

Virtualization and its Role in Cloud Computing Environment

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DOI: <https://doi.org/10.26438/ijcse/v7i4.11311136> | Available online at: www.ijcseonline.org

Accepted: 20/Apr/2019, Published: 30/Apr/2019

Abstract: In recent times Virtualization and Cloud computing are two popular research directions. In contrast with the past, Virtualization is being used by a growing number of organizations for Server Consolidation, Dynamic Load Balancing, Testing and Development, Disaster Recovery, Improved System Reliability and Security and to reduce power consumption, and also provides high availability for critical applications, and streamlines application deployment and migrations. Information Technology resources can be delivered as services over the Internet to the end user through cloud computing. One of such important core technologies of cloud computing is *Virtualization*. In this paper, we present a detailed review on virtualization. Furthermore, we also discussed the Role of Virtualization in cloud computing, we also discussed the three main types of Virtualization technologies.

Keywords: Cloud computing, Network, Virtualization, Technology, Memory

I. INTRODUCTION TO CLOUD COMPUTING

Cloud computing in simple terms means storing and accessing data and programs over the Internet instead of our computer's hard drive. The cloud is just a metaphor for the Internet [1]. Cloud computing is on demand pay-as-use i.e billing is done based on the usage of the customer which leads to low operational and capital cost. Users are able to access applications which are present outside the working site and can be accessed remotely through internet connection devices. By this, computer resources can be effectively and efficiently used and may consume less computing power and therefore resources are shared cooperatively. National Institute of Standards and Technology (NIST) has given a definition [2] for Cloud computing which says that —Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. NIST has listed five essential characteristics of cloud computing which include on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service. In recent times, mobile devices and subsequent mobile computing become an imperative component in cloud computing. Internet made the possibilities of accessing applications and data from anywhere at any time. According to Juniper research [3], the mobile users and enterprise market for mobile cloud based applications worth are

expected to increase enormously. Aepona [4] describes that MCC (Mobile Cloud Computing) as a new paradigm for mobile applications whereby the data processing and storage are moved from the mobile devices to powerful and centralized computing platforms located in clouds. These applications which are centralized are then accessed over the wireless connection based on a thin local client or web browser on the mobile devices.

II. VIRTUALIZATION

Virtualization occurs when a virtual version of something is created instead of an actual version. The combination of hardware and software engineering that creates Virtual Machines (VMs) and enables multiple operating systems to run on the same platform. In the field of Information Technology, the fundamental change happening all over is obviously Cloud Computing. Virtualization in computing is creation of virtual (not real) of virtual something such as hardware, software, platform or an operating system or storage or a network device [5]. In a virtualized environment IT enterprise has to adopt and manage many changes as the virtual environment if porn to quick changes as compared to that of the physical environment. Because of virtualization clouds are scalable and agile.

Virtualization can also be defined as a technology that has the capability of logically separating the physical resources of a server and use them as different isolated machines, called Virtual Machines. The single CPU becomes many

virtual CPUs, and the RAMs become many virtual RAMs and same becomes the case for Hard Disks.

Virtualization [6] [7] [8] [9] is a technique which allows to create abstract layer of system resources and hides the complexity of hardware and software working environment. Virtualization enhances hardware independence, isolation of guest operating system and encapsulation of entire virtual machine grouped in a one file. Virtualization is commonly implemented with hypervisor [10] [11] technology, which is a software or firmware elements that can virtualizes system resources.

III. ADVANTAGES AND DISADVANTAGES OF VIRTUALIZATION

The advantages of switching to a virtual environment are plentiful, saving money and time while providing much greater business continuity and ability to recover from disaster, following may be included as advantages of virtualization:

Advantages of Virtualization

- Cost effective
- Reduces the workload.
- Offers better uptime.
- Allows for faster deployment of resources.
- Promotes digital entrepreneurship.
- Better disaster recovery solutions.
- Efficient and economic use of energy.

Disadvantages of Virtualization

- It can have a high cost of implementation.
- Requires powerful machines.
- It still has limitations.
- Pone to physical defects.
- It creates a security risk.
- It creates an availability issue.
- It creates a scalability issue.
- It requires several links in a chain that must work together cohesively.
- It takes time.

The advantages and disadvantages of virtualization let us know that it can be a useful tool for individuals, entrepreneurs, SBMs and corporations when used properly. As it is so easy to use, however, at times some administrators begin adding new servers or storage for everything and may create problems. By staying disciplined and aware of communication issues, many of the disadvantages can be let off, which is why this is such an effective modern system.

IV. ROLE OF VIRTUALIZATION IN CLOUD COMPUTING

Virtualization is the backbone of Cloud Computing; Cloud Computing brings efficient benefits as well as makes it more convenient with the help of Virtualization, not only this, it also provides solutions for great challenges in the field of data security and privacy protection. Virtualization is the imitation of hardware within a software program. A Single computer is allowed to perform the role of multiple computers. In a web server or a file, the usage of purchase, maintenance, depreciation, energy and floor space is double, but by creating virtual web or file server all of our objectives are fulfilled like improvement in security, the use of hardware resources to its maximum, flexibility, and reduced cost. Benefits of virtualization include Efficient use of resources, increased security, portability, problem free testing, easier manageability, increased flexibility, fault isolation, rapid deployment etc.

Virtualization in Cloud Computing:

- For combining local and network resources data storage virtualization.
- For grouping physical storage devices into the single unit
- For reaching the high level of availability or improving availability using virtualization
- Improving performance using virtualization
- Using virtualization using stripping and caching
- Capacity improvement

A server or a central computer hosting an application for multiple users, thereby preventing the need for separately installing software on every machine is virtualization in Cloud Computing. The information from different databases, hard drives, and USB drives are merged into one location thereby increasing its accessibility and security. Virtualization in cloud computing refers to the creation of virtual hardware, software, or an operating system, a storage or network device. Virtual changes occur more rapidly rather than physical changes in IT environment. The changes occurring has to be managed, such changes are scalable and agile because of virtualization in Cloud Computing.

Importance of virtualization:

For the maintenance of resources in cloud computing environment, virtualization is a necessity as it makes it easier. Virtualization in Cloud Computing lets increase in security by protecting both the integrity of cloud components and guest virtual machines. Cloud Component virtualized machines can also be scaled up or down on demand or can provide reliability. High utilization of pooled resources, resource Sharing and rapid provisioning are also some of the factors Managed Service Provider VA provides.

Reasons why you should use Managed Service Provider VA:

- Simplified Management
- Reduced system administrative work
- Resource Optimization
- It saves Money
- Easier software installation
- Data center consolidation and decreased power consumption
- Testing of CD's live without even burning them
- Better use from the hardware
- Increased CPU utilization
- Virtual machine can run on any x86 server

V. VIRTUALIZATION TECHNIQUES:

Virtualization [12] [13] technology diverts the human's perspective for utilizing IT resources from physical to logical. The goal of virtualization is to collectively utilize the IT resources such as storage, processor and network to maximum level and to reduce the cost of IT resources that can be achieved by combining various idle resources into shared pools and creating different virtual machines to perform various tasks simultaneously. The resources can be allocated or altered dynamically. While using Virtualization in cloud computing the user should be conscious of basic techniques such as hypervisor, emulation, full virtualization, para virtualization and hardware assisted virtualization.

Virtual Machine Monitor or Hypervisor: A software layer that can monitor and virtualizes the resources of a host machine conferring to the user requirements [14]. It is an intermediate layer between operating system and hardware. Basically, hypervisor is classified as native and hosted [15]. The native hypervisor runs directly on the hardware whereas host hypervisor runs on the host operating system. The software layer creates virtual resources such as storage, CPU, memory, and drivers.

Emulation: This virtualization technique converts the behavior of the computer hardware to a software program and lies in the operating system layer which in turn lies on the hardware. Emulation provides enormous flexibility to guest operating system but the speed of translation process is low compared to hypervisor and requires a high configuration of hardware resources to run the software [16].

Full Virtualization: Full virtualization is a common and cost-effective type of virtualization, which is basically a method by which computer service requests are separated from the physical hardware that facilitates them. With full virtualization, operating systems and their hosted software are run on top of virtual hardware. It differs from other forms of virtualization (like para virtualization and hardware-assisted virtualization) in its total isolation of guest operating systems from their hosts. [17].

Para Virtualization: Special hypercalls are provided by this technique that substitutes the instruction set architecture of host machine. It relates communication between guest operating system and hypervisor to improve performance and efficiency. Accessing resources in para virtualization [18] is better than the full virtualization model since all resources must be emulated in full virtualization model. The disadvantage of this technique is to modify the kernel of guest operating system using hypercalls. This model is only suitable with open source operating systems.

VI. VIRTUALIZATION TYPES

There are three major types of virtualization such as Server virtualization, Client virtualization and Storage virtualization as shown in figure 1.

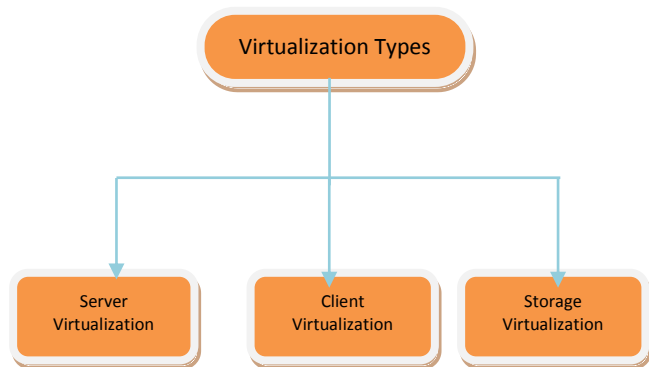


Fig 1: Types of Virtualization

Server Virtualization: In server virtualization, single server performs the task of multiple servers by portioning out the resources of an individual server across multi-environment. Hosting multiple applications and operating systems locally or remotely are allowed by hypervisor layer. The advantages of virtualization include efficient use of resources, cost savings, lower capital expenses and high availability.

Server virtualization in cloud is the most common type of virtualization and it provides advantages like optimum hardware utilization and application uptime. The main idea behind 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 operating system that runs on the virtual machine. The hypervisor controls the processor, memory, and other components by allowing different operating system to run on the same machine without the need for a source code.

Server 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.

Client Virtualization: This type of technology makes the system administrator to virtually monitor and update the client machines like laptops, workstation desktop and mobile devices. It improves the client machines management and enhances the security to defend from hackers and cybercriminals. There are three types of client virtualization [19]. First, server hosted or remote virtualization which is hosted on a server machine and operated by the client across a network. Second, local or client hosted virtualization in which the secured and virtualized operating environment runs on local machine. Third, application virtualization [20] that provides multiple ways to run an application which is not in traditional manner. In this technique an isolated virtualized environment or partitioning technique is used to run an application.

Storage Virtualization: This type of virtualization creates the abstraction of logical storage from physical storage. Three kinds of data storage are used in virtualization, these include, DAS (Direct Attached Storage), NAS (Network Attached Storage) and SAN (Storage Area Network). Direct Attached Storage (DAS) is the traditional method of data storage where storage drives are directly attached to server machine. NAS is the shared storage mechanism which connects through network. The Network Attached Storage (NAS) is used for device sharing, file sharing and backup storing among machines. Storage Area Network (SAN) is a storage device which is shared with different servers over a high accelerate network. Here many network storage resources are present as a single storage device for easier and more efficient management of these resources. It provides various advantages as follows:

- 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.
- Other types of virtualization may include the following as well:

VII. 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.

Two categories:

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

VIII. MEMORY VIRTUALIZATION

It introduces a way to decouple memory from the server to provide a distributed, shared or networked function. It improves 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** – Applications running on connected computers directly connect to the memory pool through an API or the file system.

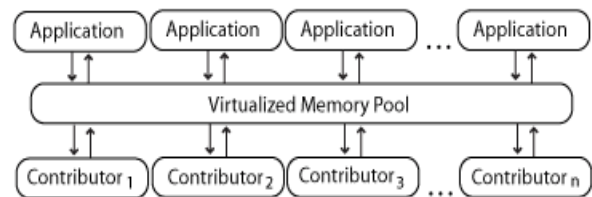


Fig 2. Application Level Integration

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

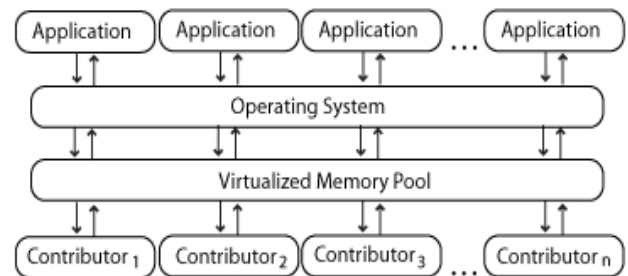


Fig 3. Operating System Level Integration

IX. 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 operating system to run. For instance letting Linux to run as a guest that is natively running a Microsoft Windows operating system (or vice versa, running Windows as a guest on Linux).

Types of Software virtualization:

- Operating system
- Application virtualization
- Service virtualization

X. DESKTOP VIRTUALIZATION

It provides the work convenience and security. As one may be able to access remotely i.e. 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 machine.



XI. CONCLUSION

Virtualization in cloud provides an easy way to set up new virtual servers, so you don't have to manage a lot of them. Keeping track of where is everything – and how your physical resources are used for virtual resources – is vital, so shop for solutions that have easy-to-use tools that help you measure and monitor usage.

Virtualization isn't a magic bullet for all. But in most cases, the efficiency, productivity, security and cost advantages outweigh any issues, and thus, virtualization is continuously gaining popularity.

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