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The Impact of Virtualization in Cloud Computing

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***Abstract*--The Cloud computing offers dynamically scalable resources provisioned as a service over the Internet. It enables individuals and organization to use various services like software as a service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service(IaaS) over the Internet. Virtualization is the fundamental technology that powers cloud computing. Virtualization allows running multiple operating systems on a single physical system and sharing the underlying hardware resources. Virtualization is a key to building cloud based architectures because it allows greater flexibility and utilization of the underlying equipment. The purpose of this paper is to describe the impact of virtualization in cloud computing. This paper begins with a discussion on concepts and terminology of cloud computing and virtualization, then it describe the architecture of virtualization and its abstraction levels. This paper also includes some popular cloud services.**

***Keywords*— Cloud Computing, Virtualization, Saas, PaaS, IaaS.**

I. Introduction

Cloud computing is emerged as new technology in organization and cooperates. Cloud computing allows users to utilize the computation, storage, data and services from around the world in pay-as-you-go manner [1]. It enables end user to use computing resources (e.g. servers, storages, and applications) as service. End users access on-demand cloud services through web browsers. Cloud computing service providers offer specific cloud services and ensure the quality of the services.

Virtualization is a foundational element of cloud computing. Virtualization is a framework or methodology of dividing the resources of a computer into multiple execution environments, by applying one or more concepts or technologies such as hardware and software partitioning, time-sharing, partial or complete machine simulation, emulation, quality of service, and many others. Virtualization software makes it possible to run multiple operating systems and multiple applications on the same server at the same time. The technology behind virtualization is known as a virtual machine monitor (VMM) or virtual manager, which separates computing environments from the actual physical infrastructure. Virtualization makes servers, workstations, storage and other systems independent of the physical hardware layer.

II. Cloud Computing

Cloud computing is a general term for anything that involves delivering hosted services over the Internet. These services are broadly divided into three categories: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). The name cloud computing was inspired by the cloud symbol used to represent the Internet. Cloud computing is an emerging distributed computing paradigm that promises to offer cost-effective scalable on demand services to users, without the need for large up-front infrastructure investments. Through the use of virtualization, cloud computing provides a back-end infrastructure that can quickly scale up and down depending on workload. Cloud computing brings significant benefits for both service providers and service users. For service users, they pay the computing resources only on demand (pay-as-you-go) and without worrying about hardware, software maintenance or upgrade. For service providers, with VMs (virtual machines), they can shrink or expand the utilization of physical resources based on requirements. Therefore, it is possible for providers to make higher profit without affecting user's satisfaction.

A. Deployment Types

A cloud can be private or public. A public cloud sells services to anyone on the Internet. (Currently, Amazon Web Services is the largest public cloud provider) [7]. A private cloud is a proprietary network or a data center that supplies hosted services to a limited number of people. When a service provider uses public cloud resources to create their private cloud, the result is called a virtual private cloud. Private or public, the goal of cloud computing is to provide easy, scalable access to computing resources and IT services.

B. Service Types

A cloud service has three distinct characteristics that differentiate it from traditional hosting. It is sold on demand, typically by the minute or the hour; it is elastic -- which means that a user can have as much or as little of a service as they want at any given time [7]; and the service is fully managed by the provider (the consumer needs nothing but a personal computer and Internet access). The cloud services are broadly divided into three categories.

1) Infrastructure-as-a-Service: Infrastructure-as-a-service like Amazon Web Services provides the customer with virtual server instances and storage, as well as application program interfaces(APIs) that allow the customer to start, stop, access and configure their virtual servers and storage [1]. This model allows a company to pay for only as much capacity as is needed, and bring more online as soon as required this model known as pay-for-what-you-use model this is just like the way electricity, fuel and water are consumed; it's sometimes referred to as utility computing[5].

2) Platform-as-a-service : Platform-as-a-service in the cloud is defined as a set of software development tools hosted on the provider's infrastructure. Developers create applications on the provider's platform over the Internet [1]. PaaS providers may use APIs, website portals or gateway software installed on the provider's computer. Force.com, (an outgrowth of Salesforce.com) and GoogleApps are examples of PaaS [5]. Developers need to know that currently, there are not standards for interoperability or data portability in the cloud.

3) Software-as-a-service : In the software-as-a-service cloud model, the vendor supplies the hardware infrastructure, the software product and interacts with the user through a front-end portal. SaaS is a very broad market [10]. Services can be anything from Web-based email to inventory control and database processing. Because the service provider hosts both the application and the data, the end user is free to use the service from anywhere.

III. Virtualization Concepts

Virtualization refers to technologies designed to provide a layer of abstraction between computer hardware systems and the software running on them [12]. Virtualization means to create a virtual version of a device or resource, such as a server, storage device, network or even an operating system where the framework divides the resource into one or more execution environments [2]. Even it is as simple as partitioning a hard drive is considered virtualization because you take one drive and partition it to create two separate hard drives. Devices, applications and human users are able to interact with the virtual resource as if it were a real single logical resource.

A. Benefits And Need Of Virtualization

- *Maximize resources*: Virtualization can reduce need of physical systems and you can get more value out of the servers. Most traditionally built systems are underutilized. Virtualization allows maximum use of the hardware investment [12].
- *Multiple systems:* With virtualization, you can also run multiple types of applications and even run different operating systems for those applications on the same physical hardware.
- *Flexibility:* Virtualization create more than one instance
- *Availability:* Increase availability through dynamic provisioning and relocation of critical systems.
- *Scalability:* Scale their infrastructure as their needs grow and very easy to insert a physical node with the basic cluster [1].
- *Hardware utilization:* Virtual machines utilize hardware resources that are left idle and provide up to 80 percent greater utilization of every server. It reduces the hardware requirements by a ratio of 10:1 or better [2].
- *Security:* Using multiple virtual machines, it is possible to separate (isolate) services by running one service on each virtual machine. This approach is also called jailing of services.

C. Traditional Server Vs Virtual Server

We know the servers as a whole unit that includes the hardware, the OS, the storage, and the applications. Servers are often referred to by their function i.e. the File server, the SQL server, the print server, the email server etc [7]. Unless there are multiple servers, if a service experiences a hardware failure, then the service is down. Virtual servers seek to encapsulate the server software (OS, the applications, and the storage for that server) away from the hardware. Virtual servers can still be referred to by their function i.e. email server, database server, etc. A virtual server can be serviced by one or more hosts, and one host may house more than one virtual server [8]. If the environment is built correctly, virtual servers will not be affected by the loss of a host. It provides resource pooling and high redundancy. It easily deploys new servers. Figure (1) shows how traditional server differ from virtual server, traditional server require different hardware for different server but in virtual server the same hardware may use for different server.

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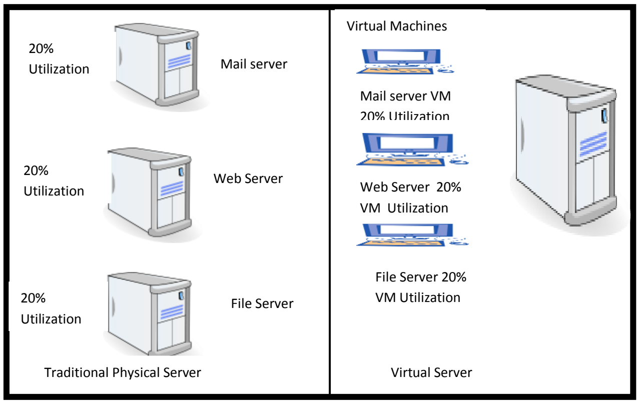


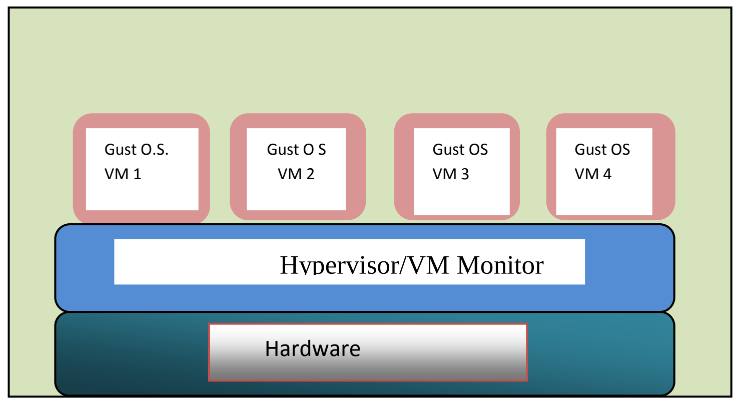
Figure 1 Traditional and Virtual Server

D. Architecture Of Virtualization

There are two major types of virtualization architecture: hosted and bare-metal. In hosted architecture, an operating system (OS) is installed on the hardware first. Then the software called a hypervisor or virtual machine monitor is installed [11]. This software is used to install multiple guest operation systems, or virtual machines, on the hardware. Applications are then installed and run on the virtual machines in the same way as on a physical machine. With bare-metal architecture, the hypervisor is installed directly on the hardware rather than on top of an underlying operating system [12]. Virtual machines and their applications are installed on the hypervisor in the same way as with hosted architecture. In either case, the guest operating systems communicate with the hypervisor rather than the underlying hardware. Either type of virtualization architecture, or a combination of both, can be used when incorporating virtualization into your data center. Hosted virtualization architecture is more useful for software development, running legacy applications, and supporting different operating systems. Applications that provide real-time access or data processing benefit from bare-metal virtualization architecture [13]. Figure (2) shows the basic elements of virtualization.

1) HYPERVISOR/ VIRTUAL MACHINE MONITOR (VMM): A thin layer of software that generally provides virtual partitioning capabilities, which runs directly on hardware. The hypervisor is a software program that manages multiple operating systems (or multiple instances of the same operating system) on a single computer system [3]. The hypervisor manages the system's processor, memory, and other resources to allocate what each operating system requires.

Hypervisors are designed for particular processor architecture and may also be called virtualization managers [5]. A hypervisor or virtual machine monitor (VMM) is a piece of computer software, firmware or hardware that creates and runs virtual machines. A computer on which a hypervisor is running one or more virtual machines is defined as a host machine. Each virtual machine is called a guest machine. Examples of VMM are: Xen, KVM, VMWare.



2) VIRTUAL MACHINES: A representation of a real machine using software that provides an operating environment which can run or host a guest operating system. Virtual machines are created and managed by virtual machine monitors [4].

3) GUEST OPERATING SYSTEM: Operating system which is running inside the created virtual machine.

E. VIRTUALIZATION IMPLEMENTATION TECHNIQUES

There are two leading implementation techniques of Virtualization are full virtualization and Para-virtualization.

1) FULL VIRTUALIZATION: Full virtualization is designed to provide total abstraction of the underlying physical machine and creates a complete virtual system in which the guest operating systems can execute. No modification is required in the guest OS or application; the guest OS or application is not aware of the virtualized environment so they have the capability to execute on the VM just as they would on a physical system. This approach can be advantageous because it enables complete decoupling of the software from the hardware. As a result, full virtualization can streamline the migration of applications and workloads between different physical systems. Full virtualization also helps provide complete isolation of different applications, which helps make this approach highly secure [6].

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Microsoft Virtual Server (VirtualPC) and VMware ESX Server software are examples of full virtualization. The VM monitor must provide the VM with an image of an entire system, including virtual BIOS, virtual memory space, and virtual devices. The VM monitor also must create and maintain data structures for the virtual components, such as a shadow memory page table. These data structures must be updated for every corresponding access by the VMs. Full virtualization is similar to emulation (A virtual machine simulates the entire hardware set needed to run unmodified guests for completely different hardware architectures) except it is designed to simulate the underlying hardware which is physically available [5]. It gives the flexibility to move entire virtual machines from one host to another host very easily.

2) *PARA VIRTUALIZATION:* Para-virtualization presents each VM with an abstraction of the hardware that is similar but not identical to the underlying physical hardware. Para-virtualization techniques require modifications to the guest operating systems that are running on the VMs. As a result, the guest operating systems are aware that they are executing on a VM—allowing for near-native performance [6]. The hypervisor exports a modified version of the underlying physical hardware. It provides better performance than full virtualization. Para-virtualization methods are still being developed and thus have limitations; including several insecurities such as the guest OS cache data, unauthenticated connections, and so forth. Para-virtualization is used by Xen, Denali , VMware ESX server and user mode Linux .

F. ABSTRACTION LEVELS OF VIRTUALIZATION

A traditional computer runs with a host operating system specially customized for its hardware architecture, after virtualization, different user applications managed by their own operating systems (guest OS) can run on the same hardware, independent of the host OS. This is often done by adding additional software, called a virtualization layer. This virtualization layer is known as hypervisor or virtual machine monitor (VMM) [13].The VMs are shown in the upper boxes in figure(2), where applications run with their own guest OS over the virtualized CPU, memory, and I/O resources. The main function of the software layer for virtualization is to virtualize the physical hardware of a host machine into virtual resources to be used by the VMs, exclusively. This can be implemented at various operational levels. The virtualization software creates the abstraction of VMs by interposing a virtualization layer at various levels of a computer system.

Common virtualization layers include the instruction set architecture (ISA) level, hardware level, operating system level, library support level, and application level [12].

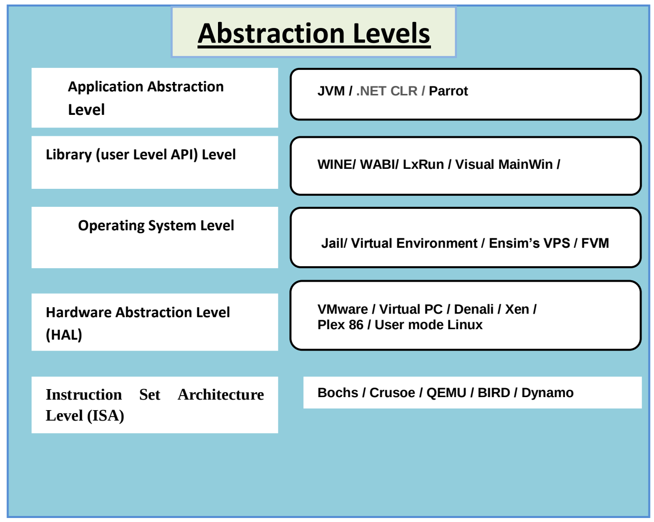

Figure 3 Abstraction Levels

1) INSTRUCTION SET ARCHITECTURE LEVEL (ISA): Virtualization at the ISA is implemented by emulating [13] an ISA completely in software. An emulator executes instruction issued by guest machine (VM) by translating them to asset of native instructions and then executing on available hardware. For example, MIPS binary code can run on an x86-based host machine with the help of ISA emulation. With this approach, it is possible to run a large amount of legacy binary code written for various processors on any given new hardware host machine [13]. Instruction set emulation leads to virtual ISAs created on any hardware machine. The basic emulation method is through code interpretation. An interpreter program interprets the source instructions to target instructions one by one. One source instruction may require tens or hundreds of native target instructions to perform its function. Obviously, this process is relatively slow. For better performance, dynamic binary translation is desired. This approach translates basic blocks of dynamic source instructions to target instructions. A virtual instruction set architecture (V-ISA) thus requires adding a processor-specific software translation layer to the compiler. Examples: Bochs, QEMU, Crusoe, and BIRD.

*2) HARDWARE ABSTRACTION LEVEL (HAL):*Virtualization at the HAL exploits the similarity in architectures of the guest and host platforms to cut down the interpretation latency.

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Most of the today's world's commercial PC emulators use this virtualization technique on popular x86 platforms to make it efficient and its use, viable and practical [13]. Virtualization technique helps map the virtual resources to physical resources and use the native hardware for computations in the virtual machine. When the emulated machine needs to talk to critical physical resources, the simulator takes over and multiplexes appropriately. Hardware-level virtualization is performed right on top of the bare hardware. On the one hand, this approach generates a virtual hardware environment for a VM. On the other hand, the process manages the underlying hardware through virtualization [13]. The idea is to virtualize a computer's resources, such as its processors, memory, and I/O devices. The intention is to upgrade the hardware utilization rate by multiple users concurrently. The idea was implemented in the IBM VM/370 in the 1960s. More recently, the Xen hypervisor has been applied to virtualize x86-based machines to run Linux or other guest OS applications. Examples are Xen hypervisor, VMware, VirtualPC, Denali[11], User-Mode- Linux (UML), and Plex86.

*3) Operating System Level :*The virtual machines at this level share the hardware as well as the operating system on the physical machine and use a virtualization layer (similar to the VMMs in VMware) [11] on top of the OS to present multiple independent and isolated machines to the user. This refers to an abstraction layer between traditional OS and user applications. OS-level virtualization creates isolated containers on a single physical server and the OS instances to utilize the hardware and software in data centers [13]. The containers behave like real servers. OS-level virtualization is commonly used in creating virtual hosting environments to allocate hardware resources among a large number of mutually distrusting users. It is also used, to a lesser extent, in consolidating server hardware by moving services on separate hosts into containers or VMs on one server. Examples are Approach, Jail, Ensim, and Linux-Kernel-Mode Virtualization.

4) LIBRARY Support Level: In almost all of the systems, applications are programmed using a set of APIs exported by a group of user-level library implementations. Such libraries are designed to hide the operating system related nitty-gritty details to keep it simpler for normal programmers [2]. In other words, virtualization techniques are used to implement a different application binary interface (ABI) and/or a different application programming interface (API) using the underlying system.

Such techniques could well be said to do the work of ABI/API emulation [11]. Since most systems provide well-documented APIs, such an interface becomes another candidate for virtualization. Virtualization with library interfaces is possible by controlling the communication link between applications and the rest of a system through API hooks. The software tool WINE [11] has implemented this approach to support Windows applications on top of UNIX hosts. Another example is the vCUDA [10] which allows applications executing within VMs to leverage GPU hardware acceleration. Other examples are WABI, LxRun [11], and Visual MainWin.

5) USER Application Level: Application-level virtualization is known as application isolation, application sandboxing, or application streaming. The process involves wrapping the application in a layer that is isolated from the host OS and other applications. The result is an application that is much easier to distribute and remove from user workstations. User-Application Level abstraction for virtual machine came to the limelight with the arrival of Java Virtual Machine (JVM). The idea is to be able to create a virtual machine at the application-level than can behave like a machine to a set of applications, just like any other machine. It supports a new self-defined set of instructions (java byte codes for JVM). The most popular approach is to deploy high level language (HLL) VMs. In this scenario, the virtualization layer sits as an application program on top of the operating system, and the layer exports an abstraction of a VM that can run programs written and compiled to a particular abstract machine definition. Any program written in the HLL and compiled for this VM will be able to run on it. The Microsoft .NET CLR, Java Virtual Machine (JVM) and Parrot are good examples of this class of VM.

IV. Some Popular Cloud Services

A. Amazon's Web Services (AWS)

Amazon was the first company that offer cloud services to the public. The services are very sophisticated, Amazon offer number of cloud services like EC2, SQS, S3 and SimpleDB. The Elastic Compute Cloud (EC2) allows users to rent computers to run computer applications in the Amazon EC2 data center. Amazon EC2 uses the Xen virtualization technique to manage physical servers. There might be several Xen virtual machines running on one physical server. Each Xen virtual machine is called an instance in Amazon EC2[14]. There are several types of instances.

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Each type of instance provides a predictable amount of computing capacity. The simple storage service (S3) the service provide 5 GB storage in Amazon's virtual storage service. The Simple Queue Service (SQS) allows your machines to talk to each other using message passing API. The SimpleDB web service works in close conjunction with EC2 and S3 , collectively provide the ability to store , process and query data sets in the cloud.

B. Microsoft Azure

Microsoft Azure is a cloud computing platform and infrastructure, it is designed for building, deploying and managing applications and services through Microsoft-managed datacenters [5]. It provides both PaaS and IaaS services and supports many different programming languages, tools and frameworks, including both Microsoft-specific and third-party software and systems. Microsoft Azure allows developers to build sites using ASP.NET, PHP, Node.js, or Python and can be deployed using FTP, Git, and Mercurial. It provides data management service known as SQL Azure Database. The Microsoft Azure Platform provides an API built on REST, HTTP, and XML that allows a developer to interact with the services provided by Microsoft Azure [15]. Microsoft also provides a client-side managed class library which encapsulates the functions of interacting with the services. It also integrates with Microsoft Visual Studio, Git, and Eclipse.

C. Google App-Engine

Google App engine is a cloud computing Platform provide platform as a service (PaaS) for developing and hosting web applications in Google managed datacenters. Programmers can write applications using most popular languages: Python, Java , PHP, and Go. It provide various framework such as Django, Flask, Spring and webaap2. Programmer can choose storage option like MySQL database using cloud SQL, a schema less NoSQL datastore or object storage using Cloud Storage. It manages services such as Task Queues, Mamcache, and User API. Google App provide various development tools: Eclipse, Intellj, Maven, Git, Jenkins, PyCharm and more [16].

V. Conclusion

Without virtualization, cloud computing is possible but it will be inefficient and inflexible. Virtualization provides flexibility scalability, and cost advantages to cloud computing. There are many levels and many ways to implement virtualization.

Some abstraction levels and their software described in this paper, to understand how virtualization is achieved in different levels of abstraction. This paper also discussed some popular cloud services to understand how these services are useful for individuals and organization.

REFERENCES

[1] Firas D. Ahmed , Amer Al Nejam "Cloud Computing: Technical Challenges and CloudSim Functionalities" International Journal of Science and Research (IJSR), India Online ISSN: 2319-7064 pp. 26-30

[2] Aishwarya Anand "Amazon's Approach to Cloud Security" Proceedings of 4th IRF International Conference, Pune, 16th March-2014, ISBN: 978-93-82702-66-5 pp. 173-178

[3] Ankita Desai, Rachana Oza, Pratik Sharma, Bhautik Patel "Hypervisor: A Survey on Concepts and Taxonomy" International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-2, Issue-3, February 2013 pp. 222-225

[4] V.Vinothina, Dr.R.Sridaran, Dr.PadmavathiGanapathi "A Survey on Resource Allocation Strategies in Cloud Computing" (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 3, No.6, 2012 pp. 97-104

[5] Manoj Sharma , Keshav Jindal , Dr. S.Srinivasan "Evaluating Various Aspects of Cloud Computing Vendors with Comparison" International Journal of Research Aspects of Engineering and Management ISSN: 2348-6627, Vol. 1, Issue 1, FEB 2014, pp. 4-8

[6] Hitesh A Bheda , Chirag S Thaker "Virtualization Driven Mashup Container in Cloud Computing PaaS Model " Proceedings published by International Journal of Computer Applications® (IJCA) International Conference on Computer Communication and Networks CSI- COMNET-2011 pp. 9-14

[7] Ahmed Shawish and Maria Salama "Cloud Computing: Paradigms and Technologies " F. Xhafa and N. Bessis (eds.), Inter-cooperative Collective Intelligence:Techniques and Applications, Studies in Computational Intelligence 495, DOI: 10.1007/978-3-642-35016-0_2, Springer-Verlag Berlin Heidelberg 2014pp. 39-67

[8] Krishna tej Koganti, Eswar Patnala , Sai Sagar Narasingu, J.N. Chaitanya "Virtualization Technology in Cloud Computing Environment" International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 3, March 2013) pp.771-773

[9] Pankaj Sareen " Cloud Computing: Types, Architecture, Applications, Concerns, Virtualization and Role of IT Governance in Cloud " International Journal of Advanced Research in Computer Science and Software EngineeringVolume 3, Issue 3, March 2013 ISSN: 2277 128Xpp. 533-538

[10] L. Shi, H. Chen, J. Sun," vCUDA: GPU accelerated high performance computing in virtual machines," in: Proceedings of the IEEE International Symposium on Parallel and Distributed Processing, 2009

[11] http://www.cse.iitd.ernet.in/~sbansal/csl862-virt/2010/readings/software_hardware_tech_x86_virt.pdf