ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 8, August 2014

Review on Virtualization for Cloud Computing

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Abstract: Virtualization and cloud computing are the technologies that go hand in hand. Cloud computing is an emerging technology that represents a new computing paradigm. It will enable individuals and organizations to access a pool of computing resources in pay as you use fashion. This technology helps small and medium companies or any company on the earth for that matter to eliminate the need for capital investment. Cloud computing offers many service models such as Platform as a Service (PaaS), Infrastructure as a Service (IaaS) and Software as a Service (SaaS). It bestows many deployment models such as private could, public cloud, community cloud and infrastructure cloud. With this technology the computing resources have been commoditized in the similar fashion which commoditizes water and electricity. However, cloud computing cannot become affordable solution without the technology virtualization. Therefore virtualization is the technology on top of it cloud computing is built. Virtualization is the process of creation of virtual counterpart of something like hardware, network, storage device, and operating system. This paper presents the insights pertaining to both technologies besides their impact on the society in all walks of life.

Keywords - Cloud computing, virtualization

I. INTRODUCTION

Cloud computing is technology that helps users to have access to huge computing resources. This access is given in the way useful to society. Individuals and organizations can avoid investments and simply use the resources as if they are in their machine. This is done in pay per use fashion. When it comes to virtualization virtual machine is a machine inside the machine which does not exist in the real world. However, it can have its own OS and serve applications of users. Virtual machienes provide hardware independence, isolation, and encapsulation. The benefits of virtualization include disaster recovery, training, product evaluations, testing, quality assurance, software development, improved security, decreased provisioning times, server consolidation, increased hardware utilization, and simplified administration.

Physical vs. Virtual Machine

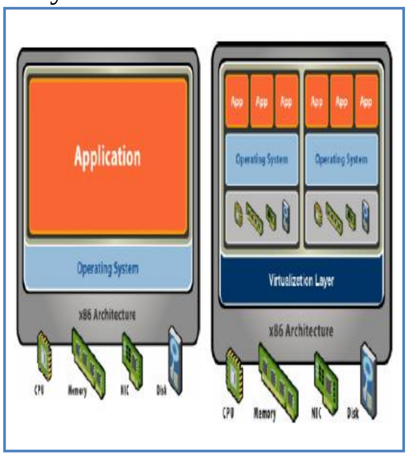

Figure 1 – Physical vs. virtual machine [1]

As can be seen in Figure 1, it is evident that the physical and virtual machines have differences in performance. Virtualization layer is additionally kept so as to share hardware resources to many virtual machines. Every virtual machine can host its own OS and run user applications. This will reduce the cost and increase scalability and performance besides making it a secure environment.

Jain and Paul [6] studied network virtualiation and software related networking used in the cloud computing context. It does mean that network virtualization is possible and it has plethora of benefits. In fact it is the crucial thing for the success of cloud. Gartner [7] provides more insights into virtualization. According to him it is not simply a cost cutting setup and it has to be viewed as catalyst for whole IT modernization. Keller *et al*. [8] presents a concept in which virualization layer is removed but the idea of virualization and its features are used. The architecture they proposed is called NoHype architecture. Simple hardware extensions are used without a virtualization layer to ahcive virtualization. Nader benmessaoud [9] from Microsoft provided architecture for network virtualization. Implementation of cloud computing is also demonstrated using networking virtualization concept. Hao *et al*. [10] focused on virtualized network infrastructure and its security merits. They proposed an architecture that takes advantage of centralized controller and virtualization. The architecture also scalable and overcomes limitations with the help of network virtualization. Josyula *et al*. [11] studied virtualized data center. Their architecture for virtualized data center has various components with definite division of labor. They are architectures, designs and implementations. There are many design components that are part of the main architecture.

In this paper cloud computing and virtualization are discussed in terms of their use in the real world and the way they work in future besides advantages of virtualization. The remainder of this paper is structured into sections like Related Work and Conclusion. Three papers are elaborately discussed in related works. They are virtualization technologies used for high performance computing, dynamic scaling of web applications in cloud and I/O bottlenecks in cloud computing.

II. VIRTUALIZATION TECHNOLOGIES FOR HIGH PERFORMANCE COMPUTING ENVIRONMENTS

Younge *et al.* [2] focused on high performance computing environments like cloud and the virtualization technologies. Virtualization technologies enable to get benefited from virtual machines that can improve scalability besides bestowing other advantages like security, cost effectiveness etc. Many hypervisors have been tested for their performance in terms of fast Fourier transform, ping pong bandwidth, ping pong latency, and speed of the hypervisors.

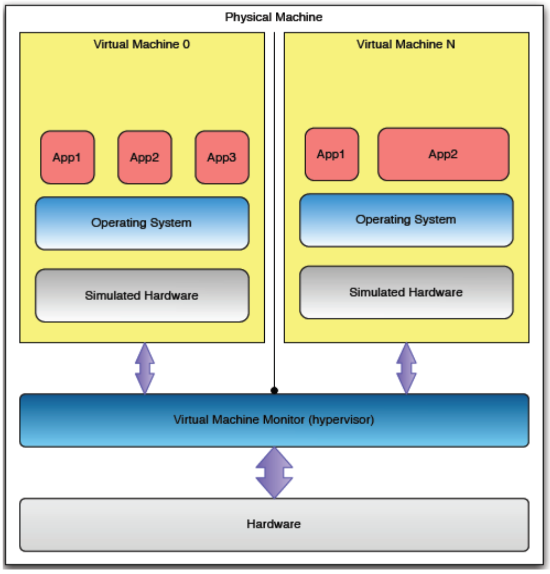

Figure 2 – Illustrates abstraction of virtual machine [2]

As can be seen in Figure 2 it is evident that the hardware is exploited by hypervisor or VM monitor in order to support multiple virtual machines. Each VM can have its own operating system and applications running in it. Thus the technology can help to avoid cost of hardware for each machine as virtual machines are software components. This enables the cost effective operations. In fact cloud computing is depending on virtualization in order to provide affordable cloud services.

	Xen	KVM	VirtualBox	VMWare
Para-virtualization	Yes	No	No	No
Full virtualization	Yes	Yes	Yes	Yes
Host CPU	x86, x86-64, IA-64	x86, x86-64,IA64,PPC	x86, x86-64	x86, x86-64
Guest CPU	x86, x86-64, IA-64	x86, x86-64,IA64,PPC	x86, x86-64	x86, x86-64
Host OS	Linux, UNIX	Linux	Windows, Linux, UNIX	Proprietary UNIX
Guest OS	Linux, Windows, UNIX	Linux, Windows, UNIX	Linux, Windows, UNIX	Linux, Windows, UNIX
VT-x / AMD-v	Opt	Req	Opt	Opt
Cores supported	128	16	32	8
Memory supported	4TB	4TB	16GB	64GB
3D Acceleration	Xen-GL	VMGL	Open-GL	Open-GL, DirectX
Live Migration	Yes	Yes	Yes	Yes
License	GPL	GPL	GPL/proprietary	Proprietary

Figure 3 – Comparison among virtualization solutions [2]

All virtualization solutions are presented in Figure 3 along with various features compared. This provides a summary of features supported by each hypervisor [2].

Experiments and Future Work

Experiments are made on virtualization technologies in terms of hypervisor technologies and speed, ping pong bandwidth performance in terms of hypervisors and bandwidth, fast Fourier transform performance in terms of hypervisors and speed, and ping pong latency performance in terms of hypervisors and latency. FutureGrid is used for cloud and virtualization test bed [2].

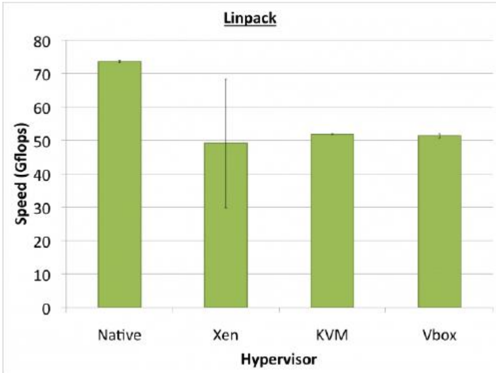

Figure 4 – Shows Linpack performance [2]

As can be seen in Figure 4, it is known that the speed of hypervisors is almost similar except Native. Xen hypervisor has shown less speed when compared with KVM and Vbox.

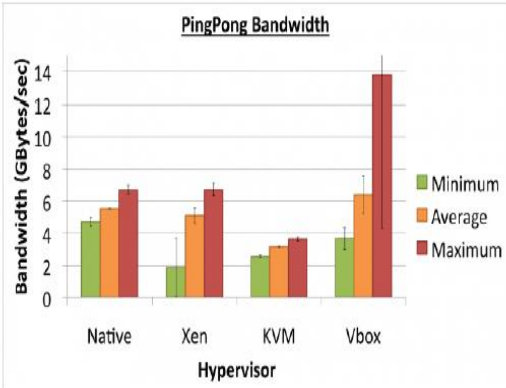

Figure 5 – Shows ping pong bandwidth performance [2]

As shown in Figure 5, the ping pong bandwidth performance is shown against various hypervisors with minimum, maximum and average.

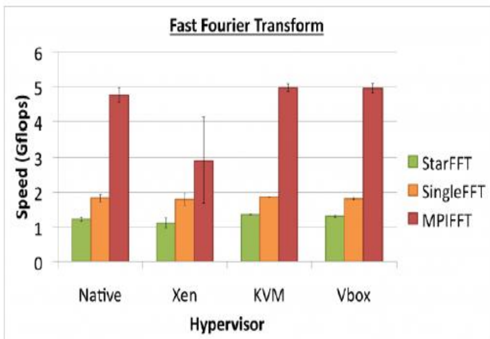

Figure 6 – Shows fast Fourier transform performance [2]

ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
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As seen in Figure 6, it is evident that performance of fast Fourier transform is shown with respect to StarFFT, SingleFFT, and MPIFFT against all hypervisors.

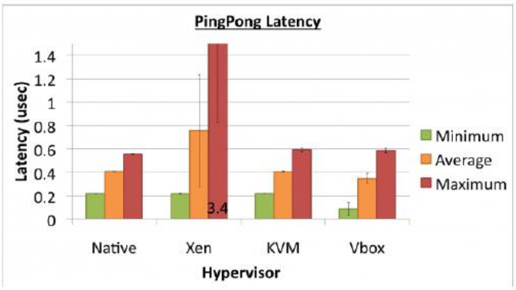

Figure 7 – Shows ping pong latency performance (lower value means high performance) [2]

As shown in Figure 7, it is known that Latency is different for different hypervisors. The results are plotted with minimum, average and maximum values. Native, Vbox, and KVM hypervisors have shown comparably similar performances while performance of Xen is degraded with respect to maximum and average values. Improvement of quality of service, computational efficiency and operational cost performance is the direction for future work [2].

III. DYNAMIC SCALING OF WEB APPLICATIONS IN A VIRTUALIZED CLOUD COMPUTING ENVIRONMENT

Chieu *et al.* [3] proposed a novel architecture for dynamically scaling web applications. These web applications provided dynamic scalability as they are deployed in cloud. As the cloud has almost unlimited scalability it helps the web applications to scale well. Cloud is able to provide various services like application services, infrastructure services and platform services. Moreover the cloud has flexible features including pay per use usage of all resources. With web applications deployed in scalable environment, it is possible that the applications work fine in spite of load in the server.

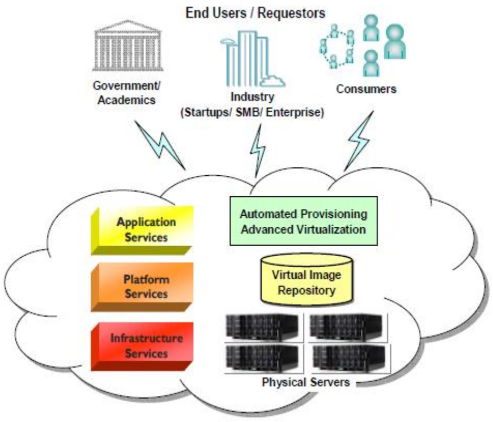

Figure 8 – Typical cloud computing environment [3]

As can be seen in Figure 8, it is known that physical server will work in virtual environment and the cloud services are in place. Automatic provisioning and advanced virtualization facilities are available. End users might be service consumers, enterprises or organizations and even governments.

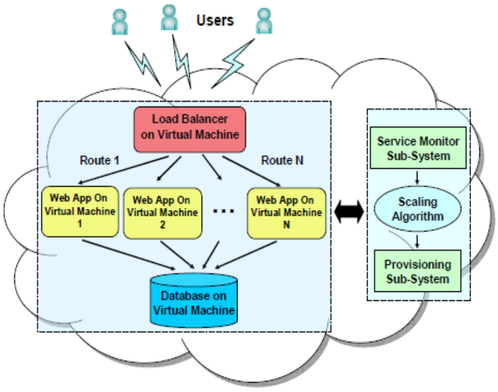

Figure 9 – Architecture for scalable web applications in cloud [3]

As shown in Figure 9 it is evident that the architecture is specially designed to be scalable. Every web application is running in a separate virtual machine and there is load balancer which takes care of balancing load so as to make the cloud scalable. Scaling algorithm, provisioning sub-system, and service monitor sub-system.

IV. EXPERIMENTS AND RESULTS

Experiments are made with web applications deployed into the cloud as per the architecture described in Figure 9. It is observed that the applications are scalable. The front end load balancer is capable of balancing load so as to ensure that no server is getting overloaded. The results revealed that the proposed architecture for scalable web application is encouraging and useful in real world scenarios. Future work includes resource optimization and utilization study for further improving the architecture [3].

I/O Virtualization Bottlenecks in Cloud Computing Today

Shafer [4] studied I/O virtualization in the context of cloud computing. There are some I/O virtualization bottlenecks in cloud computing that were explored by Shafer. I/O intensive applications have been tested with various cloud platforms. The results are compared and discussed. There is some storage limit for I/O virtualization out of the box solutions. Out of the box network band width also has limitations. For this reason it is very challenging task to make experiments with I/O related things in cloud computing [4].

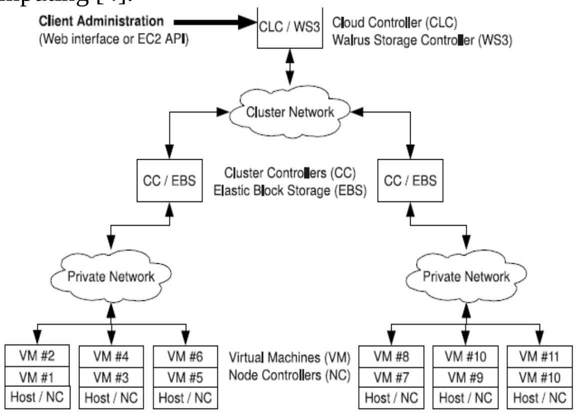

Figure 10 – Overview of Eucalyptus cluster [4]

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ISSN (Print) : 2319-5940
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Eucalyptus cluster is shown in Figure 10 which has private networks integrated elastic block storage. Cluster networks are associated with cluster controllers. VMs and node controllers and host controllers are available as part of architecture. The I/O bottlenecks are tested with this cloud platform and also with Hadoop.

Experiments and Results

Experiments are made with Eucalyptus storage bandwidth and configuration with respect to read/write operations.

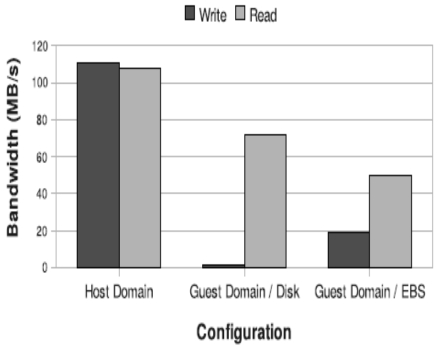

Figure 11 – Eucalyptus storage bandwidth [4]

As can be seen in Figure 11, configuration and bandwidths are tested with I/O with respect to host domain, disk and EBS. Bandwidth is high in case of host domain.

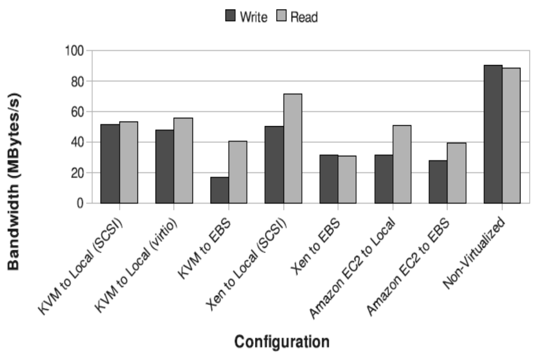

Figure 12 – Hadoop storage bandwidth [4]

Configuration versus bandwidth is tested with Hadoop using KVM, Xen and Amazon environments. Non-virtualized environment has consumed more bandwidth when compared with the virtualization counterparts.

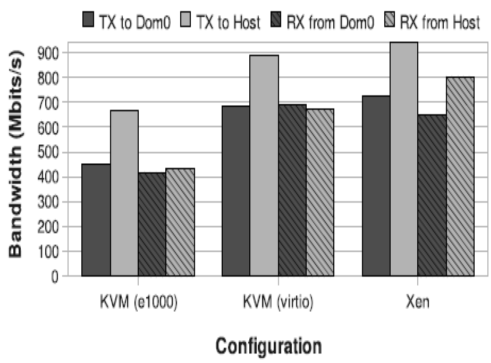

Figure 13 – Netperf network throughput [4]

KVM and Xen hypervisor environment is used for configuration and bandwidth. The results presented in Figure 13 presents the Netperf network throughput in various environments.

V. CONCLUSION

This paper studied the virtualization on which cloud computing is based. It throws light into both cloud computing and virtualization. Virtualization improves the efficiency of cloud computing. Virtualization is done with many resources like I/O, OS, network, storage and so on. Virtualization improves scalability besides making the cloud solutions cost effective. These two technologies go hand in hand in providing state of the art services to end users. Individuals and organizations can access to various kinds of clouds in pay per use fashion and obtain services pertaining to infrastructure, platform and software. Scientific and high computing tasks can take advantage of cloud computing.

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ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940

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