

Performance Analysis of Hypervisor in Nested Virtualization

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Abstract—Virtualization is nowadays mostly used in IT industry. In virtualization we can testing and debugging operating system. There are nest step of virtualization used by different cloud service providers, it is nested virtualization. Nested virtualization means a virtual machine inside virtual machine. Nested virtualization is focus on Hypervisor's testing and debugging. When client want to migrate their hypervisor on cloud then performance analysis of hypervisor is require. As per some research papers, performance analysis of hypervisor in virtual machine was done by researchers but for nested virtual machine hypervisor performance analysis work is less, So Our main focus based on the performance analysis of hypervisor in nested virtual machine. Also with results of performance analysis we will compare each hypervisor with other one, then conclude that which one is better for nested Virtualization.

Keywords—Performance Analysis, Nested Virtualization, Cloud Computing, Benchmark, CPU Usage Test, Thread Test

I. INTRODUCTION

Cloud computing is most used by client and service provider for better user functionality and scalability. Virtualization in cloud computing is provided by infrastructure as a service model. A main advantage of the virtualization is to reduce the cost and provide a basic service to the client. When user virtualizes any system then a performance of the system is affected. So it is require for user to analyze the system and try to resolve the problem related to the virtual machine. For a different operating system, there are different techniques are used for analyzing the performance of the operating system, some operating system analysis the performance using benchmark and other possible way is performance analysis tools.

The virtualization is spread their level, which is nested virtualization. A virtualization uses the resources such as processors, memory, storage, and network from physical devices where nested virtualization is used that resources from the virtual device (Virtual machine). There are so many virtualization techniques work done in the virtual machine for performance analysis but no tools available for the nested virtualization for performance analysis. There is some nested virtualization system is implemented.

Nested virtualization used for debugging and testing the hypervisor in a virtual environment before migrating it into the cloud, so the client has to be analyze the hypervisor. A performance analysis of hypervisor based on parameters (CPU usage, Disk Usage, and memory usage) when the nested virtual machine is running in the system and also some experimental programs are run in a nested virtual machine, then a performance of hypervisor is analyzed.

Rest of paper include follows: Related work is explain in section II, Section III include experiment setup, in this section system specification and method is explained. Experiment result is explain in section IV and Section V concludes the paper with direction for future work.

II. RELATED WORK

Author Hani Nemati et.al [1] implemented a method for analyses of performance in system and also detection of nested virtual machine, host machine and virtual machine. Mainly their work used the benchmark for performance analysis of the nested virtual machine. Method used for the performance analysis is divided into three steps: In first step they used nested virtual machine detection algorithm (NDA) for detect level of code execution. As per their explanation, This step host hypervisor enable the cloud administrator to differentiate the different states (host hypervisor code, virtual machine code and nested virtual machine code) of nested VMs. A second step in method is detect different states of processes using nested VM State detection algorithm in virtual machine and inside virtual machine. Last step of their method was implement a graphical views for performance analysis of nested virtual machine. They develop host based graphical view for virtual CPU which represent each vCPU with different states of the VM, second is a graphical view for nested VMs which shows vCPU thread of nested VMs with its level of code execution and states. Threads test, File I/O test are not included in their method.

Pokharana et. al [2] had implemented two virtual machines (Ubuntu and CentOS) for perform analysis, they used bench-marking tools to gather performance results from the both virtual machine. A result of One Virtual Machine compare with another and Draw the Bar chart for performance of VMs. CPU, I/O and Memory analyze for both operating system.

Barik et. al [3] had implemented a technique that explain how vendors are using container for hosting their application and also the performance of virtual machine. They conducted Quality of service, network performance and security evaluation testing using benchmark.

Graniszewski et. al [4] evaluate performance of different virtualization Technology (Hyper-V, ESXi, OVM, VirtualBox) and open source (Xen). For performance Analysis they used standard benchmark tools to compare efficiency of main hardware components. CPU test, throughput, memory test, kernel completion test are done by researchers.

Rayamanjhi et.al [5] provide a concept of virtualization with the performance comparison of virtualization technology. Feature Comparison between VMware, VirtualBox, Xen and KVM. Technical Comparison between VirtualBox and VMware. Technical Comparison between Xen and KVM. CPU speed, Cache and

memory speed, Sequential read, sequential write performance of virtual technologies is analyze using Sysbench Benchmark and compare with each one.

From observation of the research papers there are performance analysis work done on the virtualization so client can testing and debugging the operating system. With the nested virtualization testing of hypervisor possible.

III. EXPERIMENT SETUP

A details about proposed work is follow:

- Install the hypervisor (VirtualBox,VMware) on hardware then set up a guest Virtual machine (VM) on hypervisor.
- After that second thing to do is install a guest hypervisor on (VM) and install Nested guest virtual machine (NVM).
- For Analysis of NVM we are using a benchmark tool and Perform different test in virtual machine and Nested virtual machine. A result of gather test from different hypervisor for memory, CPU and threads usage.
- Analyse the performance result of the hypervisor and compare them.

A System Requirement for experiment of the proposed work is Follow:

| System | RAM | Storage | Operating System | Processors |
|-----------|-------|----------|------------------|------------|
| Host | 12 GB | 1 TB | Windows 10 Pro | 4 |
| VM | 4 GB | 256.0 GB | Ubuntu 16.04 | 2 |
| Nested VM | 1 GB | 60.0 GB | Ubuntu 16.04 | 1 |

Fig. 1: System Specification

For perform a test in windows operating system, sysbench executable or application not available so we have to build a sysbench for windows operating system. A performance analysis is done in two mostly used virtualization hypervisor VirtualBox and VMware. VirtualBox and VMware hypervisor used as guest and host hypervisor.

IV. EXPERIMENT RESULT

We have run a different test in both hypervisor for virtual machine and nested virtual machine.

A. CPU Usage

CPU usage is measured using sysbench benchmark tool. In this test there are a prime number program. We have run 10 times for different range on terminal using a different command and take an average value as a final result of the CPU usage in milliseconds. We are using number of threads for program is 1 and 10000 event execution in prime number program. An execution of program in Host, VM and Nested VM is Different time periods.

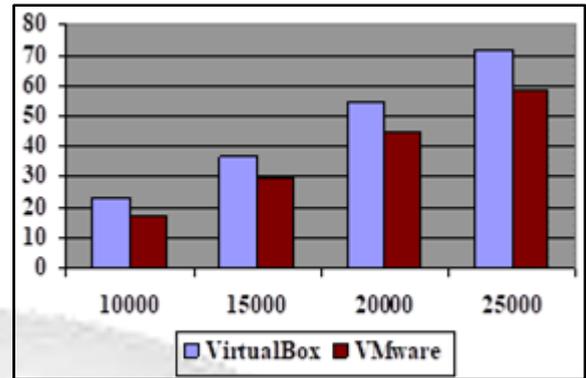


Fig. 1: Prime Number program for CPU usage in Nested Virtual Machine

We can see in a Fig.1, Y-axis indicate a time for execution of prime number program in milliseconds where x-axis indicate a number of range for prime number. As per result shown that CPU usage for VMware is less compare to the VirtualBox.

B. Thread Workload

A thread workload for test is created using a sysbench benchmark tool. We are using number of threads for program are 8, 16 and 32. An event execution in prime number program is 10000 and number of locks used in both hypervisor is 1. Also thread yield per task is 1000 for all the thread tests. We have run 10 times for different threads number on terminal using a different command and take an average value as a final result of the thread workload usage in milliseconds.

We can see in a Fig.2, Y-axis indicate a time for execution of test in milliseconds where x-axis indicate a number of threads use for test. As per result shown that usage for VMware is less compare to the VirtualBox and overhead in a VirtualBox is too much compare to a VMware hypervisor.

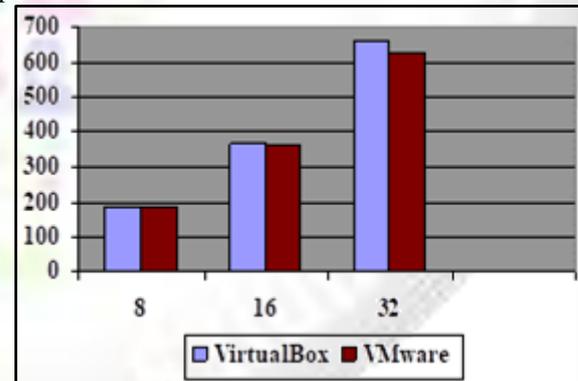


Fig. 2: Thread workload usage in Nested Virtual Machine

When Thread size is increase overhead in nested virtual machine is increase. Overhead in VMware is less compare to VirtualBox when threads are 32.

C. File I/O Test

File I/O test run using a Sysbench tool. We have first create a file which include different 128 files and total size of file is 2GB.Different mode can used using command in terminal. In this test a block size is 16Kb. A number of random request for random I/O is 10000.

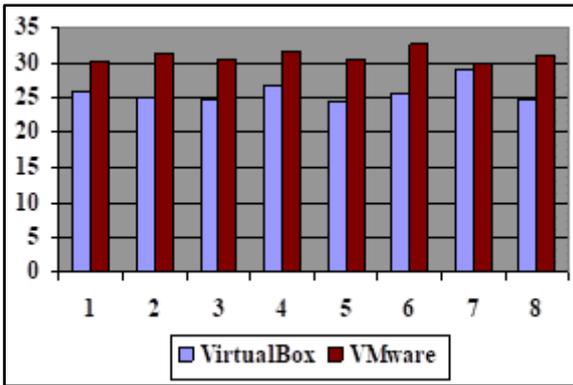


Fig. 3: File Transferred Time When Threads is 4 in Nested Virtual Machine

We can see in a Fig.3, Y-axis indicate a time for transfer a file in milliseconds. A thread which used in this test are 4.

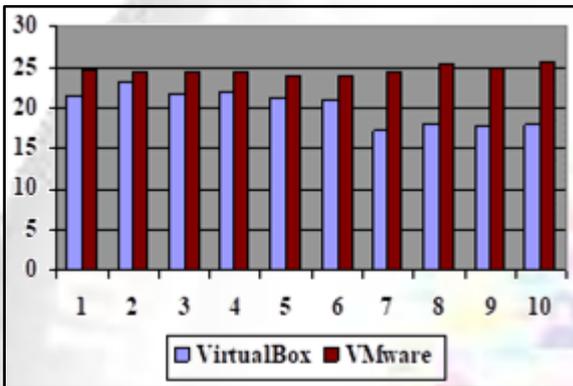


Fig. 4: File Transferred Time When Threads is 8 in Nested Virtual Machine

In Fig.4 Y-axis indicate a time for transfer a file in milliseconds. A thread which used in this test are 8 and random read and write operation perform in file I/O test. As per Fig.3 and Fig.4 VMware is slower than VirtualBox.

D. MutexWorkload Test

Mutex workload test run using a Sysbench tool. We have run a ten times a two different test in both hypervisor and then compared it. We are using 4096 number of mutex, 5000 locks and 1000 loops for mutex test.

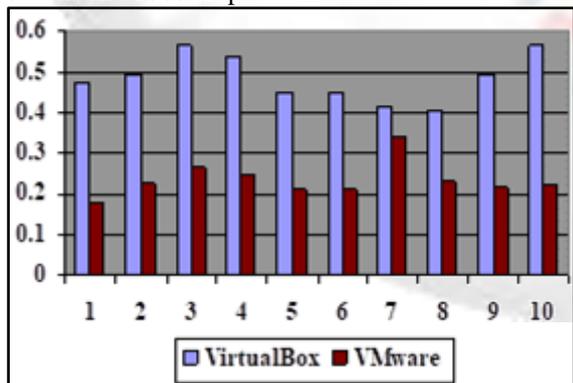


Fig. 5: MutexTest Result When Events are 64 in Nested Virtual Machine

In Fig.5 Y-axis indicate a time for execute an events in milliseconds. In mutex test 1 event per 1 thread execute and Fig.5 indicate that time require in VirtualBox is almost double to a VMware.

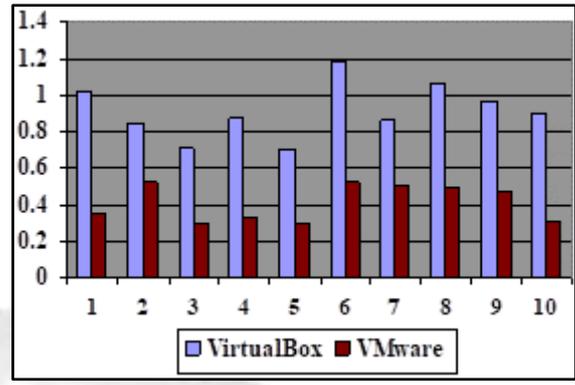


Fig. 6: MutexTest Result When Events are 128 in Nested Virtual Machine

In Fig.6 Y-axis indicate a time for execute an events in milliseconds. In this mutex test 128 events are execute and a threads are using for those events is 128.

E. Memory Test

We are run two test in sysbench for Memory transferred speed and time for execute an event. In both test memory block size is 1K, number of thread is 1 and total size for memory transfer is 2GB. In this test 2097152 operations are performWrite Test: Memory scope for this test is global

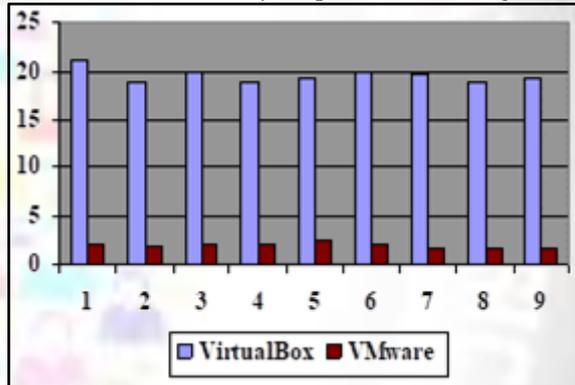


Fig. 7: Write test in Nested Virtual Machine

In Fig.7 Y-axis indicate a time for execute an events in milliseconds. In this write test VMware Superfast compared to the VirtualBox.

Read Test: In this test 2048 MB transferred in both hypervisor.

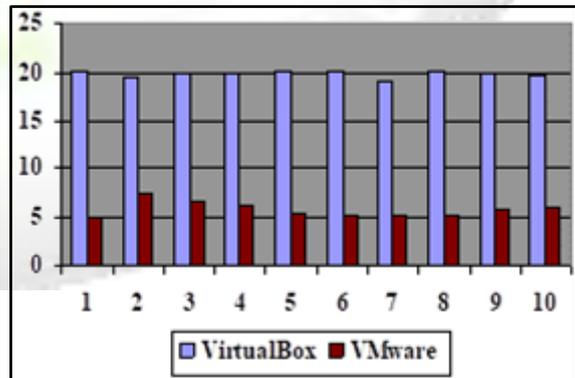


Fig. 8: Read Test in Nested Virtual Machine

In Fig.8 Y-axis indicate a time for execute an events in milliseconds. In this read test VirtualBox takes Around 100 MB/sec speed where VMware have speed in this test is more than 1200MB/sec, and also it is more accurate for test.

V. CONCLUSION

The comparison of hypervisor performance in nested virtual machine gives the information that which one is better for virtualization. A performance of hypervisor in nested virtualization analyze based on some tests. As a result shown that VirtualBox hypervisor have more overhead for threads, memory and mutex. Where for file I/O test, A VMware is slower than VirtualBox for transfer of file. So as per our test result VMware is faster on some tests so user can use both hypervisor for nested virtual machine.

As future work, we plan to run a Network throughput and oltp (Online) test for both hypervisor and also enhance memory test, CPU usage test for VMware and VirtualBox.

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