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Enhance the Performance of Virtual Machines by Using Cluster Computing Architecture

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Abstract

Virtualization is a very important technology in the IaaS of the cloud computing. User uses computing resource as a virtual machine (VM) provided from the system provider. The VM's performance is depended on physical machine. A VM should be deployed all required resources when it is created. If there is no more resource could be deployed, the VM should be move to another physical machine for getting higher performance by using VM's live migration. The overhead of a VM's live migration is 30 to 90 seconds. If there are many virtual machines which need live migration, the cost of overhead will be very much. This paper presents how to use cluster computing architecture to improve the VM's performance. It will enhance 15% of performance compared with VM's live migration.

Keywords: *Virtualization, Virtual Machine, Cluster computing*

1. Introduction

With computing technology and network bandwidth are improved, "Cloud Computing" [1] is become a popular issue in these years. It can be defined into three categories, IaaS (Infrastructure as a Service), PaaS (Platform as a Service), and SaaS (Software as a Service), in the Cloud Computing. Virtualization is a very important technology in the IaaS. The system suppliers provide users computing resources in the form of virtual machines (VMs). Virtual machine’s performance is depended on physical machine that the virtual machine is running on. If a physical machine can’t be offered more computing resources or a virtual machine is required higher performance, virtual machine migration could improve this situation. Virtual machine migration is a method to move virtual machine from one physical machine to another one owned more computing resources or higher computing ability.

A VM’s migration will cost 30 to 90 seconds [2] to finish. If there are many virtual machines should be migrated, it will cost a lot of time. In this paper, we use cluster-computing architecture to enhance virtual machine’s performance. Under the cluster computing architecture, the virtual machine which user controls is the master node. We will monitor the processor’s utility in the virtual machine with the virtual machine’s hypervisor, Xen. If the processor’s utility in the virtual machine over the threshold we defined or 100% for a while, a new virtual machine will be created as a slave node and start the cluster computing with the master node. In this architecture, it can enhance the computing ability of a virtual machine and improve the computing time cost.

2. Related Works

2.1. VM Migration

Virtualization is a technique pioneered by IBM in the 1960s. We can use the technology to simulate a new platform, virtual machine (VM). A virtual machine like a physical machine can be installed an operating system and software according to users need.

VM migration is a technique to manage virtual machines. It can move a virtual machine from one physical machine to another one and enhance the utility of the computing resources on a physical machine efficiently.

It can be separated into two categories: offline migration and live migration. A VM's offline migration can’t offer a continuous service, and a live migration must cost 30 to 90

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seconds to finish the migration. If there are too many virtual machines need to migrate, it will take a lot of time.

2.2. Problem Statement on Traditional VM's Resource Deployment

There are two physical machines (P1 and P2) and two virtual machines (vm1 and vm2) running on the physical machines. Each physical machine is deployed the same hardware (motherboard, main memory, and hard driver) beside the processor. The computing ability of the processor in the physical machine P2 is higher than physical machine P1. Assume that the computing resources (in here, we mean the main memory) are 100% in each physical machine. Figure1(a) is shown the deployment and migration of the virtual machines in the physical machines.

According to Figure 1(a), virtual machine, vm1, which is deployed on physical machine P1 that owns the normal computing ability can be migrated to physical machine P2 shown in Figure1(b), if virtual machine, vm1, would like to upgrade its performance.

In the Figure 2(a), the virtual machine, vm1, running on the physical machine P1 has used 65% of the resources, and the physical machine P2 has used 50% and left over 50% the resources. It is impossible to migrate virtual machine vm1 from physical machine P1 to P2. We can find that the resources on the physical machine P1 are still left over 35%. If we can use these 35% resources, it might be helpful on upgrading the performance of the virtual machine vm1.

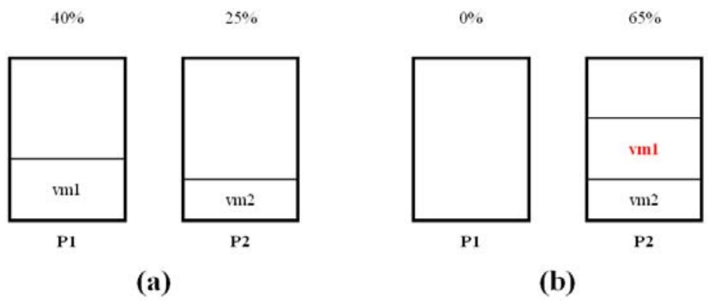

Figure 1. Deployment and migration of the VM in the physical machines

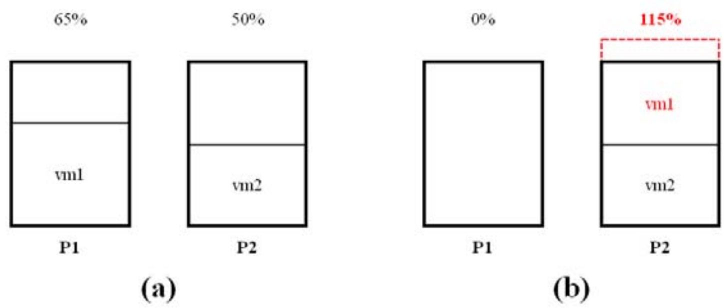

Figure 2. Overloading after vm1’s migration

3. System Design

3.1. Standardization of a Virtual Machine

Virtual machine standardization means that all virtual machines are assigned the same computing resources. Computing resources consists of a numbers of CPU's cores, the size of working memory, and the space of shared storage. The assigned resources are depended on operating system. For example, the least resources to execute a graphic Ubuntu 10.04 are 512MB of memory and 5GB of hard drive.

In the traditional virtual machine or DAVMCR, the resources must be assigned before VM is started and it can't be used by other virtual machines. If it is assigned too many resources to a virtual machine, it will cause some idle resource. It will help administrator to manage computing resources by using a standard virtual machine. We can image that the virtual machine vm1 and vm2 in Figure 2(a) will be assigned standard virtual machines as shown in the Figure 3.

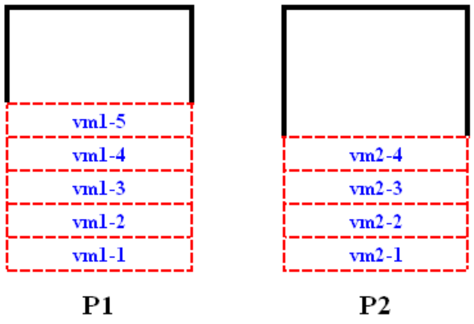

Figure 3. Virtual machine standardization

3.2. Dynamic Virtual Cluster Computing

There are many standard virtual machines could be run in a physical machine. Each virtual machine can be defined as a node in the cluster architecture. Those nodes can be separate into master nodes or slave nodes in a cluster computing system.

When system is started, each user controls a standard virtual machine as the master node in the cluster. As shown in Figure 4(a). As Figure 4(b) is shown, a new virtual machine is started as a slave node by the hypervisor when the processor's utility in the master node is over the predefined threshold for a while. The slave node will share the jobs running in the master node for cutting down cost of the total time.

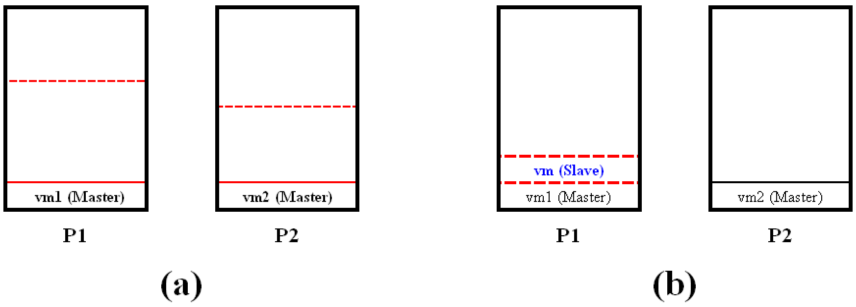

Figure 4. Virtual machines under cluster computing

3.3. The Strategy of Virtual Machines' Deployment

Before Xen hypervisor is started, we have to define a threshold of the processor's utility in a virtual machine. In Murtazaev's papers [2], 100% utilization will lead to performance degradation, and the best performance will be in processor's utility ranges from 50% to 75%. So, we define a threshold of processor's utility which will help us to evaluate increasing a new virtual machine and starting cluster computing or not.

The monitor function in the hypervisor, Xen, will be triggered when user's virtual machine is started. The function will monitor the processor's utility in the virtual machine. A new virtual machine will be started and share jobs from user's virtual machine when the utility ratio is over the threshold for a while. After the new virtual machine is finished jobs, the utility will be less than the threshold, and the monitor function will shutdown virtual machine by using Xen's API. We also defined a counter to avoid unnecessary penalty of virtual machine's shutdown when utility is less then threshold shortly.

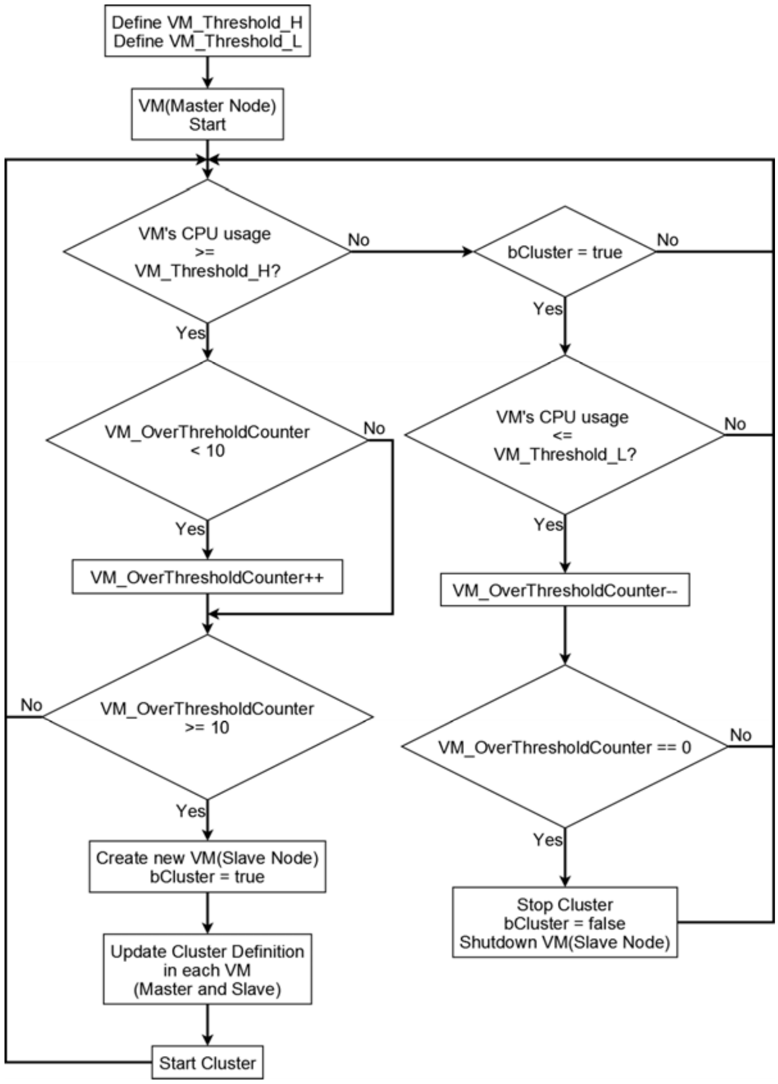

Figure 5. The strategy of VMs' deployment

4. Experimental Results and Analysis

In our experiment, we used two physical machines, Server-1 and Server-2. Server-1 has Intel Core2 Quad CPU Q6600 (2.40GHzx4), 3 GB memory, and hard driver with 250 GB. Server-1 is installed Ubuntu 11.10 with Linux kernel 3.0.0 and Xen 4.1.0. Server-2 has Intel Core CPUi7-920 (2.67GHz x 4), 12 GB memory, and hard driver with 500 GB. Server-2 is installed Ubuntu 12.04 with Linux kernel 3.2.0 and Xen 4.1.0.

We also defined four virtual machines, VM-test01 to VM-test04, and are installed Ubuntu 10.04.4 LTS, MPICH2, and OpenSSH. The resources deployed are as following (VM's name: number of the processors/memory size/hard drive space): VM-test01: 1/512MB/8 GB ; VM-test02: 2/1024 MB /16 GB ; VM-test03: 2/1024MB/8 GB ; VM-test04: 2/512MB/8 GB

We record the time of compiling the Linux Kernel 3.2.12 in the virtual machine test01 to test04 which are running in the physical machine Server-1 and Server-2. The seconds of compiling time is shown as following (VM's name: time in Server-1/time in Server-2): VM-test01: 2152/1433 ; VM-test02: 1165/878 ; VM-test03: 1224/850 ; VM-test04: 1158/1000.

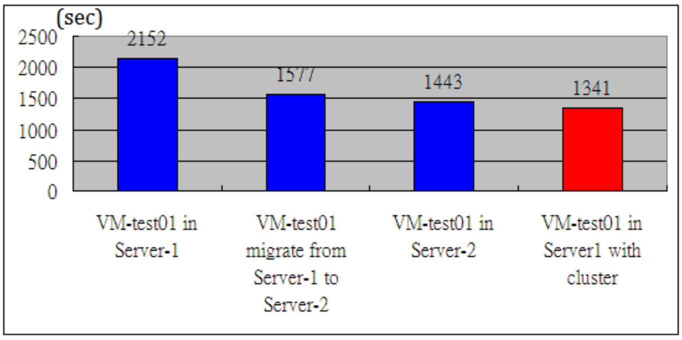

Figure 6. Compiling time of VM-test01 in different environment

So, we define test01 as a standard virtual machine. The time of compiling Linux kernel is 1577 seconds with VM's migration from Server-1 to Server-2. Our approach, constructing an cluster computing with virtual machines on the Server-1, is 1341 seconds. According to the results, several observations can be made:

1. Virtual machine performance varies greatly depending on physical machine. In the experiment, the performance of the virtual machines running on the Server-2 is 25% to 33% better than virtual machines running on the Server-1.
2. Running different virtual machines allocated different resources in the same physical machine, we can find that the number of processors will affect the performance. In the experiment, VM-test04 is allocated one more processor than in the VM-test01, and the performance is 30% to 46% better.
3. From result of VM-test02 and VM-test03, the space of hard drive will not be a large impact to the performance.
4. We run another virtual machine in the Server-02. The virtual machine is allocated the same resource like VM-test01 beside memory. We assign 1024MB memory in the virtual machine. The time is 1338 seconds of compiling Linux Kernel 3.2.12. It is just improved 7% performance. The size of memory is a little impact to performance.
5. As shown in Figure 6, our approach is improved 15% performance than VM's live migration.
6. Our approach is improved 15% performance than traditional virtual machine allocated a lot of computing resources.

5. Conclusion

Using cluster computing architecture to enhance the performance of the virtual machine can improve 15% better than VM's live migration by our experiment.

The approach in this paper can improve the resources utility and reuse utility. It should be allocated the resource before traditional virtual machines start running, and those resources allocated can't be used by others during virtual machines are running. A VM's performance will be depended on the resources allocated. A virtual machine is an optional computing resource in our approach. If a user's virtual machine is overload, the mechanism will provide a new virtual machine to help share user's jobs. Those virtual machines could be used by other users' virtual machines. So, the computing resources won't be occupied with some virtual machines.

Our experiment is focus on a physical machine. There are a lot of physical machine in a IaaS architecture. In the future, we will try to implement in many physical machines. The virtual machines working in the cluster system may be distributed in different physical machines. It can improve the utility of all physical machine. It is also not necessary to migrate virtual machine to another physical machine to start a cluster computing if there are not enough resources in the physical machine which the virtual machine is running in.

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