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Evaluation and Comparison of the Performance of Different Hypervisors under Various Workloads of GIADEC

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Abstract:- This research study evaluates and compares the performance of Hyper-V, Citrix Xen, and VMware ESXi to aid Ghana Integrated Aluminium Development Corporation (GIADEC) in informed hypervisor selection. The study focuses on identifying the optimal hypervisor for GIADEC, considering factors like effectiveness and efficient resource utilization. It aims to improve resource allocation, hypervisor selection, and performance optimization within GIADEC's IT infrastructure. Using a qualitative approach and extensive literature review, the study supports informed decision-making for hypervisor selection. Through benchmarking with Passmark Performance Test Suite and BootRacer application, each hypervisor underwent rigorous testing across various performance metrics. The study assesses performance aspects including installation and booting times, CPU, memory, disk, and network performance. Results highlight distinct advantages of each hypervisor: Hyper-V for quick virtualization deployment, VMware ESXi for superior CPU, memory, and network performance. Hyper-V excels in memory write and disk sequential read/write speeds, while VMware ESXi demonstrates low memory latency and superior network bandwidth. It is recommended that GIADEC should consider VMware ESXi due to its outstanding overall performance and suitability for diverse workload requirements. This study adds to the knowledge base on hypervisor performance evaluation and supports GIADEC's decision-making process for optimal hypervisor selection.

Keywords:- *VMware ESXi, Microsoft Hyper-V, GISDEC, Virtual Machine, Bare-Metal Hypervisors, Xen, vSphere, and Citrix.*

I. INTRODUCTION

The concept of virtualization is generally believed to have its origins in the mainframe days in the late 1960s and early 1970s, when IBM invested a lot of time and effort in developing robust time-sharing solutions. Time-sharing refers to the shared usage of computer resources among a large group of users, aiming at increasing the efficiency of both the users and the expensive computer resources they share. This model represented a major breakthrough in computer technology: the cost of providing computing capability dropped considerably and it became possible for organizations, and even individuals, to use a computer without actually owning one. Similar reasons are driving virtualization for industry standard computing today: the capacity in a single server is so large that it is almost impossible for most workloads to effectively use it. The best way to improve resource utilization, and at the same time simplify data center management, is through virtualization.

Data centers today use virtualization techniques to make abstraction of the physical hardware, create large aggregated pools of logical resources consisting of CPUs, memory, disks, file storage, applications, networking, and offer those resources to users or customers in the form of agile, scalable, consolidated virtual machines. Even though the technology and use cases have evolved, the core meaning of virtualization remains the same: to enable a computing environment to run multiple independent systems at the same time. Virtualization is basically a framework for distributing computing resources into numerous execution environs by the application of one or more technologies or concepts such as software or hardware apportioning, time-sharing, limited or complete simulation, quality of service and several others. Beside integration and cost saving, it provides services to other aspects of the information technology industry. The rapid growth of virtualization technologies has revolutionized the computing landscape, enabling more efficient resource utilization and flexible deployment of applications.

At the heart of virtualization lies the hypervisor, which is a software layer that enables the creation and management of Virtual Machines (VMs) on physical hardware. Hypervisors have become a fundamental component in various computing scenarios, ranging from data centers to cloud computing environments. This hypervisor, also called Virtual Machine Monitor (VMM), creates a virtual platform on the host computer, on top of which multiple guest operating systems are executed and monitored. This way, multiple operating systems, which are either multiple instances of the same operating system, or different operating systems, can share the

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hardware resources offered by the host. There are two main types of hypervisor.

Type 1 hypervisors (Bare-Metal Hypervisors), such as Microsoft Hyper-V, Xen, vSphere, and Citrix run directly on hardware without an operating system, managing virtual machines.

They are used on client machines or personal computers, while Type 2 hypervisors (Hosted Hypervisors), like VMware Workstation, Oracle VirtualBox, and Microsoft Virtual PC, run on top of a host operating system to manage hardware resources and provide services. Both types of hypervisors have their own advantages and use cases [7]. Type 1 hypervisors are commonly used in enterprise environments where high performance and resource isolation are crucial. They are ideal for server virtualization scenarios suitable for desktop virtualization and testing environments, as they provide a convenient and user-friendly interface.

➢ *Problem Statement*

The Ghana Integrated Aluminum Development Corporation (GIADEC) recognizes the need to incorporate virtualization, specifically virtual servers, into its IT system. However, GIADEC faces the crucial decision of selecting the most suitable hypervisor software to facilitate this transition. The choice of hypervisor software is of utmost importance as it directly influences the security, effectiveness, and performance of GIADEC's IT infrastructure. Additionally, GIADEC acknowledges that the current server resources are not being utilized efficiently, resulting in wastage.

Therefore, the research problem to be addressed is:

What is the optimal hypervisor software to be adopted by GIADEC to enhance the effectiveness, performance, and security of their IT infrastructure while addressing the issue of underutilization of server resources?

This research problem requires an in-depth investigation into the available hypervisor software options, their respective features, benefits, and drawbacks.

➢ *Study Objectives*

The aim of this study is to evaluate and compare the performance of different hypervisors under various workload of datacenter in GIADEC. To facilitate well-informed choices, optimize resource consumption, and improve system efficiency in virtualized environment by achieving the following:

- Identify and define the relevant Key Performance Indicators (KPIs) for evaluating hypervisor performance.
- Evaluate and compare different hypervisors performance in the following areas:

✓ Assess the memory implement efficiency of different hypervisors.
✓ Compare the disk, I/O results of different hypervisors.
✓ Analyze the network performance and duration of different hypervisors.

- To come with recommendation using benchmark test that will enable GIADEC to select the best hypervisor for their IT infrastructure.

II. METHODOLOGY

The study approach for evaluating and comparing hypervisor performance adopts a systematic and rigorous methodology. It uses quantitative method to gather comprehensive insights and data. The quantitative approach involves using benchmarking tools (Passmark Performance test suite and Boostracer), standardized workloads (VMware, Microsoft Hyper-V, and Xen) and Dell PowerEdge Servers to collect objective performance metrics and measurable data to evaluate and compare the performance of different hypervisors in Ghana Integrated Aluminum Development Corporation (GIADEC). The statistical analysis to provide a quantitative understanding of hypervisor performance. The research approach emphasizes a structured methodology, including setting up a dedicated test environment, following standardized procedures, and maintaining documentation. This approach ensures a holistic evaluation of hypervisor performance, enabling researchers to make informed decisions and recommendations in the field of virtualization.

The benchmarking tools allow for the measurement of various performance metrics, such as CPU utilization, memory usage, disk I/O, and network throughput while the execution of the standardized workloads on different hypervisor platforms systematically compare their performance based on these metrics.

The collected quantitative data is then analyzed using statistical techniques to identify patterns, trends, and significant differences between the hypervisors. Statistical analysis method, such as descriptive statistics are employed to draw meaningful conclusions from the data. Through the quantitative approach, the research provide objective insights into the performance of different hypervisors in GIADEC. This approach allows for the comparison of key performance metrics, enabling decision-makers to make informed choices based on statistical evidence. The quantitative research report arrangement comprises of an introduction, review of literature, methods, findings, analysis and conclusion.

Descriptive statistics include measures such as mean, standard deviation, and range, which provide insights into the central tendency and variability of the performance metrics.

The external factors such as varying hardware configurations or network conditions influenced the hypervisor performance and introduce potential confounding variables.

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Finally, the findings of the research will be reported systematically, following a structured format. This report will provide objective insights into the performance of different hypervisor platforms in GIADEC, aiding decision-making processes in virtualization environments.

III. RESULTS

With regards to the experiments conducted, the three bare-metal hypervisors were benchmarked using Passmark Performance Test Suite and BootRacer application the experiment includes CPU, Memory, Disk and Network. After conducting an extensive evaluation and comparison of the performance of three hypervisors: Hyper-V, Citrix Xen, and VMware ESXi, the following key findings emerged:

Hyper-V demonstrated the fastest installation time in 338.76 seconds and booting time in 71.91 seconds among the three hypervisors. Citrix Xen and VMware ESXi also provided satisfactory installation and booting times.

VMware ESXi demonstrated the highest CPU compression rate in 4883 kilobyte/sec and single-threaded performance in 2574.67 Mop/sec, indicating its efficiency in compressing

CPU-intensive workloads and executing tasks relying heavily on single-threaded performance. Citrix Xen followed in CPU compression and single-threaded performance, showing slightly lower performance. Hyper-V trailed behind both hypervisors, suggesting it might not be as optimized for CPU-intensive tasks or workloads that heavily depend on single-threaded performance.

VMware ESXi demonstrated the highest average memory write speed in 9634 Mbytes/sec, indicating its efficiency in writing data to memory. Hyper-V demonstrated the lowest average memory latency, indicating minimal delays in accessing memory, contributing to overall system responsiveness. Citrix Xen provided competitive performance in both memories write speed and latency, indicating a balanced approach to memory operations. Hyper-V exhibited the highest average disk sequential read in 413.33 Mbytes/sec and write speeds in 133 Mbytes/sec, indicating its proficiency in reading from and writing to disks sequentially. Both Citrix Xen and VMware ESXi offered competitive performance in disk sequential read and write speeds.

VMware ESXi demonstrated the highest average network bandwidth data received in 95.83 Mbytes/sec and data sent in 95.83 Mbytes/sec, indicating its efficiency in handling network traffic and sustaining high data transfer rates.

IV. CONCLUSION

The aim of this study was to evaluate and compare the performance of different hypervisors including Hyper-V, Citrix Xen, and VMware ESXi, has been successfully achieved. Through comprehensive analysis and evaluation, valuable insights have been gained regarding the performance characteristics of each hypervisor for GIADEC in making informed judgments about hypervisor selection.

Based on the findings, each hypervisor demonstrated distinct advantages in various performance areas. Hyper-V showcased fast installation and booting times, making it an efficient choice for swift virtualization deployment. VMware ESXi exhibited excellent CPU tests, Memory Tests and Network tests, optimizing resource utilization and handling workloads. Hyper-V excelled in memory write speed and disk sequential read and write speeds, while VMware ESXi demonstrated low memory latency and superior network bandwidth performance.

The outcome of the experiment shows that VMware ESXi outperformed the Citrix XenServer and Hyper-V in most of the test. Overall, results clearly depict that the performance of VMware ESXi is outstanding as compared to the Citrix XenServer and Hyper-V on Dell PowerEdge 740 rack server.

On this particular hardware (Dell PowerEdge 740 rack servers) VMware ESXI works better on it compare to other hypervisors. Although, VMware ESXI installation and booting times was longer compared to other hypervisors, installation is a one-time process that should not significantly impact the overall performance and efficiency of the virtualized environment.

RECOMMENDATIONS

Based on the research findings and GIADEC's workload requirements, it is recommended to adopt and personalize VMware ESXi as the preferred hypervisor, leveraging its outstanding performance and reliability to optimize virtualized environments and enhance overall performance.

Additionally, it is suggested to expand the scope of the experiment by testing the performance of VMware ESXi on different hardware brands, apart from Dell PowerEdge servers. This will help ascertain whether VMware ESXi continues to exhibit superior performance across a variety of hardware requirements or if there are any variations based on hardware compatibility or optimizations and analyze the impact of hypervisor feature on specific use cases like security and scalability.

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