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	ISRA (India) = 6.317	SIS (USA) = 0.912	ICV (Poland) = 6.630
	ISI (Dubai, UAE) = 1.582	РИНЦ (Russia) = 0.191	PIF (India) = 1.940
	GIF (Australia) = 0.564	ESJI (KZ) = 8.100	IBI (India) = 4.260
	JIF = 1.500	SJIF (Morocco) = 7.184	OAJI (USA) = 0.350

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Issue Article

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COMPARATIVE PERFORMANCE IMPROVEMENT OF VMWARE WORKSTATION AND ORACLE VIRTUALBOX HYPERVISORS

Abstract: *This article presents a comparative performance test of VMware Workstation and Oracle VirtualBox hypervisors. In order to evaluate the efficiency of each hypervisor, identical virtual machines were deployed on them, the performance of which was measured using the Phoronix Test Suite program. The testing covered the main components of the system: the performance of the processor, RAM, disk subsystem, and two-dimensional graphics. In addition, a synthetic test was conducted for an overall performance assessment. The obtained results provide a comprehensive understanding of the features of each hypervisor and allow us to determine their optimal areas of application depending on specific system requirements.*

Key words: *VMware Workstation, Oracle VirtualBox, performance test, hypervisor.*

Language: *English*

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Introduction

Virtualization is currently becoming an integral part of modern computing systems, allowing to optimize the use of hardware resources and simplify the management of information infrastructure. Type 2 hypervisors, such as VMware Workstation and Oracle VirtualBox, have become widespread due to their availability and functionality, providing the ability to run multiple operating systems on a single physical computer.

However, the efficiency of virtual machines largely depends on the performance of the hypervisor used. When choosing a suitable solution for specific tasks, it is important to have a clear understanding of how a particular hypervisor copes with various loads and under what conditions it demonstrates the best results.

The purpose of this study is to provide objective data on the performance of VMware Workstation and Oracle VirtualBox hypervisors in various usage scenarios. The results can be used to make an informed choice of hypervisor depending on the requirements of a specific project or operating environment.

In the process of analyzing this topic, a review of the achievements of existing scientific research in this area was conducted, which made it possible to identify a number of significant works.

Faizan Ali Khaji, Sri Varun Potluri et al. in their study [1] conducted a comparative analysis of the performance of virtual mail servers on type 2 hypervisors KVM, Oracle VirtualBox and VMware Player. The authors showed that KVM demonstrates better performance when processing small amounts of

data and noted the benefits of using virtualization to improve efficiency and reduce costs. However, for scenarios with a large number of clients, they recommend using type 1 hypervisors.

In a study [2] by Borislav Đorđević, Iva Jovičić et al., a comparative analysis of the performance of the VirtualBox, VMware Workstation, and MS Hyper-V hypervisors was conducted in the context of desktop virtualization. Using Filebench to measure file system performance and CentOS 7 as a guest operating system, the authors tested the hypervisors when running one, two, and three virtual machines simultaneously. The results showed that VMware Workstation outperforms the other hypervisors for all types of workloads. In addition, it was noted that VirtualBox is more efficient than MS Hyper-V for sequential operations with a low caching effect, while MS Hyper-V outperforms VirtualBox for random access with a high caching effect.

The research work by Sebastian Tarasiuk, Damian Traczuk et al. [3] focused on the performance analysis of virtualization technologies (VirtualBox, VMware, QEMU), containerization (Docker, Podman, LXD) and micro-virtual machines (QEMU, Firecracker) using the synthetic benchmark SysBench. The authors evaluated the performance of the processor, RAM and disk read/write operations. The results showed that containerization solutions outperform virtualization in most aspects, but hypervisors, in particular VMware, demonstrate an advantage in disk I/O operations.

A study [4] by Guruh Aryotejo, Eko Adi Sarwoko, and others presents a comparative analysis of the performance of VMware Workstation 15.0 and Oracle VirtualBox 6.1 hypervisors in the context of teaching computer networks in distance education. Using PerformanceMark v10 and iPerf 3.1.3, the authors evaluated the computing performance of guest operating systems and the speed of data transfer over a virtual network. The results showed that VMware Workstation outperforms VirtualBox in terms of processor, memory, and 2D graphics performance. VirtualBox failed the 2D Graphic Mark test, indicating its limited capabilities in processing 2D graphics and may negatively affect the operation of network applications that require graphics performance.

A research paper by Wari Denyefa Cletus and Seiyaboh Zidiegha [5] focuses on comparing the performance of three hypervisors: VMware Workstation, VirtualBox, and QEMU on a machine with an AMD E2-7110 QuadCore processor. Using existing benchmarks, the authors evaluated the performance of each hypervisor. The results showed that VMware demonstrated better performance compared to other virtualization tools. At the same time, it was noted that VMware Workstation and VirtualBox had similar results and outperformed QEMU in performance.

In their study [6], Saverio Giallorenzo, Jacopo Mauro, et al. draw attention to the difficulty of predicting how the use of a particular virtualization technology (VMs or containers) will affect the performance of an application. They presented a set of benchmarks that developers can use to select the best virtualization technology according to their application profile. To do this, they developed VTmark, a semi-automated open-source toolkit that integrates standard tools for benchmarking various resources used by applications (CPU, RAM, etc.).

The authors note that although their benchmarks cover the main resources (CPU, memory, I/O, and network), there is a need for more accurate benchmarks to compare the performance of complex distributed applications. They plan to expand the number of virtualization technologies supported by VTmark and the number of benchmarking tools, as well as improve the "ergonomics" of VTmark, making its execution fully automatic and parameterizable by various constraints.

A. Sergeev, E. Rezedinova, and A. Khakhina [9] performed performance testing of virtualization systems on assemblies of different pre-installed guest systems, which revealed the influence of guest OS configurations on virtualization performance. M. Polenov, V. Guzik, and V. Lukyanov [11] compared hypervisors and performed their performance testing, identifying key factors affecting virtualization efficiency. I. Aliev, St. Gazul, and A. Bobova [12] presented a comparative review of virtualization technologies and platforms, offering updated performance tests and an analysis of the current state of performance in the field of virtualization.

In the context of containerization, A. Sergeev, E. Rezedinova, and A. Khakhina [10] compared the performance of Docker containers on Windows and Linux operating systems, highlighting the performance features of containers on different platforms.

Introductory materials are useful for gaining a basic understanding of hypervisors and virtualization technologies. For example, B. Choi [13] presented an introduction to VMware Workstation in the context of network automation in Python, which provides a practical look at the application of virtualization in network systems. Huawei Technologies Co. [14] covered virtualization technology in detail as part of a discussion of cloud computing technologies, highlighting the fundamental concepts and recent advances in this area.

Building on previous research and literature, this paper aims to add to the existing knowledge base by conducting a comparative performance analysis of VMware Workstation and Oracle VirtualBox hypervisors.

Methods

Equipment used:

- Intel(R) Core(TM) i3-7020U CPU (2.30 GHz);
- 2 physical cores, 4 logical processors);
- 8 GB of RAM;
- Samsung SSD 970 EVO Plus disk storage (500 GB, PCIe Gen 3.0 x 4 interface, NVMe 1.3);
- Windows 10 Pro operating system.

VM parameters:

- Operating system Ubuntu 24.04 LTS;
- Processor (2 logical cores, 1 logical processor);
- RAM 4096 MB;
- Video memory 128 MB;
- Disk storage (20 GB, fixed-size image);
- Network adapter type NAT.

The program used for performance testing was the Phoronix Test Suite tool. This package is an open source testing platform with a constantly expanding set of test profiles and packages that allow testing various components that make up system performance (e.g. CPU, hard drive read/write speed, RAM, network, etc.).

Phoronix Test Suite also allows you to upload test results along with system specifications to openbenchmarking.org so that they can be compared with results obtained by other users [7].

During testing, the number of simultaneously running virtual machines (VM) varied from 1 to 2. All active machines were loaded with the corresponding test tasks.

When two machines were running simultaneously, the least successful result was taken into account, since it more clearly reflects the disadvantages or advantages of one hypervisor (VMware Workstation) compared to another (Oracle VirtualBox).

Results

3.1 CPU performance testing

Gzip Compression

The Gzip Compression test checks the CPU performance of a virtual machine, especially its efficiency in data compression tasks.

The test uses the gzip compression algorithm to compress a large amount of data. It measures the time spent on compression. This allows you to evaluate how efficiently the processor handles computationally intensive compression tasks.

The result is measured in execution time, so a lower value is better as it means the system completes the compression task faster.

Table 1. Gzip Compression test results

	Number of simultaneously running VMs	
	1	2
VMware Workstation	**93,315 sec**	127,411 sec **171,912 sec**
Oracle VirtualBox	**238,202 sec**	285,216 sec **304,038 sec**

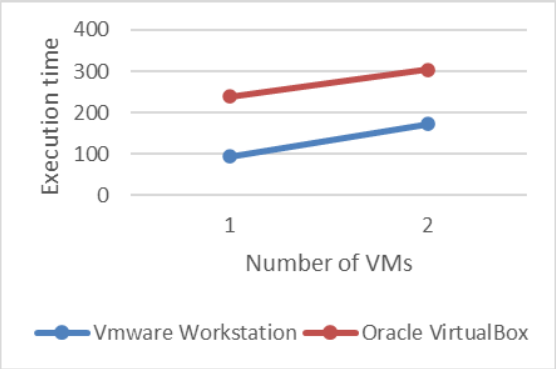

Figure 1 – Gzip Compression test results

Adding a second VM results in increased execution time for both VMs due to resource sharing. This results in longer test execution times.

The execution time on VMware Workstation increased from 93.315 seconds to 171.912 seconds, an 84.25% increase, and on VirtualBox from 238.202 seconds to 304.038 seconds, an increase of 27.64%.

With a single VM, VMware Workstation's execution time (93.315 seconds) is significantly faster than VirtualBox's (238.202 seconds), indicating significantly better performance for VMware.

VirtualBox's execution time increases by only 27.64% when moving from one to two VMs, while VMware's time increases by 84.25%, indicating a smaller percentage gain for VirtualBox.

It should also be noted that the performance of both hypervisors decreased by less than 2 times (1.3 for Oracle VirtualBox and 1.8 for VMware Workstation). This phenomenon is due to the fact that the physical resources of the host were divided into two equal parts (2 logical cores, 1 logical processor and 4096 MB of RAM), which was enough for the stable operation of two virtual machines simultaneously.

Thus, the VMware hypervisor may be more efficient in handling single VM workloads due to better CPU virtualization optimization, but VirtualBox handles resource contention more smoothly, resulting in a smaller proportional performance degradation as the number of VMs increases.

OpenSSL

The OpenSSL benchmark in the Phoronix Test Suite tests the CPU performance of a virtual machine, specifically its ability to efficiently perform cryptographic operations.

The test is performed by running various cryptographic algorithms using the OpenSSL library. Phoronix Test Suite runs a series of operations such as encrypting and decrypting data using AES, RSA, SHA, etc. Performance is measured in operations per second or data processing speed (e.g. megabytes per second), which allows you to evaluate how quickly the processor can perform these cryptographic tasks.

The test result is better when it is large, as it indicates higher performance of the processor in performing cryptographic operations. The more operations per second the system can process, the more efficiently it copes with cryptographic tasks.

Table 2. OpenSSL test results

	Number of simultaneously running VMs	
	1	2
VMware Workstation	**18770,9 op/sec**	**10016,7 op/sec** 12126,9 op/sec
Oracle VirtualBox	**11717,9 op/sec**	**6880,5 op/sec** 6897,9 op/sec

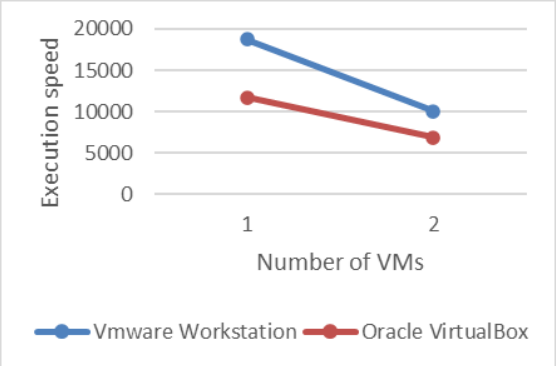

Figure 2 – OpenSSL test results

The performance degradation from one to two VMs is approximately 46.6% for VMware Workstation and 41.3% for Oracle VirtualBox, respectively.

The obtained results indicate approximately the same decrease in performance with an increase in the number of simultaneously running VMs.

The results of studies [3], [4], and [5] aimed at testing CPU performance correlate with the obtained results. The authors conclude that the VMware hypervisor copes better with increased CPU load than VirtualBox.

It is also worth noting that VMware Workstation provides better performance than Oracle VirtualBox in the tested scenarios by approximately 60% in both single and dual VM scenarios.

3.2 Memory performance testing

RAMspeed SMP

The RAMspeed SMP test is a tool for evaluating the performance of RAM in a system. It helps measure the speed of reading and writing data to memory, which is important for understanding the overall efficiency of the system.

The test performs a series of read and write operations to memory using Symmetric

Multiprocessing (SMP). It loads the system with parallel threads to maximize the processor and memory capabilities, measuring the speed of data transfer between the processor and RAM.

The best result is higher. Higher values indicate higher memory bandwidth, meaning that the RAM works faster when reading and writing data. This means that the system can efficiently process large amounts of data, which has a positive effect on overall performance.

Table 3. RAMspeed test results

	Number of simultaneously running VMs	
	1	2
VMware Workstation	**13755,71 MB/sec**	8284,60 MB/sec **6244,99 MB/sec**
Oracle VirtualBox	**14220,63 MB/sec**	8835,75 MB/sec **8784,12 MB/sec**

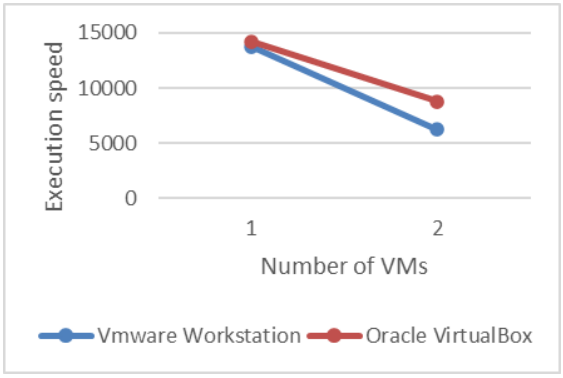

Figure 3 – RAMspeed test results

When two VMs running memory-intensive tasks run simultaneously, they compete for the same memory bandwidth, resulting in reduced throughput per VM.

The performance degradation with increasing number of concurrent VMs is approximately 54.6% for VMware Workstation and 38.2% for Oracle VirtualBox.

VirtualBox can use scheduling algorithms that minimize context switching overhead and better balance resource allocation between VMs, resulting in better performance preservation as the number of VMs increases.

In research papers [3], [4], and [5], the authors noted that VMware performed better than VirtualBox when testing RAM performance. Wari Denyefa Cletus, Seiyaboh Zidiegha [5] state that when testing RAM, the highest data transfer rate in RAM was observed in VirtualBox, and the second highest rate was observed in VMware Workstation.

As a result, when running multiple VMs under memory-intensive tasks, VMware Workstation suffers more from performance degradation due to higher overhead and less optimized resource scheduling under load.

CacheBench

The CacheBench test checks the performance of the virtual machine memory subsystem, in particular the processor cache (L1, L2, L3 caches) and RAM. It focuses on memory performance and efficiency, evaluating the access speed and throughput of caches and the overall system memory.

CacheBench performs a series of read, write, and copy operations on memory with different access patterns and data block sizes. The test is specifically designed to measure memory throughput and latency at different caching levels. It sequentially interacts with L1, L2, L3 caches, and main memory, revealing performance characteristics under different memory usage scenarios.

For the CacheBench test, a higher result (higher throughput in MB/s) means better performance. That is, the more data can be transferred through the cache memory per unit of time, the more efficiently the memory subsystem works. Therefore, a higher test result is better.

Table 4. CacheBench test results

	Number of simultaneously running VMs	
	1	2
VMware Workstation	**4191,324 MB/sec**	**3687,033 MB/sec** 4050,136 MB/sec
Oracle VirtualBox	**4161,348 MB/sec**	4117,636 MB/sec **4108,589 MB/sec**

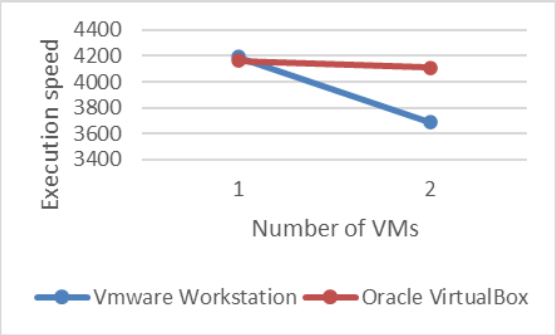

Figure 4 – CacheBench test results

Let's compare the percentage decrease in performance when increasing the number of VMs from 1 to 2 for each hypervisor: VMware Workstation – 12.03%, Oracle VirtualBox – 1.27%.

When running two VMs, VMware Workstation performance drops by 12.03% compared to one VM, while for VirtualBox this figure is only 1.27%, which is 9.5 times less.

When working with one VM, VMware Workstation's performance is slightly higher than VirtualBox's (the difference is about 30 MB/sec), but when working with two VMs, VirtualBox shows better performance compared to VMware Workstation.

This means that VirtualBox scales more efficiently as the number of VMs increases, providing consistent performance through better resource management and reduced overhead.

3.3 Disk subsystem performance testing

PostMark

The PostMark test is a benchmark that evaluates file system performance during intensive operations with small files, such as those found in mail servers, web servers, and news applications.

The virtual machine's storage subsystem is tested, i.e. the performance of the disk system and file system when performing input/output operations. This includes operations of creating, reading, writing and deleting files.

PostMark performs a series of operations, simulating a high-load environment with a large number of small files. It creates many files with random data and performs a sequence of transactions, including: creating new files, deleting existing files, reading from files, writing to files.

The test measures the speed of these operations, i.e. the number of transactions per second. Thus, PostMark evaluates how effectively the file system copes with intensive I/O operations.

The best result is a higher number of transactions per second. This means that the system is able to perform more input/output operations per unit of time, which indicates high performance of the disk and file subsystem when working with small files.

Table 5. PostMark test results

	Number of simultaneously running VMs	
	1	2
VMware Workstation	**2251 op/sec**	**1736 op/sec** 1789 op/sec
Oracle VirtualBox	**2265 op/sec**	1386 op/sec **1345 op/sec**

In the single VM scenario, both VMware Workstation and Oracle VirtualBox demonstrate similar performance levels (2251 ops/sec and 2265 ops/sec, respectively). This similarity indicates that when using the high-speed PCIe Gen 3.0 x4 NVMe 1.3 disk storage interface and the minimal workload of a single VM, both hypervisors efficiently utilize the available resources, delivering optimal performance without significant overhead.

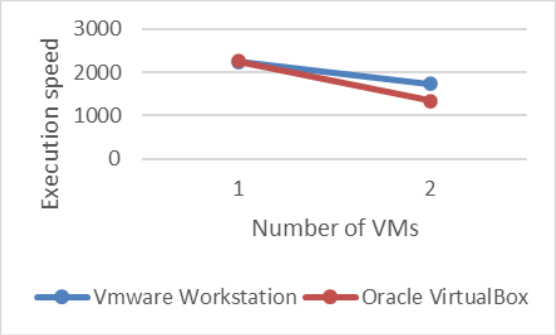

Figure 5 – PostMark test results

However, when running two VMs, there is a noticeable difference in performance: for VMware Workstation, it drops from 2251 ops/sec to 1736 ops/sec, while for Oracle VirtualBox, the drop is more significant – from 2265 ops/sec to 1345 ops/sec.

It is important to note that when using high-performance NVMe storage on a PCIe Gen 3.0 x4 interface, efficient handling of parallel I/O operations is expected. However, Oracle VirtualBox shows a sharper performance drop when moving from one to two VMs. This may indicate that VirtualBox scales I/O operations less efficiently as the number of concurrent workloads increases, even with a fast disk interface.

The differences in performance between VMware Workstation and Oracle VirtualBox in a multi-VM scenario are explained by the fact that VMware Workstation makes more efficient use of the high-speed NVMe storage. This is due to optimized mechanisms for processing asynchronous I/O, more efficient caching strategies, and better parallelization of I/O requests. At the same time, Oracle VirtualBox, despite using a fast NVMe interface, has limitations in the architecture of processing disk I/O operations, which leads to bottlenecks under intensive parallel workloads.

IOzone

The IOzone test is designed to measure the performance of the virtual machine's disk I/O subsystem. It tests the speed of the file system and disk storage, including read and write operations on the disk.

IOzone runs a series of tests that simulate different disk usage scenarios. It creates files of certain sizes and performs sequential and random read and write operations on them. The throughput and response time of these operations are measured. The following operations are tested: sequential write, rewrite, sequential read, repeat read, random read and write.

The best result in the IOzone test is a high throughput score. High scores mean that the system can perform I/O operations faster.

Table 6. IOzone test results

	Number of simultaneously running VMs	
	1	2
VMware Workstation	**2,42 MB/sec**	2,05 MB/sec **1,69 MB/sec**
Oracle VirtualBox	**0,69 MB/sec**	**0,51 MB/sec** 0,52 MB/sec

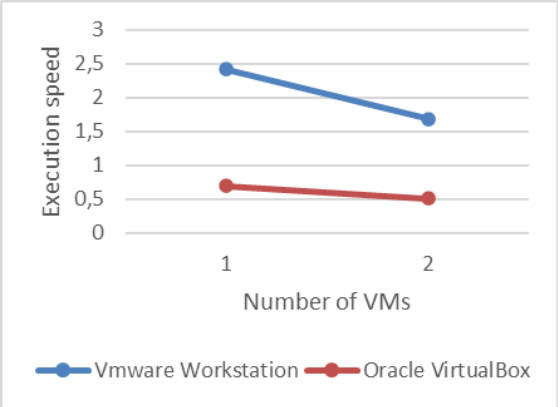

Figure 6 – IOzone test results

The performance results show that VMware Workstation significantly outperforms Oracle VirtualBox in this test, despite using a high-speed PCIe Gen 3.0 x4 disk storage interface with NVMe 1.3 support.

VMware Workstation's performance is 2.42 MB/sec when running one VM, and drops to 1.69 MB/sec when running two VMs. Oracle VirtualBox's performance is significantly lower: 0.69 MB/sec when running one VM, and 0.51 MB/sec when running two VMs.

Such low values for Oracle VirtualBox are due to the fact that, despite using fast NVMe storage via the PCIe Gen 3.0 x4 interface, VirtualBox does not use its capabilities effectively. VMware Workstation, on the contrary, uses more optimized methods of accessing the host disk, including efficient caching and buffering of disk operations. This reduces the number of direct disk accesses and increases the speed of I/O operations.

In the works [1], [2], [3] and [5] it is noted that the VMware Workstation hypervisor showed better results than VirtualBox in both read and write operations to the disk. Moreover, in the study [2] the disk subsystem was tested using 3 different tests: Fileserver, Varmail, Webserver and Randomfile access.

Thus, the performance difference between the two hypervisors may be due to VMware Workstation more effectively taking advantage of the high-speed PCIe Gen 3.0 x4 NVMe 1.3 disk interface. Oracle VirtualBox faces limitations in its disk processing architecture and scales I/O operations less efficiently as the load increases, resulting in significant performance degradation even when using fast storage.

3.4 2D graphics performance testing

x11perf

The virtual machine's graphics subsystem is tested, namely the performance of the X11 server (display system) in performing graphics operations. This includes an assessment of how efficiently the virtual machine can handle graphics tasks such as drawing shapes, displaying text, and processing images within the X Window System.

The test is performed using x11perf, a tool for evaluating the performance of X11 graphics primitives. During the test, x11perf performs a wide range of graphics operations, systematically measuring the speed and efficiency of each operation performed by the X11 server.

In the x11perf test, a higher score is better. The test measures the number of operations that an X11 server can perform per second. So, a higher number indicates that the system can handle more graphics operations in a given amount of time, which reflects better graphics performance.

Table 7. x11perf test results

	Number of simultaneously running VMs	
	1	2
VMware Workstation	**669 op/sec**	**375 op/sec** 442 op/sec
Oracle VirtualBox	**167 op/sec**	106,0 op/sec **90,6 op/sec**

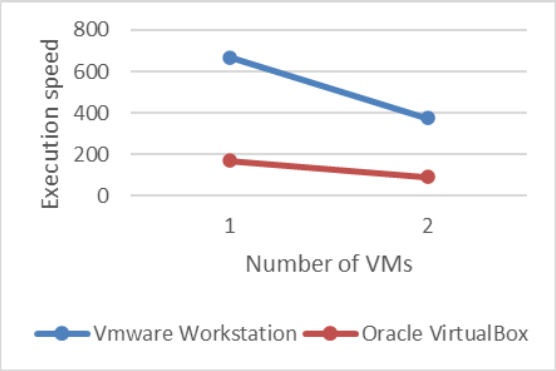

Figure 7 – x11perf test results

Both hypervisors experience similar proportional performance degradation (44% for VMware Workstation and 46% for Oracle VirtualBox). The observed degradation is a natural consequence of sharing the host's finite resources between VMs. Both hypervisors exhibit this behavior proportionally.

VMware Workstation consistently shows significantly better performance than Oracle VirtualBox in both single and dual VM scenarios.

Guruh Aryotejo, Eko Adi Sarwoko, Aris Sugiharto and Muhammad Malik Hakim in their research paper [4] note that when testing graphics performance with the GraphicMark test, VMware Workstation showed a result (13 points), while Virtual Box could not even complete the test.

Both VMware VMs had VMware Tools installed during testing. VMware Tools includes optimized drivers and utilities that improve VM performance, especially in graphics (critical for the x11perf test), disk I/O, and networking, which resulted in a significant difference in performance (VMware is about four times faster than VirtualBox).

GtkPerf

GtkPerf tests the virtual machine's graphics subsystem, including the virtual graphics adapter and its ability to efficiently render GTK+ GUI elements. The testing includes an assessment of the rendering performance of widgets and graphical components, which directly affects the responsiveness and smoothness of GUI applications in the virtual environment.

The test performs a series of operations to render various interface elements: buttons, entry widgets, lists (list widgets), combo boxes, scrolling and other GTK+ widgets.

GtkPerf measures the time it takes to repeatedly render these elements, thereby assessing the speed and efficiency of the graphics subsystem when performing standard GUI operations.

Table 8. GtkPerf test results

	Number of simultaneously running VMs	
	1	2
VMware Workstation	**111,54 sec**	**174,65 sec** 173,90 sec
Oracle VirtualBox	**163,81 sec**	**302,69 sec** 304,55 sec

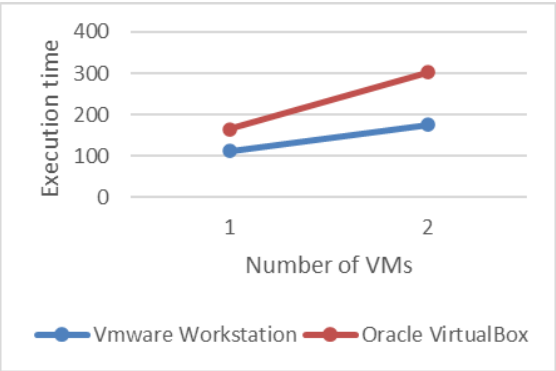

Figure 8 – GtkPerf test results

The best result in the GtkPerf test is the shortest execution time. That is, smaller values indicate higher performance of the graphics subsystem, since the system spends less time rendering interface elements. Strive for the lowest time indicators to ensure better responsiveness of GUI applications.

In VMware Workstation, the execution time increased from 111.54 seconds to 174.65 seconds (about 56%), and in Oracle VirtualBox, the jump was from 163.81 seconds to 302.69 seconds (about 85%). This indicates that Oracle VirtualBox is less efficient at allocating resources between virtual machines under high load and has a less optimized resource management mechanism compared to VMware Workstation.

When comparing the performance of different hypervisors, it is clear that VMware Workstation shows better performance in both cases. The reasons for this are the more efficient operation of the hypervisor with hardware resources, better algorithms for distributing the load and optimizing the execution of virtual machines.

It is important to note that during testing in VMware, VMware Tools were installed on both virtual machines, which contributed to the improved testing results.

3.5 Synthetic performance test

A synthetic test is a benchmark that simulates specific tasks or workloads to measure the performance of individual system components in isolation. It does not reflect the operation of specific applications or real-world usage scenarios, but is intended to create controlled conditions under which different systems or configurations can be objectively compared.

Sysbench

The Sysbench test evaluates the CPU performance of a virtual machine.

Sysbench stress tests the CPU by performing computational operations, such as finding prime numbers up to a specified limit. The test performs these operations using a specified number of threads and measures the time it takes to complete them. This allows you to assess how efficiently the virtual machine's CPU handles intensive computational tasks.

The best result is the higher the result, i.e. the higher the speed of the test execution. The higher the speed, the faster the processor copes with the computing tasks, which indicates higher CPU performance in the virtual machine.

Table 9. Sysbench test results

	Number of simultaneously running VMs	
	1	2
VMware Workstation	**1240,14 op/sec**	**902,33 op/sec** 981,31 op/sec
Oracle VirtualBox	**1448,84 op/sec**	**1117,58 op/sec** 1168,67 op/sec

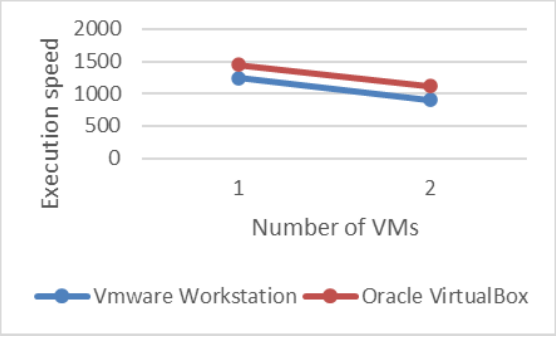

Figure 9 – Sysbench test results

When moving from one to two VMs, VMware Workstation's performance drops from 1240.14 ops/sec to 902.33 ops/sec, a drop of approximately 27%. At the same time, Oracle VirtualBox's performance drops from 1448.84 ops/sec to 1117.58 ops/sec, a drop of approximately 22%. This indicates that VMware Workstation experiences a greater performance drop as the number of VMs increases compared to Oracle VirtualBox, despite the benefits of its high-speed disk subsystem.

The obtained results show that Oracle VirtualBox provides better performance in Sysbench CPU tests compared to VMware Workstation, both with one and two VMs running. This may be due to more efficient distribution of computing resources and optimization of the processor in VirtualBox.

However, it should be noted that the Gzip Compression and OpenSSL tests show the opposite trend. These tasks are more I/O intensive and can significantly benefit from the high-speed PCIe Gen 3.0 x4 NVMe 1.3 disk interface. In addition, compression and encryption tasks make heavy use of specialized instructions and hardware acceleration, which leads to VMware advantages in these areas. While general computing tasks based on basic CPU operations and integer arithmetic, such as the Sysbench CPU test, are less dependent on the disk subsystem, allowing VirtualBox to demonstrate competitive or even better performance.

Conclusion

The choice between VMware Workstation and Oracle VirtualBox largely depends on the specifics of the tasks and the required resources.

VMware Workstation is the preferred choice for scenarios where high CPU performance is important when running a single VM and disk subsystem speed is critical, especially for intensive I/O operations. This hypervisor also has advantages in graphical applications using 2D graphics. This makes it suitable for server applications, databases, and tasks that require fast disk access.

Oracle VirtualBox is better suited for multi-virtual environments where scalability and consistent performance as the number of VMs increases are important. Its advantages are seen in memory-intensive tasks and in situations where synthetic CPU tests reflect typical workloads. VirtualBox provides more efficient resource allocation and may be preferable for developers, test environments, and workstations with several VMs running simultaneously.

Both hypervisors have their own areas of application and can be effectively used depending on specific requirements. When choosing between VMware Workstation and Oracle VirtualBox, it is recommended to consider the nature of the tasks, types of workloads and priority resources to ensure optimal performance and efficiency of virtual machines.

As part of further development of research in the field of virtualization, it would be advisable to expand the range of tested hypervisors, including such popular solutions as VMware ESXi, Microsoft Hyper-V, KVM and Xen. This will provide a more complete picture of the performance and applicability of various technologies in various use cases.

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