July – August 2020
ISSN: 0193-4120 Page No. 565 - 569

# An Empirical Study on Server Consolidation Process in Cloud Computing Environment

Dhaval R. Gandhi*1, Bakul B. Panchal2, Dubendu S. Singh3
*[1]Information Technology Department, L.D. College of Engineering, Ahmedabad, Gujarat, India
dhavalgandhi88@gmail.com
[2] Information Technology Department, L.D. College of Engineering, Ahmedabad, Gujarat, India
bakul.panchal@gmail,com
[3] Information Technology Department, L.D. College of Engineering, Ahmedabad, Gujarat, India
singhdubendu222@gmail.com

***Article Info***
***Volume 83***
***Page Number: 565 - 569***
***Publication Issue:***
***July - August 2020***

***Article History***
***Article Received**: 06 June 2020*
***Revised**: 29 June 2020*
***Accepted**: 14 July 2020*

**Abstract**

Cloud computing is an on demand resources based computing model. This requires large amount of physical resources to provide services to the users on the basis of pay per usage model. So immoderate demand of cloud computing resources has been increase in computational power. Virtualization plays an important role in reducing energy consumption. Server consolidation approach involves gathering of several virtual machines into a single physical server. Server consolidation provides a better approach to save energy and to improve resource utilization in data centers, but the aggressive consolidation of virtual machines may lead to service-level agreement (SLAs) violations. It establishes the Quality of Service (QoS) agreed between service-based systems. Therefore, our goal is to minimize energy consumptions and reduces SLA violations. it is very meaningful to strike a tradeoff between energy efficient and reduction of SLA violations. This paper critically examines and discusses the various algorithms that use in server consolidation process and compare them on the basis of energy consumption and SLA violations.

**Keywords:** Cloud Computing, Virtualization, Server Consolidation, Energy efficient, SLA violations

## I. INTRODUCTION

Cloud computing is a technology which is used everywhere now a days. It is a most widely used technology in IT and research field. Before cloud computing everyone requires their own computing resources at their location with management IT teams. Up-gradation or replacement of hardware resources is recurring issue. Capital expenditure and operational expenditure are managed by owner of an organization. While, with the help of cloud computing technology, scenario is changed completely. Cloud removes the overhead of maintenance or replaces the resources of the any organization by providing resource in the form of different categories of services on lease [1].

Cloud computing provide a three types of services IaaS (Infrastructure as a Service), PaaS (Platform as a Service), SaaS (Software as a Service). Client has to select appropriate service for their respective business and service provider must have to provide quality service for improve the profit of client at maximum. Cloud computing provide a four types of clouds public cloud, private cloud, community cloud, hybrid cloud.

Virtualization is a technology which is being widely used in today's world and provides excellent operational and financial results. It allows creating multiple VMs on a single host/physical machine or server. Thus virtualization helps in proper and efficient resource utilization and also increasing in Return on investment. Basic approach of switching ideal nodes to low power nodes is also used under virtualization for reducing energy consumption and improving resource utilization is known as server consolidation which is an essential part of resource management of virtualized data centers. Through live migration, VMs are dynamically consolidated resulting in very less fluctuations in the workload and the number of active physical servers are minimum most of the times [2].

The main problem with energy efficient model in Cloud computing is to minimize both energy consumption and SLA violations. To solve this problem of energy efficient model, we divide servers into two states 1) Host under utilization and 2) Host over utilization. When a host is underutilized, VMs are migrated from that host so that this underutilized host can be switched off in order to minimize the number of active



*Published by: The Mattingley Publishing Co., Inc.*

*July – August 2020*
*ISSN: 0193-4120 Page No. 565 - 569*

hosts. When a host is over utilized appropriate VMs are

selected and migrated to another host to avoid performance degradation which further leads to SLA violations and violation of the QoS requirements [2].
Rest of the paper is organized as follows. In Section II we discuss Background theory about server consolidation process; Section III covers previous related work and summary of the same. Section IV contains comparison of algorithms using WorkflowSim. Finally, the conclusion and future work is addressed in Section V. Section VI provides references.

## II. Background Theory

Server consolidation is a used to reduce total number of servers by facilitating better use of the available data centre resources. It has two types 1) statically and 2) dynamically.

In static server consolidation all physical resources are allocated to VMs. It is based on top load demand. It is not a good practice because resources are wasted all time. In dynamic server consolidation is based on workload variations at specific time interval and migration process is done here. This helps in utilizing the data centres resources efficiently [2], [3].

The basic challenges for efficient server consolidation can be summarized as follows:

Host under-load detection: if a host is under loaded so that all VMs from that host should be migrated to other host and this under loaded host should be put on sleeping mode.

Host overload detection: if a host is overloaded so that selecting appropriate VMs should be migrated from overload host to other active host to avoid SLA violations.

VM selection and migration: Selecting appropriate VMs to migrate from overloaded host or all VMs to migrate from under loaded host and migrating that selected VMs with minimum service downtime during this migration process.

VM placement: By placing appropriate VMs that selected for migration on other active hosts. It is most important challenge of server consolidation process. This placement should consider multiple resources such as memory, CPU and network bandwidth to reduce energy consumption and overall SLA violations [11].

Figure1 shows process of server consolidation. It has three Hosts A, B and C. Host A has only one VM, HOST B has two VMs and HOST C has three VMS. HOST A consumes low power, so we have to migrate that one VM from HOST A to another host and put HOST A to sleep mode. HOST B has average temperature and HOST C has high temperature, so HOST B is best host for migration so we put that one VM of HOST A to HOST B and power off the HOST A. HOST C also has four VMs so selecting appropriate VM from HOST C and put that selected VM to HOST B. In this way here demonstrate process of server consolidation which minimizes overall energy consumption.

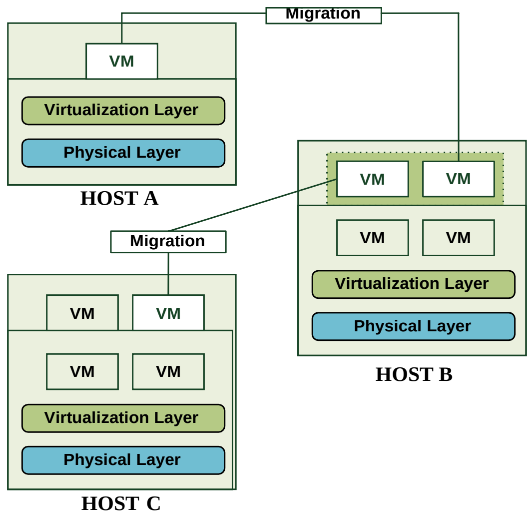


Figure 1 Server consolidation process

### A. Energy consumption model and SLA violations metrics

1) Energy Consumption: Energy Consumption of ith DC can be defined as a function of energy consume by the servers which is given below.

$$E_i = \quad E_i^k \tag{1}$$

Now, energy consumed by server is introduced in [9] and is defined as below.

$$E_k = E_{idle} + E_{max} - E_{idle} * (U_k^i) \tag{2}$$

Where, $E_{idle}$ is the idle energy consume by the $k^{th}$ server, $E_{max}$ is the maximum energy that $k^{th}$ server can consume. The level of utilization of $k^{th}$ server of $i^{th}$ DC depend on the amount of resources consumed (Rk (t)) at time t and maximum capacity of processor ($R_{max}$k) and is given as below:

$$U_k^i = ( R_k (t) / R_{max} k)) * 100 \tag{3}$$

2) *SLAV (SLA Violations)*: *SLAV* provides the combination of both metrics *SLATPAH* and *PDM*. This two metrics is introduced in [5] and is defined as below.

$$SLAV = SLATPH \times PDDM \tag{4}$$

SLATPH (SLA Violation Time per Active Host):


*Published by: The Mattingley Publishing Co., Inc.*

July – August 2020
ISSN: 0193-4120 Page No. 565 - 569

SLATPH is defined in equation 5. It represents percentage of time due to over utilization of host in data

centres. In equation 5 , M represents number of host in data centres, $T_{ol}^{i}$ represents the total time when host machine i is overloaded and $T_{ah}^{i}$ represents total time for which host i remains active.

$$SLATPH = \frac{1}{M}\sum_{i=1}^{M}\frac{T_{ol}^{i}}{T_{ah}^{i}} \quad (5)$$

PDDM (Performance Degradation during Migration): PDDM is defined in equation 6. It represents the performance degradation during vm to PM migration. In equation 6, N represents number of virtual machines in data centres. $C_{d}^{j}$ represents decrease in performance due to jth virtual machine migration. Usually it will degrade approximately 10% of CPU computing power. $C_{r}^{j}$ represents required total CPU capacity by jth virtual machine.

$$PDDM = \frac{1}{N}\sum_{j=1}^{N}\frac{C_{d}^{j}}{C_{r}^{j}} \quad (6)$$

## III.RELATED WORK

The main purpose of this study is to reduce energy consumption and guarantee QoS. This section critically examines and reviews methods of challenges faced in server consolidation process for minimizing energy consumption and SLA violations.

Shahzad, S et .al [4] proposed a Best Fit Decreasing based on Fuzzy TOPSIS method. It is Multi Criteria Decision Making techniques for server consolidation. It consists of two algorithms. First algorithm is used to find overloaded nodes at upper level threshold (peak load). Second algorithm is used to find under loaded host at lower-level threshold and putting idle server to sleep state. The proposed algorithm significantly reduces energy consumption.

Oshin Sharma, H et. al [5] proposed median based dynamic threshold approach based on history of resource usage to find out under utilization and over utilization host for minimizing energy consumption and reduces SLA violation and performance degradation. The proposed algorithm greatly reduces SLA violations.

Abdel, N et.al [6] proposed an optimized energy and SLA aware VM placement algorithm that dynamically places a VM-to-PM mapping using utility function. This function considers total income subtracted by addition of estimated energy cost, SLA violation cost and degradation cost. It will consist of five algorithms. First algorithm compares candidate and currentassignment using fitness function, after that estimated cost is found. Finally modified genetic algorithm is applied. The proposed algorithm provides better VM placement in less execution time.

Rahul Yadav, W et. al [7], proposed GDR (Gradient Decent Based Regression) adaptive energy aware algorithm based on robust regression. It is used to find overload host. GDR calculates upper CPU utilization threshold based on historical dataset of CPU utilization. It will use safety parameter for this purpose, After finding overloaded host BW (Bandwidth aware) algorithm to select VM from that overloaded host whose current utilization and total migration time is minimum than others. It will use available bandwidth and bandwidth transfer component for this purpose. The proposed algorithm considers cpu, memory and network traffic factor which improves energy consumption.

Xijia Zhou, K et. al [8] proposed an experience based scheme in which an EFA(Empirical forecast algorithm) uses to predicts the future state of host by analysing historical data of host. Here, CPU utilization threshold is given as the median absolute Deviation (MAD) which is a robust statistic that handles outliers in the dataset is more elastic than the standard deviation. A weight priority algorithm (WPA) is proposed to determine the priority of migratable VMs on an overloaded host. This algorithm assigns weights by using λ known as weighting factor to the several recent utilization factors of a VM. The proposed algorithm gives better performance in terms of energy consumption and SLA violations.

Hui Wang, H et. al [9] propose a new framework of DVMC (Dynamic Virtual Machine Consolidation) towards green cloud computing approach. In proposed system VM selection is based on High CPU utilization based migration (HS) and VM placement policy known as space aware best decreasing (SABFD).First, VM migration considers that VM having highest CPU utilization (HS) in the over loaded host will be selected first. If host is still overloaded then second highest CPU utilization VM is selected. In SPABFD, all VMs are sorted in decreasing order of their CPU utilization, and then the host with minimum available MIPS is selected as a best host after VM placing on that particular host. The proposed algorithm significantly reduces number of

July – August 2020
ISSN: 0193-4120 Page No. 565 - 569

VM migrations overall good performance on host shut down.

Ehsan, H et. al [10] proposed a TOPSIS Power and SLA Aware Allocation (TPSA) policy is used. TPSA consider five criteria for detection of host overload such as power increase, number of VMs, available capacity, migration delay and resource correlation. Based on these criteria overloaded host is found for the host who have highest score. TACND policy used for detection of under loaded PM. It considers three criteria such as number of VMs on the PM, migration delay and available capacity of PM. These policies have better performance in simulated environment but allocation of VMs to hosts considered equal weights of parameter which is not same for all time.

Table 1 summarized different techniques used for different challenges faced by server consolidation process.

TABLE I
SUMMARY OF DIFFERENT TECHNIQUES USED FOR SERVER CONSOLIDATION

| Related Work | Host Overload | Host Under load | VM selection | VM Placement |
|---|---|---|---|---|
| Shahzad, S[4] | TOPSIS | TOPSIS | BFD | - |
| Oshin Sharma, H[5] | Median Based Threshold | Median Based Threshold | - | - |
| Abdel, N [6] | - | - | Modified Genetic | Modified Genetic |
| Rahul Yadav, W [7] | GDR | - | BW | PABFD |
| Xijia Zhou, K [8] | EFA | - | WPA | - |
| Hui Wang, H [9] | - | - | HS | SPABFD |
| Ehsan, H [10] | TPSA | TACND | - | MBFD |

## IV. COMPARISON OF ALGORITHM USING WORKFLOWSIM

WorkFlow Sim provides numerous parameters that evaluate the energy efficiency of technique along with SLA-awareness and network performance. In WorkFlow Sim evaluation of proposed techniques carried out on the basis of parameters, such as, energy consumption, performance degradation due to migration, SLA violations, number of VM migrations.

In order to make simulation based evaluation applicable, we ran our experiments using real life workload traces of data centre servers, which are applicable to real cloud environments. To ensure compatibility and validity we simulate algorithms under in two kinds of workload.

1) Random Workload: Here random function generates a set of workload automatically as a cloudlet is known as random workload. It contains 50 numbers of VMs and 50 numbers of hosts.

2) PlanetLab Workload: It is real workload data provided by PlanetLab as part of the CoMon project. In this project, CPU utilization data is obtained from thousand VMs of servers. The data is stored in 10 different files. We selected one day data tracking data set of PlanetLab for the date 03/03/2011 which contains 1052 numbers of heterogeneous VMs and 800 heterogeneous hosts. The detail characteristic of host and VM is given in following section.

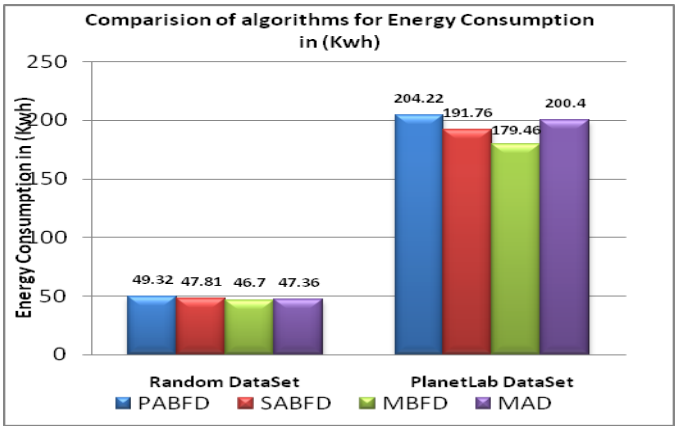


Figure 2 Comparison of algorithms for Energy consumption in (Kwh)

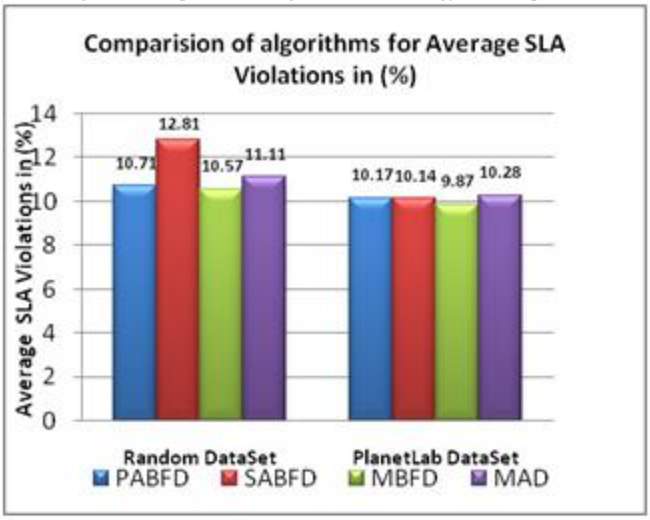


Figure 3 Comparison of algorithms for Overall SLA Violations (%)

Figure 2 is depict using Random datasets and PlanetLab dataset. Random dataset contains 50 numbers of VMs and



Published by: The Mattingley Publishing Co., Inc.

50 numbers of hosts. PlanetLab dataset contains 1052 number of VMs and 800 hosts. It shows various existing VM placement techniques such as MBFD, PABFD, SPABFD, and MAD.

Figure 3 is depict is using Planet Lab dataset that contains 1052 VMs and 800 Hosts. It shows comparison of simulation results of Average SLA Violations (%) of MBFD, PABFD, SPABFD, and MAD algorithms.

## V. CONCLUSION

It is a challenge for Cloud providers to balance between reduction in energy consumption and SLA violation. A various algorithms are discussed here which is used in server consolidation process. As shown in Figure 2 and 3 we conclude that modified best fit decreasing (MBFD) algorithm outperform all other algorithm. But MBFD had drawbacks of significantly increases overall SLA violations. We have proposed an idea for VM selection and placement which is based on minimum utilization of VM. By selecting VM with minimum utilization will give you less SLA violation and thus we can balance both energy consumption and SLA violations. For the future work we will try to implement this proposed idea using planet Lab Dataset in WorkflowSim.

## VI. REFERENCES

[1] Qi Zhang, Lu Cheng, RaoufBoutaba (2010), *"Cloud computing: state-of-the-art and research challenges",* The Brazilian Computer Society 2010, Springer, pp.7-18.

[2] AmanyAbdelsamea, Elsayed E. Hemayed, HeshamEldeeb, and HananElazhary (2014), "Virtual Machine Consolidation Challenges: A Review", Article in International Journal of Innovation and Applied Studies.

[3] Peter Mell, Tim Grance, et al. (2011), "The NIST definition of cloud computing".

[4] Shahzad Ali, Siyuan Jing and Kun She (2012), "Energy Efficient Cloud Data Center Management Based on Fuzzy Multi Criteria Decision Making", Proceedings of the Sixth International Conference on Management Science and Engineering Management, Springer, London, volume 15, page(s)355-370.

[5] Oshin Sharma and Hemraj Saini (2016), "VM Consolidation for Cloud Data Center using Median based Threshold Approach", International journal of Elsevier Procedia Computer Science volume-89 Page 27– 33.

[6] AbdelkhalikMosa and Norman W. Paton (2016), "Optimizing virtual machine placement for energy and SLA in clouds using utility functions", Springer, Journal of Cloud Computing, Advances, Systems and Application, volume 5, page 17.

[7] Rahul Yadav, Weizhe Zhang, OmprakashKaiwartya, PrabhatRanjan Singh, Ibrahim A. Elgendy and Yu-chu Tian (2018), "Adaptive Energy-Aware Algorithms for Minimizing Energy Consumption and SLA Violation in Cloud Computing", IEEE Access volume 6,page(s)55923-55936.

[8] Xijia Zhou, Kenli Li, Chubo Liu and Keqin Li (2019), "An Experience-Based Scheme for Energy-SLA Balance in Cloud Data Centers", IEEE Access Volume 7, page(s) 23500-23513.

[9] Hui Wang and HuagloryTianfield (2018), "Energy-Aware Dynamic Virtual Machine Consolidation for Cloud Data centers", IEEE Access-Volume 6, page(s) 15259-15273.

[10] Ehsan Arianyan, Hassan Taheri, Saeed Sharifian (2015), "Novel energy and SLA efficient resource management heuristics for consolidation of virtual machines in cloud data centers", Article in International Journal of Elsevier Computers and Electrical Engineering 47, 222–240.

[11] R.Yadav, and W.Zhang (2017), "MeReg: Managing energy-SLA tradeoff for green mobile cloud computing", Wireless Commun. Mobile Comput., Art. no. 6741972.