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An Energy Efficient Cost Aware Virtual Machine Migration Approach for the Cloud Environment

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Abstract**—** *Virtualization is the driving technology in the cloud which allows application isolation and enables the service provider to relocate the virtual machine (VM) from one server (PM) to another, knows as virtual machine (VM) migration. VM migration is the key features of the virtualization. It facilitates load balancing, hot spot mitigation, server consolidation, fault management, and power saving. VM migration is the multi steps process i.e. source PM selection, candidate VM selection, target PM selection and the last step is transferred VM data. This work proposed a priority-based load balancing approach that migrates and schedules the VM according to the weight or priority which is assign to each VM. In the cloud, when the user uses the cloud resources, some amount (bill) is paid by the user for using their resources. On the basis of this bill, some priority is assign to each user.VM which provides more return to the cloud owner will have more priority and schedule first. The main idea of this approach is that gives better service to those users who gives more profit to the provider.*

The proposed approach is evaluated in CloudSim simulator and experimental results illustrate that proposed approach gives a better result as compare to the competitive approach.

Keywords**—** *Cloud, virtualization, cost efficient, SaaS, PaaS, IaaS.*

I. INTRODUCTION

In the cloud computing, the computing resources are provided to the client through virtualization, via the internet. In order to fulfill the user demand large cloud infrastructure is set up by the cloud provider, so that user demand can also be satisfied at peak time. [1]. NIST definition of the cloud computing says that it is a technology that provides on demand convenient services to the client where resource are given to the client from the shared pool of resources via the internet. These computing resources can be quickly provisioned and released [2].

In the cloud, several physical machines (PM) are connected to each other in the form of a cluster. Virtualization [4-6] is the enabling technology in the cloud, which divide the physical resources to the multiple parts via virtual machine (VM). When any user needs resources scheduler assigns the resources of these PM to the user through the VM. Every client of the cloud has its own VM and the resource requirement of the VM can be changed dynamically at run time. Due to this load balancing in the cloud is the challenging task. To balance the PM, VM migration approach is used which transfers the VM from one PM to another PM.

This paper, we discuss the overview of cloud computing with their components, basic model. The goal of the paper provides a complete study of cloud computing with different types. In section 2, we discuss the background knowledge of cloud computing with their framework. Section 3 gives brief descriptions about types of cloud as public, private, community and hybrid cloud. In section 4, discuss some existing load balancing approach in the cloud. Section 5 introduce a novel load balancing approach which increases the profit for the provider and migrates the VM when the PM is either over utilize and underutilized. Section 5 discuss result evaluation and section 6 concludes the paper with the focus on the future work.

II. PAGE DELIVERY AND DEPLOYMENT MODEL

In the cloud computing there are three types of service delivery model [3] as software as a service (SAAS), platform as a service (PAAS), and infrastructure as a service (also known as hardware as a service). It can be designed by three different model i.e., private cloud, public, hybrid and community cloud. As shows in figure 1.

In Software as a Service (SaaS) delivery model only software is provided on demand to the client. There is no need to installed software on the client side. In Platform as a Service (PaaS) delivery model complete platform which required to design new application is provided to the client. It is mainly used by the developer. In infrastructure as a Service (IaaS) delivery model complete computing environment i.e., hardware, software, network etc., are provide to the user. There are four types of cloud deployment model [4] in the cloud computing known as public, private, community and hybrid cloud.

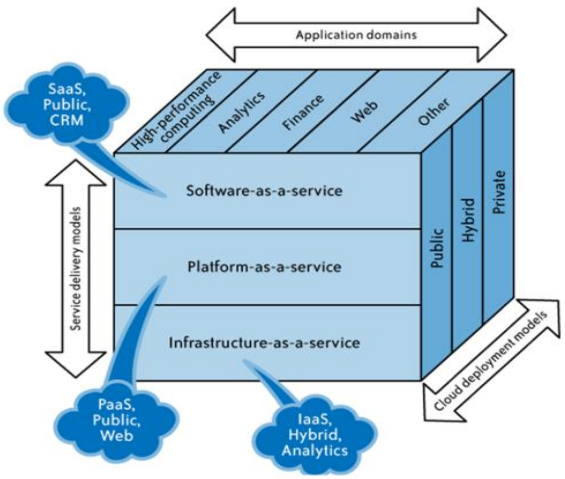

Fig. 1. Cloud computing models in 3D.

In private cloud, all computers are connected locally. Service running in a private cloud cannot be access from outside the network. It is more secure and less scalable as

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compared to the other cloud. Public cloud is a model of the cloud where all users are allowed to access services using the internet. The user needs only internet connection and web browser to access these services on pay per use scheme. All services which are provided by the provider are available on the internet. The user needs to subscribe the application and make enable to use it. Community cloud includes number of organization to share their services to increase resource utilization of cloud infrastructure. The cloud infrastructure is not limited to only one organization. A hybrid cloud combines both public and private cloud with their advantages. The hybrid cloud offers the benefits of both the public and private cloud. The hybrid cloud is the good solution for purely business oriented concept because many modern businesses have a wide range of concerns to support users demand.

III. Related Work

J. Huang et al. [8] proposed best fit VM algorithm using dynamic programming for minimizing number of VM migrations and reducing energy consumption. This Best Fit algorithm find the best host for each VM, it find the best fit VM for each host. It uses dynamic programming for each host until and unless all the VM has been allotted.

S. Gupta et al. [9] proposed a load balancing approach based on Dynamic Threshold. In cloud computing Load balancing problem categories into two approaches both are depending on the systems current state. Static approach and Dynamic approach. In the static approach, previous knowledge about the status of the system, resource requirement, and communication time are assumed. The major disadvantage of this approach is that it does not consider the current state of the system when making these decisions.

R. Buyya et al. [10] proposed Modified Best Fit Decreasing (MBFD) algorithm for energy-efficient, resource allocation to provide dynamic server consolidation, based on the adaptive utilization threshold. In this approach allocation of VMs are based on two parameters, optimized VM selection (fixed utilization threshold or Dynamic utilization threshold) then migration, and second assigning new VMs on the physical nodes. To solve the bin packing problem, modification of the Best Fit Decreasing (BFD) algorithm is proposed.

M. H. Al Shayeji et al. [11], present a migration based VM migration approach for the cloud. In this approach they set lower and upper threshold for the host and monitor the utilization of each PM. Now filter all PM where the utilization is below the lower threshold or higher than the upper threshold. Now migrates all VM from the underloaded PM and switch OFF the underloaded PM to save the energy. If the PM is overloaded then arrange all VM in the ascending order of their utilization and select the first VM for the migration. The first fit approach is used to place the migrated VM. This approach seems good but selects the small VM for the migration that can increase the number of migrations. Another problem with the this approach is that first fit approach is used to place the VM that can increase the number of running server which results in increasing the energy consumption.

M. S. Pilavare and A. Desai [12], developed a profit aware strategy for placing the VM in cloud. This approach assigns VM to the PM with the objective to produce more return (profit) to the provider. For this purpose they use some fitness value to decide the order in which VM are executed. VM scheduler schedule the VM based on this fitness value which is assign to each VM according to revenue which is generated by each VM. This approach mimics the behavior of genetic algorithm where VM is scheduled according to the fitness value. This approach estimate the fitness value to each VM and then give some weight (priority) according to this fitness value. VM with higher fitness value will get higher priority and vice versa. This approach use the following formula to measure the weight for each VM

$$\zeta = p1 * \alpha(NIC \div MIPS) + p2 * L$$

Where,

p1 and p2 represent the weight coefficient

NIC is the number of instruction in cloudlet

MIPS Million instruction per second requested by the VM

α is the cost of instruction execution

L is the delay cost

After calculating the weight for each VM, they use genetic algorithm for placing the VM, which randomly select the PM for placing the VM. The main limitation of this approach is that, energy consumption is not considered by this approach. VM migration is also not a part of this approach.

IV. Proposed Work

Energy consumption and VM migration are to major issue for the cloud provider. These issues can be handled effectively by the proper load balancing approach. After the assessment of cloud theory, it is conclude that with the help of proper VM scheduling provider can diminish the number of migration and energy consumption which directly help the provider to increase their revenue. Previous work done in the load balancing field, boost the cloud provider revenue by dropping down the energy consumption and number of migrations. But these approaches can be improved to increase the provider profit by giving more preference to the VM which gives more profit to the provider. Pilavare [12] developed a VM scheduling stratergy which is based on an idea where VM scheduling decision is taken based on the profit given by the VM. In this method most profitable virtual machine get first chance and scheduled first.

This approach can be improved by placing the VM properly. The proposed method for balancing the load enhanced the idea of the existing load balancing approach by implementing the VM migration concept. The main objective of our approach is to increase the provider profit. To achieve this our approach assign a unique number (priority) to each VM based on the bill paid (profit or revenue) by the VM after the completion of VM. This bill amount is proportional to the size and time for which VM is used.

VM migration process is used when the performance of the PM is not good or to minimize the number of running server known as server consolidation. Most of the existing load balancing approaches used the lower and upper limits

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(threshold) to identify the overloaded and underloaded server. Thresholds can be Static as well as dynamic. In case of static threshold, lower and upper thresholds are fixed thus, these value does not change with time, while in the dynamic threshold, lower and upper thresholds keep changing(usually lower threshold value is kept constant because it is pre-decided according to system configuration, minimum load to keep VM switched on otherwise service providers have to bear the cost due to wastage of energy) with time. Existing research says that static thresholds are more suitable for the cloud because resources required by the VM are changed very frequently. Our proposed approach also used the static threshold and set the value of lower and upper threshold are 20 and 90 respectively. The lower threshold is used for the server consolidation i.e., when the load on the PM is less than 20 then all VM running on the PM is migrated to the other PM whereas upper threshold is used for the load balancing purpose to optimize the system performance. Hence, to deal with both the situation VM migration process is required. Three steps are involved in the migration process

a. Source PM Selection
b. VM selection
c. Target PM Selection

a. Source Physical Machine Selection

To select the source PM lower and upper threshold is used. A PM is a candidate for the source PM when it is either overloaded or underloaded. In both situations, PM is considered as a source PM and some VM have to be migrated to balance the PM. The previous study says that response time is proportional to the server load which is increases with load. It means to get the optimal service server load must be in limit.

Since more than one VM are running on the single server, so server load is measured by adding the CPU used by each VM. Following equation is used to estimate the load on each PM.

$$PM_{load} = \frac{\sum_{i=1}^{n} MIPS\ of\ the\ VM}{Total\ MIPS\ of\ the\ PM}$$

b. Virtual Machine Selection for the Migration

The main objective of our proposed approach is to increase the provider profit and enhanced the system performance. After identifying the source PM next step is to find the VM which has to be migrated. In our proposed approach to assign the priority cost or profit is used. So first we find the cost of the VM. If size of the cloudlet running on the VM x and T_1 is the time required to execute the VM then.

$$T_1 = \frac{x}{\text{MIPS of the VM}}$$

During the experiment it is found that VM utilizing only 80% of their full capacity. So now if the T_2 is the time required to execute the VM then

$$T_2 = \frac{x}{\text{MIPS of the VM}} * 0.8$$

If CPU, memory and bandwidth is represented by x, y and z respectively then cost of the VM is calculated as follow.

$$C_{cpu} = T_2 * Cost_{cpu}$$
$$C_{mem} = T_2 * Cost_{mem}$$
$$C_{bw} = T_2 * Cost_{bw}$$

where C_{cpu} , C_{mem} and C_{bw} are the cost paid by the VM for the CPU, memory and bandwidth respectively. If T is the cost return generated by the VM then

$$T = C_{cpu} * C_{mem} * C_{bw}$$

After estimating the return for the each VM then assign some integer number (priority) to each VM based on the value of T. Higher priority is assign to the VM which has higher value of x and vice versa.

Following algorithm is used to choose VM for the migration.

Algorithm 1 VM Selection Algorithm
Input - VmList, HostList
Output - MigrationList
Step-1: Calculate the integer value which will assign to each VM to decide
the order in which VM is scheduled according to the revenue generation.
Step-2: for each host in the hostList do
Step-3: PM_{load}←host.util()
Step-4: if PM_{load} < lower_threshold
Step-5: Move or migrate all VM in order to save power.
Step-6: end if
Step-7: if PM_{load} > upper_threshold
Step-8: Arrange all VM into the decreasing order of the integer value
Step-9: Choose the last VM (VM with lower value) form the VMList and migrate them.
Step- 10: end if
Step-11: end for

c. Target PM Selection for Placing the VM

The main concern of our proposed work is to increase provider turnover. This can be achieved by minimizing the number of running PM. To achieve this we place the VM to the largest PM. The main reason for selecting the larger PM is to pack larger number of available VM in a minimum number of running PM. Algorithm for the proposed VM placement approach is

Algorithm for VM Consolidation

In cloud lower threshold is used for consolidating the VM in minimum number of PM. All VM are move to the other PM when lower threshold goes below to the pre define lower threshold value.

1. if PM_{load} <lowThresh() then
2. Migrate all VM from the host

Input - HostList, vmList
Output - Allocation of VMs
Step-1: Add all new and migrated VM in the VMList
Step-2: Calculate the integer value which will assign to each VM to decide the order in which VM is scheduled according to the revenue generation.
Step-1: For all VM in VMList do
Seep-2: Select VM with higher integer value

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Step-3: for all PM in PMList
Step-4: PMload←host.util()
Step-5: if PMload > lower_threshold && PMload < upper_threshold
Step-6: Add PM into the newPMList
Step-7: end if
Step- 8: for all PM in the newPMList do
Step-9: Select the largest PM and place the selected higher priority VM
Step-10: Updates loads
Step-11:end for
Step-12: end for

V. Result Analysis

CloudSim simulation [13] tool is used to measure the performance of the anticipated approach. For this purpose proposed approach is evaluated with the previous load balancing approach discussed in [12]. The efficiency of the proposed and competitive approach is measured in term of number of migrations, energy expenditure and number of servers required to place all VM.

To create the cloud environment 20 number of PM is created. Each PM having the configuration of 1K (1000), 2K and 3K MIPS and size of RAM and bandwidth is 10K MB and 100K bit/sec respectively. Numbers of created VM during the experiment are 40, 45 and 50. Some initial cost is also assumed for the each resource based on this cost priority to the

VM is assigned. Figure 2, 3 and figure 4 shows the number of active servers, energy consumption and number of migrations respectively.

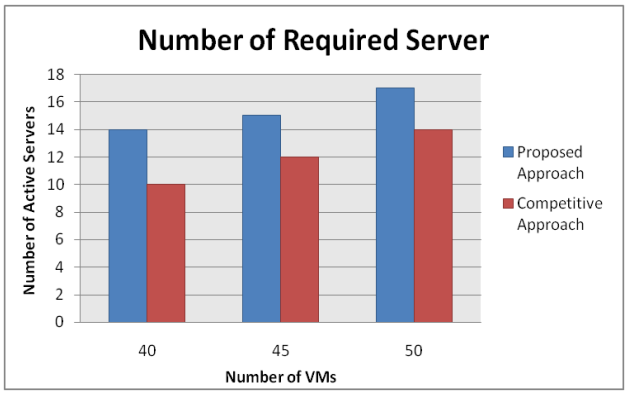

Fig. 2. Number of active servers.

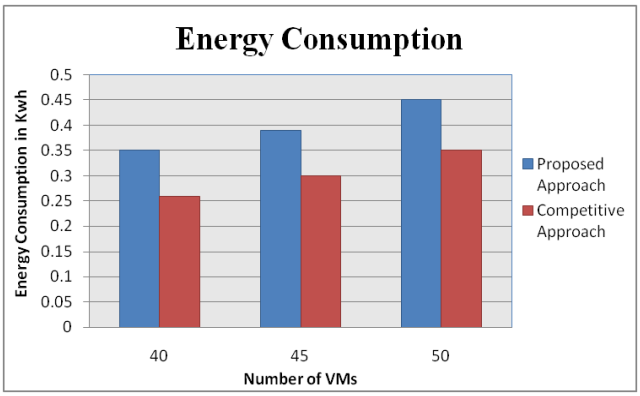

Fig. 3. Energy consumed by the datacenter.

Our approach reduces the number of active server as compared to the base approach because we select the PM with the largest capacity. So that it can host large numbers of VM as compared to the base approach.

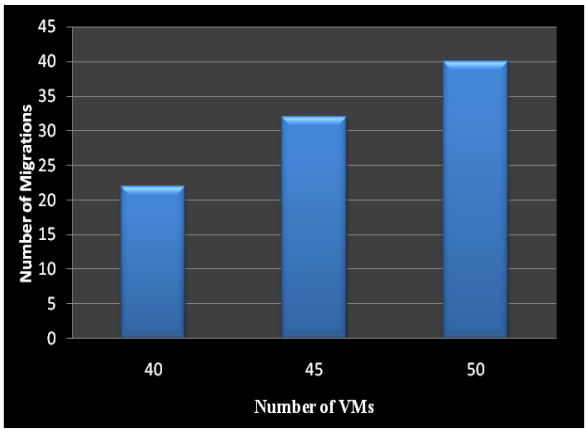

Fig. 4. Number of migrations in proposed approach.

Since our approach used less number of active server, so it will also minimize the power consumed by the datacenter.

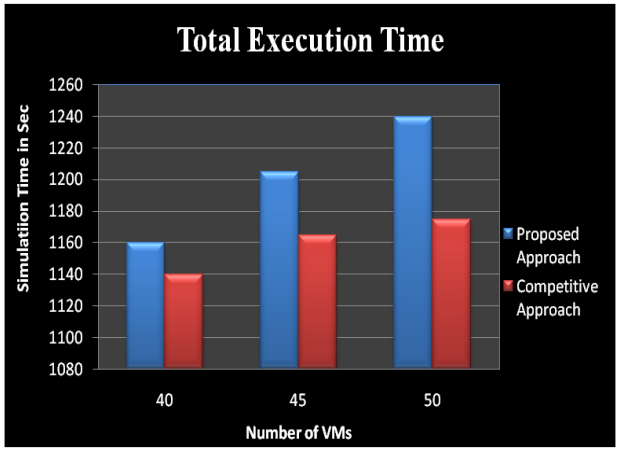

Fig. 5. Total execution time.

It is clear from the above figure that proposed approach takes less time to execute all VM in the data center which depict that its give better service to the user as compare to the competitive approach.

VI. Conclusion

VM migration is major features which is supported by virtualization. It facilitates load balancing, hot spot mitigation, server consolidation, fault management, and power saving. VM migration is the multi-step process i.e. source physical selection, virtual machine selection, target virtual machine selection and the last step is transferred VM data. The previous study says that in the migration process VM selection and VM placement are the two most difficult tasks due to the dynamic change in VM request. This work proposed a priority-based load balancing approach that migrates and schedules the VM according to the priority which is assign on the basis of return which is received by the user. Proposed

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approach schedule VM first, which gives more return to the provider. The main idea of this approach is that gives better service to those users who gives more profit to the provider. Experiment result illustrates that proposed approach gives better result in term of number of active servers, migration and energy consumption.

REFERENCES

[1] R. Buyya, C. S. Yeo, S. Venugopal, J. Broberg, and I. Brandic, "Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility," *Future Generation Computer Systems*, vol. 25, issue 6, pp. 599-616, 2009.

[2] B. Sosinsky, *Cloud Computing Bible*, Wiley Publishing Inc, 2012.

[3] R. K. Gupta and R. K. Pateriya, "A complete theoretical review on virtual machine migration in cloud environment," *International Journal of Cloud Computing and Services Science (IJ-CLOSER)*, vol. 3, no. 3, pp. 172-178, 2014.

[4] P. Barnham, B. Dragovic, K. Fraser, S. Hand, T. Harris, A. Ho, R. Neugebauer, I. Pratt, and A. Warfield, "Xen and the art of virtualization," *Proceedings of 19th ACM Symposium on Operating System Principles (SOSP'03)*, pp. 164–177, 2003.

[5] VMware, VMware ESX and VMware ESXi. [Online]. Available: http://www.vmware.com/files/pdf/VMware-ESX-and-VMware-ESXi-DS-EN.pdf

[6] C. Clark, K. Fraser, S. Hand, J. G. Hansen, E. Jul, C. Limpach, I. Pratt, and A. Warfield, "Live migration of virtual machines," in *Proceeding NS DI'05 Proceedings of the 2nd conference on Symposium on Networked Systems Design & Implementation*, vol. 2, pp. 273–286, 2010.

[7] R. K. Gupta and R. K. Pateriya, "Survey on virtual machine placement techniques in cloud computing environment," *International Journal on Cloud Computing: Services and Architecture (IJCCSA)*, vol. 4, no. 4, pp. 1-7, 2014.

[8] J. Huang, K. Wu, and M. Moh, "Dynamic virtual migration algorithms using enhanced energy consumption model for green cloud data centers," *IEEE*, pp. 902-910.

[9] S. Gupta, D. Tiwari, and S. Singh, "Energy efficient dynamic threshold based load balancing technique in cloud computing environment," *International Journal of Computer Science and Information Technologies*, vol. 6, issue 2, pp. 1023-1026, 2015.

[10] A. Beloglazov and R. Buyya, "Adaptive threshold –based approach for energy-efficient consolidation of virtual machine in cloud data centers," *Proceedings of the 8th International Workshop on Middleware for Grids, Clouds and e-Science*, 2010.

[11] M. H. Al Shayeji and M. D. Samrajesh, "An energy-aware virtual machine migration algorithm," *Proceeding of International Conference on Advances in Computing and Communications (ICACC)*, pp. 942-946, 2012.

[12] M. S. Pilavare, and A. Desai, "A novel approach towards improving performance of load balancing using genetic algorithm in cloud computing," *IEEE Sponsored 2nd International Conference on Innovations in Information Embedded and Communication Systems ICIIECS'15*, pp. 1-4, 2015

[13] R. N. Calheiros, R Ranjan, César A. F. De Rose, and R. Buyya, "CloudSim: A novel framework for modeling and simulation of cloud computing infrastructures and services," 2011.