Quantitative Server Virtualization Evaluation of Citrix XenServer Vs.Vmware ESXi on the bases of CPU, RAM and Network

***Abstract*— Nowadays, server and processing virtualization plays a significant role in IT Industries in terms of workload management, cost reduction and simplify many systems appear to be one. The Citrix XenServer and Vmware ESXi are the top two-part of server virtualization, which beneficial to provide high availability, increase network performance and productivity. In this research theme, The aim to focus on delivering solutions for virtualization technology to more reliable, effective and safe use by comparing these two types -1 bare-metal hypervisors in terms of performance based on CPU, RAM and Network. Additionally, We have shown architectures of Citrix and VMware explains server virtualization environment. The novelty of this research is to connect XenServer to Citrix center and ESXi to VMware vSphere client and Analyse performance. Moreover, For performance comparison, the research tends to use the assessment tools and at the end, analyse results.**

Keywords*— *Citrix Xenserver, VMware ESXi, Hypervisor, Performances.

I. INTRODUCTION

In the day by day development of cloud technology, virtualization delivers lots of enhanced features, benefits. It makes proper utilization of infrastructure resources, specifically in Infomation and communication technology (ICT) Industry. Virtualization is the right phrase that applies to abstract computing resources. The virtual computing environment's aim is to be able to maximise resource usage by providing users and applications with an integrated operating framework focused on aggregating heterogeneous and stand-alone resources as well as it helps by reducing the expense of hardware, using infrastructure services, and using electricity [3]. Moreover, It offers multiplication of utilisation of The resources, flexibility of device management, high protection and failure resistance. The powerful weapon is hypervisor used by virtualization technology responsible for reinforcing the separation between virtual machines and hardware resource management. Also, It referred to as the central controller for virtual machine access to all physical server resources. However, The primary concern of cloud service provider is any hypervisor failure can violate virtual machine security because all operations on virtual machines become vulnerable.

On the other hand, While considering big information system infrastructure, maintain the highest security and resource management is the primary concern of the IT industry. There are many various types of hypervisors that are present in the market. Since there is a wide range of hypervisors used by different vendors that can pose a new challenge in managing various machine resources and diverse feature set of different application programming interfaces for different virtualization platforms, it also offers a collection of chances whether applications will fit the appropriate hypervisor [4].

We present the comparison of Citrix Xenserver, and VMware ESXi is the open-source top two players in the server and processing virtualization. These are categorised into a "type-1" bare-metal called a native hypervisor [3]. However, Citrix Xenserver used in small and medium-sized companies as well as for personal use as compared to VMware ESXi used in SMB but not available for personal use. Both hypervisors have different storage, network connectivity options. This extensive comparison includes performance on the basis on storage, network and memory and makes usable as a real-time hypervisor. Also, this comparison Offer a few insightful insights into the different market models. We will test the alternatives and suggest possible solutions to make the use of virtual machines, even the use of more effective and safer to industries [6] [5].

The rest of this paper is structured, as shown below. In Section 2, we illustrate the background of server and processing virtualization. Section 3 shows Current challenges and limitations. Next Section 4 presents a critical analysis of previous works. Section 5 Evaluation setup and results as well as Section 6 Security Finally section 7 shows the conclusion of this report.

II. BACKGROUND OF SERVER VIRTUALIZATION

A. Server Virtualization vs Processing virtualization

In the virtualization era and cloud data centres, Server virtualization plays a vital role in IT infrastructure allows abstracting a server's physical resources into logical resources, isolating a server into several virtual servers, or combining multiple servers into one server [12]. Also, Improve the usage of resources by the CPU, memory, I / O, disk and other dynamic hardware, so that device management is more versatile and simpler.[11] Additionally, It helps to reduce power and energy consumption, that's why it referred to as a server consolidation technique.[1] Citrix Xenserver, VMware vSphere, Microsoft Hyper-V are examples of hypervisors supports server virtualization.

On the other hand, Processing virtualization is a way to allow an operating system and all its supporting applications to live in a logical or virtual environment. Moreover, The solutions ranging from making several methods seem to be a single system to increase performance, scalability or reliability or to make one system appear to be several individual systems to consolidate several different workloads on a single physical machine. Both Type-1 and Type-2 hypervisors, i.e. hosted (VMware Workstation) supports this category. However, Vmware vSphere does not support full virtualization as compare to Xenserver [13].

B. Citrix XenCenter architecture

Recently released 2020 [14], Citrix Hypervisor 8.1 is Citrix's full server virtualization platform allows to build and maintain the deployment of virtual x86 computers operating on Xen, the near-native-performing open-source paravirtualization hypervisor. Simultaneously, It runs directly on server hardware without the need for an underlying operating system resulting in an effective and scalable system, designed for both Windows and Linux virtual servers.

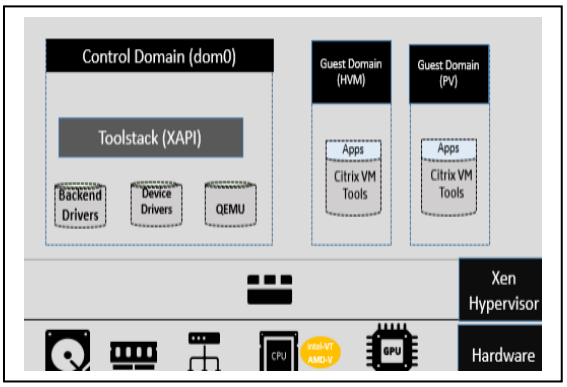

Fig.1: Technical architecture of Citrix XenServer [14]

Hardware

It includes resources of the physical server such as CPU, memory, network, and disk drives as well as supports Intel VT or AMD- 64-bit x86-based device with one or more CPUs to run all compatible guest OS.

Control Domain

Gives control functions for Citrix Hypervisor runs the physical system drivers for networking, storage, etc. Also, interact with the hypervisor to tell them to start or stop guest VMs.

Xen Hypervisor

Several instances of an operating system or multiple operating systems run concurrently on a single computer and used as the basis for a wide variety of commercial and open-source software, such as server virtualization, IaaS infrastructure, desktop virtualization, security software, embedded and hardware appliances.

Toolstack

It manages hypervisor and Monitors operations of the Server lifecycle, host and server networking, storage, and user authentication.

Guest Domain(VMs)

It can be a hardware virtual machine(HVM) or Paravirtual (PV) for virtualizing OS and helps to boost hardware-sensitive application efficiencies such as a disk or network access and customise para-virtualized drivers.

Citrix VM tools

It requires I / O drivers and management agent to provide high- I / O services without the conventional system emulation overhead.

C. Vmware vSphere Client Architecture

VMware vSphere is the server virtualization platform that converts data centres into aggregated computing infrastructures that provide resources for CPU, storage, and networking as well as As a single operating system, vSphere manages these infrastructures and provides tools to control the data centres [15]. Besides, it maintains a powerful hypervisor called Vmware ESXi.

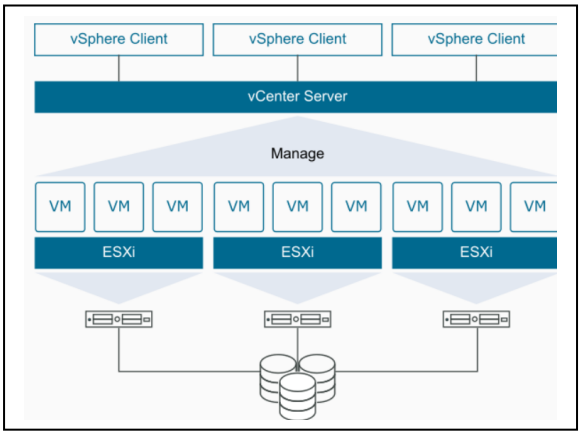

Fig.2: VMware vSphere Management architecture [15]

The ESXi compact architecture is designed for direct integration into virtualization-optimized server hardware, allowing fast installation, setup, and deployment [16].

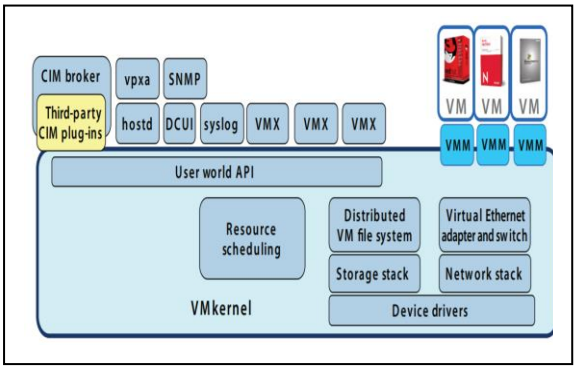

Fig.3: Detailed view of VMware ESXi architecture [17]

VMKernel

It is a primary component of ESXi hypervisor that provides all system operations, including management programs and agents, and virtual machines. It is specifically designed to accommodate multiple virtual machines running and offers such core features as Resource Scheduling, IO stacks, System drivers.

User Worlds

IT refers to a process running in the VMkernel operating system and offers only appropriate context for the operations to be run in the hypervisor environment.

Direct Console user interface

It is a low-level configuration and management interface, accessible can server console (ESXi Framework), used primarily for initial basic configuration and troubleshooting, as well as a BIOS-like, menu-driven interface for device interaction. Also, It is responsible for such tasks such as setting an administrative password, setting networking,

performing essential network monitoring, viewing logs, restarting agents, restoring defaults.

Common Information Model
It is responsible for remote device hardware-level control over a collection of standard APIs.

III. Problem Definition

The [14] Both Citrix Xenserver and VMware Esxi are the bare metal type-1 hypervisors, top 2 players in server virtualization manage various types of workload, mixed operating systems, and [16] storage or networking configurations, and maximize overall usage of existing hardware resources, thus reducing total ownership costs of infrastructure as well as provides efficient business models and solutions to IT industries.
Both show certain limitations in performance includes CPU, RAM and network latency. In this research, We aim to focus on a comparison of these hypervisors performance on the bases of memory, CPU and network and determine which one right fit for a virtual environment.

IV. Literature Review

A. Critical Analysis of related work

In 2019, Jiang, C and Wang, Y, 2019 present [1] a distinct comparison based on power and energy features of four different hypervisors and container such as Microsoft Hyper-V, VMware ESXi, Citrix XenServer, KVM and Docker. Besides, The comparison based on various hardware platforms like one emerging ARM64 server, one desktop server and laptop, three mainstream 2U rack servers. The goal of the authors is using single server compare energy efficiencies of hypervisors. Subsequently, for the evaluation author used three symmetric measurements such as hardware, workload and hypervisor. The workload includes computation-intensive and memory-intensive and memory for hypervisors. The experimental results show hypervisors with different power and energy characteristics for the same workload on the same hardware.

The J. Torbic, I. Stankovic,2018 [2] demonstrates the assessments based on the performance of two type-1 hypervisors includes VMware ESXi and Microsoft Hyper-V using Windows server 2012 virtual operating system. The aim to focus of this assessment is to compare server virtualization performance using the top 2 players in the market. Simultaneously, the author present architectures of two hypervisors help to understand features as well as limitations. Moreover, the author proposed various mathematical expressions for benchmark two workloads. For the evaluation and testing of this experiment author used HD Tune PRO and ATTO benchmarks include read and write tests. Overall, the results show Microsoft Hyper-v perform well than Vmware ESXi.

The B. Dordevic, V. Timcenko,2019 [3] introduced a novel comparison based on file system performance of two type-1 hypervisors include Vmware Esxi and Citrix XenServer, as well as authors, provide solution on the significant issue of hardware virtualization dependency on full virtualization. The proposed solution used unique features of processors (Intel VT-x and AMD). Both hypervisor architectures show features and limitations helps to made changes. The objective of this experiment not only focus on performance but evaluation of full virtualization effects. Moreover, the author proposed mathematical expressions to calculate the processing time of the workload. Furthermore, results and tests were carried out using different VM instances and for simulation using Filebench benchmark tool. The final benchmark results and tests graphs show Vmware ESXi perform well than Citrix Xenserver with QEMU full virtualization.

In 2016, V.K.Manik and D. Arora [4] presented a novel qualitative comparison based on the performance of three various hypervisors includes Xen, KVM, Hyper-v and ESXi.Additionally, this comparison focus to provide solution on Maintaining multiple computing resources and specific application programming interface features for specific virtualization platforms. Moreover, the performance comparison can be carried out using particular VMs (Windows Server 2008) with one virtual machine and 2048 MB of memory to calculate total time requirements when compiling a multidisk partition SQL query for KVM, ESXi, Hyper-V, and Xen on a computer. Besides, the authors apply various workloads on the hypervisor and compare according to different criteria like memory, processor and disk I/O. Finally, the author show results by using graph include Hyper-V performance better than other hypervisors.

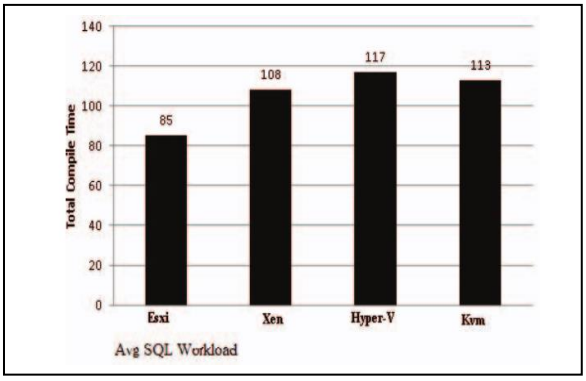

Fig.4: Performance difference between hypervisors [4]

In 2019, L. Abeni and D. Faggioli [7] investigated and measured latencies of the two most widely used hypervisors named as Xen and KVM. The objective of this investigation is to analyse the real-time performance of hypervisor and evaluate through scheduling techniques. Additionally, for the evaluation authors used cyclictest tool and analyse latency. Overall, the experiment result and graph shows Xen hypervisor latency is high than KVM.

In 2017, D. Kumar and A. Magloire [5] investigated survey of two opensource hypervisors named Xen, and KVM and compared them on bases of performance, flexibility, cost, security and maintenance. The aim to focus on providing solutions to Cloud technology and virtual environments allow much more effective and safer use. Both architectures present characteristics and drawbacks. Additionally, the author proposed another approach is the security of the foundation of an authorized management hypervisor operating system to make data safe. Overall, the survey, results and graph show limitations, benefits and misconceptions of Xen and KVM.

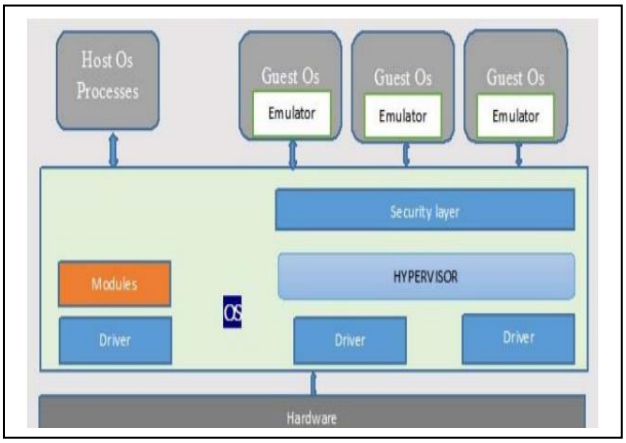

Fig.5: A proposed architecture of Security in Hypervisor [5]

The M. Polenov, V. Guzik 2018 [8], aims to focus on modern network infrastructure and show a comparison of common hypervisors includes Microsoft hyper-v, Xenserver,vSphere on the same physical machine. The comparison is based on RAM, CPU Utilization and workload management with or without a virtual machine. Moreover, For the evaluation of performance, authors used netbook with its configuration and calculate results. They do not focus on resource management.

The D. Pousa and J. Rufino 2019 [9], talks about system virtualization and show the performance-based evaluation of type-1 hypervisors. The architectures and analysis show the features and limitations of hypervisors. The assessment completed by using PassMark, UnixBench and DiskMark and results shows exper Hyper-V other hypervisor has little overhead.

B. Critical Analysis of Assessment Tools

Following is a summary of various types of benchmarking tools are available in the market to calculate the performance of hypervisors as well as many authors used them.

TABLE I. Summary of Assessment tools

Hypervisors	Benchmarking Tool	Description
VMware ESXi and Microsoft Hyper-V	Filebench	For performance time of workload [3]
Vmware Esxi and Citrix XenServer	HD Tune PRO and ATTO	Performance of disk read and write operations. [2]
Xen and KVM	Cyclictest	To analyse network latency [7]
Microsoft hyper-v,Xenserver,vSphere	Netbook	Compare Performance of resources [8]
Microsoft Hyper-V, Vmware vSphere, KVM	PassMark, UnixBench and DiskMark	Compare Performance [9]
Xen	Sysbench	Analyse and Compare Performance measurement [17]
Vmware Workstation	Netperf	Compare network performance[19]

V. EXPERIMENTAL METHODOLOGY

A. Benchmarking Tool (Sysbench and Netperf)

The objective is to analyse and compare the performance of Type-1 Hypervisors such as XenServer and ESXi using Sysbench and Netperf benchmark tool. In this experiment, we evaluate CPU, RAM and network parameter to calculate performance. For the CPU, Sysbench assigns a prime number as well as for memory assigns block size and total size. Additionally, Netperf assigns network parameter (IPV6 address).The performance measurement of CPU and RAM speed evaluation based on speed, total thread execution time, total operations per second and for network-based on total throughput per second.

B. FlowChart Plan

The procedure flowchart shows the proper plan for this experiment. Firstly, we install ISO image of XenServer 6.2.0 and VMware ESXi 5.5 in VMWare workstation. Moreover, we install Citrix XenCenter 6.2.0 and VMware vSphere Client 5.5. Secondly, By using the assigned IP address of the server, we connect XenServer to XenCenter as well as ESXi to the vSphere Client. Thirdly, Create ubuntu 18.04 VM on both (Xencenter and vSphere Client) and install benchmarking tools. Finally, Analyse and compare performance results and draw bar charts.

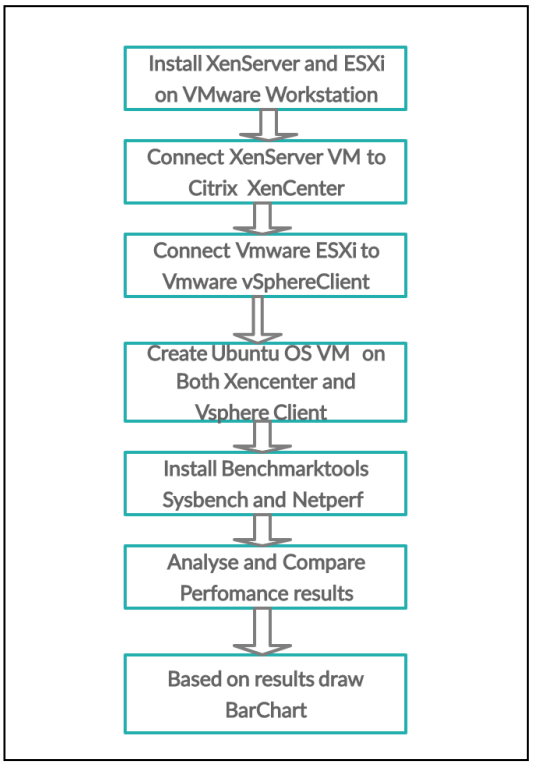

Fig.6: Plan Flow of Experiment

C. EXPERIMENTAL SETUP

To compare the performance of Citrix XenServer and VMware ESXi we based on CPU, RAM and Network, we need to configure Virtual machines as follows:

TABLE II. Configuration of System prerequisites

CPU	Intel Core i5 8250U 1.80 GHz
RAM	4 GB assigned both VM
No. of Cores	2
No. of Processors	1
OS type	64-bit
Machine Name	ASUS
HDD Capacity	1 TB
VM Hard Disk	90 GB
Host OS	Windows 10 Home Single Language
Guest OS	XenServer and VMware ESXi
VMware workstation version	15.5
XenServer Hypervisor Version	6.2.0
VMware Hypervisor ESXi	5.5
XenCenter Version	6.2.0
VMware vSphere Client Version	5.5
Guest OS on XenServer and vSphere Client	Ubuntu 18.04 LTS

D. Installation of XenServer, ESXi, XenCenter and VMware Vpshere Client

1. XenServer Installation on VMware Workstation

Step 1: Download *XenServer 6.2.0 ISO* from the official Citrix website and create VM as per configuration requirements on VMware Workstation.

Fig.7: Booting process of Citrix XenServer

Step 2: Power on VM and Enter onto the Citrix Xen Booting Process. After that choose a preferred language and click on license agreement *ACCEPT EULA*

Step 3: Select *sda* as a preferred VM storage and click on ok. Next, select Local Media as an installation source and click No for *supplementary packs*.

Step 4: Set Password for the root user of XenServer and next for networking select *automatic configuration DHCP* and set a *hostname*

Step 5: Select timezone from the geographical area and System Time Using Manual time Entry option Click on Ok

Step 6: Confirm Installation by click on install XenServer. It takes 2-3 minutes for booting. Finally, Show the *XenServer Control Page*.

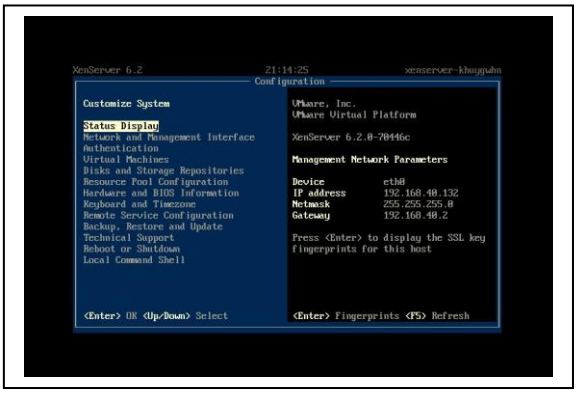

Fig.8: XenServer Configuration Control

2. ESXi Installation on VMware Workstation

Step 1: Download *Vmware ESXi 5.5 ISO* from the official VMware website and create VM as per configuration requirements on VMware Workstation.

Fig.9: VMware ESXi loading process

Step 2: Power on VM and Enter onto the ESXi Booting Process. Select ESXi 5.5 standard installer. After that accepts license agreement and click on continue.

Step 3: Select Disk where install ESXi and click on continue. Next, choose the preferred language and click on continue.

Step 4: Set Password for the root user of ESXi and confirm installation by click on install. It takes 2-3 minutes to install.

Step 5: After installation, select the Reboot option.

Step 6:ESXi show the DHCP and Static address. For the configuration press F2.

Fig.10: VMware ESXi

3. Citrix XenCenter Configuration on Host System

Step 1: Download Citrix Xencenter 6.2.0 from the official Citrix website and install on the Host machine, i.e. Windows 10
Step 2: Click on Add Server. Put XenServer IP on server section and username root and enter a password. Click on Add.

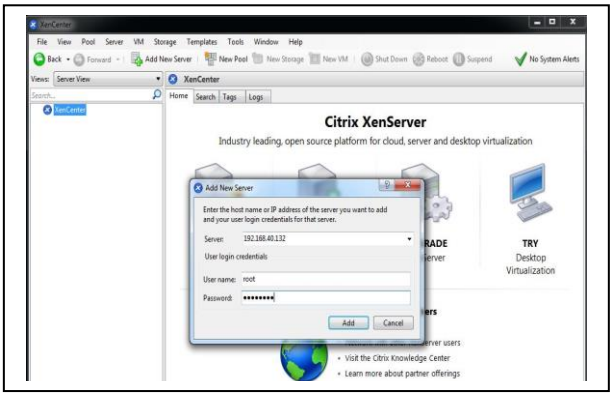

Fig.11: Adding XenServer on Citrix XenCenter

Step 3: Click on New VM and select installation media as ubuntu 18.

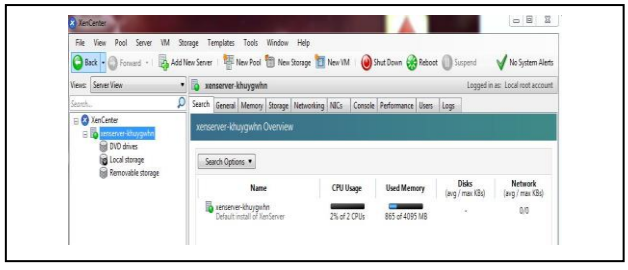

Fig.12: XenServer connected to Citrix XenCenter

Step 6:Give memory as 4GB, select storage as local storage and click on create new.
Step 7: Go to the Console and see the ubuntu home screen.

4. VMware vSphere Client Configuration on Host System

Step 1: Download VMware vSphere Client from the official Vmware website and install on the Host machine, i.e. Windows 10
Step 2: Put ESXi IP on server section and username root and enter a password. Click on Login. It opens inventory where manage VM's through ESXi host.
Step 3: Click on New VM and select datastore for storage. Click on next. Select Disk Size and click on finish.
Step 6:Go to the summary tab on storage section right-click on datastore and upload ubuntu 18 ISO file. Click on Ok.

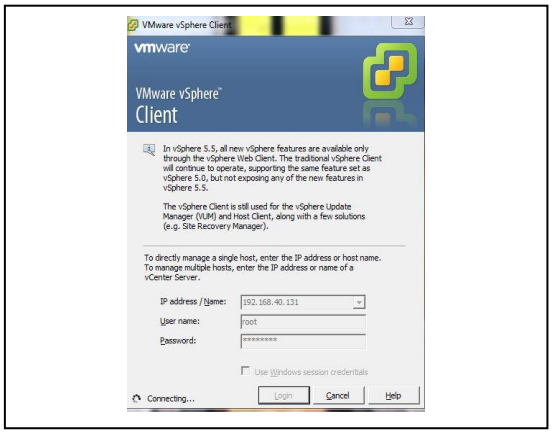

Fig.13: Login ESXi Host on VMware vSphere Client

Step 7: Edit VM settings under CD/DVD option select Datastore Ubuntu. Click on Ok and Power On.

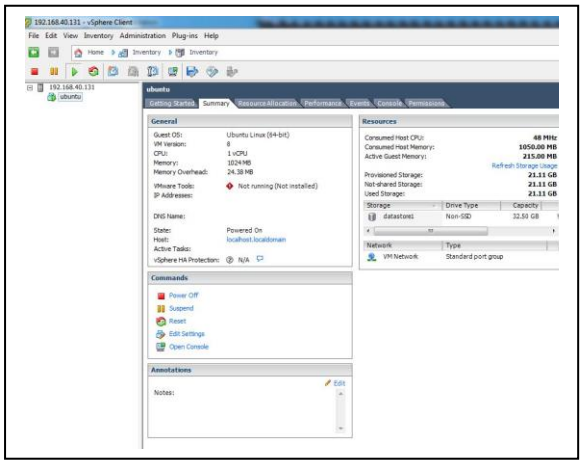

Fig.14 Ubuntu VM on VMware vSphere Client

Step 8: Go to the Console and see the ubuntu home screen.

Fig.15: Ubuntu VM on vSphere Client

5. *Installation of Benchmarking Tool on Ubuntu*

Sysbench installation Command for Ubuntu

Sudo apt-get install sysbench

Netperf Installation Command for Ubuntu

Sudo apt-get install -y netperf

VI. EXPERIMENTAL RESULTS

To analyse and compare performance, we need to evaluate the results of two type-1 hypervisors.

A. *Compare CPU Performance*

We have compared CPU performance of Xenserver and ESXi by applying Total time, Prime Numbers and number of threads using Sysbench tool. The Sysbench [19] command for CPU evaluation is

sysbench --test=cpu --cpu-max-prime=20000 --num-threads =1 run

This command we fire on ubuntu 18.04 OS which we installed in both XenCenter and VMware vSphere Client.
For the comparison, we applied different values as per given below.
Condition 1: For this, We apply prime numbers such as 20000,50000,70000 and 90000 with by default thread value 1. The ESXi server takes more time as compare to XenServer for the execution of a thread.

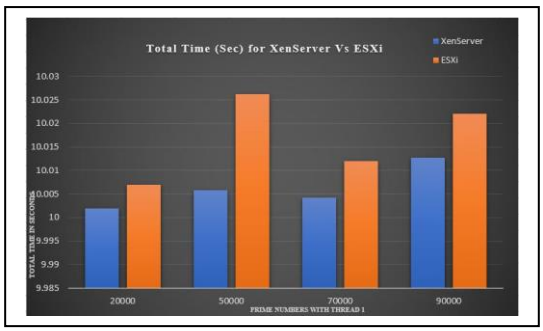

Fig.16: Total Time with Thread 1

Condition 2: For this, we apply Thread value 7. In this condition, the same as previous results ESXi increases time as compared to XenServer CPU speed fast.

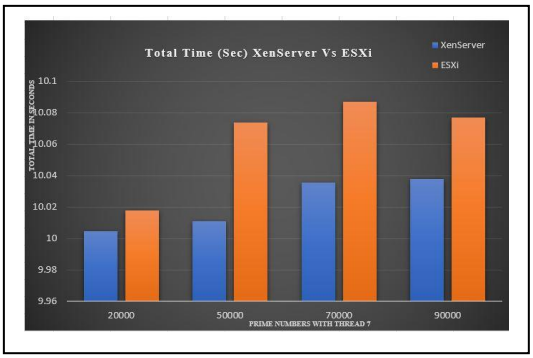

Fig.17: Total Time with Thread 7

Condition 3: In that, we change the thread value as 10. Overall, we analyse thread value increases the total time also increases for VMware ESXi server.

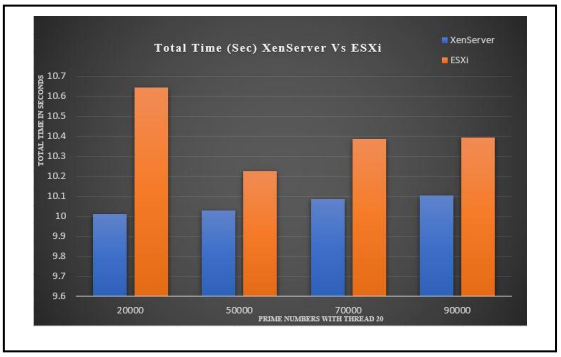

Fig.18: Total Time with Thread 20

B. *Compare Memory Performance*

We have compared RAM performance of Citrix XenServer and VMware ESXi server by applying memory block size, total memory size, total operations per second and a number of threads using the Sysbench Tool. The Sysbench [20] command for Memory evaluation is

sysbench --test=memory --memory-block-size=1M --memory-total-size=100G --num-threads=1 run

For the comparison, we applied different values as per given below.
Condition 1: For this, We apply memory block size 1024KiB and different total size 100,500,700 and 900 with thread 1. In the following graph, the ESXi server takes more time to execute operations per second as compared to XenServer.

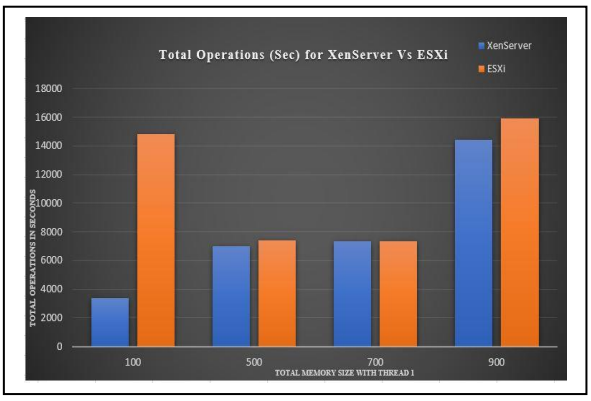

Fig.19: Total Operations with Thread

Condition 2: For this, We apply block size 2048KiB and different total size 100,500,700 and 900 with thread 6. The evaluation results show XenServer takes more time to execute operations as compared to ESXi.

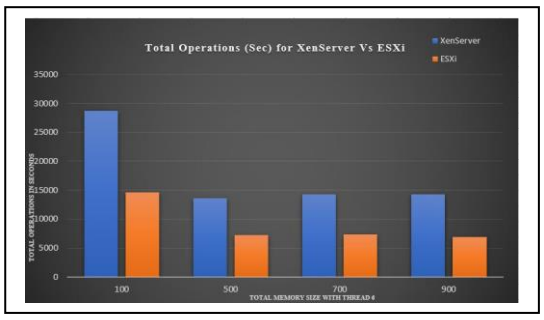

Fig.20: Total Operations with Thread 6

Figure 15 and Figure 16 shows as per thread value change the memory performance also change for Citrix XenServer and VMware ESXi.

C. Compare Network Performance using Netperf

In this, We evaluating and measure network performance on the bases of throughput receive from the server by testing UDP_STREAM. The UDP_STREAM [21] is a client and receive results from TCP_STREAM is a server using netperf command. For client-side:

netperf -H localhost -t UDP_STREAM -- -m 1024

For server-side: ***netperf***

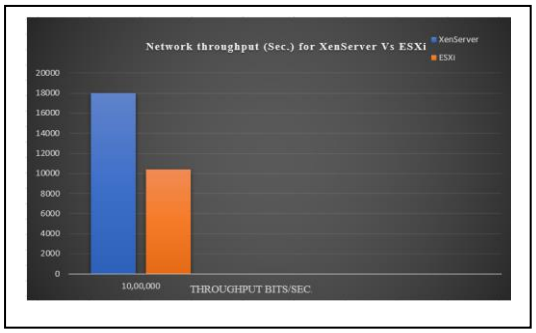

Fig.21: Throughput receive from TCP_STREAM

Overall, The ESXi server receives early throughput as compare to XenServer takes time to receive a response.

VII. Security Of Server Virtualization

Server Virtualization plays a significant role to provide security to different hypervisors and cloud data centres by eliminating servers called server consolidation. It adds a security layer to protect hypervisor as well as a virtual machine from various types of network attacks like Denial of service(DoS).In this research theme, we are talking about the top 2 hypervisors Citrix Xenserver and Vmware ESXi security.

Citrix [22] integrates with Bitdefender to Allow memory introspection from outside the VM, enabling even sophisticated unknown threats such as APTs (Advanced Persistent Threats) to be identified, intercepted and prevented from memory stacking. The benefit of this approach is Centralizing of Data: Data accessed by the client was stored safely in a datacenter and never transmitted to the endpoint. The data is safe even if a parameter is stolen.

VMware [23] designed Trust Platform control to protect Virtual machines and hypervisors by reducing the number of open ESXi firewall ports, Automate ESXi host administration and allow authentication through smart cards.

VIII. CONCLUSION

Server Virtualization is a powerful virtualization component that provides higher flexibility and reliability with massive savings in power consumption, as well as eliminating servers in cloud data centres saves the capital cost of many Industries.

The Citrix Xenserver and Vmware ESXi are the top 2 market players of server virtualization. In this research theme, We used a novel technique to evaluate the performance of type-1 hypervisors. We connect Xenserver to XenCenter and ESXi to vSphere Client and assess performance. Additionally, we have successfully evaluated the performance of two hypervisors on the bases of CPU, Memory and Network using Sysbench and Netpef benchmarking tools. The experimental results show XenServer performs well in terms of CPU than ESXi as well as ESXi performs well in Memory and network as compared to Citrix XenServer.

VIII. References

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