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Systematic Study of Virtualization

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Abstract: ***With the increasing physical system footprint, the infrastructure becomes too complex to manage installation, regular updates and application software. The goal of virtualization is to mitigate these issues by constructing a more flexible and manageable IT infrastructure. Virtualization eliminates most of the inflexibilities inherent in the hardware system and allow for better manageability leading to a better utilization of the system. In this paper we will classify the virtualization by various ways. So that novice person can understand the concept of virtualization in an easy way. Also, this paper will draw various comparison tables, these will help to develop a precise level of understanding about several type of virtualization as well as it will tell us, how does virtualization improve the efficiency of the system.***

Keywords: Virtualization, VMM, OS Virtualization, Server Virtualization, Hardware Virtualization.

I. INTRODUCTION

Virtualization refers to the technique of building an abstraction layer over the hardware that closely resembles the underlying hardware, OS or other system components, thereby, cloning the functionality of the original components into software. The virtual machine allows for Better manageability, better change management and better utilization of the overall infrastructure.

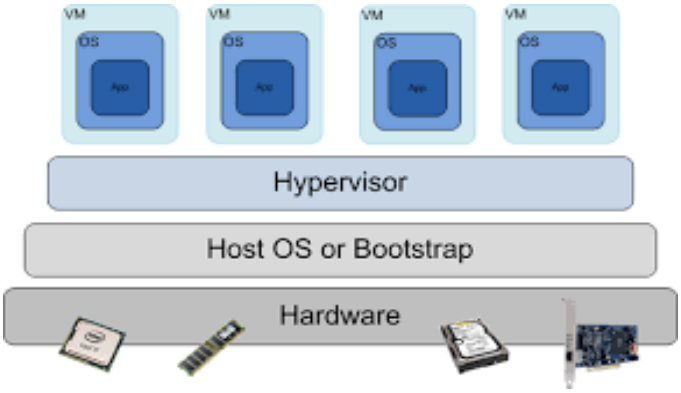

Figure1

With the large participation of IT in business, the complexity of the system has gone up. Also, with the advancement of technology, the resources available on an average hardware system exceeded the requirements of an application.

This leaves lot of capacity underutilized on these systems and a result has come that systems are not effectively utilized their full capacity.

These systems still consume power and cooling and take up space in the data center. Since a single hardware system only offers limited isolation between applications, this poses a limit on the number of application you may want to put on a single hardware system. This has been fine until the system capacity closely matched the requirement of the applications.

Comparison Table:

Table 1

Parameter	ClassicalIT Infrastructure	Virtualization
Efficiency	0-20%	60-70%
Cost	High cost investment in hardware purchasing	Low cost, Cost reduction up to 40% in purchasing of hardware.
Optimization	Difficult, No way to monitor load balancing	Easy, Resource sharing and load balancing
Configuration	6-8 weeks	1 day
Sizing	Resizing need new software and planned downtime	Easy to resize

Virtualization is a vast field. It is now possible to virtualized all aspect of an IT infrastructure ranging from desktop to enterprise servers. Typically, 60-70% of the infrastructure can be virtualized thus resulting in reduction of about 60-70% physical server. This enables better asset management and monitoring. Virtualization saves cost on three fronts: people, process and technology. Benefits of Virtualization are shown in Table1.

II. APPLICATION OF VIRTUALIZATION

- Server Consolidation
- Clustering
- Data Mirroring
- Data Replication
- High availability
- QoS

III. CLASSIFICATION OF VIRTUALIZATION

a) Classification on the basis of extent of hardware emulation

i) Para virtualized device model: There is no hardware simulation or emulation done by the Virtual machine. The virtual machine uses hyper call API to communicate with the hypervisor for instruction dispatch and other purposes. The guest OS must be modified to work with the hyper call API. Only open source OS/Certified OS that can be modified are suited for para-virtualization. This method places additional constraints on the OS. For example: Xen-ParaVirtualization.

ii) Full Emulation: The virtual machine emulates complete set of hardware and peripheral components. This allows for an emulation of a completely different type of hardware distinct from the real hardware. For example: A PowerPC architecture can be emulated over x86 hardware. The guest OS designed for PowerPC, in this case can be run unmodified on the emulated hardware. A few examples of emulated hardware are Qemu-PPC Emulator, Alpha ES40 emulator, Qemu-ARM emulator etc.

***iii) Native Virtualization*:** It is possible to emulate only a section of hardware and use the real-hardware for the rest. For example: The x86 Xen Full-Virtualized machine would generally emulate the hard drive and use the real x86 cpu with no emulation. This offers higher performance as you bypass the emulation layer and use/multiplex the real hardware (with aid from the hypervisor) wherever possible. This also places a constraint on what kind of virtual machine can be defined. For example: The full-virtualized virtual machine can only be a x86 instruction compatible when running on a x86 hardware. For example, Xen-Full Virtualization, Qemu-x86.

Comparison for all three type of virtualization are given in Table 2.

Comparison Table:

Table 2

Emulated device	Para virtualized device	Native Virtualization
It simulates hardware for a guest operating system.	In this, the guest operating systems run on the hypervisor.	Use Type-2 hypervisor
It is difficult	It has complex driver architecture	It allows to load a full operating system
It offers low performance.	It offers higher performance	It offers moderate performance
Widest hardware compatibility	Direct hardware access is possible	VMware Server, Workstation, Virtual PC, and Virtual Server.

b) Classification based on interaction layer

i) Hardware Virtualization: A virtualization gives the concept of running multiple operating systems on a single physical machine. This is hardware virtualization, and while it's not the only important kind of virtualization, it is undoubtly the most significant today.

The fundamental idea of hardware virtualization is to use software to create a virtual machine (VM) that emulates a physical computer. When multiple VMs available at once, this approach allows running several operating systems simultaneously on a single physical machine.

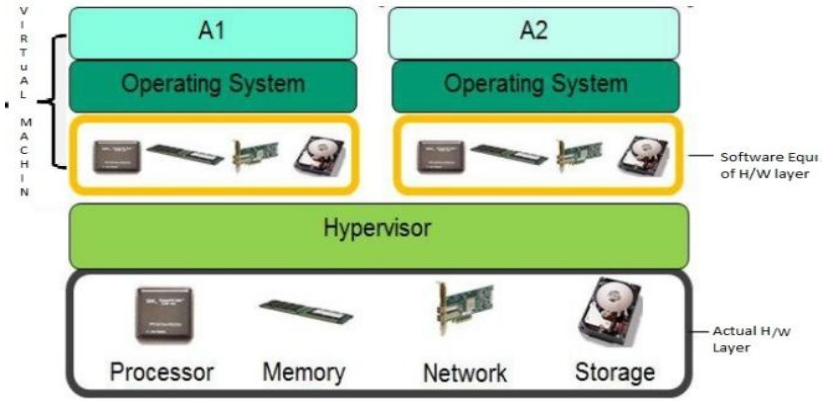

Figure 2: Hardware virtualization

There are two hardware virtualizations, first is Desktop virtualization and second is server virtualization. When we use client machines, then it is called *desktop* virtualization, while using it on server systems is known as *server* virtualization.

There are many condition when we can use Desktop virtualization, one of them is to deal with incompatibility between applications and desktop operating systems. For example, suppose a user running Windows XP needs to use an application that runs only on Linux. By creating a VM that runs this Linux operating system, after that application can be installed in that VM.

The use server virtualization is to restore failed systems easily. Virtual machines are stored as files, so restoring a failed system can be as simple as copying its files into new machine. Physical machine may have different configuration for their VMs, thus there is no need of identical configuration in restoring of System.

ii) Presentation Virtualization: This approach allows creating *virtual sessions* for different users. Each user interacts with a remote desktop system. The applications executing in those sessions depend on presentation virtualization to project their user interfaces remotely. However, many persons use single machine to run and present their software. If any organization uses many machine, then data security and maintenance require more money and time. In that case presentation virtualization plays a big role.

In this, each session runs only a single application, or it might present its user with a complete desktop having multiple applications. One benefit of presentation virtualization, one installed application can give service to many session of the users.

iii) Application Virtualization: Application as a virtue of their design and implementation allows virtualization by creating a separate sub-application instance with components that are not shared within the application (files, memory objects). For example: Java Virtual Machine.

Comparison for such type of virtualization are given in Table 3.

Comparison Table:

Table 3

Hardware Virtualization	**Application Virtualization**	**Presentation Virtualization**
A standard OS gets installed on a fictitious piece of hardware	You can install incompatible applications	Each session can runs single application, or a complete desktop.
Hyper-V Virtual Desktop Virtual PC 2007, (MED-V)	Microsoft SoftGrid	Remote Desktop Services—RDS
High performance	Low Performance	Single level Processing
straightforward	Complex	Simple

c) Virtualization can also be classified based on the technology or the area that is being virtualized: Server, Storage, Network

i) Storage Virtualization:A technique which creates a logical abstraction of the underlying storage hardware/firmware components and provides a uniform view of the heterogeneous storage hardware used within a storage infrastructure. This allows for enough flexibility in managing the storage hardware

ii) Network Virtualization:A technique which creates a logical abstraction of the underlying network hardware and resources and provides a uniform view of the heterogeneous network hardware used within the infrastructure. This allows for enough visibility and flexibility in managing the network hardware.

iii) Server Virtualization:Refers to virtualization of the server hardware components so that each virtual machine canrun its own logical server instance. A virtual machine provides a complete operating environment regardless of others. All server components for the virtual machine are virtualized.

***iv) Memory Virtualization*:**Memory is required in every digital machine, PC, Switches, routers and servers. Each has physical memory which can be used by CPU. Firstly, Memory Virtualization initiated a way to decouple memory from the processor, AND, from the server to provide a shared, distributed and functions. This virtualized memory is shared between multiple machines.

Memory virtualization Extend memory beyond a physical server's capacity and implement memory among cluster or grid environments. It also enables cloud computing data center and Real time infrastructure data center.

Table 4 demonstrate the comparison among storage, network, and server virtualization.

Comparison Table:

Table 4

Storage Virtualization	**Network Virtualization**	**Server Virtualization**
Disk storage complexities are hidden from operating systems	Network applications are moved into the network devices	Physical server hardware is separated from Guest operating systems
Data core	Cisco, 3Com ON	VMware Server, ESX Server, Xen, Virtual Iron, Microsoft Virtual PC,
Combines multiple pools of storage into one or more logical containers	provides a strong foundation for software-defined datacenter	greater reach and High speed

IV. CONCLUSION

Virtualization has become more attractive from last few years as cost controlling measures are sought out in enterprise environment. In an effort to improve performance of these virtualized systems, precise knowledge of virtualization is needed. In this paper, several virtualization classification techniques with examples are discussed.

Also, paper explored various way to classify the virtualization and have discussed little bit about almost all type of virtualization. Moreover, paper has also served comparison among various type of virtualization. It gives a enough explanation so that novice person could understand the things in easy way. In future, we will explore each type of virtualization in detail.

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