A Green Computing Supportive Allocation Scheme Utilizing Genetic Algorithm and Support Vector Machine

Gurpreet Singh, Manish Mahajan

Abstract*: *Green Computing leads to energy-aware computation. When a Physical Machine gets a job from user, it intends to complete it at any cost. Virtual Machine (VM) helps to attain maximum completion ratio. The Host to VM ratio increases with the increase in the workload over the system. The allocation policy of VM has ambiguities with leads to an overloaded Physical Machine (PM). This paper aims to reduce the overhead of the PMs. For the allocation, Modified Best Fit Decreasing (MBFD) algorithm is used to check the resources availability. For the allocation, Modified Best Fit Decreasing (MBFD) algorithm is used to check the resources availability. Genetic Algorithm (GA) has been used to optimize the MBFD performance by fitness function. For the cross-validation Polynomial Support Vector Machine (P-SVM) is used. It has been utilized for training and classification and accordingly, parameters, viz. (Service Level Agreement) SLA and Job Completion Ratio (JCR) are evaluated. A comparative analysis has been drawn in this article to depict the research work effectiveness and an improvement of 70% is perceived.

Key words: Green Computing, VM Allocation, MBFD, GA, SLAV, JCR

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I. INTRODUCTION

Clouds are a huge pool of virtualized and physical resources available (like; storage, CPU and network bandwidth, etc.) [1]. These resources could be re-allocated dynamically for the adjustment to varied load to gain the benefit of resource utilization. High performance is required for the data centres that can only be fulfilled without giving more attention in terms of energy consumption which is enhancing quickly [2]. With this consideration, depicting the significance of energy consumption reduction is also important, so, a novel concept termed as Green computing is introduced. Green computing is considered as environmentally feasible computing [3]. It is the research of using the computing resources in an effective and eco-friendly manner. The aim of green computing includes:

a) Enhancement of power management and energy efficiency practices
b) Enhancing the efficiency of hardware usage
c) Reduction in life-cycle cost
d) To discover the ways to lessen the computer wastes

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While there are huge problems that come up from high energy consumption, starting from high energy bills in data centres, to raise environmental concerns and an increase of system failures [4]. That's why infrastructure providers are under massive pressure to decrease the consumption of energy, the goal is not only to reduce data centres' energy cost but also to meet government rules and environmental standard.

The purpose of green computing is to lessen the usage of risky materials, to maximize energy efficiency throughout the life of the product, and to encourage the imbalance or biodegradability of non-destructive products and plant wastes [5]. Green computing also tries to improve the performance and usage of the system while achieving economic and physical-economic benefits, complying with social and ethical responsibilities [6]. It also offers energy-saving solutions at different levels. The pros of a green computer are numerous. It is not only from the client or the business or the countries point of view but an inclusive advantage. It assists in reducing the energy waste, cost and the demands to utilize the technology that helps to affect the environment [7].

Green design involves the synthesis of environment-friendly products with design and efficiency. During the literature survey, the environmental impacts of the project were ignored. Hazardous waste was disregarded with environmental considerations [8].

Most of the products are ineffective with large operating costs. In today's world, the green design problem is to design and produce products that combine analytical and efficient environmental issues. This requires changes in existing techniques [9]. It is difficult to change the design technique for many contradictory goals and demands that require high operational speed and cost-effectiveness. Environmental issues should be incorporated into these new and sophisticated design processes in real time. Virtualization in general means to create a visual point of something which is somewhere connected to a physical source [10]. They use cloud computing and energy efficient technologies to prevent the efficiency of operations by virtual migrations technology. Virtualization operates on software layers within the operating systems and hardware. Virtualization offers some different layers on the software which are called Virtual Machine Monitors (VMM) [11]. These controls and maps the machines on a different platform. These are some important tasks done by VMM [12]:

a) Resource Allocation
b) Control over the hardware resources

c) Conversion of the instructions given by the operating system.
d) Processing of operating system.
e) Interrupt handling managed by operating system.

The concept of virtualization lies in the abstraction layer which permits a number of operating systems executed side by side with VMs as a lone unit as shown in Figure 1 [13]. It gives encapsulation, hardware independence, and VM migration and server consolidation [14].

Virtualization helps in creating a more eco-friendly environment by cloud computing. Virtualization is important for these three aspects [15]:

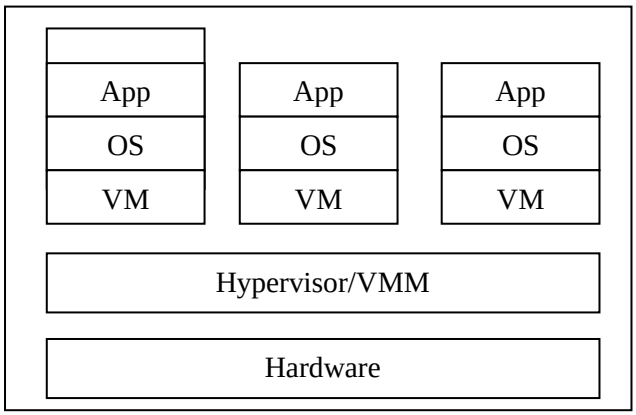

Fig.1 Virtualization[15]

a. Cost saving
b. Energy Saving
c. Hardware reducing.

i. The users will all be working separately because they will be inaccessible for others to contact and will also not be able to go for anyone's data.
ii. Virtualization also provides security for cloud computing by saving the data of the client on a virtual machine with cloud components. VMs can be increased or decreased according to the need and thus provides reliability.
iii. The resources available can be increased with the help of Virtualization to the point needed; this is called AOR (Aggregation of Resources).
iv. Virtualization provides the user with a choice of sharing. These resources are dynamic or highly utilized pooled

Virtualization essentially creates a virtual image/version, for example for, server, Operating System (OS), saving media or network sources for utilizing them on various machines at the corresponding time [16].

The virtualization objective is to handle the workload by modifying traditional computing to work in a more scalable, effective and economical way [17]. Virtualization can be implemented in a broad multiplicity of OS virtualization, hardware level and server virtualization. Virtualization scheme is hardware decreasing cost maintenance and energy efficient technology which is quickly transforming the principle way of computing[18]. By using virtualization, one can improve the utilization of resources accessible to the user to perceive more gains [19].

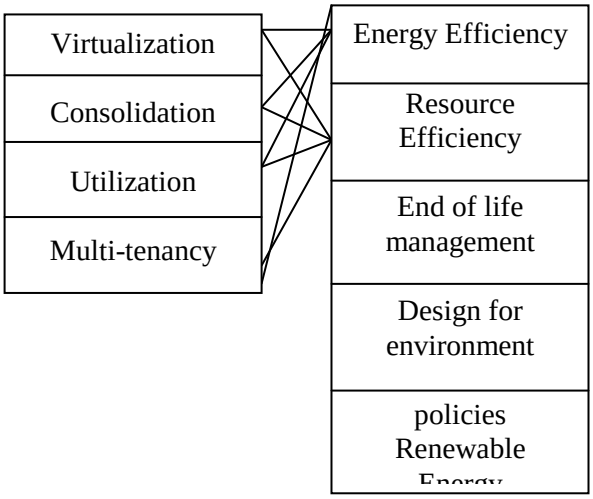

Fig.2 Virtualization based green computing architecture [19]

Virtualization helps in reducing the cost with the consolidation of data centres to enhance the agility and flexibility via persistent virtualization usage for faster dynamic and service deployment workloads placements [20]. The process of virtualization on the basis of green computing is depicted in Figure 2 [21].

A virtualization is a tactical approach which gives a technique for sensibly bringing inheritance applications in the cloud to gather the benefits to lessen energy consumption [22].The VMs are created to share the load of the physical machine and to help the architecture to reduce the energy consumption and hence it is also referred to as green computing [23-24].

This paper focuses on the development of a suitable VM Placement and optimization scheme to reduce the overload of the PMs. So, to achieve this, in this research work, the MBFD algorithm has been considered when the process of allocation initiates to the Host Machines (HM) [25]. GA is considered for the optimization of the performance of MBFD algorithm. For the classification of over utilized and under-utilized host, SVM is used. The purpose of migration of VMs from over-utilized to under-utilized is to maintain the VM allocation process [26].

The rest of the paper is organized in the following manner. Section II represents a brief of Green Computing and the need for VM allocation and Migration whereas Section III represents the work done in algorithmic architecture. Section IV presents a detailed analysis of the results and Section V concludes the paper.

II. RELATED WORK

Research in the green cloud computing area has gained more attention in recent times due to large IT capabilities. Task allocation in the cloud environment is one of the important research issues to optimize time, energy, and cost. Robust

Heterogeneous-Earliest-Finish-Time (R-HEFT) algorithm has been presented that demonstrates regular utilization among different resources availability. There is a reduction in error rate but there could be some other technique that can estimate he ready queue better than that of RHEFT[27]. In [28], Rimal and Maier proposed a method of scheduling workflows to minimize makespan, task execution cost to utilize the resources efficiently.The researchers have reviewed only CPU-intensive tasks and have been involved in both structured and non-structured work planning. They have compared their approach to contributeto FCFS, EAST, and Minimum Graduation Time planning. Novel Cloud-Based Workflow Scheduling (CWSA) algorithm is proposed that has assisted in lessening the workflow completion time, execution cost, and tardiness and has utilized unoccupied resources for cloud effectiveness. Several CPUs meet different energy consumption of key memory and secondary storage. CWSA could explained the allocation problem by changing the expense, using a two-sided graph of changing outside costs. To solve their problems they used a dynamic Hungarian algorithm and proved the accuracy of their algorithms, including tax efficiency. The Hungarian algorithm could be even utilized for further purposes, viz. transportation-related be optimized for the scheduling purpose and could be utilized by means of green cloud computing. Mills-Tettey et al. [29] have offered the nearest optimal solution to the task assigned to increase the maximum level of bulk profits or reduce the energy value of the cloud data center. The researchers have compared their work with a random algorithm in the cloud environment [30]. The research lacks in the utilization of classification of underutilized an over-utilized host that may help in more efficacy. [31]has provided an algorithm for distributing tasks that dynamically corrects costs based on previous allocations. The goal is to provide load balancing and to ensure that the tasks are implemented. There is no utilization of optimization and classification method that could assist in providing more reliable results.

Beloglazov et al. [32] proposed the architectural framework and principles for green cloud computing. Their method covers architectural principles for energy efficient management of clouds and energy-saving resource allocation. In their work, the authors have confirmed their approach with a performance evaluation study using the CloudSim Toolkit. The research lacks in decreasing the cost of software that could utilize the cloud middleware and linked technologies. The collaboration between power consumption optimization planning and evaluation techniques in a cloud environment [33] is shown. This technique improves performance for green cloud computing. The researchers could have used energy efficient technologies such as Dynamic Voltage and Frequency Scaling (DVFS) to decrease power consumption processing.

A random algorithm for the task division [34] is proposed, thanks to the reduction of complexity of both time and space. The researchers could utilize an optimization technique that might help in more accurate task allocation process. An intermediate program is proposed to perform a hybrid simulation of large-scale critical systems [35].

This add-on enables you to focus on a very objective optimization to optimize the deployment of simulation tasks in a particular cloud. The research can utilize the scalability algorithms by considering different scenarios and the concept of complexity increment could be delineated. The researchers have offered an algorithm to cloud performance and to allocate cloud resources to cloud computing so as to maintain the power consumption of data centre's. We have been well-received by a large number of researchers by allocating resources using Round Robin and the start-up (random allocation) algorithms [36-39].

Random based assignment algorithm has been used for comparing the proposed technique performance to the common algorithms. The task scheduling and data allocation manner could also be improved by considering the algorithms on parallel and distributed environment.

VM migration is considered for energy consumption optimization in data centres. VM migration and placement has always considered as a huge task from some time. The selection of Exact VM is mandatory or it might result in SLA violation and could enhance the number of migrations that lead to cause energy consumption negatively. The state when VM PM lacks in fulfilling the need of VM, then there occurs the VM Migration requirement. A number of researchers has tried their hand in minimizing the number of migration and SLA violations by using different algorithms. But the traditional researcher is considered as complex and usually consumesa lot of time for discovering and allocating PMs. Therefore, the objective is to lessen energy consumption, SLA violation, so, for this purpose, GA and SVM with MBFD algorithms are utilized.

A. Green computing and need of VM Migration

Modern data centre runs in a cloud computing model for host for many applications varying from applications that run for few seconds (for example, requests for web operations, for instance e-commerce along with social network portals with instant Artificial ANIMUS framework workloads) to run applications on shared hardware platforms for enlarged time period (such as analogue or large data set processing) [18]. The management of manifold operation in the data centre possesses a challenge of responding to on-appeal mean furnishing together with allotments of time-varying workloads [19-20]. Typically, assets of the data centre are assigned statically to functions based onfeatures of peak load to retain remoteness and provide performance guard Artificialness [21]. Till now, high performance has been the only concern in data centre deployments, and this requirement hasbeen achieved with little concern for energy consumption. The data centre is not only expensive for upholding but also atmosphere inhospitable. A user needs to control as well as chill large number of servers that are accommodated in the

mentioned data centres [22]. Workers of cloud service have to guarantee that their limits of earnings will not artificially reduce owing to lofty costs of energy. Reducing energy usage in the data centre is an exigent along with multifaceted subject as computing operations in addition to data grow so fast that increasingly large servers along with disks are indispensable to develop them quickly over the required period of time. Green cloud computing is conceived to not only enable resourceful handing out along with the operation of computing infrastructures but also minimizes the energy consumption. This is critical to guarantee that the progress of cloud computing is feasible in the future. [23]. Otherwise, cloud computing and the growing popularity of front-end client devices and back-end data centre interaction will lead to huge energy upgrade. To solve this problem, it is necessary to manage data centre resources in an energy-profitable mode to endorse calculating of the green cloud [24]. A cloud resource calls for allocation not only to meet the needs of QoSprecise by the user through the Service Level Agreement (SLA), but also reduces the energy usage. Green computing is portrayed and perceived as a new technology in industrial societies after the revolution in computer

science, but it is also widely accepted as a technology of

various technical fields like data centre networks, data centre hosting services, application performance measurement etc [25]. This is also known as green technology. At the late 1970s, the world saw a computer revolution, and in the early 1990s, green computing became convincing [26]. Then, companies began to use environmentally friendly ways to do business. Because of green computing evolutionary temperament, it may mean something different, so, it is sensible to forfeit attention to the definition of green computing [27]. Green Computing is a representation that is easy to implement and environmentally sustainable in IT that can be delivered quickly with minimal administrative effort or green supplier interface. Green computing has been broadly acknowledged by government-authorized employees [28]. Green Computing has been achieved through the availability of broadband networks and inexpensive end-user devices, as well as commodity computing nodes that can be simply interconnected and controlled, as well as virtualization to provide an appearance of the isolation process by sharing the computer by reducing the CO2 emission rate [29].

B. Proposed Structure and Algorithm

The allocation process of the cloud structure starts with the Modified Best Fit Decreasing algorithm which checks the availability of the resources. The algorithmic structure of MBFD is as follows:

Algorithm1:Modified_Best_Fit_Decreasing (MBFD)

Input :Physical_Machine_list, VM list
Output: Allocation of VMs
Vm_list.sort decreasing utilization ( ) // To store VM list with sorting order
For each VM in VM list do
minPower←max // Assigning maximum value initially allocated
Physical_Machine←null //No Physical_Machine is allocated
For each Physical_Machine in Physical,Machine list do // For every physical_machine in the list
If Physical_Machine has enough resource
For VM then // Checking feasibilitypower←estimate power (MC,Vm)// Estimating power
If power<manpower thenAllocate Physical_Machine←host // Allocation is done on the basis of sorting
Mini power←power
If Allocated Physical_Machine≠null Then
Allocate VM to allocated Physical_Machine

Above mentioned MBFD algorithm is used for the allocation of the PM based on their sorted power. The MBFD algorithm checks the PM for its resources only. It is quite possible that only one PM can satisfy the needs of all the VMs but it may also cause an overload for PM. Hence the proposed work structure utilizes GA to optimize the performance of MBFD and minimize the overload problem of the system.

Population Size	N_k where **k**is tottheal number of PMs available other than current **PM**
Mutation Type	Mutinf
Cross Over	Linear
Fitness Function Type	Adaptive

Table 1.Simulate parameters

The parameters utilized to configure GA are shown in Table 1.

Algorithm 2: Modified Generic Genetic Algorithm
Input:Initial Allocation
Output: Optimized _Allocation
For each allocation in the Allocation_List
CurrentVm=Allocation_List.VM
AllocatedHost=Allocation_List.Host
HLoad=Find(Allocation_List==AllocatedHost)// Find the allocations to the current Host
OtherHost= Allocation_List.Hosts ! = AllocatedHost // Finding the Other Host In the //Allocation List

Loadvalue=OtherHost.Load(Allocation_List.Load)// Finding the load on Other Hosts
IfHLoad> Loadvalue
Host is OverLoaded( );
Pop_size= OtherHost;options = gaoptimset(population size',50,'SelectionFcn'...,@selectionstochunif,^'
MutationFcn^',{@mutationuniform, 0.05},'CrossoverFcn'…,
{@crossoverintermediate, 0.8});
ParameterValue=EnergyConsumptionNetwork;
f= GAFit(Popsize , ParameterValue)
If f=1
Change Allocation to fvalue;
End For
End Algorithm

The modified GA is used to minimize the overloading problem. Based on the load on the PM, GA evaluates each machine using fitness to check their load. The Modified structure of Genetic Algorithm utilized a designed fitness function and hence it needs to be cross-validated. The cross-validation structure is supported by SVM. SVM is a binary classifier and every data is either true for it or false. The allocated structure is passed to SVM with the host CPU utilization and energy consumption as the main parameter. If the cross-validation value is positive then the allocation is set to be true else it is again passed to Genetic. The training and classification architecture for SVM is shown in Figure 3 and Fig.4.

Once the entire allocation process is done, the simulation engine checks the system is cross-validated by the simulation engine to check whether any MC is getting overloaded or not. The cross-validation procedure is done using Polynomial Support Vector Machine (P-SVM). The P-SVM is trained with two target label. The first one is allocated VM number and the second one is a random value which indicates the class reference. The SVM is binary class classifier which can only bifurcate between only two categories. The proposed algorithm utilizes a polynomial kernel for the bifurcation.

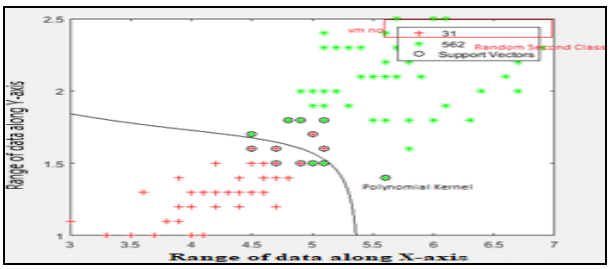

Fig.3 SVM Training Architecture

The SVM is also a two-phase algorithm which includes training and classification. The proposed algorithm uses a supervised learning method for training and classification.

Based on the classification mechanism and proposed model, the parameters such as SLA violation and JCR are evaluated.

SLA is the Service Level Agreement. When a service provider interacts with the customer, he agrees to provide services to the user.

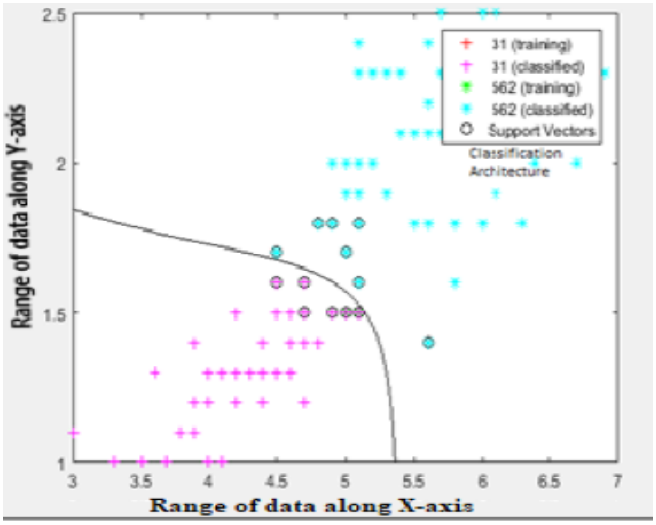

Fig.4 SVM Classification Architecture

III. RESULT AND ANALYSIS

This paper considers energy consumption, Job Completion Ratio (JCR) and time consumption for SLA-V. For computation, HVR has been considered. The mathematical expression for the same is given in equation (1).

$$HVR = \frac{Total_H}{Total_{,}} \quad (1)$$

When so ever the service provider fails to provide the committed services, it violates the service terms and it is termed as Service Level Agreement Violation (SLA-V).

The next evaluation parameter is the job completion rate. The proposed algorithm considers 1000 to 10000 jobs. 1000 jobs are incremented with iteration.

$$\text{Job completion rate} = \frac{Total_{CompletedJobs}}{Total_{SuppliedJobs}} \quad (2)$$

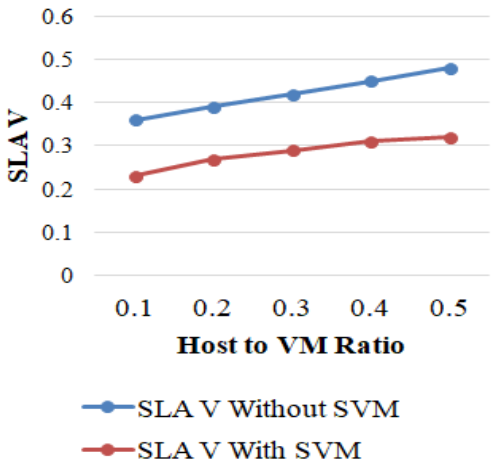

Fig.5 SLA V With and Without SVM

Fig.5 describes the outcome of SLA V with and without SVM. The x-axis in the figure describes the Host to VM Ratio(HVR) and Y-axis defines the obtained values of SLAV. Red line describes

the result of SLA V with SVM whereas blue line describes the result of SLA V without SVM. It can be seen from the figure that SLA violation with improvement is less and is 0.286. Fig.6 describes the outcome of JCR with and without SVM. Redline describes the result of JCR with SVM whereas blue line describes the result of JCR without SVM. It can be seen from the figure that JCR with improvement is more and is 0.538. The maximum JCR is attained when the maximum numbers of supplied jobs are provided to the system. This is kind of paradox to the real nature of the job completion. This only happens because as the supplied job increases, the VM to that host ratio also increases. Hence the jobs are equally divided and the completion rate increases with the increase in supplied jobs. There is one drawback with this architecture, with every increase in the VM, the energy consumption also increases and hence the violation increases with the increase in the HVR.

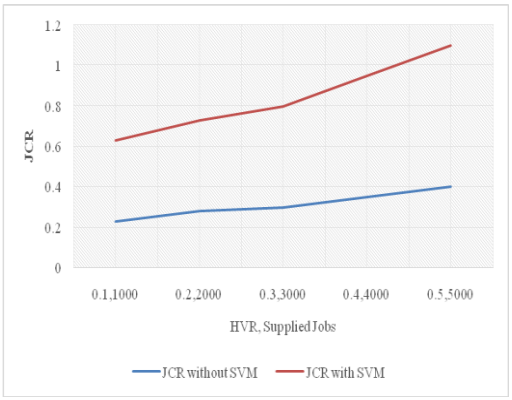

Fig.6 JCR Vs Supplied Jobs and HVR

IV. COMPARATIVE ANALYSIS OF PROPOSED AND EXISTING WORK

This section covers the comparison of existing work with the proposed approach and for that, [40] has been considered.

Table 2.Comparison of proposed and existing work w.r.t SLA violation

SLA violation (Proposed)	SLA violation (Existing) [40]
0.286	0.98

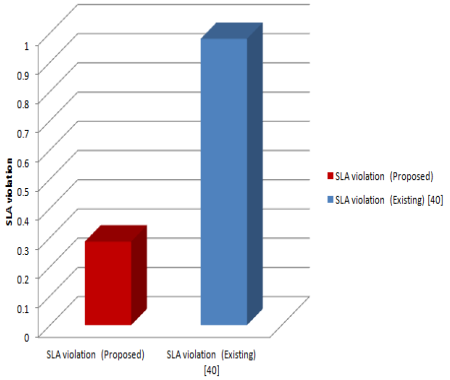

Fig.7 Comparison of SLA violation with existing approach [40]

Fig.7 and table 2 delineates the comparison f SLA violation of existing and proposed approach. The comparison has been drawn to show the effectiveness of the proposed work. It can be seen from the assessment that the proposed mechanism has outperformed in SLA violation and has shown its efficacy by 70%.

V. CONCLUSION

This paper utilizes SVM and GA for the optimization of the VM allocation process. This paper enhances the performance of the MBFD algorithm. MBFD Algorithm lacks in the allocation policy management as it only considers the resource availability of the Host and does not check the load over the hosts. The paper presented a total HVR of .1 to .5. The increase in the HVR leads to optimality of JCR as the load is distributed quite magnificently. The increase in the HVR also leads to an increase in the SLA Violation. A comparison has been drawn to show the efficiency and reliability of the proposed work and an improvement of 70% has been noticed. Although the utilization of SVM with the combination of GA reduces it to an extent still there are future possibilities to reduce it. Utilization of Neural Network may lead to a decrease in SLA Violation but with enhanced JCR.

REFERENCES

1. K.Ye, D.Huang, X.Jiang, H.Chen, S.Wu, “Virtual Machine Based Energy-Efficient Data Centre Architecture for Cloud Computing: A Performance Perspective”, IEEE/ACM International Conference on Green Computing and Communications, 2010, pp.171-178.
2. D.Jayasinghe, C.Pu, T. Eilam, M.Steinder, I.Whalley, E.Snible, “Improving Performance and Availability of Services Hosted on IaaS Clouds with Structural Constraint-aware Virtual Machine Placement”, IEEE International Conference on Services Computing, 2011, pp.72-79,
3. C.T.Man, M.Kayashima, “Virtual Machine placement algorithm for virtulized desktop infrastructure”, Proceedings of IEEE CCIS, 2011, pp.334-337.
4. C.Lin, P.Liu, J. Wu, “Energy-Aware Virtual Machine Dynamic Provision and Scheduling for Cloud Computing”, IEEE 4th International Conference onCloud Computing, 2011, pp.736-737.
5. Y. Jadeja and K. Modi, “Cloud computing-concepts, architecture and challenges”, in Computing, Electronics and Electrical Technologies (ICCEET), International Conference, 2012, pp. 877–880.
6. 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”, Futur. Gener.Comput. Syst., Vol. 25, No. 6, 2009, pp. 599–616.
7. Yamini, B.; Selvi, D.V., “Cloud virtualization: A potential way to reduce global warming”, Recent Advances in Space Technology Services and climate Change (RSTSCC), 13-15, 2010., pp.55-57.
8. Witkowski, M.; Brenner, P.; Jansen, R.; Go, D.B.; Ward, E., “Enabling Sustainable Clouds via Environmentally Opportunistic Computing”, IEEE Second International Conference on Cloud Computing Technology and Science (CloudCom), 2010., pp.587-592.
9. Youwei Ding, Xiaolin Qin, Liang Liu, Taochun Wang, “Energy efficient scheduling of virtual machines in cloud with deadline constraint”, Science Direct 2015.
10. Xiaomin Zhu, Laurence T. Yang, Huangke Chen Ji Wang, Shu Yin and Xiao cheng Liu, “Real-Time Tasks Oriented Energy-Aware Scheduling in Virtualized Clouds”, IEEE, 2014.
11. Jinn-Tsong Tsai Jia-Cen Fang, Jyh-Horng Chou “Optimized task scheduling and resource allocation on cloud computing environment uses Improved Differential Evolution Algorithm (IDEA)”, Computers & Operations Research Elseveir, vol. 40, no. 12, 2014, pp.3045-3055.
12. Qiang Li, QinfenHao, Limin Xiao, and Zhoujun Li, “Adaptive Management of Virtualized Resources in Cloud Computing Using Feedback Control,” in First International Conference on Information Science and Engineering,, 2009, pp. 99-102.
13. W. E. Walsh, G. Tesauro, J. O. Kephart, and R. Das, “Utility Functions in Autonomic Systems”, in ICAC ’04:

Proceedings of the First International Conference on Autonomic Computing. IEEE Computer Society,2004, pp. 70–77.
14. Jiayin Li, MeikangQiu, Jian-Wei Niu, Yu Chen, Zhong Ming, "Adaptive Resource Allocation for Preempt able Jobs in Cloud Systems", In 10th International Conference on Intelligent System Design and Application, 2011, pp. 31-36.
15. Shi J.Y., Taifi M., KhreishahA.," Resource Planning for Parallel Processing in the Cloud", In IEEE 13th International Conference on High Performance and Computing, 2011, pp. 828-833..
16. Goudarzi H., Pedram M., "Multi-dimensional SLA-based Resource Allocation for Multi-tier Cloud Computing Systems", In IEEE International Conference on Cloud Computing, 2011, pp. 324- 331.
17. Gaurav Dhiman, Giacomo Marchetti ,TajanaRosing, " vGreen: A System for Energy Efficient Computing in Virtualized Environments", In conference of ISLPED 2009 San Francisco, California ,USA, 2009, pp.19-21..
18. H. Jin, L. Deng, S. Wu, X. Shi and X. Pan, "Live virtual machine migration with adaptive, memory compression", IEEE International Conference on Cluster Computing and Workshops, New Orleans, LA, 2009, pp. 1-10.
19. G. von Laszewski, L. Wang, A. J. Younge and X. He, "Power-aware scheduling of virtual machines in DVFS-enabled clusters", IEEE International Conference on Cluster Computing and Workshops, New Orleans, LA, 2009, pp. 1-10.
20. B. Li, J. Li, J. Huai, T. Wo, Q. Li and L. Zhong, "EnaCloud: An Energy-Saving Application Live Placement Approach for Cloud Computing Environments", IEEE International Conference on Cloud Computing, Bangalore,2009, pp. 17-24.
21. M. Devare, M .sheikhalishahi, L.Grandinetti, "Prototype Implementation of Desktop cloud", by IOS press, Netherland, presented in Centraro International workshop on HPC, Grids and clouds,2010.
22. Haikun Liu, Cheng-Zhong Xu, Hai Jin, Jiayu Gong, Xiaofei Liao, "Performance and energy modeling for live migration of virtual machines", International Symposium on High Performance Distributed Computing, 2011.
23. Jiandun Li, Junjie Peng, Wu Zhang, "A Scheduling Algorithm for Private Clouds", Journal of Convergence Information Technology, Vol. 6, No. 7, 2011, pp.1-9.
24. A.K, M.Z, EL Bakkali, Da_r EL Kettani, "Load Balancing Cloud Computing: State of Art", IEEE, ISBN 978-1-4673-1053-6, 2012, pp.106-109.
25. Sourabh Dave, Abhishek Raghuvanshi, "Fault Tolerance Techniques in Distributed System", International Journal of Engineering Innovation & Research, vol. 1, no. 2, 2012, pp. 124-130.
26. J. J. Prevost, K. Nagothu, B. Kelley and M. Jamshidi, "Load prediction algorithm for multi-tenant virtual machine environments", World Automation Congress, Puerto Vallarta, Mexico, 2012, pp. 1-6.
27. JyotiThaman, ManpreetSingh, "Green cloud environment by using robust planning algorithm", Egypt Inform J, Vol. 18, No3, 2017 pp. 205-214.
28. B. P. Rimal and M. Maier, "Workflow Scheduling in Multi-Tenant Cloud Computing Environments", in IEEE Transactions on Parallel and Distributed Systems, vol. 28, no. 1, 1 Jan. 2017, pp. 290-304.
29. G. Ayorkor Mills-Tettey Anthony Stentz M. Bernardine Dias, "The dynamic Hungarian algorithm for the assignment problem with changing costs", Technical report Carnegie Mellon University (CMU-RI-TR-07-27), 2007.
30. Y. Wang, S. Chen and M. Pedram, "Service Level Agreement-Based Joint Application Environment Assignment and Resource Allocation in Cloud Computing Systems", IEEE Green Technologies Conference (GreenTech), Denver, CO, 2013, pp. 167-174.
31. T. Penner, A. Johnson, B. Van Slyke, M. Guirguis and Q. Gu, "Transient clouds: Assignment and collaborative execution of tasks on mobile devices", IEEE Global Communications Conference, Austin, TX, 2014, pp. 2801-2806.
32. Anton Beloglazov, JemalAbawajy, RajkumarBuyyaa, "Energy-aware resource allocation heuristics for efficient management of data centres for cloud computing", Fut Gen ComputSyst, Vol. 28, No.5, 2012, pp.755–768.
33. S. Vakilinia, B. Heidarpour and M. Cheriet, "Energy Efficient Resource Allocation in Cloud Computing Environments", in IEEE Access, vol. 4, , 2016, pp. 8544-8557.
34. S. Kentros, C. Kari, A. Kiayias and A. Russell, "Asynchronous Adaptive Task Allocation", IEEE 35th International Conference on Distributed Computing Systems, Columbus, OH, pp. 83-92,2015.
35. Massimo Ficco, Beniamino Di Martino, Roberto Pietrantuono, StefanoRusso, "Optimized task allocation on private cloud for hybrid simulation of large-scale critical systems", Future Generation Computer Systems, vol. 74, 2017, pp. 104-118.
36. Ziqian Dong, Ning Liu and Roberto Rojas-Cessa, "Greedy scheduling of tasks with time constraints for energy efficient cloud-computing data centres", Journal of Cloud Computing: Advances, Systems and Applications, vol.4, no.1, 2015, pp.2-14.
37. Chen J, Li K, Tang Z, Bilal K, Yu S, Weng C, Li K, "A Parallel Random Forest Algorithm for Big Data in a Spark Cloud Computing Environment", In IEEE Transactions on Parallel and Distributed Systems, vol. 28, no. 4, 1 April 2017 pp. 919-933.
38. D. Chitra Devi and V. RhymendUthariaraj, "Load balancing in cloud computing environment using Improved Weighted Round Robin Algorithm for nonpreemptive dependent tasks", Sci World J, 2016, pp. 1–14,
39. Elmougy S, Sarhan S, Joundy M, " A novel hybrid of shortest job first and round Robin with dynamic variable quantum time task scheduling technique", J Cloud Comput, Vol. 6, No. 1, 2017, pp.12.
40. YadaiahBalagoni and Dr. R.Rajeswara Rao, "SLA-AWARE scheduling of VMs for load balancing in cloud using a three phase optimal VM migration technique", International Journal of Latest Trends in Engineering and Technology, Vol. 10, No.2, 2018, pp.217-227.

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