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Virtualization: One of The Core Technologies of Cloud Computing and Its Success

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Abstract- Virtualization is a technique, in which the creation of a virtual, rather than actual version of something. In computing, virtual is a digitally replicated version of something real. The replication, which is created with software, may not be an exact copy of the actual item, but it is similar enough in essence to be described as a digital rendition. The term virtualization broadly describes the separation of a resource or request for a service from the underlying physical delivery of that service. With virtual memory, for example, computer software gains access to more memory than is physically installed, via the background swapping of data to disk storage. Similarly, virtualization techniques can be applied to other IT infrastructure layers - including networks, storage, laptop or server hardware, operating systems and applications. Virtualization is a combination of software and hardware engineering that creates Virtual Machines (VMs) - an abstraction of the computer hardware that allows a single machine to act as if it where many machines. There are many challenges in business like, cost-effective resources utilization, responsiveness in supporting new business initiatives, flexibility in adapting to changes in organization function, expansion and sense of urgency and so on. Virtualization is a fundamental technological innovation that allows skilled IT managers to deploy creative solutions to such business challenges. This paper discusses what virtualization is, how technologies improve it, and how organizations can benefit from adopting virtualization into future IT plans.

Keywords: Cloud Computing, Grid Computing, Virtualization, Utility Computing, Autonomic Computing.

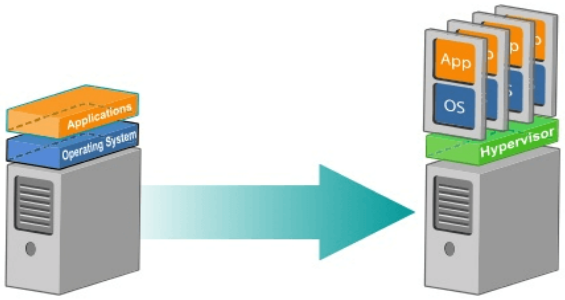
I. INTRODUCTION

In contemporary situation, computer science researchers and developers and scientists try to define their inventions or developments based on their experience and realization. Hence it is little difficult to have a single definition for a terminology and generally we choose a most appropriate one among them. Similarly virtualization is understood in different ways and we choose a appropriate one.

This paper is organized as follows: Section I discusses the introduction of terminology used by developers. Section II gives the idea of Virtual Machines. Section III introduces the concept of virtualization. Section IV gives Virtualization infrastructure, Section V briefs the types of virtualization. Section VI deals with the advantages and disadvantages of virtualization. Section VII differentiates the virtualization and cloud computing and the last section VIII Concludes the paper.

II. VIRTUAL MACHINES

Previously, can be called as traditionally, there were computers that ran an Operating System (OS) and application on top of the OS, but now, with the help of virtualization software like Hypervisor, one can create multiple Virtual Machines (VMs) on a single computer and install OS on them and run all of them at the same time.

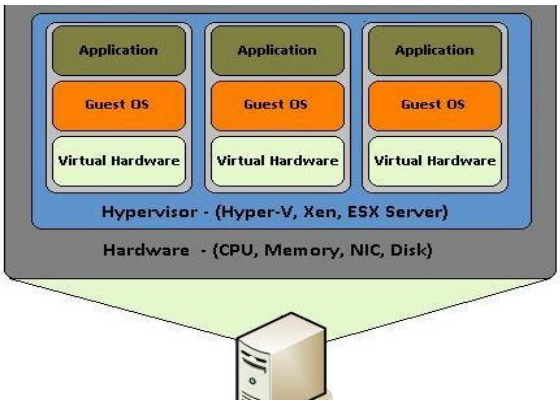


A virtual computer system is known as a "virtual machine" (VM): a tightly isolated software container with an operating system and application inside. Each self-contained VM is completely independent. Putting multiple VMs on a single computer enables several operating systems and applications to run on just one physical server, or "host."

A thin layer of software called a "hypervisor" decouples the virtual machines from the host and

dynamically allocates computing resources to each virtual machine as needed.

As mentioned above, a software makes virtualization possible. This software is known as a Hypervisor, also known as a virtualization manager. It sits between the hardware and the operating system, and assigns the amount of access that the applications and operating systems have with the processor and other hardware resources, as shown in the figure.



We can define Virtualization as a technology that provides the capability to logically separate the physical resources of a server and use them as different isolated machines, called Virtual Machines. The CPU becomes many virtual CPUs, and same becomes true for RAMs and Hard Disks.

Key Properties
VMs have the following characteristics, which offer several benefits.

Partitioning
Run multiple operating systems on one physical machine. Divide system resources between virtual machines.

Isolation
Provide fault and security isolation at the hardware level. Preserve performance with advanced resource controls.

Encapsulation
Save the entire state of a virtual machine to files. Move and copy virtual machines as easily as moving and copying files.

Hardware Independence
Provision or migrate any virtual machine to any physical server.

III. THE CONCEPT OF VIRTUALIZATION.

Virtualization is the process of creating a software-based, or virtual, representation of something, such as virtual applications, servers, storage and networks. It is the single most effective way to reduce IT expenses while boosting efficiency and agility for all size businesses

Virtualization as a concept enables multiple/diverse applications to co-exist on the same underlying hardware without being aware of each other.

As an example, full blown operating systems such as Windows, Linux, Symbian etc along with their applications can coexist on the same platform. All computing resources are virtualized.

What this means is none of the aforesaid machines have access to physical resources. The only entity having access to physical resources is a program known as Virtual Machine Monitor (aka Hypervisor).

The hypervisor provides a virtualized environment to each of the machines above. Since these machines access NOT the physical hardware BUT virtualized hardware, they are known as Virtual Machines.

Due to the limitations of x86 servers, many IT organizations must deploy multiple servers, each operating at a fraction of their capacity, to keep pace with today's high storage and processing demands. The result: huge inefficiencies and excessive operating costs.

Virtualization relies on software to simulate hardware functionality and create a virtual computer system. This enables IT organizations to run more than one virtual system – and multiple operating systems and applications – on a single server. The resulting benefits include economies of scale and greater efficiency.

IV. VIRTUALIZATION INFRASTRUCTURE (NESTED VIRTUALIZATION)

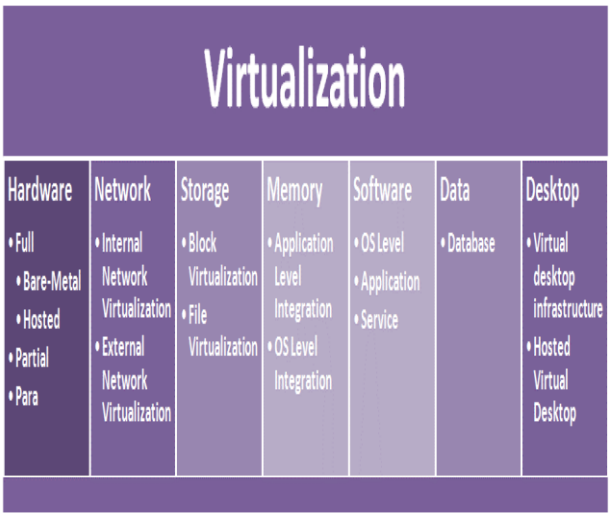
Nested virtualization refers to the ability of running a virtual machine within another, having this general concept extendable to an arbitrary depth. In other words, nested virtualization refers to running one or more hypervisors inside another hypervisor. Nature of a nested guest virtual machine does not need be homogeneous with its host virtual machine; for example, application virtualization can be deployed within a virtual machine created by using hardware virtualization.

Nested virtualization becomes more necessary as widespread operating systems gain built-in hypervisor functionality, which in a virtualized environment can be used only if the surrounding hypervisor supports nested virtualization; for example, Windows 7is capable of running Windows XP applications inside a built-in virtual machine. Furthermore, moving already existing virtualized environments into a cloud, following the Infrastructure as a Service (IaaS) approach, is much more complicated if the destination IaaS platform does not support nested virtualization.

The way nested virtualization can be implemented on a particular computer architecture depends on supported hardware-assisted virtualization capabilities. If a particular architecture does not provide hardware support

required for nested virtualization, various software techniques are employed to enable it. Over time, more architectures gain required hardware support; for example, since the Haswell microarchitecture (announced in 2013), Intel started to include VMCS shadowing as a technology that accelerates nested virtualization.

IV. THE DIFFERENT TYPES OF VIRTUALIZATION.



Hardware/Server Virtualization

It is the most common type of virtualization and it provides advantages like optimum hardware utilization and application uptime. The basic idea is to combine many small physical servers into one large physical server, so that the processor can be used more effectively. The operating system that is running on a physical server gets converted into a well-defined OS that runs on the virtual machine.

The hypervisor controls the processor, memory, and other components by allowing different OS to run on the same machine without the need for a source code.

Hardware virtualization is further subdivided into the following types:

Full Virtualization – In it, the complete simulation of the actual hardware takes place to allow software to run an unmodified guest OS.

Para Virtualization – In this type of virtualization, software unmodified runs in modified OS as a separate system.

Partial Virtualization – In this type of hardware virtualization, the software may need modification to run.

Hardware-assisted virtualization is a way of improving overall efficiency of virtualization. It involves CPUs that provide support for virtualization in hardware, and other hardware components that help improve the performance of a guest environment.

Hardware virtualization can be viewed as part of an overall trend in enterprise IT that includes autonomic computing, a scenario in which the IT environment will be able to manage itself based on perceived activity, and utility computing, in which computer processing power is seen as a utility that clients can pay for only as needed. The usual goal of virtualization is to centralize administrative tasks while improving scalability and overall hardware-resource utilization.

With virtualization, several operating systems can be run in parallel on a single central processing unit (CPU). This parallelism tends to reduce overhead costs and differs from multitasking, which involves running several programs on the same OS. Using virtualization, an enterprise can better manage updates and rapid changes to the operating system and applications without disrupting the user. "Ultimately, virtualization dramatically improves the efficiency and availability of resources and applications in an organization. Instead of relying on the old model of “one server, one application” that leads to underutilized resources, virtual resources are dynamically applied to meet business needs without any excess fat" .

Key benefits of Hardware/Server Virtualization include:

Greater IT efficiencies
Reduced operating costs
Faster workload deployment
Increased application performance
Higher server availability
Eliminated server sprawl and complexity

Network Virtualization

It refers to the management and monitoring of a computer network as a single managerial entity from a single software-based administrator’s console. It is intended to allow network optimization of data transfer rates, scalability, reliability, flexibility, and security. It also automates many network administrative tasks. Network virtualization is specifically useful for networks that experience a huge, rapid, and unpredictable traffic increase. The intended result of network virtualization provides improved network productivity and efficiency.

By completely reproducing a physical network, network virtualization allows applications to run on a virtual network as if they were running on a physical network — but with greater operational benefits and all the hardware independencies of virtualization. (Network virtualization presents logical networking devices and services — logical ports, switches, routers, firewalls, load balancers, VPNs and more — to connected workloads.)

Two categories:
Internal**:** Provide network like functionality to a single system.
External**:** Combine many networks, or parts of networks into a virtual unit.

Storage Virtualization

Storage virtualization: the process of completely abstracting logical storage from physical storage
Distributed file system: any file system that allows access to files from multiple hosts sharing via a computer network
Virtual file system: an abstraction layer on top of a more concrete file system, allowing client applications to access different types of concrete file systems in a uniform way
Storage hypervisor: the software that manages storage virtualization and combines physical storage resources into one or more flexible pools of logical storage[10]
Virtual disk: a computer program that emulates a disk drive such as a hard disk drive or optical disk drive
Simply, multiple network storage resources are present as a single storage device for easier and more efficient management of these resources.

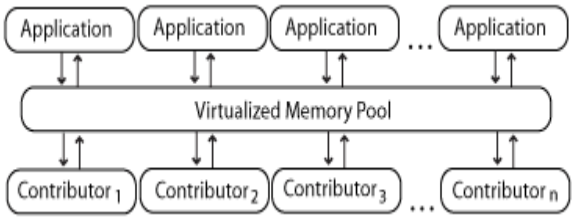
Advantages:
Improved storage management in a heterogeneous IT environment
Easy updates, better availability
Reduced downtime
Better storage utilization
Automated management
In general, there are two types of storage virtualization:
Block- It works before the file system exists. It replaces controllers and takes over at the disk level.
File- The server that uses the storage must have software installed on it in order to enable file-level usage.

Memory Virtualization

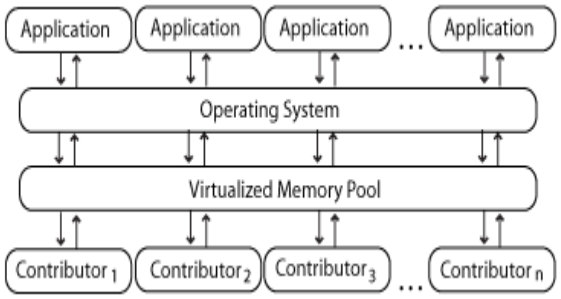
It introduces a way to decouple memory from the server to provide a shared, distributed or networked function. It enhances performance by providing greater memory capacity without any addition to the main memory. That's why a portion of the disk drive serves as an extension of the main memory.

Implementations –
Application-level integration
Operating System Level Integration

Application-level integration – Applications running on connected computers directly connect to the memory pool through an API or the file system.



Operating System Level Integration – The operating system first connects to the memory pool, and makes that pooled memory available to applications.



Software Virtualization

It provides the ability to the main computer to run and create one or more virtual environments. It is used to enable a complete computer system in order to allow a guest OS to run. For instance letting Linux to run as a guest that is natively running a Microsoft Windows OS (or vice versa, running Windows as a guest on Linux).

Types:
Operating system
Application virtualization
Service virtualization

Operating-system-level virtualization: hosting multiple virtualized environments within a single OS instance

Application virtualization and workspace virtualization: isolating individual apps from the underlying OS and other apps; closely associated with the concept of portable applications

Service virtualization: emulating the behavior of specific components in heterogeneous component-based applications such as API-driven applications, cloud-based applications and service-oriented architectures

Data Virtualization

Data virtualization: the presentation of data as an abstract layer, independent of underlying database systems, structures and storage

Database virtualization: the decoupling of the database layer, which lies between the storage and application layers within the application stack over all

Desktop virtualization

Desktop virtualization is the concept of separating the logical desktop from the physical machine.

One form of desktop virtualization, virtual desktop infrastructure (VDI), can be thought of as a more advanced form of hardware virtualization. Rather than interacting with a host computer directly via a keyboard, mouse, and monitor, the user interacts with the host computer using another desktop computer or a mobile device by means of a network connection, such as a LAN, Wireless LAN or even the Internet. In addition, the host computer in this scenario becomes a server computer capable of hosting multiple virtual machines at the same time for multiple users.

It provides the work convenience and security. As one can access remotely, you are able to work from any location and on any PC. It provides a lot of flexibility for employees to work from home or on the go. It also protects confidential data from being lost or stolen by keeping it safe on central servers.

Deploying desktops as a managed service enables IT organizations to respond faster to changing workplace needs and emerging opportunities. Virtualized desktops and applications can also be quickly and easily delivered to branch offices, outsourced and offshore employees, and mobile workers using iPad and Android tablets.

V. ADVANTAGES AND DISADVANTAGES OF VIRTUALIZATION

There are many benefits of Virtualization, like it optimizes hardware resource utilization, saves energy and costs and makes it possible to run multiple applications and various operating systems on the same SERVER at the same time. It increases the utilization, efficiency and flexibility of existing computer hardware.

Provides ability to manage resources effectively.

Increases efficiency of IT operations.

Provides for easier backup and disaster recovery.

Increases cost savings with reduced hardware expenditure.

Disadvantages of virtualization are almost negligible when compared to the multiple advantages it offers.

Software licensing costs.

Necessity to train IT staff in virtualization.

VIRTUALIZATION VS. CLOUD COMPUTING

Although equally buzz-worthy technologies, virtualization and cloud computing are not interchangeable.

Virtualization is software that makes computing environments independent of physical infrastructure, while cloud computing is a service that delivers shared computing resources (software and/or data) on demand via the Internet.

As complementary solutions, organizations can begin by virtualizing their servers and then moving to cloud computing for even greater agility and self-service.

VI. CONCLUSION

Virtualization technology is possibly the single most important issue in IT and has started a top to bottom overhaul of the computing industry. The growing awareness of the advantages provided by virtualization technology is brought about by economic factors of scarce resources, government regulation, and more competition.

Virtualization is being used by a growing number of organizations to reduce power consumption and air conditioning needs and trim the building space and land requirements that have always been associated with server farm growth. Virtualization also provides high availability for critical applications, and streamlines application deployment and migrations. Virtualization can simplify IT operations and allow IT organizations to respond faster to changing business demands.

The socio-political ramifications of global warming requiring good corporate citizens to meet greenhouse gas reduction targets, creates an added incentive for virtualization.

The availability of better virtual machine isolation through Virtual Technology hardware support in commodity systems together with the broad availability of virtualization software provides a level of efficiency to meet these demands.

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Author Profile

A proud soldier from the Corps of EME, Indian Army, put his unparallel service for 16 years and 03 months, Dr M E Purushoththaman, Professor from the department of Computer Science and Engineering, Hyderabad.

A doctorate in Neural Networks(2007) and Cloud Computing(2016), achieved his AMIE (Computer Science) from the Royal Charter, "The Institution of Engineers(India)" Calcutta on 2000 and his Masters (M.Tech in Information Technology) on 2003 from the Punjabi University, Patiala, decorated by the Fellow of IE(India) and also Chartered Engineer(India).

In academics, He has rich 17 years of teaching experience including 14 years of Research experience, held various positions for seven years as Asso. Prof. and Professor and was heading the departments and from 2007 onwards continuing as Principal & Professor for more than a decade. He has published more than 20 research papers in reputed national and international journals and organized workshops & conferences and attended many. His main research work focuses on Cloud Computing, Network Security, Cloud Security and Privacy, Big Data Analytics, Data Mining,

