A Comparative Study of Algorithms For Efficient Dynamic Consolidation of Virtual Machines In Cloud

Madhu B. R.
Research Scholar, Jain University, Bengaluru, Karnataka, India.

Dr A.S. Manjunatha
CEO & MD, Manvish eTech Pvt. Ltd., Bengaluru, Karnataka, India.

Prakash Chandra
M.Tech Student, SET, Jain University, Bengaluru, Karnataka, India.

Chidananda Murthy P.
Research Scholar, Jain University, Bengaluru, Karnataka, India.

Abstract
In order to avoid the initial capital investment on setting up the IT infrastructure and to minimize the additional cost incurred in the maintenance of hardware and the software, most of the companies have started adopting the cloud computing as part of their computing solutions. The cloud service providers should setup large scale datacenters since the demand for cloud computing solutions have increased substantially. These large datacenters do consume large amount of electrical power and emit greenhouse gases. This has led to the increase in maintenance overhead and operational cost to the cloud service providers. The main challenge for the cloud service providers is to minimize the consumption of electrical power without violating the service level agreement. The dynamic consolidation of virtual machines by using the live VM migration technique and switching off the unnecessarily running hosts in the datacenter can be a way to solve the problem mentioned. This paper presents the comparative study of various provisioning technique by setting up the simulated environment using the CloudSim for the power-aware datacenter.

Keywords: Cloud computing, Live VM Migration, CloudSim, Dynamic VM Consolidation

Introduction
The cloud computing is a large scale distributed, parallel computing platform in which the computing resources are provided as the utility, based on the service level agreement signed between the cloud service provide and its users. The Amazon EC2, Microsoft Azure and Google App Engine are the key cloud service providers which provide services with respect to Infrastructure, Platform and Software as part of their utility computing services respectively. To avoid the initial capital investment on setting up the IT infrastructure and to lessen the burden of hardware and software maintenance, most of the companies are outsourcing their IT management to the cloud. Thus, the demand for increased computing services has forced the cloud service providers to set up the large scale data centers with very high computational power. Large volume of electrical power is required in order to keep these datacenter up and functioning, which directly results in the increase of operational cost. Apart from that, these datacenters also emits greenhouse gases like carbon dioxide. This has emerged as a great challenge to tackle for the cloud service provider. Since the idle servers also consume the 50% of the peak power and there can be 5%-15% idle server unnecessarily running in the datacenter, the power management has become a vital issue for the cloud providers. The virtualization technology is the backbone of the cloud computing which helps in efficient utilization of computing resources by assigning the number of virtual machines to the single physical host. Since the cloud environment experiences dynamic nature of workload, there might be some hosts running unnecessarily. In a datacenter, there can be some hosts which are underutilized as well some hosts which are over utilized at the same time. In order to achieve load balancing and to avoid unnecessary power consumption and for efficient utilization of computing resources we can implement the concept of the live VM-migration. Live VM migration is defined as the process to migrate the virtual machine from one physical host to another while client is still connected, with minimum down-time. By using the live VM migration process, the VMs from the under-utilized as well as over-utilized host can be consolidated to the appropriate server, so the unnecessarily running nodes can be switched off. Since the over consolidation of VM using live VM migration will result in performance degradation, this paper presents the comparative study of various provisioning technique to achieve energy-performance tradeoff while keeping up with the service level agreement.
Related Work
There has been extensive research work going on to build the power efficient datacenter by maintaining energy-performance trade-off in the cloud environment. The CloudSim tool is used for conducting experiments on the power aware datacenter[1]. There are various algorithms and technologies for the efficient utilization of cloud resources by server consolidation. The workload aware migration strategy has been analyzed by considering the downtime, total migration time as the performance metrics[2]. It also analyzes the effect experienced by the source and target machine when resource reservation technique is used for live VM migration. The contention for the shared resources results in the performance degradation due to the VM consolidation, and have presented the performance preservation system which selectively packs the VM that are less probable for contention of shared resources[3]. The careful analysis of the existing optimization technique for the VM placement during the server consolidation, and by performing the various experiments and empirical analysis [4] has provided insights in to the questions like, what factors govern the performance model that drives VM consolidation? The survey and implementation of the various aspect of the VM migration process such as security-performance tradeoff and the impact of memory and network transfer during the process is analyzed [5]. The technique to achieve efficient dynamic VM consolidation has been implemented by selecting the best VM for the process [6].

System Architecture
Multiple servers will be residing in a cloud datacenter, each having their own configuration in terms of CPU cycle (MIPS), amount of RAM, power model and network bandwidth allocated to them. The storage is provided in the form of network attached storage to facilitate smooth live VM migration. The user request for the service is in the form of virtual machines. VM by each user have different configuration based on their requirement. Since each user may request for different type of services like web app, business processing, scientific calculation etc., which may require different processing power, it is the duty of the cloud service provider to maintain the quality of service as mentioned in the service level agreement.

CloudSim
The CloudSim is the simulation tool written in java programming language to support the simulation of cloud environment to test various hypotheses by the academician, cloud provider or the researcher in dependable, scalable and repeated manner. Various java APIs, abstract classes, sub-classes and methods are provided by CloudSim, which can be extended to perform the modeling of the cloud components and to test the resource provisioning policies at both host level and VM level. According to the official website of the CloudSim, it supports the following novel features:
1. Modeling and simulation of large-scale cloud computing environments, including data centers, on a single physical computing node.
2. A self-contained platform for modeling Clouds, service brokers, provisioning, and allocation policies.
3. Simulation of network connections among the simulated system elements.
4. Simulation of federated cloud environment that inter-networks resources from both private and public domains [7]. The layered architecture of the CloudSim is as follows:

Dynamic Vm Consolidation
The CloudSim provides the built-in support for the VM placement optimization technique in the power aware datacenter which uses the historical data of resource
utilization to support the dynamic VM consolidation. The optimization technique uses the given list of hosts as its input and produces the migration map for the selected VMs. The algorithm for VM placement optimization technique works as follows:-The overloading detection algorithm iterates through the given list of host, to determine if the given host is overloaded or not based on the chosen upper threshold value of CPU utilization. Once determined to be overloaded, the appropriate VM selection algorithm chose the VM to be migrated. Once we have the list of VM to be migrated, the placement algorithm finds the new host for these VMs. The same above mentioned process is repeated to find the under loaded host based on lower threshold value of CPU utilization and VMs are selected for migration. The under loaded hosts are switched to the low power consumption mode.-The optimization technique now returns the migration map which contains information about the placement of these VMs selected for the migration process. Following are the lists of overloading detection algorithms provided by CloudSim kit:

1. Power Vm Allocation Policy Migration Inter Quartile Range (IQR)
2. Power Vm Allocation Policy Migration Median Absolute Deviation (MAD)
3. Power Vm Allocation Policy Migration Local Regression (LR)
4. Power Vm Allocation Policy Migration Local Regression Robust (LRR)
5. Power Vm Allocation Policy Migration Static Threshold
6. Power Vm Allocation Policy Simple (DVFS)

CloudSim provides the following algorithm for the VM selection:

1. Power Vm Selection Policy Maximum Correlation
2. Power Vm Selection Policy Minimum Migration Time
3. Power Vm Selection Policy Minimum Utilization
4. Power Vm Selection Policy Random Selection

### Experiment Setup and Result Analysis

The experiment was carried out on Mac OS X machine with 4GB RAM and 2.5GHZ Intel core i5 processor using the CloudSim as the simulation kit integrated with the Net Beans IDE, for the single datacenter. The datacenter comprised of 20 hosts which hosted 20 virtual machines. Each host consists of single core CPU with CPU cycle of 1000,2000 and 3000 MIPS assigned iteratively, 10000 MB RAM and 100000 MB of bandwidth. VMs were provided with the CPU cycles of 250, 500, 750, 1000 MIPS iteratively, 128MB RAM and 2500MB of bandwidth. The XEN hypervisor was selected for the experiment. The comparative study was done to find out the power efficiency and the number of VM migrated using minimum migration time as the VM selection Policy. The experimental result clearly shows that the local regression Policy combined with minimum migration time produces the better results compared to other Policy. The dynamic consolidation of virtual machine has consumed very less power compared to the DVFS (Dynamic Voltage and Frequency Scheduling) which do not implement the live VM migration approach.

### Table 1: Simulation Result

<table>
<thead>
<tr>
<th>ALGORITHM</th>
<th>NO. OF VMs MIGRATED</th>
<th>POWER CONSUMED (KWH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LR</td>
<td>13</td>
<td>0.07</td>
</tr>
<tr>
<td>IQR</td>
<td>19</td>
<td>0.11</td>
</tr>
<tr>
<td>MAD</td>
<td>13</td>
<td>0.09</td>
</tr>
<tr>
<td>LRR</td>
<td>15</td>
<td>0.12</td>
</tr>
<tr>
<td>DVFS</td>
<td>0</td>
<td>0.33</td>
</tr>
</tbody>
</table>

### Figure 3: DVFS consumes highest power with zero migration

### Conclusion

There has been extensive research work going on to minimize the heavy power consumption at the datacenter by efficiently utilizing the available physical resources. This paper presents the comparative analysis of various VM allocation policies for migration using the minimum migration time as the VM selection Policy. The experimental result clearly shows that the local regression Policy combined with minimum migration time produces the better results compared to other Policy. The dynamic consolidation of virtual machine has consumed very less power compared to the DVFS (Dynamic Voltage and Frequency Scheduling) which do not implement the live VM migration approach.

### References


International Conference on Cloud Computing, 2011


