Relative Performance Analysis of Major Virtual Machine Monitor in Cloud Computing

Samjhana Rayamajhi, Asif Khan, and Zinnia Sultana

Abstract— Cloud Computing uses various virtualization technologies. A virtual machine monitor (VMM) is a piece of that computer software, firmware or hardware that creates and runs virtual machines which makes multi-tenancy possible which is also known as hypervisor. A virtualized system allows multi-tenancy. Multi-tenancy allows multiple tenants to coexist in the same physical machine sharing its resources and at the same time, creates an isolated environment for each of them. Cloud service providers (CSP) uses this technology to maximize their infrastructures using this architecture by allocating resources from physical machines that are not being fully used. Multi tenancy can be obtained by virtualization. The main objective of this study is to deliver concept of virtualization, VMM along with the performance comparison of some common virtualization technologies using many benchmarks which is chosen as it gives a good idea how the hypervisor's performance is. First method of comparison chosen is features comparison, further those virtualization techniques are technically compared along with data compression and decompression speed, File I/O benchmark, CPU benchmark sequential read-write performance, memory and cache performance and Network speed performance of the VMs running at the top of the virtualized layer is studied, ultimately concludes giving an overall guideline to choose a wise hypervisor depending upon the purpose.

Index Terms— Cloud computing, hypervisors, hypervisor's performance, Virtual Machine Monitor, virtualization technology, benchmarks.

1 Introduction

Alike traditional computing cloud computing arrived with the solution to reduce costs in organizations and at the same time to provide on-demand resources and computation without requiring to create an IT infrastructure.

To create such environment, cloud service providers (CSP) make use of virtualization technologies so that they can maximize the value of their systems [7]. To avoid other services to interfere with them servers have always needed to run alone in physical machines; but disadvantage of this was the waste of resources which can be overcome by Virtualization by sharing them between the guest operating systems (OS). [1]

This research deals with the four most common virtualization technologies out of number of virtualization technologies available. They are VM-ware, Virtual Box, KVM and Xen. VM-ware VBox is type 2 or hosted hypervisors where they are more like an application running on a host Operating system. KVM and Xen are native or bare metal hypervisors which runs directly on a hardware, in a sense they are both hypervisor and an OS.

2 Related Works

In recent years virtualization has grown its popu-larity in many different areas such as server consolidation, information security and cloud computing due to an increase in hardware performance of about ten fold in the past decade and the goal to reduce capital and operational costs within the data center. [3]

In recent history there have been many work of comparisons related to virtualization technologies and Cloud computing itself. The first performance analysis of various hypervisors started with the hypervisor vendors themselves. VMWare, as well as the original Xen which compares Xen, and VMWare across a number of a number of more seamless reports originated, prioritizing server consolidation and web application perfor-mance with fruitful yet sometimes incompatible results. A feature base survey on virtualization technologies [4] also illustrates the wide variety of hypervisors that cur-rently exist. Furthermore, there has been some investigation into the performance within HPC, specifically with InfiniBand performance of Xen and rather recently with a detailed look at the feasibility of the Amazon Elastic Compute cloud for HPC applications, however both works concentrate only on a single deployment rather than a true comparison of technologies.

As these underlying hypervisor and virtualiza-tion implementations have evolved rapidly in recent years along with virtualization support directly on standard x86 hardware, it is necessary to carefully and accurately evaluate the performance implications of each system. Hence, we conducted an investigation of several virtualization technologies, namely Xen, KVM, Virtual Box, and in part VMWare.

3 Virtual Machine Monitor (VMM) Architecture And Classification

In their 1974 article "Formal Requirements for Virtualiza-ble Third Generation Architectures" Gerald J. Popek and Robert P. Goldberg classified two types of hypervisor.

Type 1 (or native, bare metal) hypervisors run directly on the host's hardware to control the hardware and to manage guest

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operating systems. A guest operating system thus runs on another level above the hypervisor.

This model represents the classic implementation of virtual-machine architectures; IBM developed the original hypervisors as bare metal tools in the 1960s: the test tool SIMMON, and CP/CMS. CP/CMS was the ancestor of IBM's z/VM. Modern equivalents include Oracle VM Serv-er for SPARC, Oracle VM Server for x86, the Citrix Xen-Server, VMware ESX/ESXi and Microsoft Hyper-V 2008/2012.

Type 2 (or hosted) hypervisors run within a conventional operating system environment. With the hypervisor layer as a distinct second software level, guest operating systems run at the third level above the hardware. VMware Workstation and VirtualBox exemplify Type 2 hypervisors

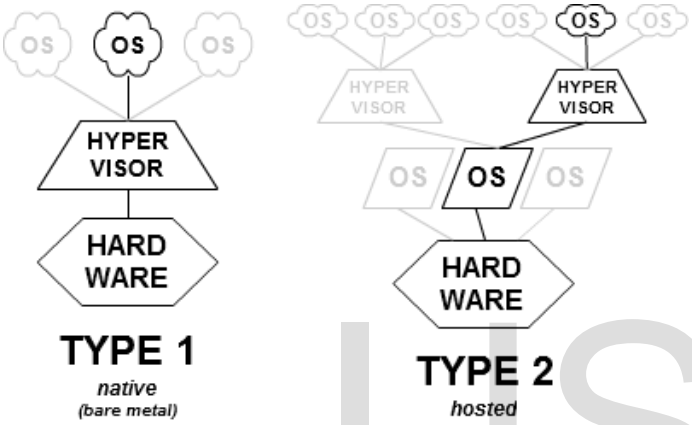

Fig.1: hypervisor classification [2].

4 Experimental Arrangement

We have choosed the simplest way to perform this certain tests. This work of comparison of VMM is done by virtual-izing my system with the main specification like Proces-sor: Intel Core i5 430M (2.26GHz, 1066MHz, 3MB) OS: Windows 8 Professional (32-bit) Memory: 4GB Dual Channel DDR3 at 1066MHz Storage: 320GB 7200rpm HDD. We have also virtualized external 1Tb hard disk to run the test concurrently and more smoothly. At the top of the every virtualization technology three instances of the operating system is created where one of them is Linux Ubuntu and other two are windows 7 operating system.

5 Evaluation And Comparison

5.1 Feature Comparison

Vehicle The number of VMM is growing with the growing technology. With the wide and large number of potential choices of virtualization technologies available, it is often difficult for users to identify which platform is best suited for their needs. Basically none of the virtualization technique is bad but the degree of its superlative depends up-on the need. In order to simplify this task of choosing, a detailed comparison chart between VMWare ESX, Virtu-alBox 3.2, Xen 3.1 and KVM from RHEL5 is provided. The first way chose of comparison is the virtualization method. Every VMMs are designed concentrating on some specific task to perform.

TABLE 1
The Feature Comparison Table Of VMMs

	Xen	KVM	VBox	VMWare
Para-virtualization	Yes	No	No	No
Full virtualization	Yes	Yes	Yes	Yes
Host PC	x86, x86-64, IA-64	x86, x86-64, IA64, PPC	x86, x86-64	x86, x86-64
Guest PC	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
3DAcceleration	Xen-GL	VMGL	Open-GL	Open-GL, DiectX
Live Migration	Yes	Yes	Yes	Yes
License	GPL	GPL	GPL/proprietary	Proprietary

5.2 Technical Comparison: VMware and VBox

In technical comparisons between the virtualization techniques certain few points are considered though there can be many other functionality to be considered.

In host operating system support, we found virtual box is better and configuring, updating and editing is easier in virtual box then that of VM-ware. VM ware is better in USB support. Virtual box supports relatively larger range of virtual hard disks. Teleportation or migration of VM in virtual box is better along with the command line options where copying and editing is very easy. In case of graphics and Ovf support it is found that VM-ware is better.

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TABLE 2

THE TECHNICAL COMPARISON TABLE (VMWARE & VBOX)

	VMware	Virtual box
Host OS support		●
VM editing		●
USB support	●	
Range of virtual hard disk		●
Remote connection		●
VM cloning		●
Graphics	●	
Cmd line		●
Teleportation		●
Ovf support	●	

5.3 Technical Comparison: KVM & Xen

Similarly the comparison between KVM and XEN says that in host operating system KVM isn't an option on older CPUs made before the virtualization extensions were developed, and it rules out newer CPUs like Intel atom CPUs that don't include virtualization technique.

XEN is very widely used in the market then KVM. In case of Operating System overhead XEN is less burdened with any operating system overhead that is unrelated to processing a series of guests on a given machine. XEN ensures the high security via variety of features like guest isolation, privileged access, small code base and operating system separation. XEN hypervisor has been introduced long time back. It is available since 2004 and is the first open source hypervisor to successfully be deployed by Linux vendors. Xen uses its own kernel for thread scheduling and dispatching VMs while KVM accepted into mainline Linux kernel sources. KVM is generally considered easier to configure and operate.

In memory page sharing XEN does not implement memory page sharing and KVM does it very efficiently. KVM has many performance benefits like less I/O Latency due to lack of Dom 0.

TABLE 3

THE TECHNICAL COMPARISON TABLE (KVM & XEN)

	KVM	XEN
Host OS		●
Market		●
OS overhead		●
Security		●
Maturity		●
Memory Page Sharing	●	
Ease of use	●	
I/O latency	●	

5.4 Data Compression and Decompression speed (s)

In order to measure data compression and decompression speed of a linux system gzip compressor is choosen and the time taken is measured by time cmd in seconds.

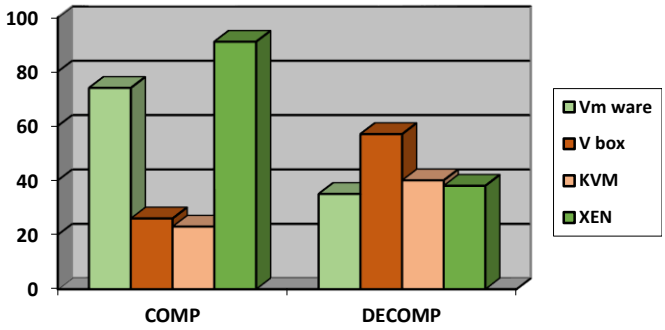

Fig.2: Data compression and decompression speed (s).

We can see that the time taken to compress by VM ware and Xen is quiet more then those of Virtual Box and KVM. Similarly for the decompression time taken by the VBox is highest wherease others seem to be close to each other. KVM and Vbox seems to be the winner in nthis test with average time.

5.5 Benchmark performance comparisons

5.5.1 CPU Speed

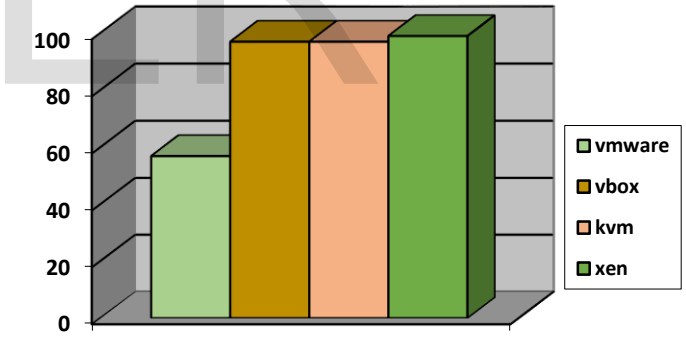

Fig.3: CPU Overhead Performance Test.

In Sysbench simple CPU load performance the comparison shows that Xen, KVM and Virtual Box have great percentage of CPU utilization where VM-ware seems to be the poor one.

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5.5.2 Cache and Memory performance

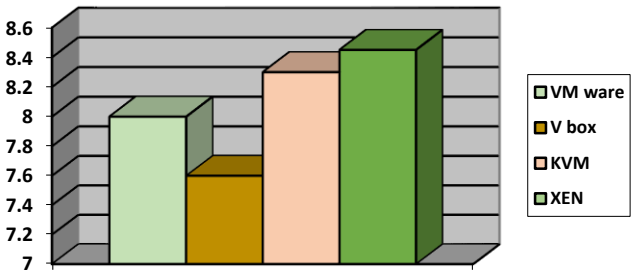

Fig.4: Cache and Memory Performance Test.

Cache and memory speed performance shows that Xen is the fastest one and KVM is also remarkably close. Vm ware is slight faster and least the vbox. It seems that Xen do a good use of nested page table feature.

5.5.3 Sequential read performance

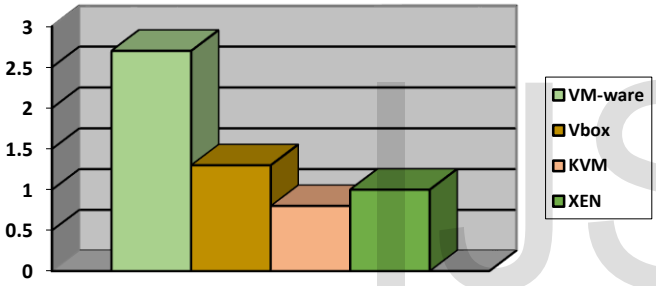

Fig.5: Sequential Data Read Performance.

In sequential read test VM-ware amazed me with great performance where KVM is much slower it is because of the very poor caching and great I/O overhead.Virtual Box Nd Xen seems to be the average one.

5.5.4 Sequential write performance

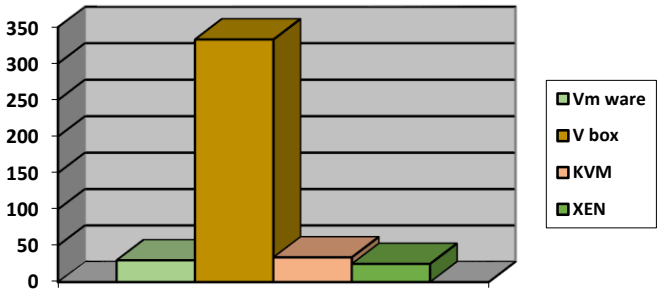

Fig. 6: Sequential data write performance.

Virtual Box surprisingly come up with best score in Sequential write test for me it seems like it use a write back cache algorithm while the other use a write through policy, though greater risk of data loss in spite of speed. In this test VM-ware, KVM and Xen are quite close to each other and the clear loosers.

5.5.5 Network Speed performance

In order to determine the network speed ping flood CPU test was performed where the results of all the VMM are similar except Xen.

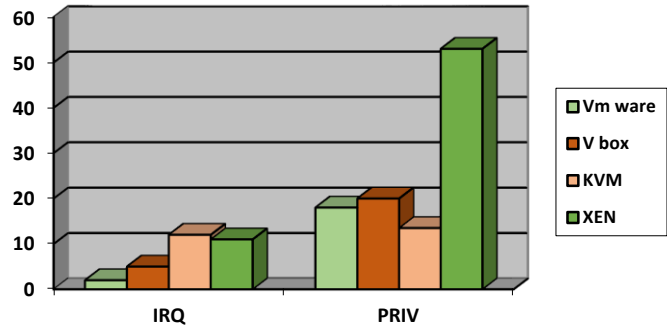

Fig. 7: Network speed performance

In this test we can see that the percentage of IRQ servicing time of KVM is dominating others which implies that the Network related syscalls are executed fastest on KVM and slowest on VM-ware. Privilege time of Xen is very high but not the IRQ time which also says that the network syscalls are executed slowly here. Virtual Box seems to be the average one with similar percentage of IRQ and PRIV time.

6 Result And Discussions

From a feature comparison point of view, most of today's virtualization technologies fit the small scale deployment, including VMWare. All the tests done shows the overall wise hypervisor depending upon what actually the client desires.

In short, each support Linux x86 64 platforms, use VT-X technology for full virtualization, and support live migration. From a CPU and memory point of view, Xen seems to provide the best expandability, supporting up to 128 cpus and 4TB of addressable RAM. So as KVM's vCPU limit. One of Virtualbox's greatest limitations was the 16GB maximum memory allotment for individual guest VMs, which actually limited us from giving VMs more memory for our performance benchmarks. If this can be fixed and Oracle does not move the product into the proprietary market, VirtualBox may also stand a chance for deployment in HPC environments. The data compression and decompression test also is very useful to determine which virtualization technique to be choosen. In this research work we have also tried to give the reasons behind such performance of the virtualization technologies.

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From the benchmark results point of view in CPU overhead performance and cache and memory performance tests Xen seems to be the winnerWhereas in sequential read and write test Xen and Kvm looks poor. According to sequential read performance surprisingly vm-ware is best and in write test virtual box is the clear winner.in network speed performance test KVM and VBox seems to be the wise one in the coparison with better score in compression and decompression timing.

7 Conclusion

In conclusion, it is the authors' projection that none of the virtualization technologies can be marked as best or worst because every technologies are efficient enough in their own way of computing. KVM's feature-rich experience and near-native performance makes it a natural fit for deployment in an environment where usability and performance are supreme. In some tests, VM ware and Vbox has also shown its remarkable performance so it is very hard to conclude with one best name. On the other side XEN is also very remarkable in security and memory sub system.

Primary goal of this manuscript is to understand the virtualization and multi-tenancy together with VMM in the cloud computing,After our analysis, the answer seems to be a resounding "yes." However, we also hope to select the best virtualization technology. After these certain tests we concluded that to benchmark best to any virtualization technology is not possible it depends upon the purpose of the use.

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