# Analysis on Virtualization Technologies in Cloud

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## I. Abstract

*Virtualization was one of the trending research technologies in the IT industry now days. Organizations which were working for the advancement in Cloud Computing were concentrating more on virtualization technology. Virtualization technology brought many changes in the functionality of cloud computing technology through which solutions for very long lasting problems were found. One such solution found by virtualization technique is 'hypervisor' which is a software layer inserted between the hardware and the operating system was solving many of the security issues. In this paper we will discuss about virtualization technologies in different areas of cloud computing.*

*Key Words: Virtualization, Cloud Computing, hypervisor, Software layer, Operating System.*

## II. Introduction

The number of resources being networked and shared to the world is increasing day by day. There are many computing techniques to share the resources all over the world like grid computing and distributed computing but there is a more advanced technology emerged from the above listed technologies called cloud computing. There are many issues occurred in cloud computing for which there are no solutions found till now. Despite the issues the demands for cloud services are increasing day by day. Definitely the issues are obstacles for the development of cloud computing technology.

## III. Definition

Virtualization is a technique of dividing the computational and physical resources of a computer into multiple identical execution environments [1]. Virtualization creates a virtual version of a system or resources like storage, network, and OS etc. The virtualization software will be like a layer of medium between the computational hardware and the applications running on the hardware [2]. Virtualization provides the capability for a single physical host to act as multiple hosts that operate independently.

## IV. Virtualization of a System

Virtualization can be done by partitioning the hardware into multiple segments or by using software called hypervisor.

### a) Partitioning hardware

Dividing the physical resource into several sub parts where each part can run applications identical as the source system is called virtualization through hardware partitioning [10]. In this method we can't get the complete benefits which are generally obtained from the resource.

  

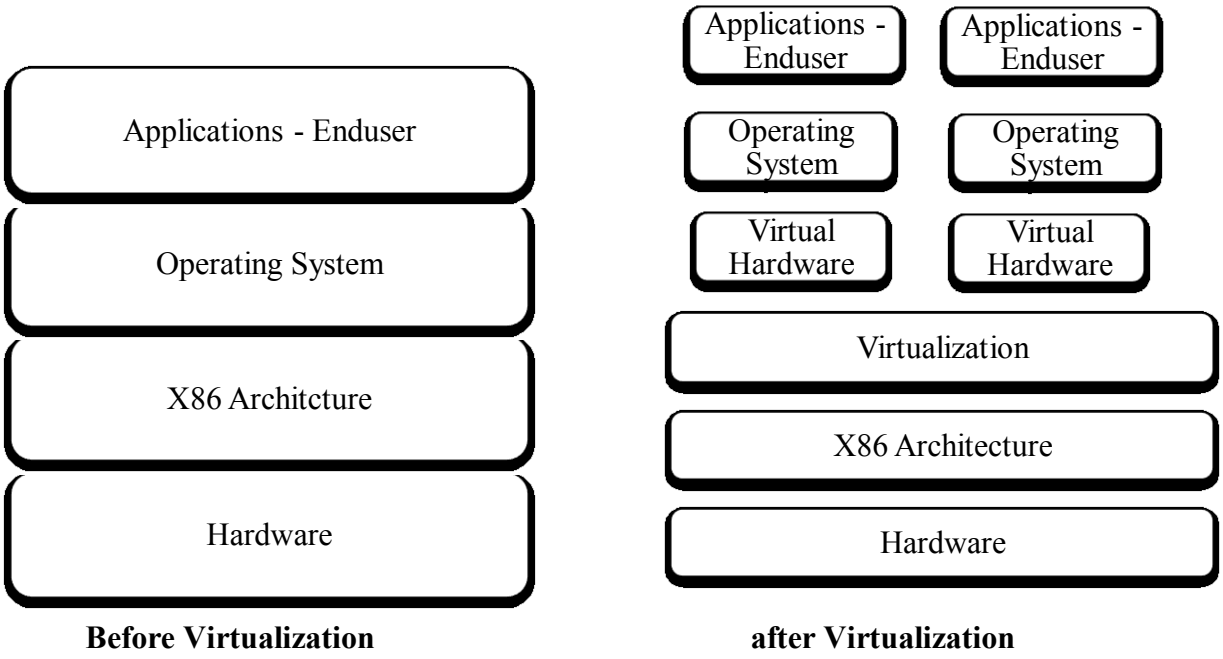


**Fig 1: Generalized Architecture of a system before and after virtualization**

**b) Hypervisor**

Hypervisor is a piece of code or a thin layer of software which allows sharing a single resource by multiple operating systems through which it appears like each OS is having its own processor, memory and other hardware resources. Hypervisor is of two types, type1 hypervisor runs directly on the hardware of the system whereas the type2 hypervisor runs on the systems operating system [9].

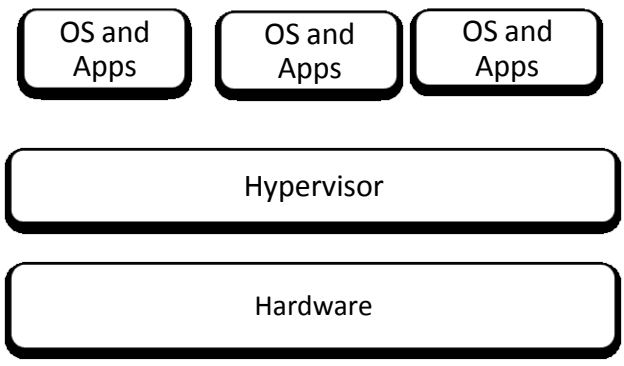


**Fig.2 Type1 Hypervisor**

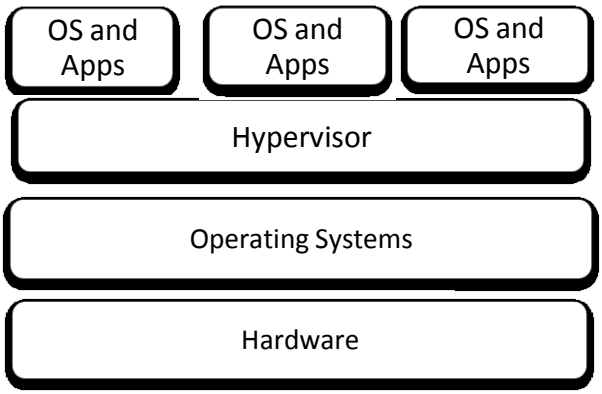


**Fig.3 Type 2 Hypervisor**

  

*Type1 Hypervisor:* This type of hypervisor runs directly on the system hardware. This hypervisor is preferred because of the advantages like achieving higher efficiency in virtualization because of the direct contact with the system hardware and also having higher performance and security [4].
*Example:* Power5 server, Xen Hypervisor, VMware ESX server etc.

*Type2 Hypervisor:* This type2 hypervisor runs on the operating system of the host. Type2 hypervisors are less efficient that type1 hypervisor in many issues like performance, security etc. Mostly the type2 hypervisors are used on client systems where the performance of the system is not so critical [4].
*Example:* VMware GSX server, Microsoft Virtual server etc.

## V. Virtualization Areas

The idea of virtualization is not new. The notion of Virtualization has taken place around in the age of first main frame systems. Virtualization can be applied to any part of a computing system. Generally the virtualization can be applied to three categories in a computing system such as operating system, storage and applications. But these are very broad categories to specifically define a particular area for virtualization, so these broad areas are distilled into 8 specific categories such as:

### A. Network Virtualization

Network virtualization reproduces the complete physical network in software. The process of combining all the network resources available into a single unit and then dividing that into several virtual execution systems which are isolated from each other is called network virtualization [6]. The above stated network resources include fundamental resources such as nodes, links and also derived resources like topologies or a combination of both which can be virtualized recursively. The network virtualization became more popular these days because of some techniques which are already in commercial use such as

a) *Virtualization of the network infrastructure:* The network virtualization began with the virtualization of the fundamental building blocks of network like Network Interface Cards (NICs) and Routers. The NIC virtualization involves sharing of NIC hardware among several instances of virtual OS. Virtual routers share the hardware resources like memory, CPU, NIC etc with other execution environments of virtual operating system in the same physical machine [6].
b) *Virtualization of Links:* The technologies for creation of virtual links include Bandwidth virtualization, Physical channel multiplexing, and data path virtualization. Even though multiplexing is not a technology for virtualization it was performing many functions similar to virtualization [6]. The bandwidth virtualization refers to the combination of bandwidth of individual channels into a single channel to create virtual links.

  

c) *Virtualization of the Data Path:* The virtual link which reflects the virtualization of data path will not depend on the physical properties of the links like bandwidth to direct the data. The data direction will be taken care by nodes which uses various technologies to direct the data. Some concepts to be discussed here in data direction are Labels, Tunnels and encapsulation [6]. Labels are like tags or ID's which will contain some information of the packet header and can be used by the nodes to direct the data to the destination through virtual links. Tunnels use encapsulation techniques like GPRS tunneling protocol and MPLS labeled switch path etc to provide virtual connections between network devices.

d) *Virtualization of Networks:* Currently in the industry there are many technologies being used depending on the virtualization of network. Few examples are Overlay networks which are built on an existing physical network, Virtual Private Networks shortly called as VPN; it is a collection of private networks which can create a network among themselves but that network is isolated from public networks such as internet. Virtual sharing Networks will share the physical resources among the network to multiple virtual environments which are isolated from each other so that there will be a clear marking out from each other. All the above listed are currently existing and being used technologies in the industry. Besides these technologies there are some emerging technologies which are reflecting the advancement in the area of network virtualization, some of them are

e) *Leasing the network:* Today the owners of the infrastructure are able to share or lease parts of their network infrastructure with the help of virtualization. Till now the service is provided by the VPNs in the corporate culture. Today there are more technologies that are being emerged by using the technique of virtualization [6]. The owners of the physical resources can become an Infrastructure provider by leasing the unused resources of them.

f) *Virtualization of Wireless Networks:* Till now the world has done experiments of the network virtualization on the wired networks section only [6]. Very recently the researchers started exploring about the wireless network virtualization. Some of the wireless network virtualization techniques are mobile cellular network virtualization, Sensor Network virtualization etc.

Despite the progress in the network virtualization there are some obstacles being found along with the advancement in the technology. Some of them are listed below

**B. Storage Virtualization:**

All the physical network storage devices when combined into a single unit by taking into consideration the parameters like performance, capacity, availability, cost and then divide that unit into several isolated parts and allocate them to virtual versions of a system which makes some improvement in the so considered parameters performance, capacity, availability, cost is called virtualization of a storage area [7]. The combined single unit of resource will be managed from a central system. The storage virtualization refers to the abstracting of the software or logical applications from the storage hardware which is underlying physically. Storage virtualization simplifies the management of the resources and reduces the complexity in

  

administering the storage infrastructure. Although the cost of storage devices came down the maintenance charges of applications, software and administration charges became overhead for the companies. Virtualization of the storage devices helps in controlling these costs. The storage virtualization technologies which are existing and are upcoming are discussed shortly below.

a) *Virtualization based on Host:* This virtualization method supports multi-vendor storage systems which give flexibility in using devices of user's choice [7]. But here the software vendor will be only one company which will create problems in the case of multiple platforms. In this technique it is required to install and manage software and applications on each host which requires bandwidth from the host itself and results in effecting the performance of the host.
b) *Virtualization through in-band application:* In this technique the performance will be increased if we use a dedicated switch. Using a switch from a single vendor will create some obstacle while upgrading the network frequently [7]. Here also there is a requirement of bandwidth from the host which will affect the performance of the host. This in-band appliance technique also supports multi-vendor systems.
c) *Virtualization through out of band application:* The functionality is almost similar to the in-band appliance technique but the difference is here the location will be out of I/O path [7]. While virtualization we must install software on each and every host which will affect the performance of the host like slow snapshot capabilities etc.
d) *Storage Subsystem:* This virtualization technique reduces the management complexity by using standard hardware and integrated RAID management. The only drawback here is there will be only a single storage vendor.

**C. Server Virtualization:**

The division of a single physical server into multiple virtual servers is called server virtualization. Server virtualization creates a more efficient and simple environment to use a server by abstracting the operating system and applications from the physical hardware. By the virtualization of a server we can run multiple virtual machines with different operating systems on each VM which will be having access to the underlying infrastructure of the server. The software layer that lays on the physical hardware abstracts the resources logically from the physical layer is called hypervisor. Hypervisor is also called as virtual machine monitor (VMM) which allows to create virtual machines. There are some methods for the virtualization of a server such as full virtualization**,** Para virtualization and OS-level virtualization etc. The physical servers are called hosts and the virtual servers are called guests.

a) *Emulation:* In this virtualization method software will be built which can perform all the complete functionalities of the physical server's hardware [8]. The software reflects all the properties of the server's hardware. Because of the architecture incompatibility there is no need to change the guest system [8]. The only drawback here in this method is the

  

instruction from the guest system should be translated into the form that the hardware can understand. This translation process is very slow when compared to the original speed of the hardware.

b) *Full Virtualization:* In this method a software layer called "hypervisor" is used. The hypervisor can directly interact with the physical server's processor and disk and acts like a media between the operating systems of the virtual servers [9]. The hypervisor monitors the physical server's resources and provides those resources to the virtual servers based on their needs also maintains isolation between the virtual servers. It translates the commands of guest system to the physical hardware quickly. The hypervisor itself requires some resources for its own functionality like some space in the hard disk and some processing power etc. The virtualization capabilities can be improved without making changes to the guest system.

c) *Para Virtualization:* This method is almost similar to the full virtualization but the difference will be in the functionality of the hypervisor. Here the virtual servers will not be isolated from each other [9]. Each guest operating system will know the demands of the other operating systems. So here there will be less resource requirement of resources by the hypervisor because each guest operating systems will know the demands of others and the whole system will be treated as a single unit.

d) *OS-level Virtualization:* In this virtualization method there will be no hypervisor. The OS will take care of all the functionalities of a virtualized hypervisor. Here the drawback is every guest server must use same operating system [9]. But every guest server will be isolated and works independently from others. This method of server virtualization is faster and efficient than other methods.

**D. Hardware Virtualization**

Hardware virtualization means the process of embedding software on physical hardware components and making a single physical hardware component to act as multiple virtual hardware components. The virtualization of the operating system is one of the needs to occur for the hardware virtualization to happen. Some examples are

a) *Slicing:* In this technique a 25% of the CPU resources are reserved for encryption purposes. If the amount of process requirements doesn't reach 25% then the remaining reserved resources will go unutilized and if there is an excess requirement of resources i.e. more than 25% then the requests will be queued and will be allocated resources based on FIFO methodology. This method of virtualization of hardware is also called pre-allocation.

b) *Asymmetric multiprocessing:* This method is a replica for pre-allocation method. Here the resources such as CPU segments are allocated specifically for certain resources statically. Pre-allocation method is suitable for certain hardware tasks that cannot run everywhere

  

but only on specific platforms. Asymmetric multiprocessing can cause resource shortages also.

c) *Symmetric multiprocessing:* The only difference between Asymmetric and Symmetric multiprocessing is here there will be a dynamic allocation of resources that means tasks can run on any CPU which provides more benefits than static method of resource allocation. The drawback of symmetric multiprocessing is there will be no control on the process and the resource allocation which will cause resource scarcity when all the resources are allocated to few processes only.

### E. Application Server Virtualization

Normally in standard computing process, applications will configure the host system settings based on the operating system of host but in application virtualization each application will become centralized management systems which results in not disturbing other applications [8]. That means each application will carry out the necessary configurations along with them on-demand. In this process the settings on the host will not be changed. Application virtualization will be above all the other virtualization technology layers because in the virtualization layers like storage there will be having distribution of resources to be done in real time. Application virtualization helps the end-users to have flexibility in their work with multiple applications.

a) *Application Streaming:* Normally when an application is needed there will be a package of entire application obtained. But in application streaming all the resources will be obtained in small pieces of configuration settings, code and data that are needed in the beginning [4].
b) *Remote Desktop Services:* This comes under the category of terminal services. Remote desktop service allows a client to access his system remotely on another system on a network. Here in this technique Remote Desktop Protocol (RDP) is used [4].
c) *Desktop Virtualization:* Desktop virtualization is a generalized term which means separating a part or complete applications of a desktop from the physical device through which we access it generally. One of the best examples is "Hypervisor".

## VI. Conclusion

In this paper we discussed different areas of virtualization in Cloud Computing and different techniques that are being developed in each area. Some of the virtualization techniques that are listed in above sections are already implemented as commercial components by industrial organizations and some of them are future technologies that are still to be implemented and now in the planning phase. Current virtualization technology has solved problems in multiple areas of cloud such as security, scalability, implementation costs etc. In the near future virtualization will spread in many more areas of IT industry and bring a revolutionary change.

  

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