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Performance Comparison of VMware and Xen Hypervisor on Guest OS

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ABSTRACT

Virtualization has become a critical element in today's enterprise network. It makes more efficient use of server resources and setup different types of servers within both public and private cloud platforms. Hypervisor plays an important role in the virtualization of hardware. It provides a virtualized hardware environment to support running multiple operating systems concurrently using one physical server. This paper focuses on the performance comparison of guest operating system (Microsoft Window Server 2008 r2, 64-bit) under virtual environment by using two most useful hypervisors Citrix XenServer 6.5 and VMware ESXi 6.0. Their different parameters such as CPU, disk, memory and system response time are calculated to show the performance level of Guest OS in both hypervisors.

1. INTRODUCTION

Virtualization is the key component of cloud computing. It provides a logical abstraction of physical computing resources and creates computing environments that are not restricted by physical configuration or implementation. Computer hardware is rapidly increasing its performance and thus tends to make some resources not to be fully utilized. Maximum utilization of computer system is become possible with the help of virtualization technology [1]. Virtualized computing environment gives the capability to the host operating systems to run multiple operating systems over same physical computer. It provides many features such as: Scalability, efficient resource utilization and resource sharing. Many of the security issues in virtualization arise due to the difficulty of inspecting and monitoring a virtual machine continuously.

In virtualization, all the applications runs in the operating system that is running over the abstraction layer also called virtual machine monitor or hypervisor [2]. A Hypervisor creates multiple virtual machines where each virtual machine could have its own operating system installed in it. Multiple operating systems competes for resources such as CPU, memory, data, network etc. and hypervisor is responsible to manage all such requests. By using server virtualization, the number of physical servers could be reduced significantly. While virtualization provides many advantages, it comes at a cost. The hypervisor incurs some overhead sometimes because of the layer of abstraction it must add between a VM and the physical resources it makes use of.

Virtualization platforms can be open-source hypervisors such as Xen and KVM or commercial hypervisors such as VMware vSphere and Microsoft Hyper-V. The system administrators are responsible for picking the ideal virtualization platform based on its performance, features, and price. First, they have to make sure that the hypervisor is compatible with their hardware platform [3]. Then reliability, scalability and availability of hypervisor should also be considered. Different cloud services make use of different virtualization platforms. Amazon EC2 uses Xen as a hypervisor, VMware partners use ESX, Microsoft Azure uses Hyper-V and Google launched its own IaaS cloud that uses KVM as a hypervisor.

The combination of new CPU architectures with embedded virtualization support have eliminated many of hypervisor overheads [4]. But popular hypervisors still exhibit different levels of performance. As an example, we have configured two different hypervisors: VMware ESXi and Citrix Xen and then analyzed and compared their performance based on Guest Operating System (Windows Server 2008 R2) by using Performance Monitor. We compared their performance by analyzing resources such as CPU, memory, disk, and

network. Our results suggest that our Guest Operating System-Microsoft Windows Server 2008 r2 (64-bit) perform significantly better in VMware ESXi 6.0 than in XenServer 6.5.

2. BACKGROUND

Virtualization refers to the creation of a virtual version of something: hardware, a network, a software environment or storage. Hypervisor plays an important role in the virtualization of hardware. Its primary task is to abstracting the real computer resources and providing the virtual environments in which operating systems may be installed. These virtual environments are referred as virtual machines. There are three major components in a virtualized environment: guest, host and virtualization layer [5]. Guest server have an operating system installed that is compatible with the virtual hardware and with the host server. It interacts with the virtualization layer rather than with the host. The host represents the original environment where the guest is supposed to be managed. It is the physical bare metal, x86 server computer on which the virtualization resides and guest is managed. The virtualization layer is used to create the abstraction between the physical hardware and virtual environments. It creates an environment where the guest will operate.

2.1. Types of Hypervisor

There are two major types of hypervisor: Type I and Type II shown in figure 1 and 2.

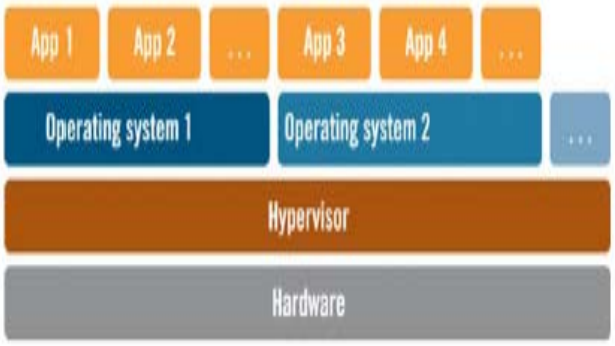


Figure 1: Type 1 Hypervisor

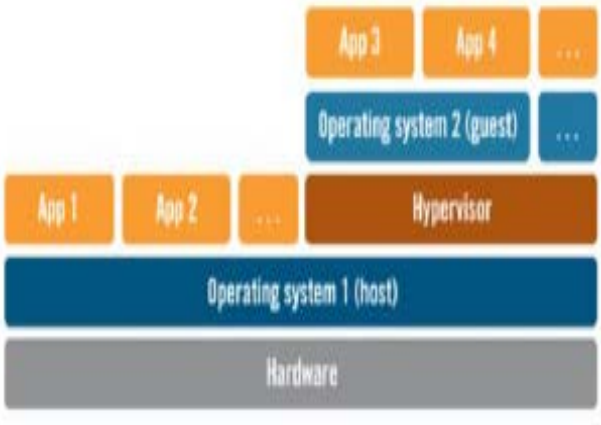


Figure 2: Type 2 Hypervisor

Type 1 Hypervisor, which runs directly on the system hardware and then install guest operating system on that hypervisor. This is also known as bare metal approach Hypervisor.

Type 2 Hypervisor, which runs on host operating system and then guest operating systems are installed on that hypervisor. Hypervisor cannot directly communicate with hardware [6]. This is also known as a hosted approach Hypervisor. VMware workstation is an example of such environment.

2.2. VMware ESXi and Citrix XenServer

VMware ESXi is a type I Hypervisor and the most advanced hypervisor architecture of VMWare. Its architecture is shown in figure 3. VMware ESXi lacks the service console included in VMware ESX. ESXi is a Bare Metal hypervisor and directly installed on top of the physical machine without any operating system. It is based on the concept of full virtualization in which the underlying hardware is replicated and made available to the guest operating system, which runs unaware of such abstraction layers and does not need to be modified [7]. VMware ESXi partition a physical server into multiple secure and portable virtual machines that can run side by side on the same physical server, thus increases hardware utilization and decreases capital costs. Virtual machines are completely isolated from each other by the virtualization layer, thus preventing a crash or configuration error in one virtual machine from affecting the others [8]. ESXi uses a small direct console user interface instead of a full server console and can be installed easily and booted even from a USB flash drive. It provide virtual machines with built-in high availability, resource management and security features.

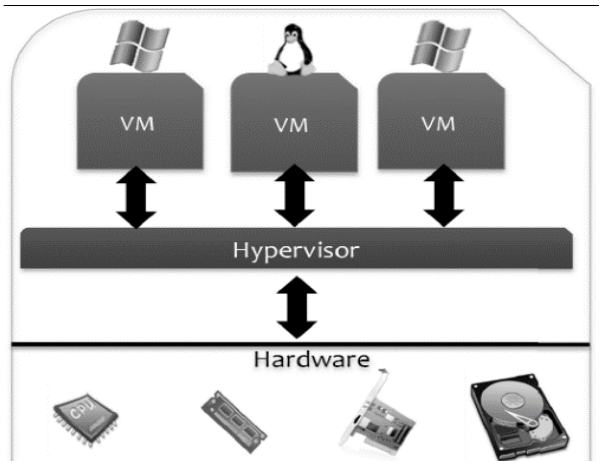


Figure 3: VMware ESXi Architecture

Citrix XenServer is an open-source, complete, managed server virtualization platform built on the powerful Xen Hypervisor shown in figure 4. Paravirtualization is the technique used by Xen which present a virtual machine abstraction that is similar, but not identical to the underlying hardware [9]. XenServer is installed on bare-metal servers, requiring no dedicated host operating

system. It creates and manages unlimited servers and virtual machines to run safely and securely from a single management console. This increases server and storage utilization and reduces costs of equipment, power and physical space. Customers can upgrade to a premium edition of XenServer to add additional management, availability, integration, or automation capabilities.

The idea behind Xen is to run guest operating systems not in ring 0, but in a higher and less privileged ring. The default Xen installation on x86 runs guest OS in ring 1 [10]. It is a highly reliable, available, and secure virtualization platform that provides near native application performance.

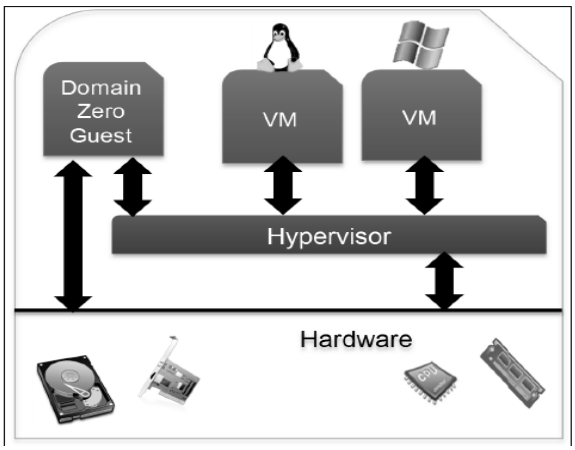


Figure 4: XEN Architecture

3. METHODOLOGY

In our performance comparison of hypervisor we analyse each resource component one by one using Microsoft Windows based performance monitoring tool. The components include CPU, memory, disk and system up time. Each of the component has different performance in different hypervisors. When a virtual machine is created, it is assigned a certain number of virtual CPUs (VCPU). A virtual CPU also known as a virtual processor, is a physical central processing unit that is assigned to a virtual machine (VM). We installed VMware ESXi 6.0 and XenServer 6.5 on the system to measure the performance of the hypervisor using the guest operating system which is Microsoft Windows Server 2008 R2 (64- bit). The performances are analysed by using Performance Monitor tool of Windows Server and after that we compare the results and decide on which hypervisor our guest OS run efficiently.

4. RESULT

4.1. Experimental Setup

The objective of this experiments was to test the performance of the two virtualization hypervisors. The tests were performed using a configuration with a single virtual CPU.

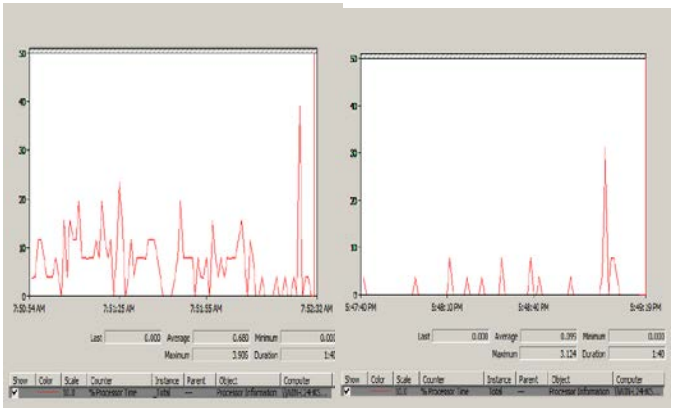
- **Hardware configuration:**The hardware settings are same for all the hypervisors by using one server machine. The machine has Intel Core 620LE 2.50GHz four core CPU with 8GB memory and the network is Intel 82546 Gigabit Ethernet. All tests were controlled from within the virtual machine itself.
- **Software configuration:**We configured two hypervisors: VMware ESXi 6.0 release and Citrix Xen Server 6.5 release. Both are the latest releases for the two virtualization hypervisors at this time.
- **Virtual Machine configuration:**The base guest virtual machine OS is Microsoft Windows Server 2008 R2 (64-bit), 10GB size disk image, and has 4GB memory assigned. Each hypervisor has this guest virtual machine with the same environment setup. We use Performance Monitor tool of Windows server to analyse the performance of both the hypervisors.

4.2. Performance Analysis:

In our experiment, we analyse different components and on the basis of which we conclude that on which hypervisor our guest OS run efficiently.

4.2.1. CPU Analysis:

We calculated CPU usage of both the hypervisor in terms of Megahertz (MHz) and average use of CPU. After analysing their components, from the guest OS point of view we conclude that the VMware average usage time is better than XenServer. In the fig 5, we can clearly see that VMware perform better without consuming more power than XenServer.

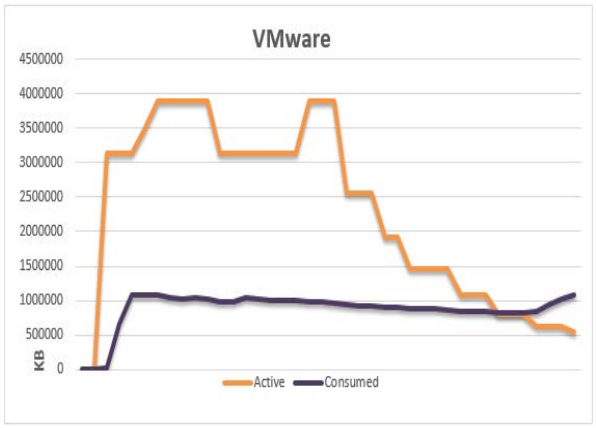


Xen Server **VMware**

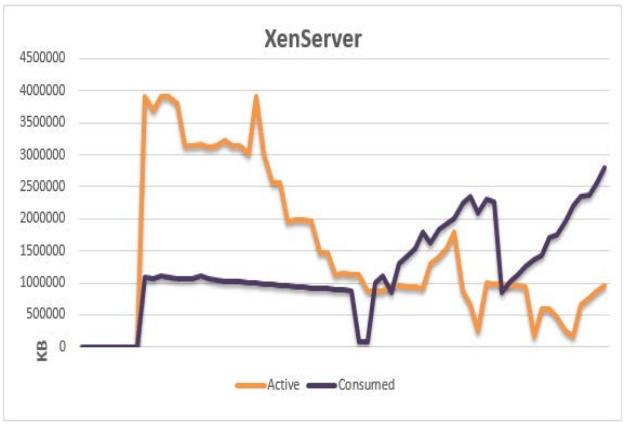
Figure 5: Performance Comparison of VMware ESXi and XenServer

4.2.2. Memory Performance Analysis:

We calculated memory performance by setting up counter value in Performance Monitor and compare the read (Active) and write (Consume) value of memory shown in fig 6. From our analysis, we conclude that from the Guest OS point of viewVMware memory consumption is less than XenServer in term of both Read and Writeterms.



a) Memory Analysis in VMware ESXi

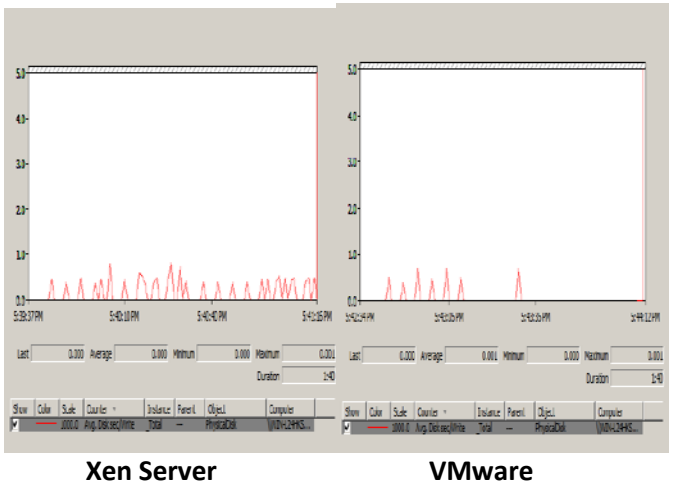


b) Memory Analysis in XenServer

Figure 6: Memory Analysis a) VMware ESXi 6.0 b) XenServer 6.5

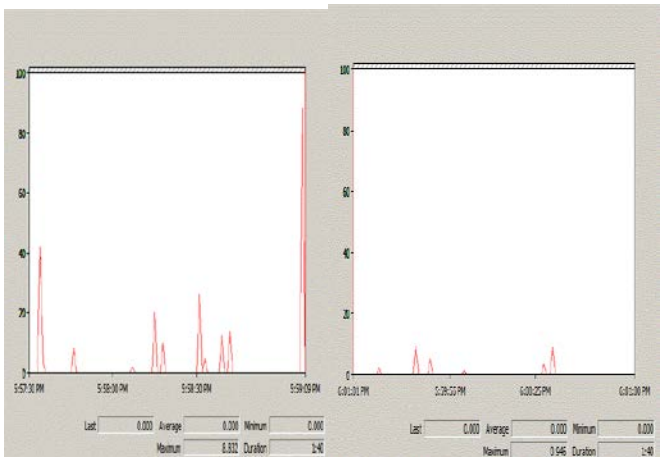
4.2.3. *Disk Performance Analysis:*

We set the counter to read rate and write rate of the disk component in Performance Monitor tool and compared both read rate and write rate frequency of disk for a fixed time interval.. After analyzing their graphs, we conclude that our Guest OS disk performance is better in Vmware ESXi than in XenSever.Xen exhibits high overheads when performing small disk operations as shown in fig 7 and 8.



Xen Server **VMware**

Figure 7: Disk write rate frequency comparison of VMware ESXi and XenServer

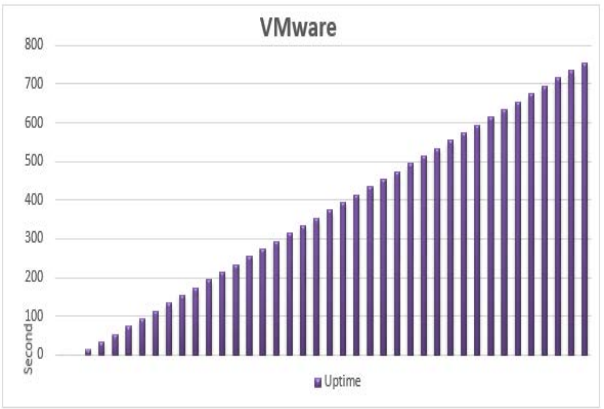


Xen Server **VMware**

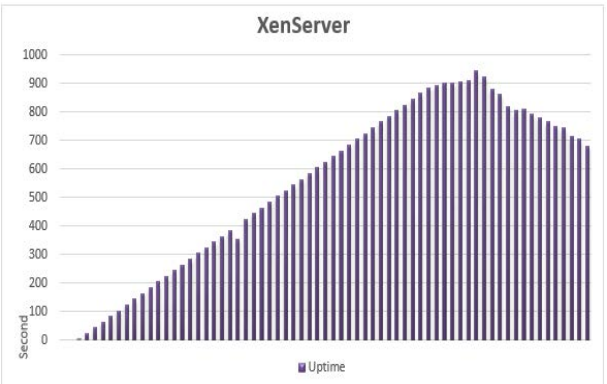
Figure 8: Disk read rate frequency comparison of VMware ESXi and XenServer

4.2.4. *System Analysis:*

After analyzing overall system uptime of both hypervisors from our guest OS point of view, we find that as the time increasing VMware uptime is increasing continuously whereas XenServer take initial increase but after a certain time its system uptime decreased with large margin as shown in fig 9. Therefore,we can say that system performance of VMware proves better than XenServer.



a) System Performance Analysis in VMware ESXi



b) System Performance Analysis in XenServer

Figure 9: Memory Analysis a) VMware ESXi 6.0 b) XenServer 6.5

5. CONCLUSION

Today, IT managers are looking at virtualization technology to lower IT costs through increased flexibility, efficiency and responsiveness. Therefore, it is critical that virtualization infrastructure can address the challenges and issues faced by the enterprises in the most efficient manner. In this paper we have compared two hypervisors: VMWare ESXi 6.0 and Citrix XenServer 6.5. We measure the performance of our guest OS (Microsoft Windows Server 2008) on both the hypervisors by using Performance Monitor tool. Our results indicate that Xen Hypervisor, which uses Para-virtualization, was not able to outperform ESXi, which uses full-virtualization. VMware ESXi Server is far better to meet the demand of an enterprise than the Xen hypervisor. We believe that the results of our study demonstrate the benefits of building large data center and cloud environments. Future work includes more subjective tests covering a wider set of applications.

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