IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol-6, Special Issue-5, Jun 2018 E-ISSN: 2347-2693

Least Migration Load Based Virtual Machine Selection Policy for Migration Process in Clouds

Minu Bala

Department of Computer Science, Higher Education Department, J&K Govt., India

e-mail: ind_minu@yahoo.com

Available online at: www.ijcseonline.org

Abstract- Migration of Virtual Machines is one of the efficient ways to manage resources in a Cloud Data Centre, dynamically, and reduce various runtime costs. But, sometimes, rigorous movement of virtual machines from over-utilized or under-utilized physical machines, results in performance degradation and service level agreement violation. Hence, it must be done carefully. A new virtual machine selection policy has been proposed in this paper which uses the concept of least deviation and resource satisfaction aspect for selection of a virtual machine which need to be migrated from overloaded servers in a cloud data centre. The proposed policy has been evaluated via extensive simulations by performing experiments on real workload traces from PlanetLab. The performance of proposed policy has been compared with already existing traditional policies for selection of virtual machine from over-utilized or under-utilized machines like Minimum Migration Time (MMT), Minimum Utilization (MU) and Random Selection (RS) available in CloudSim toolkit. The results show that the proposed policy outperforms the above mentioned policies on the basis of parameters like Power Consumption, SLA violation, No. of migrations, Energy Violation Metric.

Keywords: Cloud Data Centre, VM Selection, Energy Efficiency, Resource Satisfaction Aspect, QoS, SLAs, VM Consolidation and Redistribution

I. Introduction

Cloud computing is the latest model of computing, based on already available technologies like virtualization, grid computing, distributed computing, autonomous computing, utility computing etc., in which resources like storage, computing power, software services, platform services, infrastructural services etc., are provided to the customers on subscription basis. Modern cloud data centres have the characteristics to provide resources to its customers in an on demand fashion with the flexibility to increase or decrease the number of provisioned resources as per the requirements of the client. Implementation of such type of cloud data centres is quite challenging as it requires continuous monitoring of the system in order to fulfill the demands of clients at short notices. Virtualization is the prime technology which provides various kinds of flexibilities in cloud environment.

The main goal of cloud service providers is to meet the service level agreements done with cloud users by operating all the resources of the data centre at best utilization levels. The provisioning of computing resources, in excess, leads to loss in revenue whereas over commitment of cloud resources may lead to violation of SLAs. Hence, it is very important to have an efficient resource management policy for cloud based system which sees the interest of both clients as well as service provider. It is not good to have under-utilized and over-utilized resources in a cloud data centre both from economical and environmental perspectives. Hence there is dire need to devise optimal policies which could handle dynamic workload patterns of all times and could make a balance between service provider's and client's interests.

In this paper, a novel VM selection policy has been proposed which tries to reduce the migration load by decreasing the number of migrations and also take the resource satisfaction aspect of VMs into consideration before migration of a VM. The main contributions of the study are as follows: The present paper contributes the following: (1) The development and implementation of Least Migration Load Based VM Selection Policy which takes Resource Satisfaction aspect and quantity of load to be migrated, into consideration (2) Evaluation of the proposed policy on the basis of various parameters like percentage of SLAV, Energy Usage, energy consumption, number of migrations, degradation in performance due to migration and energy-violation metric.

The paper has been composed into six areas. Segment 2 tosses light on the writing survey identified with the concerned region. Segment 3 exhibits the system model used in the work. Segment 4 talks about the proposed policy for VM selection in detail. Area 5 clarifies different execution measurements, utilized as a part of the examination, for breaking down the new approach in correlation with officially accessible customary strategies in CloudSim toolkit. In segment 6, assessment of the proposed strategy has been done and outcomes have been compared with MMT (minimum migration time), MU (minimum utilization), RS (Random Selection) approaches. Various simulation scenarios and work load patterns, considered in the experimentation, have also been discussed. The final section presents the conclusion of the whole study.

II. Related Work

A lot of work has been done in the last few years on VM consolidation in order to improve Cloud Power Efficiency. The literature shows several works which strive for reduction of number of active servers for the sake of power consumption reduction. Kim et al. have focussed on the provisioning of Cloud resources for real-time services and have proposed a policy that uses SLAs for resource allocation and increases power efficiency by having a trade-off between powered off servers and task completion time. In [12], the authors have introduced different VM consolidation techniques to minimize Cloud power consumption, but the proposed algorithms do not consider service provider SLAs, hence the usage of such solutions in real world situations can lead to performance degradations. In [2], authors have suggested a new Fast and Parallel ABC based VM Allocation policy which is a modification of their previous work, in which there were two issues: (1) how to reduce the decision time of VM allocation; (2) how to find global optimized solutions efficiently. In the present work they have used the idea of gradient descent to find the optimal solution with higher speed and idea of simulated annealing to find the global optimal solutions in Δt. They have compared the simulation results with the ABC based policies and proved that FP-ABC policy reduce energy consumption of data centre with relative high QoS. In [3] authors have proposed a new energy-aware scheduling algorithm which uses a set of objective functions defined in terms of newly introduced consolidation fitness metric to evaluate the benefit of consolidating a number of known VMs on a PM based on the processing and storage workloads of VMs. They are with the view that blind consolidation of virtual machines in a cloud data centre results in energy wastage and have proposed four models: the target system model, the application model, the energy model, and the migration model to find out the performance interferences between processor and disk utilizations and the costs of migrating VMs. The proposed scheduling algorithm packs a set of VMs to a set of PMs in a way to minimize the total power consumption in the whole data centre. Simulative results showed 24.9% power savings compared to two other methods. but slightly degraded the system performance by 1.2% in the worst case. In [4], authors have implemented a policy named MiyakoDori which uses "memory reusing" technique in VM live migration process. The memory image of the migrated VM is kept in the source machine even after its complete migration to the target machine. When the VM migrates back to the original machine later, the kept memory image will be "reused", i.e. memory pages which are identical to the kept pages will not be transferred. The results show that the proposed system: MiyakoDori significantly reduced the quantity of transferred memory of live migrations and reduced 87% of unnecessary energy consumption when used with dynamic VM consolidation system. A new VM placement policy called the minimum correlation coefficient (MCC) and a new VM selection policy called the meet performance policy (MP) have been proposed by authors in [5]. The correlation coefficient is used to represent the degree of association between a chosen VM and the target host. Greater is the correlation coefficient; greater is the influence on the performance of the other VMs, when the chosen VM is migrated to the target host. The results obtained are compared with traditional policies and it has been found that results obtained in case of proposed policies are better in three aspects: energy consumption, migration and SLA violation [1]. Gao et. al have proposed a multi-objective ant colony system algorithm whose main objective is to efficiently find a set of non-dominated solutions (the Pareto set) that reduce total resource wastage and power consumption [6]. The results obtained in case of proposed algorithm are better than multi-objective genetic algorithm and max-min ant system.

Li et al. propose a method in which an off-line VM placement is done through emulated VM migration, while the on-line VM placement is solved by a real VM migration process [7]. The VM is directly placed to the PM as long as it has enough capacity. Otherwise, if the migration constraint is satisfied, some other VM is migrated from the considered PM and the new VM is accommodated in its place. The performance comparisons with first fit and best fit show that results are better in case of the proposed method.

A novel policy has been proposed by Beloglazov and Buyya for VM consolidation, based on adaptive CPU Utilization thresholds, for cloud data centres [9]. The policy estimates the new CPU utilization threshold by finding the median absolute deviation value from the past CPU utilization history and automatically adjusts its CPU Utilization threshold on the basis of that. They evaluated their policy using the Planet Lab workload traces [10]. The proposed policy has been able to satisfy the requirements of users to a large extent.

A novel technique for dynamic load balancing with effective bin packing and VM reconfiguration (DLBPR) has been proposed by Komarasamy et al., [11]. The proposed technique assigns jobs to VMs on the basis of the processing speed. The main goals of the proposed policy were to process the tasks within their deadline constraint and to balance the load among the resources. The VMs are dynamically grouped into three categories according to their processing speeds: small, medium and large and the incoming client's requests are assigned to the most suitable VM in the group. In case of overloading of any of the groups, that group is dynamically reconfigured using receiver-initiated approach. The proposed methodology works in three tiers: (1) web tier, (2) schedule tier, (3) resource allocation tier. At an arbitrary time, the requests coming from the users are submitted to the web tier, which are forwarded to the scheduler tier. The job of the deadline-based scheduler tier is to classify and prioritize the incoming jobs which are further processed efficiently by VMs in the resource allocation tier. The proposed policy is implemented using CloudSim toolkit.

III. System Model

A vast scale server farm comprises of m heterogeneous servers which give IaaS to its customers. Every server in the data centre comprises of processor which has single or various processing components, called cores, whose processing limit is characterized in MIPS (millions of instructions per second), RAM, and system transmission capacity i.e. network bandwidth. The processing limit of a server or physical machine with 'a' no. of processing components in its processor, each having 'b' MIPS of processing power is computed as a*b MIPS. IaaS supplier has no earlier learning of sort and amount of workload. Different independent clients send their requests for making of ‘n’ heterogeneous VMs. The VMs are described by CPU power in MIPS, RAM and bandwidth capacity. As VMs are utilized for different purposes like HPC, stockpiling, web applications and so on and are overseen and claimed by different clients, a blended sort of workload is looked by cloud data centres. The data centre is capable of dealing with four kinds of VMs: High-CPU Medium Instance, Extra Large Instance, Small Instance and Micro Instance It has been supposed in this model that that the processing power of each considered VM instance must be less than or equal to processing power of a single CPU core of a physical machine.

IV. Proposed Policy: LML_VM$_S$

The virtual machine consolidation process consists of migration of virtual machines from target host to destination host for various reasons like saving energy, load balancing, maintenance etc. The primary focus of study is to balance the load among the resources in such a way to reduce the energy consumption and keeping SLA violation percentage to an acceptable level.

A novel VM selection policy named as **Least Migration Load Based VM Selection Policy** has been proposed in the present work which is quite different from the other traditional policies for VM selection. Figure 1 shows the working model of the proposed policy. The main objectives of the proposed policy are:

- To reduce the number of migrations in order to minimize the overall migration impact on the Data Centre and on its clients.
- To optimize the performance by taking into account the resource satisfaction aspect of VMs running on an overloaded host.

4.1 Least Deviation and Resource Satisfaction Aspect

The concepts of Least Deviation and Resource Satisfaction aspect of a VM have been used in designing the proposed LML based VM selection policy. By least deviation, it means to select that VM for migration whose migration leaves the Host machine’s CPU Utilization least deviated from the Upper CPU utilization threshold. This is done by selecting the most appropriate virtual machine from the over utilized host for migration. The most appropriate virtual machine is that whose migration reduces the percentage of host utilization less than but close to upper CPU utilization threshold of host.

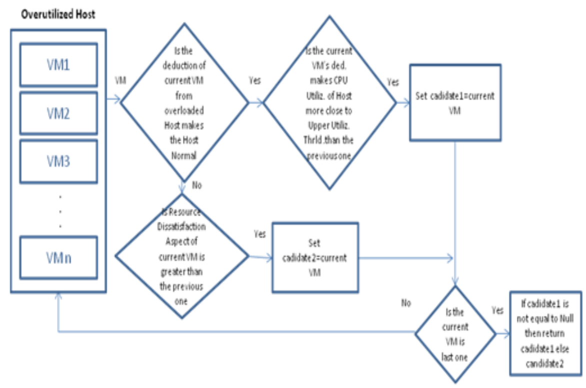


Figure 1 Model of LML_VM$_S$

The VM with the lowest resource satisfaction will get priority to be migrated. The resource satisfaction of VM is calculated as the ratio of the difference between resources requested & allocated and resources requested.

4.2 Steps in the Proposed VM Selection Policy

If **vmlist = {V_1, V_2, ..., V_n}** denote the list of VMs running on the over-utilized host H. The proposed VM allocation policy workss as follows:

Step 1. The host utilization **hUtilz** of over utilized host H is computed by dividing the total CPU Utilization of H by the total CPU Capacity of H.

Step 2. The host utilization **hUtilz_without_vm** of H without candidate VM, V_i’s share, is computed by subtracting CPU Utilization share of V_i in H from **hUtilz** and is compared with **Upper CPU utilization threshold** to check whether its migration makes the over utilized host normal or not.

Step 3. If hUtilz**_without_vm < Upper CPU utilization threshold**, it means that migration of candidate VM, V_i, makes the host H normal and V_i is set as **vm_to_migrate.** If **hUtilz_without_vm > Upper CPU utilization threshold,** it means **V_i**’s migration does not make the over utilized host normal.

Step 4. Step 2 is repeated for next VM, V_{i+1} in the vmlist. If V_{i+1}'s migration makes host H normal, then **hUtilz_without_vm value** in case of current VM, V_{i+1}, is compared with previous one, i.e. V_i and **vm_to_migrate** is set to that VM whose **hUtilz_without_vm** is more close to **Upper CPU utilization threshold.**

Step 5. Step 2 to Step 4 are repeated for all VMs in the vmlist. If **vm_to_migrate** is equal to null, it means no single VM migration makes the host H normal. Then resource satisification aspect, **VM_{RS}** of each VM in the vmlist is calculated according to equation I, below and **vm_to_migrate** is set to that VM whose **VM_{RS}** value is greatest.

VM_{RS} = (ReqdCPUMIPs-AllocatedCPUMIPs) / ReqdCPUMIPs

4.3 Algorithm: LML_VM_S Policy

Algorithm: Least Migration Load Based VM Selection Algorithm

Input:

migrtblevm_list	**List of Migratable VMs from the Over-Utilized Host**
host	**Over-Utilized Host.**
upper_threshold	**Upper CPU Utilization Threshold of Host**

Output:

vmtomigr **Virtual Machine to migrate**

1. initialize maxmetric= 0, vmtomigr1=Null,vmtomigr2=Null, ressatis=0
2. **for** each vm in the migrtblevm_list **do**
3. **If** (vm is in migration process) **then goto step number 2**
4. **end if**
5. **Compute** HUtiliz= (total_host_mips_utilization) / (total_host_mips)
6. **Compute** metric = (getCurrentReqdMipsByVM / getTotalHostMips) * 100
7. **Compute** HUtilizwithoutvm= HUtiliz – metric
8. **Compute VM_{RS}=(MIPSrequested-MIPSallocated)*MIPSrequested**
9. **If** (HUtilizwithoutvm < upper threshold) **then**
10. **If** (HUtilizwithoutvm >maxmetric) **then**
11. maxmetric= **HUtilizwithoutvm**
12. vmtomigr=vm
13. **end if**
14. **Else**
15. **If (VM_{RS}>ressatis) then**
16. **ressatis=VM_{RS}**
17. **vmtomigr2=vm**
18. **end if**
19. **end if-else**
20. **end for**
21. **if (vmtomigr1==Null) then**
22. **return** vmtomigr2
23. **else**
24. **return vmtomigr1**

V. Performance Metrics

5.1 SLA violation Time Per Active Host: The utilization of host above the upper CPU utilization threshold and below the lower CPU utilization threshold caters to performance degradation and also violates SLAs. Hence VMs are migrated from over-utilized and under-utilized hosts to keep the CPU utilization between the set upper and lower CPU utilization thresholds. The Time fraction during which a VM is in the state of migration. The time fraction for which available host MIPS are less than the requested MIPS, there is SLA violation for that time period. The SLA violation time per active host is calculated as:

$$\textbf{SLAViolTAH} = \frac{1}{N}\sum_{i=1}^{N}\frac{T_{s_i}}{T_{a_i}}$$

where N is the no. of hosts, T_{si} is the total time for which the host i has experienced the shortage of CPU MIPS and T_{ai} is the total time for which the host i remains in the active state.

5.2 Migration Time: The two important parameters which contributes to migration time of a VM are 'm_i' (the total memory used by the VM) and 'bi'available network bandwidth. It is the time taken to complete the migration of virtual machine from source machine to destination machine. Let vm_i be the virtual machine having mi as amount of RAM and b_i as available bandwidth, which is to be migrated. Time taken for migration , denoted by Tm_i, is calculated as :

$$T_{m_i} = \frac{m_i}{b_i}.$$

In the present work, it is assumed that half of the total available bandwidth is used for migration purpose and other half is used for VM communication.

5.3 Migration Overhead: VM migration puts extra load on overall CPU utilization of a machine and sometimes increases the SLA violation. It can be calculated as some fraction of CPU utilization overhead because of migration and is estimated about 10% of CPU utilization. It is calculated as below:

$$U_{d_i} = 0.1 * \int_{t_0}^{t_0+T_{m_i}} u_i(t)\,dt$$

Where U_{d_i} is the overall utilization overhead by migration of vm_i, t_0 is the starting time of migration, $u_i(t)$ is the CPU utilization of vm_i.

5.4 Performance Degradation Due To Migration (PDM)

The migration of a virtual machine puts extra load and hence, it is necessary to lessen the quantity of VM migrations as much as possible. Performance degradation due to migration is calculated as:

PDM = $\frac{1}{m}\sum_{j=1}^{m}\frac{C_{d_j}}{C_{r_j}}$ where m is the no. of VMs, C_{d_j} is the evaluator of performance degradation because of VM migration and is assumed as 10% of the CPU utilization during the all migrations VM_j and C_{r_j} is the overall CPU capacity requested by VM_j during its lifetime.

5.5 SLA violation (SLAV)

It is the time slab during which quality of service agreement is not fulfilled by the cloud service provider and hence results in SLA violation. It is calculated as:

SLAV= SLAViolTAH * PDM

5.6 Energy-Violation Metric (EVM)

EVM is calculated as: **EVM= EC *SLAV,** where EC is the overall energy consumption of the data centre and SLAV is the overall SLA violation rate in the data centre. This metric calculates Energy -Violation level of the data centre

VI. Performance Evaluation

6.1 Experimental Setup

It is quite cumbersome and expensive to evaluate the performance of proposed policies in real world environments. It is very challenging to have a real test bed to carry out experiments in a repeatable manner so we have used CloudSim for modelling and simulation of cloud computing environments. The simulation experiment has been conducted on a single computer using Cloudsim -3.0.3 on Eclipse SDK. [8]. The hardware configuration of the computer is shown as follows: Intel(R) Core(TM) i5-3770 CPU @ 3.40 GHz, the OS is Windows 8, RAM is 8 GB and its system architecture is 64bit. The cloud scenario that was created for experimentation consists of one data centre with 800 heterogeneous hosts. The two systems which have been modelled in the present study are: HP ProLiant ML110 G4 and HP ProLiant ML110 G5. The frequencies of the servers CPUs were mapped onto MIPS ratings: HP ProLiant ML110 G4 consists of 1860MIPS Processing Speed, 2 Processing Elements, 4 GB RAM, 1 Gbits/s Bandwidth, 1 GB Storage and HP ProLiant ML110 G5 consists of 2660MIPS Processing Speed, 2 Processing Elements, 4 GB RAM, 1 Gbits/s Bandwidth, 1 GB Storage. Four types of Virtual Machine instances, considered for simulation are: i) High-CPU Medium Instance (2.5 EC2 Compute Units i.e. 2500MIPS, 0.85 GB RAM), ii) Extra Large Instance (2 EC2 Compute Units i.e. 2000MIPS, 3.75GB RAM), iii) Small Instance (1 EC2 Compute Units i.e. 1000MIPS, 1.7 GB RAM) and iv) Micro Instance (0.5 EC2 Compute Units i.e. 500MIPS, 0.633 GB RAM).

The sample workloads that have been used for the execution assessment of suggested model have been taken from the CoMon venture, an observing framework for PlanetLab. The workload traces comprise of CPU usage of thousands of virtual machines running on various physical machines situated at distinct places in various topographical territories of the world, which have highlights like large data volume, various data types, low value density and fast processing speed.

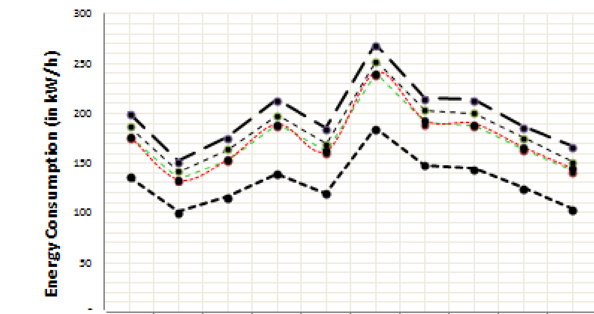
6.2 Power Consumption Model: The power used by a server in a server farm is, for the most part, reliant on the CPU, disk storage power supplies, memory and cooling arrangement of the server. A cloud data centre consists of virtualization innovation, various compute nodes having extensive lumps of memory; influences the overall power utilization of cloud significantly (Minas and Ellison, 2009). It is exceptionally hard to logically model such complex frameworks for power utilization. In the present study, the genuine information on power utilization is used from the outcomes gave by the SPECpower benchmark (Lange 2009).

6.3 Results and Discussions

We have re-enacted the proposed policy using workload traces from CoMon project, an undertaking of PlanetLab, in combination with the estimator S_n based overload detection policy [13].

6.3.1 Energy Consumption Evaluation

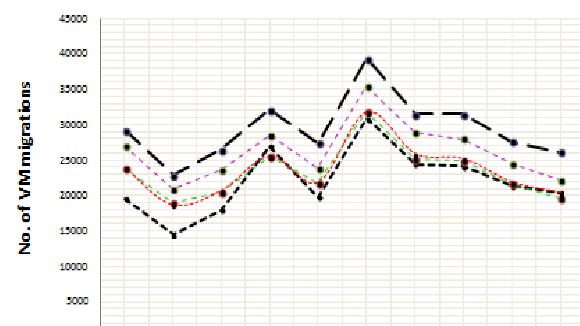
Figure 2 depicts the energy consumption of Cloud Data Centre under five different policy combinations. As consolidation of VMs consists of Host Overload Detection, VM Selection and VM Placement, the proposed framework for VM consolidation consists of three proposed policies: Sn Estimator based Host Overload detection Policy, Least Migration Load based VM Selection Policy and Proportionate Resource Utilization based VM Placement Policy. The proposed approach is compared with four traditional VM consolidation approaches such as Mad_Mmt, Mad_Mu, Mad_Mc & Mad_Rs . The experimental results for each combination have been obtained from simulation runs after considering 10 days cloud workload from PlanetLab. The time interval considered in the present experiment is 300 sec., and safety parameter is 2.5. In 2, five curves show the energy consumed by the data centre under five considered policy combinations and solid points on the curves show energy consumed by a particular combination on particular day. Noticeably, S_nBODA_LML can save energy greatly. The energy consumption is maximum in case of Mad_Mu.



Dates of workload traces →	20110303	20110306	20110309	20110322	20110325	20110403	20110409	20110411	20110412	20110420
SnBODA	136.63	100.94	116.66	139.53	120.02	185.87	148.68	144.25	124.73	104.62
MadMc	176.99	133.59	153.81	188.9	161.71	240.28	190.6	188.54	164.14	142.17
MadMmt	186.98	141.34	163.99	197.69	169.62	252.5	203.33	200.15	175.27	151.68
MadMu	200.09	151.88	176.55	214.27	186.16	270.31	215.96	214.01	187.47	167.62
MadRs	176.98	133.38	154.39	189.27	162.7	240.82	193.04	189.7	166.06	145.32

Figure 2: Energy Consumption of Data Centre using Real Workload Traces

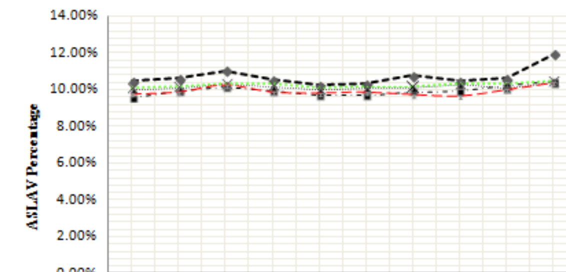
6.3.2 Figures 3 illustrates the no. of VM migrations in the data centre. The curves in the figure show that migrations are maximum in case of Mad_Mu policy and minimum in case of the proposed policy. There are two points in the graph where the performance of Mad_Mc & Mad_Rs islittle better than the proposed policy. On 22032011,, the no. of migrations is 5.53% and 5.49% more in case of proposed policy than Mad_Mc and Mad_Rs policy, respectively and on 20042011, it is 3.86% and 0.57% more in case of proposed policy than Mad_Mc and Mad_Rs policy, respectively. In rest eight points on the graph, the no. of VM migrations are minimum in case of the proposed policy. As migrations in a data centre incur extra load, decrease in no. of migrations, results in better performance and decrease in energy consumption.



Dates of workload traces →	20110303	20110306	20110309	20110322	20110325	20110403	20110409	20110411	20110412	20110420
SnBODA	19610	14481	17904	26962	19825	30954	24496	24080	21461	20492
MadMc	23924	18996	20410	25469	21718	31933	25179	24948	21625	19700
MadMmt	26928	20853	23587	28508	23832	35464	28888	27916	24482	22146
MadMu	29302	22929	26469	32249	27412	39424	31623	31476	27637	26161
MadRs	23937	18632	20658	25481	21824	31806	25855	25154	21863	20375

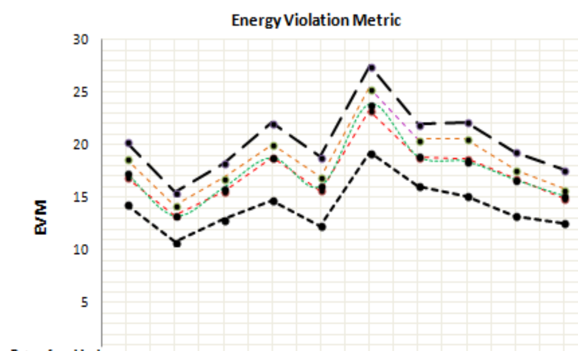
Figure 3: Number of VM Migrations in a Data Centre using Real Workload Traces

6.3.3 Figure 4 illustrates the Average Service Level Agreement Violation in the cloud data centre for the considered five policy combinations. It is clear from the figure that there is slight increase in ASLV in case of proposed policy as compared to other four policy. The increase in ASLV is obvious because the SLAV and Energy Consumption are inversely proportional to each other. Thus, reduction in energy consumption of the data centre results in increase in SLA violation.



Dates of workload traces →	20110303	20110306	20110309	20110322	20110325	20110403	20110409	20110411	20110412	20110420
SnBODA	10.46%	10.63%	11.05%	10.56%	10.24%	10.35%	10.79%	10.48%	10.62%	11.95%
MadMc	9.56%	9.91%	10.11%	9.93%	9.66%	9.69%	9.87%	9.90%	10.20%	10.47%
MadMmt	10.01%	10.10%	10.29%	10.16%	10.00%	10.06%	10.09%	10.27%	10.07%	10.41%
MadMu	10.13%	10.20%	10.35%	10.30%	10.11%	10.18%	10.16%	10.35%	10.30%	10.51%
MadRs	9.78%	9.89%	10.27%	9.89%	9.84%	9.89%	9.76%	9.68%	10.01%	10.38%

Figure 4: ASLAV using Real Workload Traces



Dates of workload traces →	20110303	20110306	20110309	20110322	20110325	20110403	20110409	20110411	20110412	20110420
SnBODA	14.291498	10.729922	12.89095	14.734568	12.290048	19.257545	16.042572	15.1174	15.246526	12.50209
MadMc	16.920244	13.258769	15.550191	18.75777	15.621186	23.285152	18.81222	18.66546	16.74228	14.885199
MadMmt	18.716698	14.27534	16.874571	20.085504	16.962	25.4015	20.515997	20.555405	17.649689	15.789888
MadMu	20.269117	15.49176	18.272925	22.06981	18.820776	27.517558	21.941536	22.150035	19.30941	17.616862
MadRs	17.308644	13.191282	15.855855	18.718803	16.00968	23.817098	18.840704	18.36296	16.622606	15.084216

Figure 5: Energy Violation Metric using Real Workload Traces

6.3.4 Energy-Performance Metric Evaluation

Figure 5 depicts the Energy-Performance Metric in case of five different policy combinations. The results of Energy-Performance Metric in case of the proposed policy are best among other four considered policy combinations and results are worst in case of Mad_Mu. The EPM is an aggregative statistic to evaluate policy's energy-performance level with energy consumption and SLAV. As we know that in a green data centre, there is negative correlation between the energy consumption and service level agreement violation. A good energy-efficiency policy in a data centre should get the lowest EPM value when compared with other policies.

		Percentage Change in the Value of Parameters in case of SnBODA LML PRU as compared to other Combinations			
Comparison		mad_mmt	mad_mu	mad_rs	mad_mc
S_nBODA_LML_PRU	Energy Consumption	28.26% ↓	33.38% ↓	24.54% ↓	24.06% ↓
	Number of Migrations	16.12% ↓	25.25% ↓	6.50% ↓	5.83% ↓
	ASLAV	5.23% ↑	4.20% ↑	7.19% ↑	7.28% ↑
	Energy Violation Metric	24.38% ↓	30.66% ↓	18.81% ↓	18.20% ↓

Table 1: Comparison of Results of Proposed Framework with other Policy Combinations

The EVM value is 18.20% more in case of Mad_Mc as compared to proposed policy, 18.81%, 24.38% and 30.66% more in case of Mad_Rs, Mad_Mmt & Mad_Mu respectively as compared to the proposed policy.

VII. Conclusion

The main thirst behind the work is to come up with an optimal VM Selection Policy that optimizes the results in terms of energy consumption, no. of migrations, SLA violations by efficient resource utilization of data centre as compared to other traditional policies. In this paper, we design a new VM selection policy (LML) which minimizes the frequency of migrations and considers the resource satisfaction aspect of VM before migration. The adoption of least migration load based VM selection policy reduces the frequency of VM migrations greatly and consideration of resource satisfaction aspect decreases the violation rate of SLA The proposed LML_VM_S based VM selection policy produces better results as compared to MMT, MU and RS Policies for VM selection. Although the proposed policy has better performance in the simulated environment, we still do not know their effects in a real cloud infrastructure. In future work, we will extend them to a real-world cloud environment like OpenStack in order to evaluate the proposed policy.

References

1. Mastroianni, C., Meo, M., & Papuzzo, G. (2013). Probabilistic consolidation of virtual machines in self-organizing cloud data centers. *IEEE Transactions on Cloud Computing*, *1*(2), 215-228.
2. Kim, K. H., Beloglazov, A., & Buyya, R. (2009, November). Power-aware provisioning of cloud resources for real-time services. In *Proceedings of the 7th International Workshop on Middleware for Grids, Clouds and e-Science* (p. 1). ACM.
3. Jiang, J., Feng, Y., Parmar, M., & Li, K. (2016). FP-ABC. *Scientific Programming*, *2016*, 13.
4. Sharifi, M., Salimi, H., & Najafzadeh, M. (2012). Power-efficient distributed scheduling of virtual machines using workload-aware consolidation techniques. *The Journal of Supercomputing*, *61*(1), 46-66.
5. Akiyama, S., Hirofuchi, T., Takano, R., & Honiden, S. (2012, June). Miyakodori: A memory reusing mechanism for dynamic vm consolidation. In *Cloud Computing (CLOUD), 2012 IEEE 5th International Conference on* (pp. 606-613). IEEE.
6. Fu, X., & Zhou, C. (2015). Virtual machine selection and placement for dynamic consolidation in Cloud computing environment. *Frontiers of Computer Science*, *9*(2), 322-330.
7. Gao, Y., Guan, H., Qi, Z., Hou, Y., & Liu, L. (2013). A multi-objective ant colony system algorithm for virtual machine placement in cloud computing. *Journal of Computer and System Sciences*, *79*(8), 1230-1242.
8. Li, K., Zheng, H., & Wu, J. (2013, November). Migration-based virtual machine placement in cloud systems. In *Cloud Networking (CloudNet), 2013 IEEE 2nd International Conference on* (pp. 83-90). IEEE.
9. R. N. Calheiros, R. Ranjan, A. Beloglazov, C.A. F. De Rose, and R. Buyya, "CloudSim: a toolkit for modeling and simulation of cloud computing environments and evaluation of resource provisioning algorithms, "Software: Practice and Experience, vol. 41, no.1, pp.23–50,2011.
10. A. Boglazov, Energy-Efficient Management of Virtual Machines in Data Centres for Cloud Computing, The University of Melbourne, Victoria, Australia, 2013.
11. PlanetLab,http://planet-lab.org/.
12. Beloglazov, A., & Buyya, R. (2010, May). Energy efficient resource management in virtualized cloud data centers. In *Proceedings of the 2010 10th IEEE/ACM international conference on cluster, cloud and grid computing* (pp. 826-831). IEEE Computer Society.
13. Bala, M., & Padha, D. (2017). An Adaptive Overload Detection Policy Based on the Estimator S_n in Cloud Environment. *International Journal of Service Science, Management, Engineering, and Technology (IJSSMET)*, *8*(3), 93-107.

