ISSN 2186-5647

2-83

Efficiency Analysis of Cloud-Based Enterprise Information Application Systems

China University of Technology ○Hua Yi LIN
China University of Technology Jiann Gwo DOONG

1. Introduction

Recently, cloud computing becomes a hot topic. In the future, software services, data analysis, online games, audio and video transmission will be performed on the cloud. This study concentrates on introducing IaaS (infrastructure as a service) cloud computing infrastructure into the physical server for an enterprise. We build several virtual machines to simulate the system architecture on a high computing power server. The virtual machine is implemented on windows server 2012, and we exploit Hyper-V to construct the network, storage, and computing resources. Then this study analyses the energy consumption, hardware efficiency, and implementation costs to verify that the cloud architecture significantly improve the efficiency of traditional server equipment.

Keyword: cloud computing, IaaS, Virtual Machine, Hyper-V, server management

2. System architecture and implementation

In order to verify the cloud system is flexible, highly reliable, and efficient. This study uses a single physical computer via constructing VMware workstations to simulate the proposed cloud system. The following is our entire hardware and software infrastructure.

Hardware infrastructure:

This study adopts a physical computer to simulate the cloud computing environment, including four virtual machines, and there are servers DC, iSCSI, Node1 and Node2, via VMware workstation. In additional, this study constructs four network segments, and there are VMnet1、VMnet2、VMnet3、VMnet8, to simulate the networking environments, as shown in figure 1.

DC server plays the role of controller in the entire cloud computing system. It is responsible for remotely controlling the virtual resources and virtual nodes. iSCSI server provides applications, development tools, testing bed and storage spaces. Node1 and node2 provide network server services.

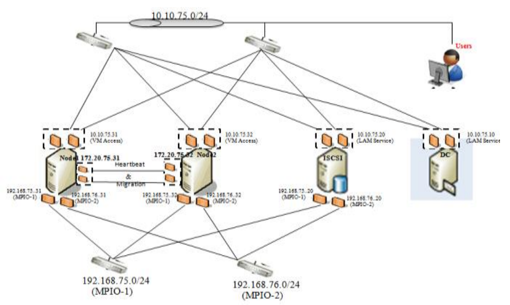

Fig. 1 Infrastructure of the proposed system

According to the above infrastructure, this study constructs the physical system using the following steps, as shown in Fig. 2. The implementation steps are divided into three parts, and there are building physical environment, initial configuration, and pre-operation of failover transfer. The detailed procedures are as follows.

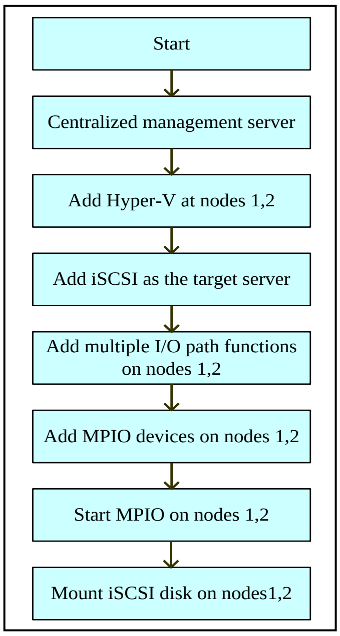

Fig. 2 Procedures of the system implementation

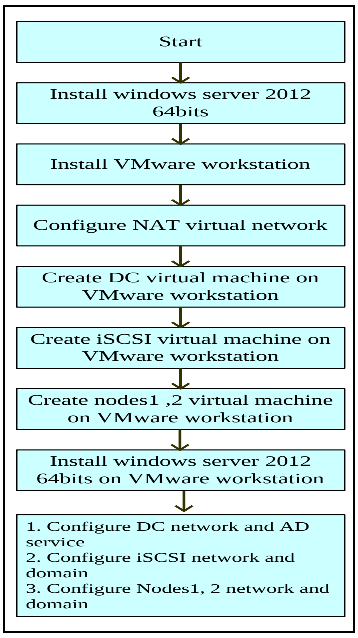

Fig. 3 Procedures of the building failover configuration

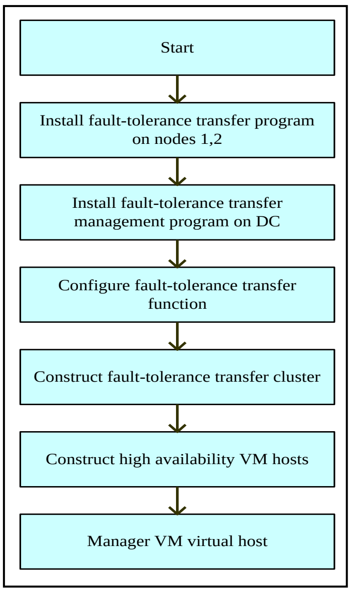

Fig. 4 Operations of building failover cluster transfer

Fig.5 MPIO1 network traffic on iSCSI server

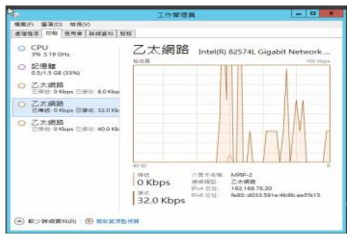

Fig.6 MPIO2 network traffic on iSCSI server

This study adopts a server with CPU I5, 3.2Ghz supporting EPT, 8G memory, hard disk SATA 500G, working on a Windows server 2012 64bit. Additionally, this study installs a VMware workstation to be the first layer for host Hypervisor, and then we create Windows server 2012 on the VMware workstation to be the second layer. Subsequently, this study exploits Hyper-V (default function on Windows server 2012) to create guest OS to be the third layer. Then, this study estimates several measure of performance on the guest OS. The detailed environment is as shown in table 1.

Table 1 Working environment

Role	OS	Number of NIC		IP address	Virtual network
DC	Windows Server 2012 64Bit	2	2	10.10.75.10	VMnet8「NAT」
iSCSI	Windows Server 2012 64Bit	4	2	10.10.75.20	VMnet8「NAT」
			1	192.168.75.20	VMnet2
			1	192.168.76.20	VMnet3
Hyper-V Cluster				10.10.75.30	
Node1	Windows Server 2012 64Bit	6	2	10.10.75.31	VMnet8「NAT」
			2	172.20.75.31	VMnet1
			1	192.168.75.31	VMnet2
			1	192.168.76.31	VMnet3
Node2	Windows Server 2012 64Bit	6	2	10.10.75.32	VMnet8「NAT」
			2	172.20.75.32	VMnet1
			1	192.168.75.32	VMnet2
			1	192.168.76.32	VMnet3

After the implementation, this study performs several testing to verify the system stability and network connection. Initially, DC server managers Node1 and adds VM on it, and then installs windows server 2012 on the VM. During the procedure, this study switches to server iSCSI, Node1 and Node2 to observe the network balance performance on the multiple paths IO, MPIO1 and MPIO2, as shown in Figs. 5-8

Fig.7 MPIO1 network traffic on Node1 and Node2

Fig.8 MPIO2 network traffic on Node1 and Node2

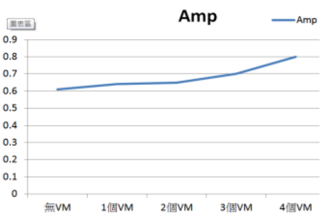

Fig. 9 the Amp consumption on the number of VMs from 0 to 4

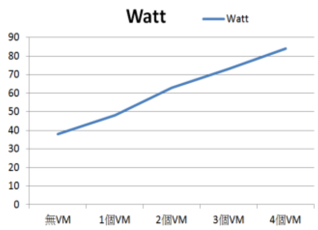

Fig.10 the Watt consumption on the number of VMs from 0 to 4

3. Performance evaluation 7

Analysis on energy conservation

When the virtual machines are running under full load of CPU and memory, this study uses SPG-26MS to monitor and measure the consuming of Amp and Watt. Subsequently, we analyses the energy consumption of virtual machines that running on the physical machine, as shown in Figs.9-10. Tables 2 and 3 present the detailed statistics. Figs. 11-12 depict the Amp and Watt consumption on physical machine.

Table 2. The comparison of Amp, Watt and memory utilization on the number of real machines from 0 to 4 [No VM]

The number of computer	Amp	Watt	CPU utilization /Full load	Memory utilization /Full load
1 PC(DC)	0.56	38	100% 3.43GHZ	7.8/8.0(98%)
2 PC (DC,iSCSI)	1.13	86	100% 3.43GHZ	7.8/8.0(98%)
3 PC (DC,iSCSI,Node1)	1.73	138	100% 3.43GHZ	7.8/8.0(98%)
4 PC (DC,iSCSI,Node1,Node2)	2.31	178	100% 3.43GHZ	7.8/8.0(98%)

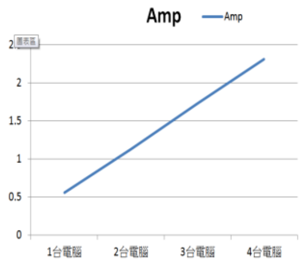

Fig. 11 the Amp consumption on the number of the physical computer from 0 to 4

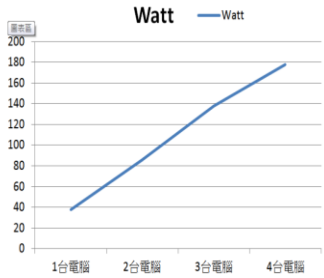

Fig. 12 the Watt consumption on the number of the physical computer from 0 to 4

Table 3. The comparison of Amp, Watt and memory utilization on the number of VMs from 0 to 4 [With VM]

The number of VMs	Amp	Watt	CPU utilization /Full load of VM	Memory utilization / Full load of VM
0 VM	0.61	38	0	0
1 VM (DC)	0.64	48	23% 2.66GHZ	2.5/8.0(31%)
2 VMs (DC,iSCSI)	0.65	63	56% 3.49GHZ	4.1/8.0(51%)
3 VMs (DC,iSCSI,Node1)	0.7	73	80% 3.43GHZ	6.2/8.0(78%)
4 VMs (DC,iSCSI,Node1,Node2)	0.8	84	100% 3.43GHZ	7.8/8.0(98%)

Analysis on resources utilization

In real environment, this study adopts a physical computer to perform 4 virtual machines (DC, iSCSI, Node1, Node2). If we transfer a desktop computer to a rack server that can perform at max 8 virtual machines. However, it depends on the specification of physical computers and running applications. Then, this study analyses the CPU utilization under standby and full load condition from 0 to 4 virtual machines.

In order to realize the utilization under different situations, this study estimates different number of virtual machines from 0 to 4. Here, the CPU and memory utilization is under standby and full load condition. After testing and capturing the utilization of resources, this study depicts the results as shown in Figs. 13-26.

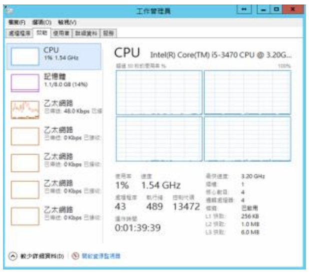

Fig. 13 CPU utilizations under standby without virtual machine

Fig. 14 Memory utilizations under standby without virtual machine

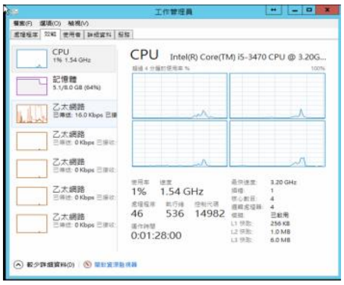

Fig. 21 CPU utilizations under standby with three virtual machines

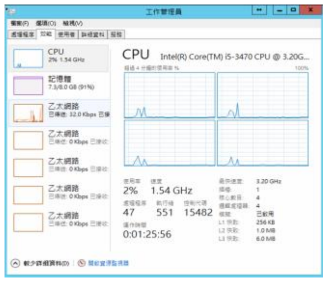

Fig. 22 Memory utilizations under standby with three virtual machines

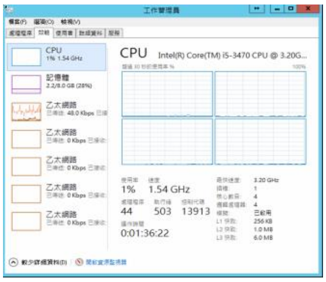

Fig. 15 CPU utilizations under standby with one virtual machine

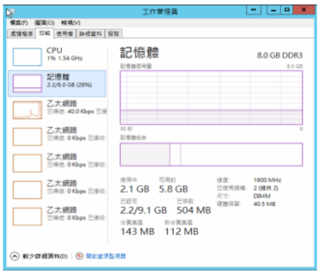

Fig. 16 Memory utilizations under standby with one virtual machine

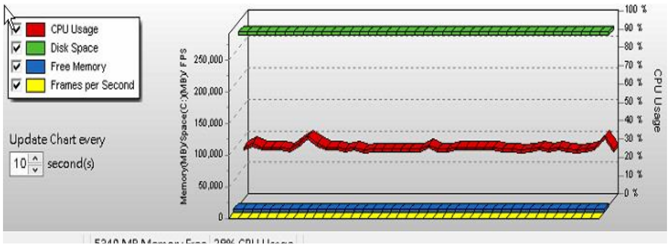

Fig. 17 CPU and memory utilizations are under standby and full load condition with one virtual machine

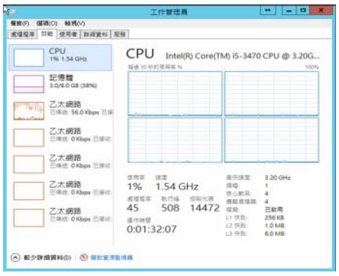

Fig. 18 CPU utilizations under standby with two virtual machines

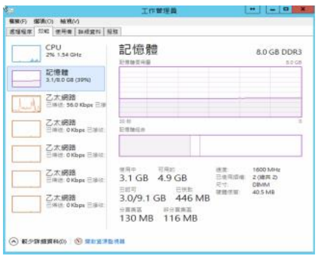

Fig. 19 Memory utilizations under standby with two virtual machines

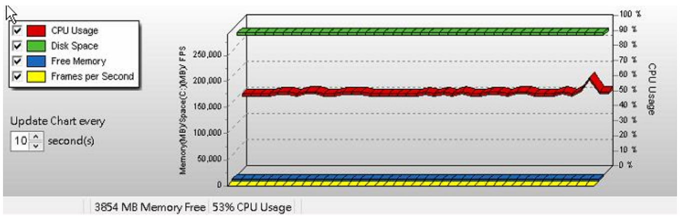

Fig. 20 CPU and memory utilizations are under standby and full load condition with two virtual machines

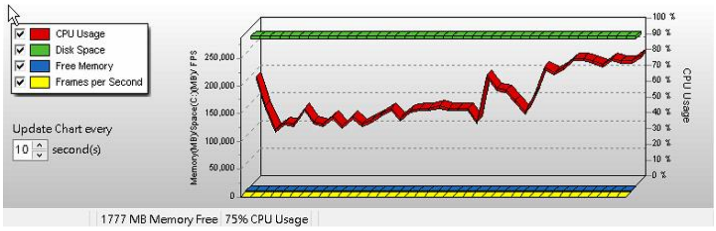

Fig. 23 CPU and memory utilizations are under standby and full load condition with three virtual machines

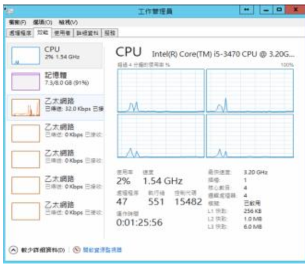

Fig. 24 CPU utilizations under standby with four virtual machines

Fig. 25 Memory utilizations under standby with four virtual machines

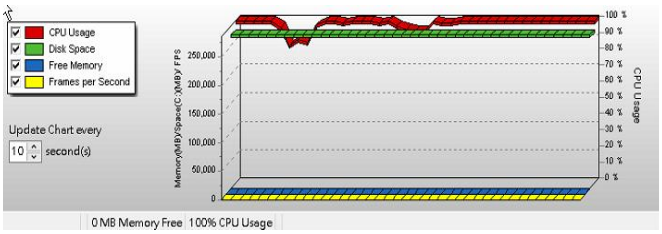

Fig. 26 CPU and memory utilizations are under standby and full load condition with four virtual machines

This study starts the virtual machine, and increases the number of virtual machines from 0 to 4. Subsequently, we estimate the CPU and memory utilizations are under standby and full load condition respectively, and record the resource utilization. Table 3 describes the comparison of utilizations at standby and full load conditions from 0 to 4 VMs

Tab. 3 The comparison of utilization at standby and full load conditions from 0 to 4 VMs

The number of VM	CPU utilization /standby	CPU utilization /full load	Mem utilization /standby	Mem utilization /full load
0 VM	1% 1.54GHZ	-	1.1/8.0GB (14%)	-
1VM (DC)	1% 1.54GHZ	28%11.76GHZ	2.2/8.0GB (28%)	2.6/8.0(33%)
2VMs (DC,iSCSI)	1% 1.54GHZ	53% 1.76GHZ	3.1/8.0GB (39%)	4.0/8.0(50%)
3VMs (DC,iSCSI, Node1)	1% 1.54GHZ	75% 3.36GHZ	5.1/8.0GB (64%)	5.9/8.0(74%)
4VMs (DC,iSCSI,Node1,Node2)	2% 1.54GHZ	100%3.36GHZ	6.4/8.0GB (80%)	7.5/8.0(94%)

service switches to the backup node or disk, and this study observes that the switching procedure does not loss packets. In case, the switching process fails, and the system will use the original storage and abandon the newer data.

This experiment costs 7 minutes and 32 seconds. Considering the data integration, this study verifies the number of 10000 small files whether they are lost at the folder C:\test on Node1's Hyper-V host VM. The simulations results indicates that the sending packets do not lost and only stretch the response time at max 22ms. Users do not fell the pause and error at data transmissions.

Energy Conservation

With more and more expensive electricity, since enterprises increase their servers gradually, thus enterprises need to reduce the power consumption on devices, and otherwise it will increase the cost. The analysis results demonstrate that the general infrastructure consumes 178 Watts, and the cloud infrastructure only consumes 38~84 Watts. From the above results, the cloud infrastructure almost saves 50% of energy consumption. Additionally, this study realizes when the physical computer is in standby and the number of VM increases from one to four VMs. The CPU usage is only 1%~2%. The number of VMs almost does not influence the CPU utilization. However, the memory utilization is up to 14%~80%, since the virtual machines share the physical memory. But the individual VM under standby condition, each VM's CPU and memory utilizations are 1%~2%. Under full load condition, CPU and memory utilizations increase 25%-100% as the number of VM raises. Since the physical memory is allocated to each VM, therefore even each VM performs at 100% of virtual memory utilization that does not influence the physical memory. From the above results, after virtualization, enterprise can improve the resource utilization and reduce the purchase of physical devices. Additionally, cloud infrastructure also achieves to maximize the resource efficiency, and reduces the waste of idle equipments.

Fast deployment

In enterprises, the number of servers are a dozen to hundreds, when more servers to provide more services, it brings complicated managements. Under none cloud infrastructure, this study installs the OS, driver, and application. It costs at minimum 100 minutes, and only can be performed at the dedicated physical machine. However, in cloud infrastructure, we can exploit DC server to manage and construct all servers no matter when you add a new node, mount a hard disk, add a new VM, or transfer VM. The cloud management provides a convenient interface.

Additionally, in cloud infrastructure, this study transfers a VM image file that only needs 34 seconds, and has no problem of hardware compatibility. The created virtual machine can be used at any physical machine with VMware work station or Hyper-V. Therefore, IT staff saves the time of building the system, migration and management. They do not need to switch and configure different servers. Only one computer can manage all of the servers and flexibly reduce the operations and workload.

High reliability

Enterprise always depends on the computer system. In case, the computer crashes that seriously influences the entire company operations. In traditional server infrastructure, if the hardware or software breaks down, administrator has to transfer the computer into a new machine that causes the system offline. In cloud infrastructure, administrator can transfer all systems into new machines without offline or shutdown. From the above results, this study indicates when the system is migrated or restored into a new machine; the processing (10000 files with 1K bytes) data are never lost. Additionally, the continually pinging packets are still running without interruption. The simulation results demonstrate that the cloud infrastructure has a high reliability, since the enterprise needs 24 hours none stop services. Therefore the high reliability and online migration are feasible in cloud infrastructure.

4. Conclusions and future work

This study analyses the advantage of introducing cloud computing into enterprise. However, most of enterprises are not willing to construct the cloud infrastructure, because the security and reliability issues. Even the enterprise has complete backup solution, if man-made, natural disasters or unavoidable factors occur, it cannot ensure the security of the entire system. In additional, the professional ethics of IT members are another issue. In case, IT member hacks into the system and reveals personal private data to malicious hacks, it will cause the risk of the client's confidential information leakage. Therefore, this study suggests that enterprise can introduce private cloud infrastructure first. Thus, enterprise own the convenience of cloud computing and easily manage the entire enterprise data. For example of BENQ Inc., it replaces the original system with virtual machines, and thus one physical machine provides more than one OS services. In addition, it vacates more physical servers to be spare parts. Also the energy consumption reduces. Since the image files are simple to be created and deployed, thus can reduce the burden of administrators. BENQ Inc. develops many applications based on cloud, such as ERP flow that providing web interface and management interface including application form, flow control and organization management. Users do not need to install any extra applications, and just needs a browser.

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