www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 3 Issue 10 October, 2014 Page No.8850-8853

Cloud Computing And Virtualization: Trends And Technologies

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ABSTRACT

In our world today, the inculcation of ICT in government and business has become an indispensable tool in the implementation of government's policies and also for businesses to tap into the realms of competiveness. Previous studies have proved the ubiquitous of ICT to be one of the efficient and effective way in realizing this phenomenon. A contemporary technology in recent times is cloud computing; whose aim is to deliver the utility of ICT in a cost efficient and effective manner. It adopts the technique of elasticity that rides on the principle of "pay as you need", which prevents redundancies and allows for scalability and much more diversity in the use of resources. This paper aims at reviewing the provision of the cloud computing capabilities and the constraints that comes with it.

KEYWORDS

Cloud computing, Virtualization, Computer Network, Cloud services

1. INTRODUCTION

Cloud computing refers to both the applications delivered as services over the Internet and the hardware and systems software in the data centers that provide those services [1]. These services can be categorized as Software as a service (SaaS), Platform as a service (PaaS), and Infrastructure as a service (IaaS). These services can be distinguished based on the level of abstraction and the level of management of resources presented to the client. A cloud structure basically is made up of various data center hardware and software which are connected through a wide area network. Each of the data centers has the capability of *virtualization*: each physical machine supports multiple interconnected virtual machines [2].These virtual machines share the same hardware and storage, and can be migrated from one physical machine to another in the same data center or even in a remote data center.

Users requirement and needs have become very complex in recent times, partly due to the fast revolution and emergence of new technology. A user may wish to upgrade his software application to meet new requirements, or may wish to expand his IT infrastructure to meet the growing clientele demand, or even increase his bandwidth size to upgrade his services in terms of speed etc. These upgrade requirements are very common in any typical business establishment or organization and usually leaves business owners in a state of disarray, especially when they are compelled to readjust their current system to meeting a pressing demand. Sometimes upgrading from a particular application to a newer one would mean changing your application server entirely due to compatibility issues and/or paying huge amount of money for experts to deploy the new application on the new application server.

Cloud computing, also known as utility computing came in to existence to help cure and mitigate these constraints in computer usage. "Utility" as used in our social context connotes satisfaction, and suggests benefits/satisfaction that accrues an individual when he needs a service. Example, when a user needs a utility such as electricity, water, phone etc , he pays for that service as and when he uses it. At a point in time when he feel the need to use a specific utility, he do not pay for it. The principle of Cloud computing, is thus clad in this principle. The cloud is made up of various resources and they are made available on demand. This whole paradigm is made possible by a concept or technique known as virtualization.

Virtualization basically allows partitioning one physical machine to a host of multiple virtual instances running concurrently and sharing the same physical resources. Virtualization is the main technology of cloud computing due to the fact that it enables resource sharing in an efficient and cost effective manner [3]. It also provides energy saving capability by enhancing the full resource of various physical machines to be mapped to, or migrated on to virtual machines for simultaneous usage. Furthermore, it enhances the

cloud platform scalability and availability through the instantiation of new isolated virtual instances on demand [4].In the nutshell, virtualization can be seen as the main technology to enhance cloud computing, in that, it creates replica or instance(s) of servers for operating systems, middleware and applications of the participating cloud servers and slice or distribute them to users who subscribe to the cloud and reassign licensing of application software to new users who subscribe on to the cloud. Technically it serves as the administrator of cloud computing. The rest of the paper is organized into section 2 which talks about trends in virtualization and finally section 3 for discussions and conclusion.

2. TRENDS IN VIRTUALIZATION

IBM defined a virtual machine as an isolated and fully protected copy of the physical hardware of a machine [4] . Though some researchers have argued that virtualization is not the only technique that can be used in cloud computing, it is obvious that the inculcation of virtualization in cloud computing would go a long way to providing sharing of physical resources within the cloud and allow for higher utilization rates of resources and also goes a long way in reducing hardware investment, save space and reduce power consumption [5].

Currently there are a number of public clouds that uses virtualization technology to offer infrastructure as a service (IaaS). A typical example is the Amazon Elastic Compute Cloud (EC2) which is one of the most visible cloud systems that is in use in contemporary time. Nimbus [6],[7] and Eucalyptus [8] are two popular private infrastructures as a service (IaaS) platforms in both the scientific and industrial communities. Nimbus infrastructure, sprawled from the concept of deploying virtual workspaces on top of existing Grid infrastructure using Globus, pioneered scientific Clouds since its inception. Eucalyptus has historically focused on providing an exact EC2 environment as a private cloud to enable users to build an EC2-like cloud using their own internal resources [9]. Xen hypervisor [10] has been recognized by many researchers as the most widely used technology in recent times. Due to the fast growth of technology, technologies such as VMWare ESX [11], Oracle VirtualBox [12] and the Kernelbased Virtual Machine (KVM) are gradually becoming popular.

According to [3] KVM was seen as the overall choice for use within HPC Cloud environments after their study. They observed that KVM's had a feature-rich experience and near-native performance that makes it natural fit for deployment in an environment where performance and usability are critical. They then concluded that the KVM hypervisor outperform Xen and exhibits lots of resilience when deployed in a cloud platform.There are basically three techniques that can be used to virtualize a guest operating system. These include Full virtualization, Hardware-assisted virtualization and Paravirtualization

Full virtualization

One basic attribute of full virtualization is the fact that guest OS in fully virtualized environment are provided with all the services provided by physical systems which include a virtual BIOS, virtual devices as well as virtualized memory [13]. With this technique of virtualization the host operating system is unaware of any other versions[10] of it being virtualize, hence there is no provision for modification by the host Os. Although full virtualization has the obvious benefit of allowing unmodified operating systems to be hosted, it also has a number of drawbacks. This is particularly true for the prevalent IA-32, or x86, architecture[10].

The original design of the x 86 architecture did not support full virtualization technology. For this technique to work in a cloud environment, it required certain supervisor instructions to be handled by the virtual machine monitors for correct virtualization, but executing these with insufficient privilege fails silently rather than causing a convenient trap [14]. Efficiently virtualizing the x86 MMU is also difficult.

These problems can be solved, but only at the cost of increased complexity and reduced performance. VMware's ESX Server [15] dynamically rewrites portions of the hosted machine code to insert traps wherever VMM intervention might be required. This translation is applied to the entire guest OS kernel (with associated translation, execution, and caching costs) since all non-trapping privileged instructions must be caught and handled. ESX Server implements shadow versions of system structures such as page tables and maintains consistency with the virtual tables by trapping every update attempt — this approach has a high cost for update-intensive operations such as creating a new application process [16].

Para virtualization

Paravirtualization is a technique used to virtualize a guest OS to allow better performance than full virtualization or hardware-assisted virtualization [56]. With paravirtualization the guest OS is able to communicate with the hypervisor this is achieved through modifications of the guest OS to translate non-virtualizable instruction with hypercalls. Hypercalls are instructions that are able to communicate directly with the virtualization layer. Modification of the guest OS involves low compatibility and portability problems [17].

The drawbacks of full virtualization could be averted by a virtual machine abstraction that is similar but not identical to the underlying hardware as exhibited in this technology. Paravirtualization improves performance, although it does require modifications to the guest operating system. It is important to note, however, that we do not require changes to the

application binary interface (ABI), and hence no modifications are required to guest applications [17].

Hardware-assisted virtualization

Hardware-assisted virtualization has been developed to overcome the drawback of paravirtualization due to hardware modification that allow the guest OS to communicate with the VMM without modifications. Hardware types supporting this kind of virtualization are Intel Virtualization technology (Intel VT) and AMD virtualization (AMD-V). Those processors have features that trap OS requests that come from ring 1 (Figure 4). Due to that ring 0 is transformed as a virtual ring -1 and ring 1 is a virtual ring 0 where the guest OS can operate without any modifications [16]. The development of virtualization have been an important factor in the development of cloud computing also this have been permitted by the development of new x86 processors which come with support for virtualization. Para-virtualization is able to give the best performances because it is the type of virtualization with the least overhead. However with this type of virtualization it is required to modify the guest OS system to be able perform virtualization. Also the use of para-virtualization is often completed with hardware assisted virtualization to virtualize guest Operating System (OS) such as Windows. Cloud computing can be provided a different levels such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS). The services provided can be deployed on different type of cloud such as public cloud, private cloud, community cloud and hybrid cloud.

As seen previously there are many different type of virtualization. To be able to

provide the best performances cloud computing is using para-virtualization as well as hardware-assisted virtualization. Full virtualization is not used in cloud computing due to poor performances cause by its considerable overhead. Virtualization technology is not a new technology however it has regain popularity in 2005 with the apparition of AMD and Intel processors which had support for virtualization. Virtualization brings many advantages such as the improvement of security, the enhancement of the efficiency of server utilisation and so on. Also during the past few years due to the popularity of virtualization and its utilisation in the cloud computing many studies have been made. From those research lot of improvement have been made to try to obtain performances near to native performances.

3. DISCUSSIONS AND CONCLUSIONS

According to [17] Virtualization is basically making a virtual image or "version" of something such as server, operating system, storage devices or network resources so that they can be used on multiple machines at the same time. The main aim of virtualization is to manage the workload by transforming traditional computing to make it more scalable, efficient and economical. Though virtualization has been extol by many as a major breakthrough in the Information Communication Technology industry, there are numerous issues that undermine its capabilities. Below are a few identified drawbacks;

***Storage concerns*:** Due to the fact that in a typical cloud environment, the cloud allows for addition and removal of as many virtual machines as possible spontaneously, and if a particular virtual machine (VM) leaves a cloud and its data is not cleared from physical memory of the server on which it resided, and the same space is reallocated to another virtual machine (VM), there would be a greater chance of information leakage, typically in a public cloud environment. One of the best approaches to remedy this occurrence is for virtual machine users to responsibly free or delete all relevant data on their allotted cloud before relinquishing the space.

***Data Standardization*:** There have been issues about data migration from one cloud to the other. Users find it difficult to move their data from one particular cloud to the other due to difference in data representation and format. Due to this, there is a level of laxity on the path of service providers to give users the optimum attention and address their concerns. This is because, they know once a user subscribe to their cloud, it would be very difficult to transfer data to another provider due to disparity in data presentation. One best solution is for a body to be setup to come up with a standardization procedure in creating, deploying, presenting, storing and managing data in a cloud environment for adoption by all participating providers.

***Monitoring Network in a cloud*:** Due to the fact that most current monitoring techniques and software perform very well on static and physical components, in controlling and maintaining the network. In a cloud environment, because of the virtual nature and the fact that it is a very dynamic setting, configuring and monitoring in cloud systems leaves a lot to be desired. Fortunately there are currently software that can be used to mitigate and fix the problem, some of these companies include VMware, IBM, Hewlett-Packard, and CA) their software cans monitor virtual systems and also manage dynamic systems.

Computing security: there has been a lot of talk about the security of cloud systems. Most researchers are of the view that because there is a single layer (hypervisor) that manages and controls the entire virtualization task in the cloud, the entire cloud system would be compromised once an attacker gains access to it. But the fact is, unlike a normal operating system that is versatile in its dealing, that is, it manages all the

hardware components, application software, utilities etc. The hypervisor is a simple operating system that has a specific task of a traffic cop to ensure that things happen in an orderly manner. Though there is no perfect system and this is not a yardstick to safety, further skewing hypervisor(s) to specific role in a cloud system would make it difficult for attackers to gain control of the entire VM's.

In recent times, there has been a lot of concern about the rate of emissions of carbon dioxide and other gases that causes an overwhelming depletion of the ozone layer. In 2007, the total carbon footprint of the IT industry including personal computers, mobile phones, telecom devices and datacentres was 830 MtCO2e that is it contributed 2% of the estimated total emissions from all human activity that year. This figure is expected to grow in the coming years [9]. The argument here is that, construction of datacenters requires a huge power generation source for it functioning. And this power generation systems emits gases that cases the further depletion of the ozone layer. This is mainly because, these datacenters are powered 24/7 and a huge amount of power is required to power and sustain the work of the datacenter. As far as I am concern, there hasn't been any comparative analysis in respect to the power consumed by multiple isolated servers and a composite datacenter such as the one used by YAHOO or AMAZON. In each case, there could be advantages and disadvantages, in the case of isolated servers, a user may switch the server off when it is not in used or at the close of work. But in the case of a datacenter, it is almost impossible to switch an entire datacenter that services clients in different geographical area. Again one of the undeniable advantages of a datacenter is the ability of creating multiple virtual machines that utilizes the power of varied or agglomerated resources simultaneously. This in a way cuts down the supposed power that might have been consumed by individual servers or computers accessing different resources.

In the nutshell, I think virtualization is one powerful technique that should be fine-tuned to better enhance the ever growing advantages of using cloud computing. There should be a standard procedure that would compel service providers of cloud to adopt in order to have a harmonious working environment of cloud computing. There should be standard practices and procedures for allocation and reallocation of virtual machines in a cloud environment and finally there should be better security features to prevent advisories or attackers from gaining access to the hypervisors and subsequently gaining control of the entire virtual machines on the cloud. .

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