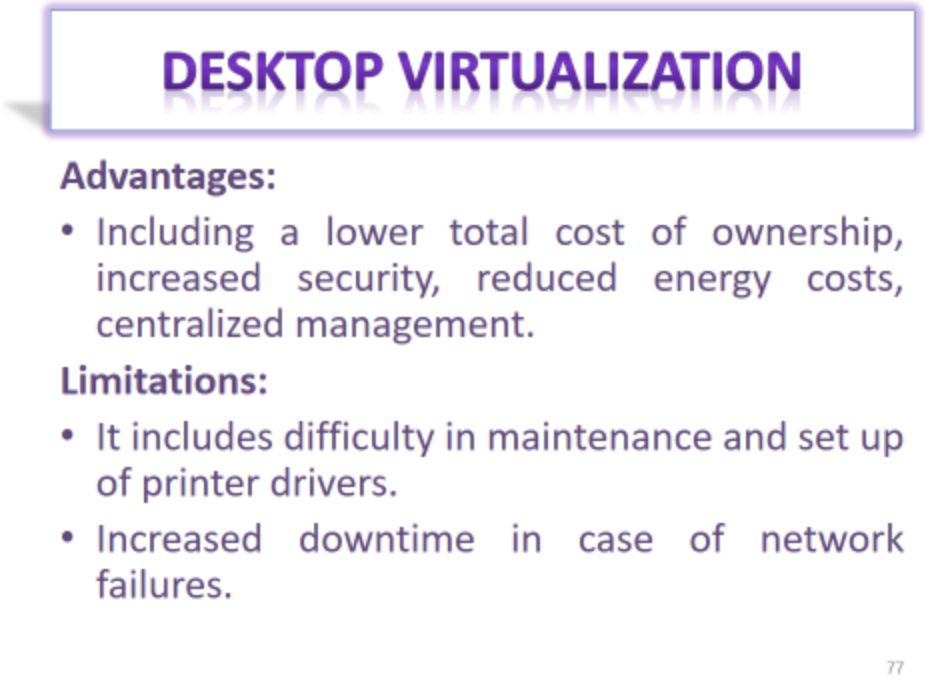


5. Desktop Virtualization

- It is a virtualization technology that separates an individual's PC applications from his or her desktop.
- Virtualized desktops are generally hosted on a remote central server, rather than the hard drive of the personal computer. Because the client-server computing model is used in virtualizing desktops.
- It is also known as client virtualization.



- The user’s desktop is stored on a remote server, allowing the user to access his/her desktop from any device or location.
- Employees can work conveniently from the comfort of their home. Since the data transfer takes place over secure protocols, any risk of data theft is minimized.



6. APPLICATION VIRTUALIZATION

Application virtualization software allows users to access and use an application from a separate computer than the one on which the application is installed. Using application virtualization software, IT admins can set up remote applications on a server and deliver the apps to an end user's computer. For the user, the experience of the virtualized app is the same as using the installed app on a physical machine.

Advantages:

- Gives administrators better control over virtualized organization apps.
- An effective way for organizations to maintain their desktop applications.
- Makes it easy to update apps and roll them out globally.
- Gives room for flexibility to deliver and manage a user setting
- Offers businesses a cost-effective strategy when setting up a remote office.
- Controls and contains messy interactions with operating systems.

Disadvantages:

- Greater IT complexity
- Losing out to competition
- More business disruption
- High hardware and management costs in the long run

Scaling

There are two types scaling

1. **Horizontal scaling**
2. **Vertical scaling**

Horizontal scaling refers to provisioning additional servers to meet your needs, often splitting workloads between servers to limit the number of requests any individual server is getting. Horizontal scaling in cloud computing means adding additional instances instead of moving to a larger instance size.

Vertical scaling refers to adding more or faster CPUs, memory, or I/O resources to an existing server, or replacing one server with a more powerful server. In a data center, administrators traditionally achieved vertical scaling by purchasing a new, more powerful server and discarding or repurposing the old one.

Cloud bursting

Cloud bursting is an application deployment technique in which an application runs in private cloud or data center and bursts into a public cloud when the demand for computing capacity. This deployment model gives an organization access to more computing resources when needed.

When compute demand exceeds the capacity of a private cloud, cloud bursting gives an organization additional flexibility to deal with peaks in IT demand. In addition, cloud bursting frees up local resources for other critical applications.