

The Analyses of Efficiency and Performance on Cloud-Based Versus Traditional Infrastructure

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Abstract: Along with the progress of science and technology, server performance and specifications become more and more powerful. Coupled with the rise of the cloud and virtualization technology, this study would like to realize that the efficiency of server managements introduces IaaS and PaaS to replace with the traditional physical server. In this study, we adopt a single physical server to execute multiple virtual hosts to simulate the entire system of an enterprise via cloud platforms. During the implementation, this study takes advantage of VMware workstations on a Windows server 2012 to build a private cloud architecture. Subsequently, we take the advantage of cloud computing to analyze the hardware performance, energy consumption and building cost to validate the feasibility of transferring a traditional infrastructure to a cloud computing platform. Eventually, the experiment results indicate that our proposal indeed greatly improves the utilization of the server devices and hardware and also reduces the expansion of the equipment and energy consumption.

Key words: Physical server, PaaS, IaaS, cloud computing, utilization, computing, proposal

INTRODUCTION

Lately, many types of research concentrate on cloud computing. Enterprises have gradually paid attentions to cloud computing. Many companies stepwise transfer software, data and storage to the cloud platform to save the hardware equipment spending. Practically, cloud computing derives from the Internet computing approach (Mell and Grance, 2011; Rajan and Jairath, 2011). Through, this way, the computing power, software and hardware resources, various devices and data can be shared with other computers according to user's needs. Its progress derives from the centralized large-scale computer. Instead, small computers share individual resources including storage, memory, network and CPU with each other over the internet to complete the function of the centralized large-scale computer. In the evolution of the cloud computing has developed the following stages.

Distributed computing: It divides a large amount of computational work into several small jobs. By a number of computers individually calculate their responsible parts. Finally, the entire system merges the result of each part to get the final result and returns it back to the requester.

Grid computing: It is through the internet to connect heterogeneous computers to form a virtual large-scale

shared pool. Through, the integration of resources, scheduling and coordination complete the assignment of computing tasks. Grid computing focuses on the integration and management of resources that are scattered across heterogeneous systems of resources. And it usually consists of many supercomputers to work together to solve a very large amount of computing time and a huge amount of data access such as high-energy physics accelerator data analysis, gene sequencing, astronomical meteorology, mass spectrometry, etc. Users need to join the grid organization to share resources with each other.

Cluster computing: In order to improve the speed of operation and system reliability. It directly connects neighboring computers through a network to achieve redundancy and fault tolerance to support for unexpected procedures (Nishimura *et al.*, 2007). Clustering operations are usually used in homogeneous operating systems. Through the network in series with the computer's CPU enhances the overall computing power, cuts a task into smaller computational tasks and distributes them to each computer in parallel to speed up the processing of complex operations and services.

Cloud computing: Cloud computing emphasizes that many servers combine to provide a powerful computing power, rather than just a few supercomputers or a small

number of computer combinations (Gong *et al.*, 2010). Cloud is the internet and the client is the use end. We adopt the specific term cloud to describe a variety of resources on the internet. The user does not need to know where the server and the storage device are located in the cloud. Users do not need to install any software. Through a browser, users can enjoy the hardware and software of cloud.

So far, cloud computing gradually replaces the distributed computing, grid computing, cluster computing. The requirement of computing such as hardware, input and output data and application software are stored in the cloud server and storage devices (Zhang and Zhou, 2009). As long as the user requests, all operations can be performed in the cloud's huge server. Through, the browser, users can see the results of the operation. Cloud computing can be through as a new generation of network. In order to achieve our experimentation, we decided to use Windows server 2012, VMware and Hyper-V (Anonymous, 2018) to build up our cloud operating environment and entire cloud computing platform. Additionally, For the sake of verifying the cloud system is highly reliable, available, rapid deployment and other features. We exploit a physical computer to install a virtual machine to imitate the building of a fault-tolerant migration cluster to test the migration time of a transferring deployment (Nagarajan *et al.*, 2007). When a non-planned disaster occurs with the high reliability of the fault-tolerant transfer of the cluster, this system can move the processing data reliably and quickly without

shutting down the system. In other words, there will be no "Downtime" during the transfer and the process of migration does not lose packets. We also measure Amp and Watt when the physical server turns on multiple VMs with a full load of CPU and memory to realize that the energy consumption links with VMs and physical server.

MATERIALS AND METHODS

System architecture and implementation: For the sake of verifying the cloud system is scalable, highly reliable and efficient. We construct a cloud environment which is composed of a physical computer and we use the VM ware workstation to build up four "DC, iSCSI, node 1, node 2" virtual hosts and establish four "VMnet 1, 2, 3, 8" network segments to imitate the required cloud infrastructure, hardware and virtualization architectur as shown in Fig. 1. DC is esponsible for controlling the entire cloud system (Begnum, 2012) and is used to remotely integrate the virtualized resources and the various node servers of the cloud environment. ISCSI is a node server which provides the application, development, testing and other hard disk spaces. Node 1 and 2 are used to offer the network service server.

System architecture: In this study, we adopt a physical server with CPU I5 3.2 GMHz supporting 8G memory, hard disk 3.5 inch SATA 500 G and EPT which installs the Windows server 2012 64 bits version and supports for more than 4G physical memory. We install the VMware

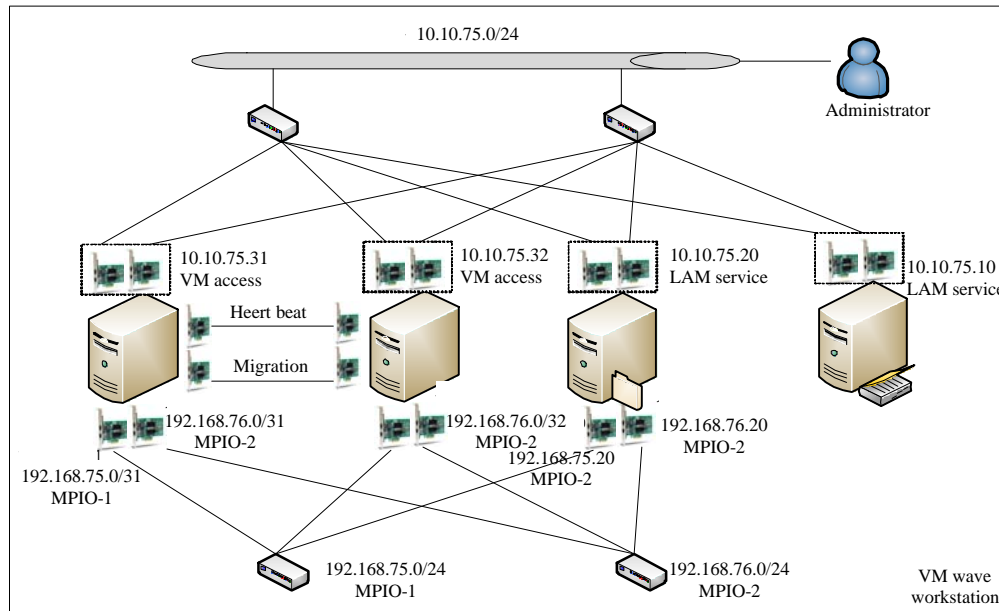


Fig. 1: Infrastructure of the cloud environment

Table 1: The server role of VM, operating system and network configuration environments

Role	OS	----No. of NIC----		IP address	Virtual network
DC	Windows server 2012 with 64 bits	2	2	10.10.75.10	VMnet 8 [NAT]
iSCSI	Windows server 2012 with 64 bits	4	2	10.10.75.20	VMnet 8 [NAT]
			1	192.168.75.20	VMnet 2
			1	192.168.76.20	VMnet 3
Hyper-V cluster				10.10.75.30	
Node 1	Windows Server 2012 with 64 bits	6	2	10.10.75.31	VMnet 8 [NAT]
			2	172.20.75.31	VMnet 1
			1	192.168.75.31	VMnet 2
			1	192.168.76.31	VMnet 3
Node 2	Windows Server 2012 with 64 bits	6	2	10.10.75.32	VMnet 8 [NAT]
			2	172.20.75.32	VMnet 1
			1	192.168.75.32	VMnet 2
			1	192.168.76.32	VMnet 3

workstation on the Windows server 2012 in the physical server which acts as the “First layer” of the “Host” hypervisor role. Then, we set up a virtual host with Windows server 2012 on the VMware workstation as the “Guest” hypervisor role which is the “Second layer”. Through the VMware workstation with VHV (Virtual Hardware-assisted Virtualization) functions, we exploit the Hyper-V virtualization technology that the Windows server 2012 has functions. This study uses Hyper-V to create VM virtual hosts named guest OS as the “Third layer” to carry out the entire cloud environment. The environmental architecture is as shown in Fig. 1. The server role, operating system, IP and virtual network and other configurations are as shown in Table 1.

In terms of the above architecture, we build up the entire system via the next steps as shown in Fig. 2. The constructing phases are split into three portions and there are constructing the physical infrastructure, initializing configurations and preparation of the failover transfer. The particular procedures are as the following.

The implementation step of system: This study is divided into three stages to build up the entire system.

The implementation environment and the initial set: In the physical machine, this stage installs a Windows server 2102, 64 bits version and uses a VM workstation to build up four “DC, iSCSI, node 1 and 2” virtual hosts. Additionally, in the virtual host, we install Windows server 2102 64 bits operating system, establish four “VMnet 1-3 and VMnet 8” network segments, build up AD (Active Directory) service and configure host network environments to simulate the entire cloud platform.

The establishment of a fault-tolerant transfer cluster pre-operation: This study centrally manages iSCSI, node 1 and 2 virtual hosts through the DC host add the Hyper-V role in node 1 and 2 add

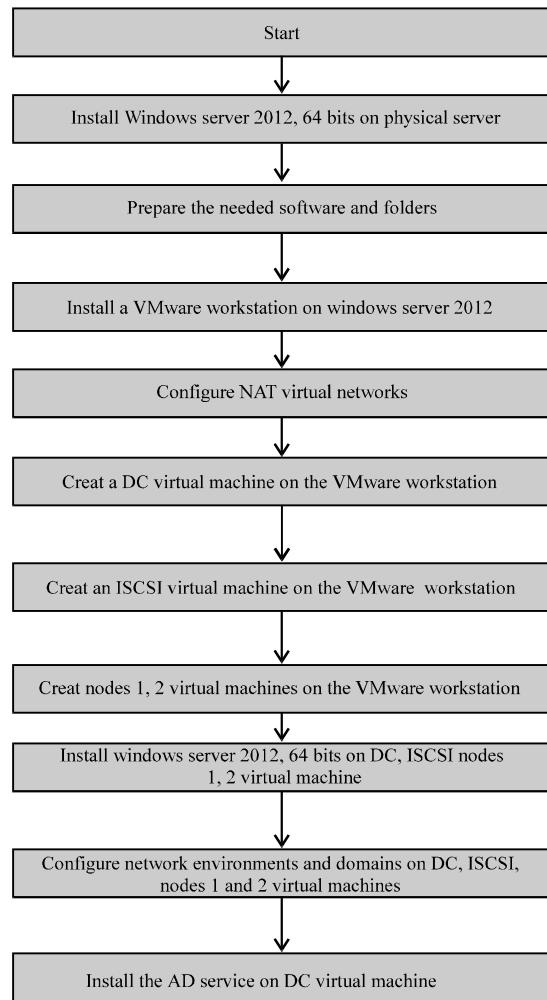


Fig. 2: Process for the initial system implementation

iSCSI as the object server; install the multipath I/O functions add MPIO devices and mount disk resources.

Building the fault-tolerant transfer cluster operating environment: This phase installs functions of the fault-tolerant transfer clusters in node 1, 2 virtual hosts

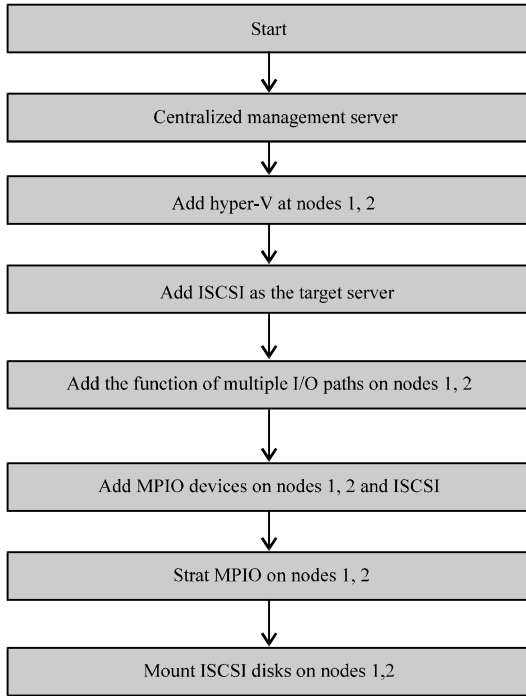


Fig. 3: Process of constructing the failover configuration

installs a management tool of the fault-tolerant transfer on the DC host performs the cluster validation settings and creates the fault-tolerant migration clusters and high availability VM hosts. The detailed implementation of each stage is described in Fig. 3-4, respectively.

System test: After three phases, we build up the fault-tolerant transfer cluster for the operating environment. After the construction of the entire system and establishment of the high availability VMs. This study implements several scenarios to test and verify that the system and the network are properly interoperable and operational. When the DC host manages the node 1 host and adds a VM host. During the installation of a Windows server 2012 in VM, we switch to the iSCSI, node 1 and 2 host's task management to inspect the MPIO1 and MPIO2 network traffic on the iSCSI host and MPIO1 and MPIO2 network traffic on the node 2 host. Through this way, this study examines whether the load balance (Miyamoto *et al.*, 2010; Altman *et al.*, 2011) function automatically evens the network traffic. Simultaneously, we execute the connection test from the DC host pinging the VM virtual host to verify the delay time.

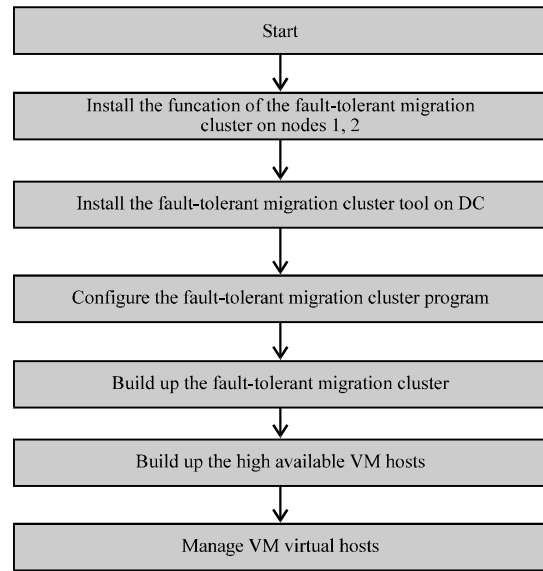


Fig. 4: Process of constructing the failover cluster transfer

RESULTS AND DISCUSSION

System efficiency and performance: This study compares the performance of traditional servers with the cloud platform. We build up the traditional infrastructure and cloud infrastructure on the same specification computer. In the cloud platform, we install virtual machines on the physical server to simulate the cloud environment of an enterprise. Compared to the rack server used in the enterprise, its CPU, memory, storage space, efficiency (Deelman *et al.*, 2008; Pike *et al.*, 2005) have some differences. Therefore, this study only discusses the efficiency and benefits of implementing applications on the cloud platform and the feasible study (Ostermann *et al.*, 2009). If enterprises apply our proposed infrastructure to the rack server, it will be able to enhance the operation, deployment, speed and performance, since, the hardware is faster and more stable than personal computers.

This study is divided into two comparisons of a traditional server and a cloud platform with the same specification computer as shown in Table 2. We analyze the energy saving, resource utilization, deployment, high reliability and performance analyses.

Energy saving analyses: In the actual test, when we start several virtual hosts on the Server 1 under the condition of the memory and full load CPU, we use the SPG-26MS power monitor to survey the power consumption and the energy loss.

Table 2: Server specifications of cloud-based vs. traditional infrastructures

Variables	Server 1 (cloud-based)	Server 2 (Traditional)
Brand	Acer M2611 G	Acer M2611 G
CPU	Intel I5-3470 3.2 GHz	Intel I5-3470 3.2 GHz
Memory	DDR3 1600 8 G	DDR3 1600 8 G
Storage	Seagate SATA 500 G	WD SATA 500 G
Power	250 W	250 W

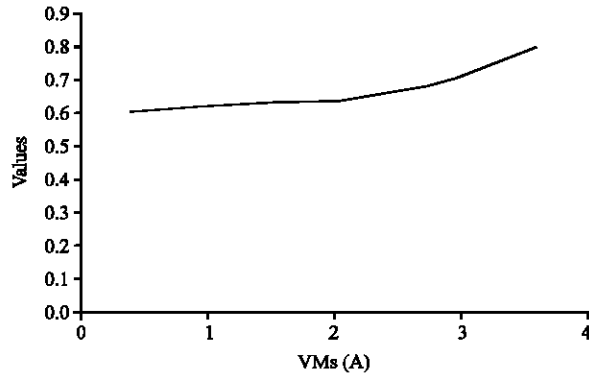


Fig. 5: The consumption of Amp on the amount of VMs from 0-4 of server 1

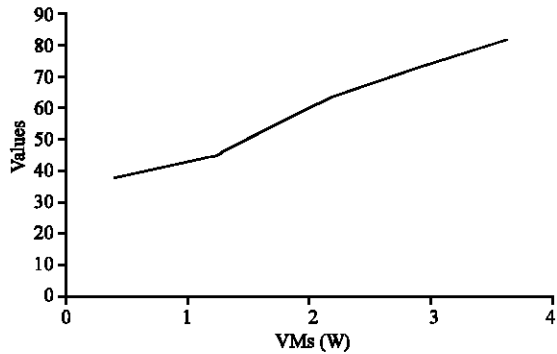


Fig. 6: The consumption of Amp on the amount of Watt from 0-4 of server 1

This study measures the consumption of Watt, AMP, CPU and memory on the cloud-based server1 from 0-4 VMs. The variation is as shown in Table 3 and the measurement results are shown in Fig. 5 and 6. Additionally, we prepare the same environment without virtualization on the server 2 and also measure the consumption of Amp, Watt, CPU and memory from 1-4 PCs. The variation is as shown in Table 4 and the measurement results are shown in Fig. 7 and 8.

Analyses of the resource utilization: In this study, we use a physical PC (server 1) to perform virtual machines which are 4 (DC, iSCSI, node 1 and 2) virtual hosts. If we switch to a physical rack server, the average number of virtual machines that can be executed is about 2-8 times, which depends on the hardware specification and the usage of the service resource. This study analyzes the

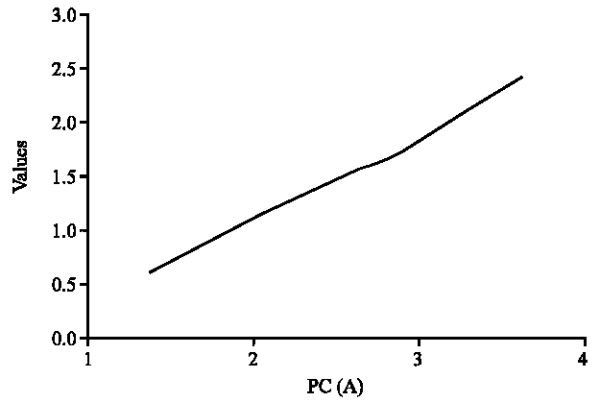


Fig. 7: The consumption of Amp on the amount of the physical server from 1-4

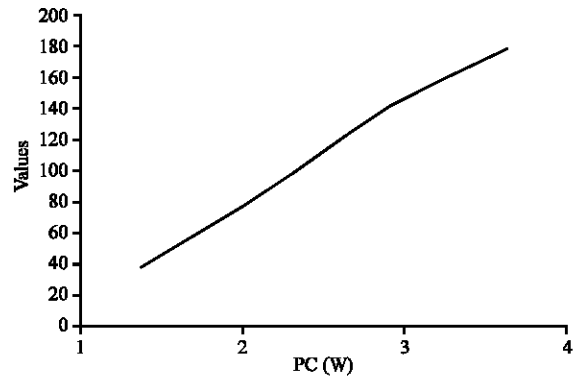


Fig. 8: The consumption of Watt on the amount of the physical server from 1-4

standby and full load status of the server 1 when it turns on from 0-4 VMs. In this study, we turn on VMs in order and measure the usage of memory and CPU on the scenery of standby and full load status when we start the number of VMs from 0-4. We record and sort out the usage of resources as shown in Table 4.

Quick deployment service analyses: On the cloud-based server1, the implementation of this study would like to build up a fault-tolerant migration cluster (failover cluster). When a Hyper-V host or virtual host needs to be moved to another device, we can use the real-time transfer function of the fault-tolerant migration clusters (live migration) and the fault-tolerant management tool on DC to remotely migrate Hyper-V host on node 1 and 2 in time. This implementation migrates the Hyper-V host in node 1 and 2 and verifies the time consumption of transferring the deployment.

Quick deployment service testing: During the implementation phase of the fault-tolerant migration

Table 3: The comparison of Watt, Amp and memory utilization on the amount of VMs from 0-4 on the cloud-based computers

The amount of VMs	Watt	Amp	CPU utilization with full load of VM	Memory utilization with full load of VM
0 VM	38	0.61	0	0
1 VM (DC)	48	0.64	23% 2.66 GHZ	2.5/8.0(31%)
2 VMs (DC, iSCSI)	63	0.65	56% 3.49 GHZ	4.1/8.0(51%)
3 VMs (DC, iSCSI, node 1)	73	0.70	80% 3.43 GHZ	6.2/8.0(78%)
4 VMs (DC, iSCSI, node 1 and 2)	84	0.80	100% 3.43 GHZ	7.8/8.0(98%)

Table 4: The comparison of Watt, Amp and memory utilization on the amount of VMs from 0-4 on the cloud-based server

The number of VM	CPU utilization/standby	Mem utilization/standby	CPU utilization/full load	Mem utilization/full load
0 VM	1% 1.54 GHZ	1.1/8.0 GB (14%)	-	-
1VM (DC)	1% 1.54 GHZ	2.2/8.0 GB (28%)	28% 1.76 GHZ	2.6/8.0(33%)
2VMs (DC, iSCSI)	1% 1.54 GHZ	3.1/8.0 GB (39%)	53% 1.76 GHZ	4.0/8.0(50%)
3VMs (DC, iSCSI, node 1)	1% 1.54 GHZ	5.1/8.0 GB (64%)	75% 3.36 GHZ	5.9/8.0(74%)
4VMs (DC, iSCSI, node1and 2)	2% 1.54 GHZ	6.4/8.0 GB (80%)	100% 3.36 GHZ	7.5/8.0(94%)

cluster, this study sets up the mechanism of “Multi-path I/O, MIPO” to achieve the load balancing and fault-tolerant migration. Thus, we can speed up the deployment of VM. This experiment migrates virtual the host in node 1 and 2, the completion time within 14 sec. Besides, the Hyper-V host in node 2 automatically turns on within 20 sec. The total completion time of the fault-tolerant transfer is 34 sec. During the migration operation from node 1 and 2, this process only loses 5 packets because the Hyper-V needs to restart the virtual host after the completion of the migration.

High-reliability analyses: During the migration process of server 1, we perform a high-reliability experiment and adopt the live storage migration feature in a fault-tolerant transfer cluster. We simulate the situation of non-planned disaster happening. And this experiment deals with the migration of being processed data via high-reliability of the fault-tolerant transfer cluster without stopping the running service. In another word, there is no need to shut down the server. That is during a process of dealing with a data migration when a disaster occurs. We need to switch the service to another node or move data to another hard disk. During the process of switching that can lose any packet. Namely, the system must achieve that the service is not interrupted and the data is not lost. If the switch action is wrong, this operation will keep using the original storage and abandon the data of the destination storage. The experiment steps are as follows.

Instantaneous data transfer and high-reliability analyses:

Step1: Set up a Hyper-V host environment: Turn on the Hyper-V host VM on node 1→open the command mod→ cd\→mkdir test→cd test→for /l %i in (1,1,10000) do futil file create new %i 1024 (in waiting mode). The main purpose of this step is to create 10000 small files.

Step 2: DC host performs a live migration: DC host performs the server management tool→ tool→fault-tolerant migration cluster administrator→role→move→virtual machine storage location→choose all virtual machines,

then press copy→ press paste on volume 2. When you are performing a virtual host storage transfer, return to the Hyper-V host VM on node 1, perform for /l %i in (1, 1, 10000) do futil file create new %i 1024.

This implementation takes 7 min and 32 sec to complete an entire virtual host storage migration. In order to ensure the integrity of the information, we enter the folder C:\test of Hyper-V host VM on node 1 to verify if there are 1-10000 1 k data files created during the migration process.

This study simulates the performed services and verify whether the transferred data will be interrupted and the integrity of the test data during the migration process. After the migration is complete, we can find that the DC host pings the packets of the Hyper-V host VM during the migration process. There is no packet loss. At most, the response time becomes longer (up to 22 msec). The integrity of the test data is also complete and correct. This is almost no pause and error during the migration of the storage device.

Analyses on the resources utilization: On the experimental environments, we use a desktop to execute 4 virtual hosts (node 1 and 2, DC, iSCSI). When we change a desktop into a rack server that can execute at max 8 virtual hosts. However, it is according to the amount of running processes and the specification of hardware. Subsequently, we survey the CPU utilization on the scenery of full load and standby situations from 0-4 virtual hosts.

For the sake of realizing the utilization of various conditions, we evaluate a different amount of virtual machines from 0-4. This study surveys the memory and CPU utilization on the condition of full load and standby. After experimenting and recording the utilization of resources, we depict the experimental results as shown in Fig. 9-12.

While we initiate the virtual machine, then raise the amount of virtual machines from 0-4. And then, this study evaluates the memory and CPU utilizations on the condition of full load and standby, respectively and writes

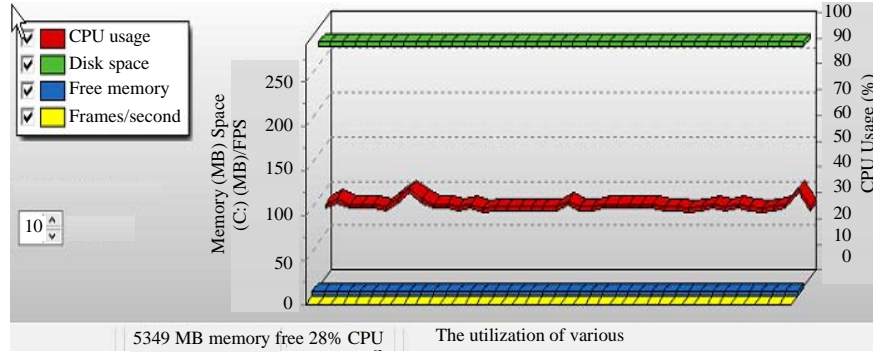


Fig. 9: The utilization of CPU and memory under full load and standby with 1 virtual host

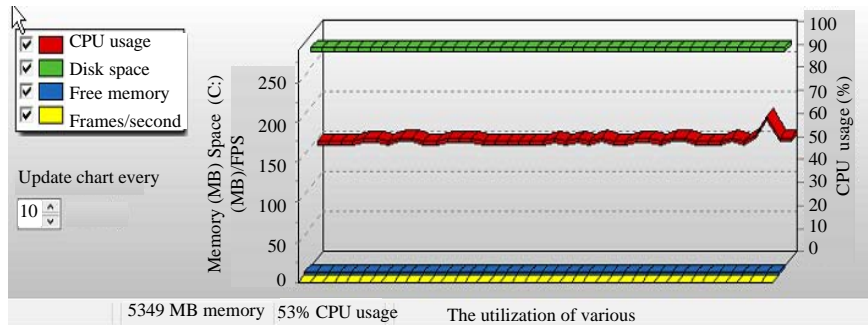


Fig. 10: The utilization of CPU and memory under full load and standby with 1 virtual host

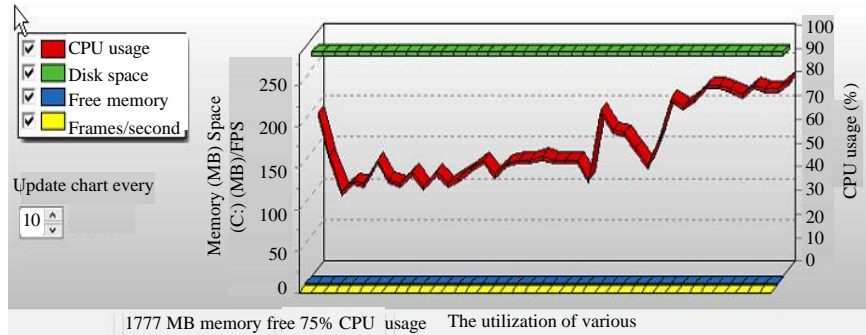


Fig. 11: The utilization of CPU and memory under full load and standby with 1 virtual host

down the resource utilization. Table 5 indicates the comparison of resource utilizations under the full load and standby situations from 0-4 VMs

The comparison of cloud-based infrastructures and traditional architectures: In this study, we would like to compare the cloud-based infrastructures with traditional architectures on the energy saving, fault tolerance, deployment and system stability. The detailed descriptions are as follows.

Supporting various operating systems and software: On the traditional architectures, one server provides one Operating System (OS). If users want to expand services on different OS, they need to buy another servers to implement the different OS. However, through the cloud-based infrastructure users implement various operating systems on the same hardware via the virtualization technology. Thus, enterprises and users reduce the implementing costs and also reduce the maintenance costs. Besides, the administrator does not

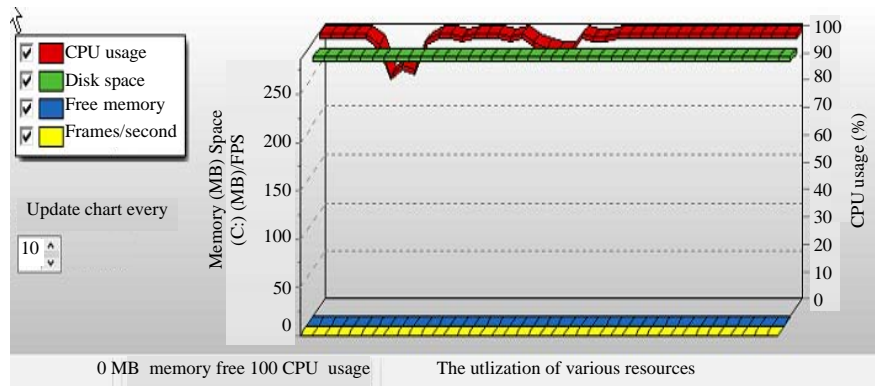


Fig. 12: The utilization of CPU and memory under full load and standby with 4 virtual host

Table 5: The comparison of utilization at full load and standby situations from 0-4 VMs

The amount of VM	CPU utilization under standby	Mem utilization under standby	CPU utilization under full load	Mem utilization under full load
0 VM	1% 1.54 GHZ	1.1/8.0 GB (14%)	-	-
1 VM (DC)	1% 1.54 GHZ	2.2/8.0 GB (28%)	28% 1.76 GHZ	2.6/8.0 (33%)
2 VMs (DC, iSCSI)	1% 1.54 GHZ	3.1/8.0 GB (39%)	53% 1.76 GHZ	4.0/8.0 (50%)
3 VMs (DC, iSCSI, node 1)	1% 1.54 GHZ	5.1/8.0 GB (64%)	75% 3.36 GHZ	5.9/8.0 (74%)
4 VMs (DC, iSCSI, node 1 and 2)	2% 1.54 GHZ	6.4/8.0 GB (80%)	100% 3.36 GHZ	7.5/8.0 (94%)

need to purchase and install diverse software, since the software is embedded on the cloud platform. Users access the cloud service through a browser, desktop application or mobile App. Administrators believe that the cloud-based infrastructure enables enterprises to deploy applications more quickly and reduce the complex management and maintenance costs and allow rapid redistribution of IT resources to respond quickly to business needs.

Accelerate the system deployment: The cloud-based infrastructure allows users to construct virtual hosts on demand and installs diverse applications. In other words, the user can specify the required host with resources, including the CPU, memory, hard drive capacity and then in accordance with the use of time to pay and can be created or terminated at any time, this can quickly on-line off the service. When enterprises expand more services, the amount of servers will be a dozen to hundreds. Without a cloud architecture, administrators install the operating system, drivers and applications. The entire process takes at minimum 90 min and merely can be executed on the devoted servers. However, on the cloud-based architecture, we use the DC server to remotely construct and manage all servers regardless of when you add a new VM, switch into a VM, add a new node or mount a new hard disk.

In addition, we transmit a VM image file that only takes 34 sec without the hardware compatible problem. The established virtual machine image can be adopted at any

physical server which has VMware workstations or Hyper-V environments. Consequently, IT staffs decrease the time of building the entire system, migrating and managing the system. IT staffs no more need to configure the server environment for various machines due to the different hardware. They merely need a computer to manage all virtual machines and elastically decrease the operations and workload.

System fault tolerance and fast migration: When the virtual machine in the primary server does not work because of a disaster, the virtual machine of the replica server will take over the primary server to continue providing the service and duplicate the data back to the primary server. This study considers the reliability of a storage migration online. Therefore, we successively generate network packets to evaluate the failover operations. While the system breaks down, the running virtual host must be switched to a spare node or a spare disk. This study surveys that the switching progress does not miss network packets. If the switching procedure faults, the system adopts the original storage data instead of the newer data. This process of implementation entirely takes 7 min and 32 sec. Taking the data integration into account, this study validates the amount of 10000 slight files if they are missed in the folder C:\test on the Hyper-V host VM of node1. The experimental results do not miss delivering packets and only raise the response time at max 22 msec. Users feel no pauses and errors during the data migration.

High stability and reliability: On the traditional server architecture, if the hardware or software faults, the system administrator has to switch the computer on a new machine and restore the backup data that leads to the system offline and time consuming. Enterprises cannot allow the system to be shut down. On the cloud-based architecture, the administrator transfer all computer systems into new machines without shutdown or offline. Hyper-V provides a stable and reliable function to tolerate a disaster. Our experimental results demonstrate that when the original system is restored or migrated into a new machine, the transferring data are never missed. In addition, the repeatedly pinging packets still keep going without disturbance. This study indicates that the cloud-based architecture has a high stability, since, the enterprise needs none stop services. Therefore, the high stability, reliability and online migration are practical in the cloud-based architecture.

Green energy saving: For example, in a general system with a 30% loading, it costs about \$ 2,300/kW/year. If the system is properly decreased and maximized the resource performance, the costs can be reduced to about \$ 1,440/kW/year, saving 38% of the cost of electricity. Our experimental results indicate that the traditional architecture uses 180 W and the cloud-based architecture only uses 40~85 W. It nearly economizes 50% of the energy consumption. In addition, we comprehend that when the physical computer is on standby and the amount of VM raises from 1-4 VMs, the utilization of CPU is only 1~2%. The amount of VMs nearly does not affect the utilization of CPU, although the utilization of memory reaches to 14~80%, because the virtual hosts use the same physical memory. In addition, under the standby situation, the individual VM's utilizations of memory and CPU are 1~2%. On the condition of full load, utilizations of CPU and memory raise 25~100%. Since, each VM allocates its own virtual memory, therefore, even each VM exhausts 100% virtual memory that does not affect the physical memory. From the above experimental results, through virtualization technology, enterprises enhance the utilization of computing resources and decrease the purchase of physical computers.

CONCLUSION

In this study, we evaluate the benefit of bringing the cloud-based architecture into the enterprise. However, most enterprises are unwilling to implement the cloud architecture, since, the enterprise consider reliability and security issues. Even though the enterprise owns a perfect backup plan when man-made mistakes, natural disasters or unavoidable factors occur, it cannot guarantee the security of the entire system. Moreover, the

ethics of IT staffs are another issues. For example, an IT staff invades the system and discloses private information to malicious attackers, it will raise the risk of revealing the confidential information of clients. Hence, we advise that enterprises can bring a private cloud architecture into the enterprise first. Thus, enterprises have the advantage of cloud computing and can simplify the management of the entire system. For instance, the BENQ Inc. takes the place of original servers with virtual machines and one physical server provides more than one operating system. Therefore, BENQ withdraws more physical machines to be the spare parts. At the same time, the virtual machines reduce the energy consumption. Besides, the image files are easy to be generated and deployed and thus, administrators can decrease the burden of management. BENQ builds up many applications and systems based on cloud infrastructures. For example, the ERP flow provides a management interface and a web entrance including the flow control, application forms and organization managements. In this company, there is only one thing that needs that is the browser. Users do not need to install any additional applications.

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