Comparative Analysis and Evaluation of Load Balancing Algorithms

Savitri S. Sutagatti
Department of Computer Science and Engineering
KLS Gogte Institute of Technology
Belagavi, Karnataka, India

S. G. Kulkarni
Department of Computer Science and Engineering
KLS Gogte Institute of Technology
Belagavi, Karnataka, India

ABSTRACT
In today's environment the challenging task within cloud computing is to distribute workload among all arriving requests and also balancing those requests. To improve entire system performance, a broker policy has been taken into addition which distributes workload equally with different datacenters in computing environment. A different VM load balancing algorithms will be compared along with different data center broker policies. A cloud analyst simulator, simulate these approaches and final results will be evaluated on several parameters. It covers all the feasible simulations and results will specify the finest possible combinations.

Keywords
Cloud Computing, Virtual machines, Load balancing, Broker policy, Performance Evaluation

1. INTRODUCTION
Cloud computing is a computing system where communication takes place between thousands of computer systems to fulfill the user's needs, where user feels that as if he/she using a particular large resource. Cloud computing gives a larger number of computing assets, applications, storage for huge quantity of data and many more. The idea behind Cloud Computing is to give secured, speedy and suitable data storage and figuring organizations. [3]

Cloud computing mainly focuses to give maximum numbers of shared resources and support for user requests in actual time. The cloud services are of three classes: Infrastructure as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS).The key disadvantage is its redundant power utilization, enormous quantity of energy loss and higher infrastructure cost.

1.1 Load Balancing in Cloud Computing
To perform load balancing, various algorithms were proposed. Load Balancing is a method which redistributes the workload with system nodes, to improve resource consumption and system performance. Load Balancing is taken in to account so that all virtual machine gets equal quantity of workload which increases throughput and reduces response time. Load balancing is a technique that helped systems and assets by giving a maximum throughput and less response time. Load balancing separates the traffic between all servers, so information can be sent and get back immediately with load balancing[10].

2. LITERATURE SURVEY
Authors in [4] discussed about architecture plan of cloud computing where cloud computing framework are divided in to two parts that is front-end & back-end. Both are connected through the internet. Front end is the thing that is visible to users and back end is for cloud framework. Front end consist of client's computer accessed by the cloud, where as back end gives the 'cloud computing services' like storage, computers etc. Author also discussed about the services and layers provided by cloud computing design which are Software as a Service, Platform as a Service, and Infrastructure as a Service. And also some issues related to privacy, security, reliability etc

Authors in [6] depict the key ideas of cloud computing, administrations offered, & its key constituents, capacities given by the cloud, and furthermore checked on some current load balancing algorithms which will be trained on cloud [6]. The closed-form solution for smallest amount of estimation & announcing time for single level tree systems with various load balancing techniques were likewise examined. The implementation of these systems as for the planning and impact of link & evaluation speed were studied.

Authors in [10] studied the art of load balancing in cloud computing. They build up the art of load balancing for cloud computing, giving a meaning of this term, its characterization and cases of its execution in established disseminated frameworks.

In [7] author proposed algorithms called Join-Idle-Queue for distributed load balancing in extensive frameworks constrain. This algorithm gives better outcomes for system load. It produces 30-fold diminish in lining overhead when contrasted with Power-of-Two at medium to high load.

In [11] author discussed the distinctive type of long availability applications, which are progressively well known these days in distributed computing. An enhanced algorithm is projected based on weighted least connection algorithm. The new algorithm measures the load & power, and single exponential smoothing forecasting is included. At long last, the article demonstrates by examinations that the new algorithm can decrease the server stack tilt, & enhance customer benefit quality adequately.

Authors in [5] discussed Load Balancing Strategy of Cloud Computing on Artificial Bee Algorithm, is a technique based on gathering performance of honeybee. Through impression of conduct of honeybees, it improves the measure of nectar to achieve the most extreme throughput.

In [12] Author discussed about the tool called Cloud-Analyst. Cloud analyst is used to study the performance of social application which is put up on cloud. It is the newer edition of CloudSim.

In [9] authors have discussed lots of load balancing algorithm which are circular robin algorithm, imperative queuing algorithm and Randomized algorithm, their investigation is connected on MIPS vs. VM and MIPS versus HOST ground work. Their result demonstrate that these calculations can no doubt fortify the response time all together of greatness, with

appreciate to amount of VMs in Datacenter. Execution judgment of the impersonation demonstrates that the change of MIPS will affect the response time. Expanding MIPS versus VM reducing the response time.

In [13] authors addressed execution of three load balancing algorithms examined the inadequacies and researched why it is unrealistic to have Centralized Scheduling policy during the cloud condition. Author inspected three possible solutions which are Honeybee Foraging Behaviour algorithm, Random Sampling algorithm and Active Clustering algorithm proposed for load balancing.

In [14] authors made study on Modified Throttled algorithmwhich protects a list table of virtual machines. An effort has been taken to recover response time & achieve viable use of virtual machines. The proposed agenda utilizes a technique for picking a VM for handling out client's demand where, VM at first list is principally assigned relying on the condition of the VM. In the event that the VM is existing, it is allocated with the demand & id of VM is returned to Data Center, else - 1 is returned.

In [15] author made comparison of two load balancing algorithms that is Round Robin and Throttled algorithm. In this swot Round Robin and Throttled algorithm were used with Optimize Response Time Service Broker Policy and simulation is done to calculate overall response time, datacenter processing time & total data transfer cost. After performing simulation, Throttled algorithm with Optimized Response Time policy had improved performance when compared with round robin

In [16] author made study on four different load balancing algorithms. The performance of Round Robin, Throttled, Execution Load and FCFS algorithms was compared on the basis of average response time, average datacenter request servicing time and cost. According to simulation results, it says that round robin has best performance.

3. OBJECTIVE

To perform load balancing, various algorithms were proposed. All previous algorithms focused on balancing the load in datacenters. Balancing the load between datacenters is so effectual that it distributes the workload equally among datacenters which is approved by datacenter brokers and simulates this approach appropriately. The proposed system consists of two stages in load balancing system the first policy is CloudAppServiceBroker which manages routing from users to datacenters. The three datacenter policies are Closest datacenter, Optimize Response Time, ReconfigP dynamically with load. The second is provided by VM load balancing algorithms. Three common algorithms are Round Robin, Throttled, and ESCE which will be compared with these three policies. A Cloud Analyst simulates these approaches and results will be on different Parameters which are Overall Response Time, Datacenter Processing Time etc. It mainly focuses to get better response time for respective algorithms. The result will specify the finest possible solution. The further part will be discussed on simulated scenario and broker policy.

4. SYSTEM MODEL

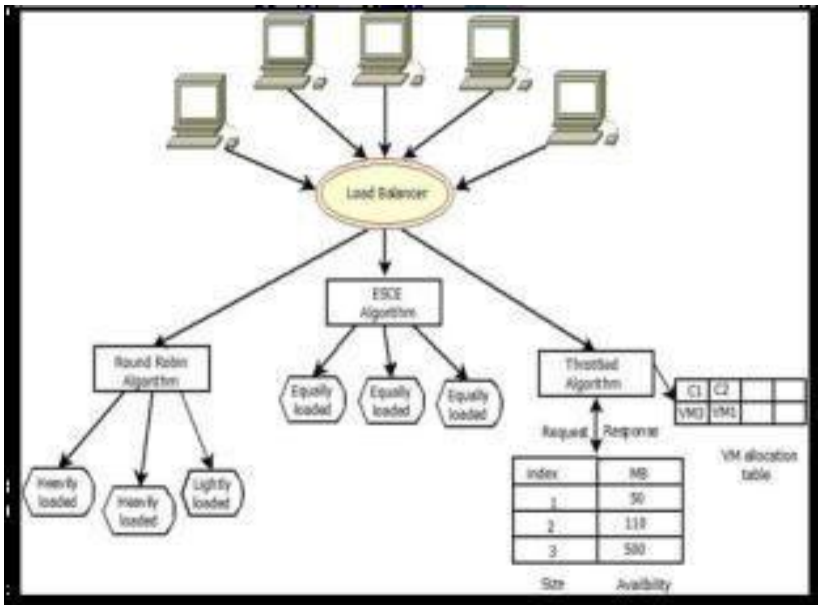

Fig 1: Load Balancing Approaches used in Cloud Analyst

4.1 Round Robin Algorithm

Round Robin is one of the commonly used algorithms which utilize the control called time cuts. It designates the solicitations in a round manner to the current virtual machine without considering the current load on the machine. The downside of this algorithm is that it takes a great response time which will bring down system performance.

4.2 Throttled Algorithm

Throttled algorithm starts by appointing appropriate virtual machine when customers send demand to load balancer. This VM load balancing algorithm confines the quantity of solicitations being prepared in each virtual machine to a throttling edge. The primary part of throttled load balancer is to care for a file table of all virtual machine together with their states delineating occupied and accessible mode. If the customer demands making this limit be surpassed in all accessible virtual machines, load balancer returns - 1 and datacenter lines the demand until a virtual machine is accessible.

4.3 Equally Spread Current Execution Algorithm

Equally Spread Current Execution algorithm adjusts the assignments among accessible VM's in an approach to try and out the quantity of dynamic errands at any given time on each VM. ESCE depends on system workload priorities. By inspecting the size, ESCE arbitrarily distributes workload and will transfer the stack to the available virtual machine which has fewer loads. It searches for the virtual machine which has less no of allocation so that all virtual machine is equally distributed among the Vm's.

5. IMPLEMENTATION DETAILS

In the experimental part a cloud analyst tool has been used to evaluate three algorithms which are Round Robin, Throttled and Equally Spread Current Execution. Simulation is done for six userbase with same or different regions for each user. In this simulation four datacenters are taken into addition which is named as DC1, DC2, DC3, and DC4. Cloud Analyst is open resource toolkit which simulates and evaluates various cloud services. Cloud analyst allows modeller to simulate simple experiments with a little variation in parameters in a swift way. Cloud analyst is equipped with a feature called GUI. It is an extended version of CloudSim.

The experimental part consists of detailed information about simulated scenario and datacenter broker policies.

5.1 Simulated Scenario

Figure 2 shows the simulated picture in CloudAnalyst simulator. Datacenter 1 is placed on R0 but has no userbase in R0. There is no datacenter placed in R1 but has one userbase, where R4 has datacenter 2 and one userbase. R2 has no datacenter and no userbase where R5 has only one userbase and no datacenter .By this type of scenario it simulate all possible ways for simulation process.

5.2 Datacenter Broker Policies

Three datacenter broker policies will be introduced in Cloud Analyst Simulator. First policy, Closest Data Center policy which routes the traffic to nearest datacenter from userbase. Second policy, Optimize Response Time policy defines the time occupied to send data from userbase to datacenter. Third policy, Reconfigure Dynamically with Load will share the load with different datacenter's when the presentation of datacenter degrades above the doorsill value.

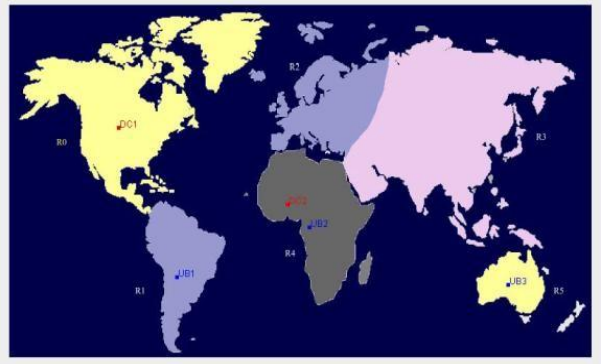

Fig 2: Cloud Analyst

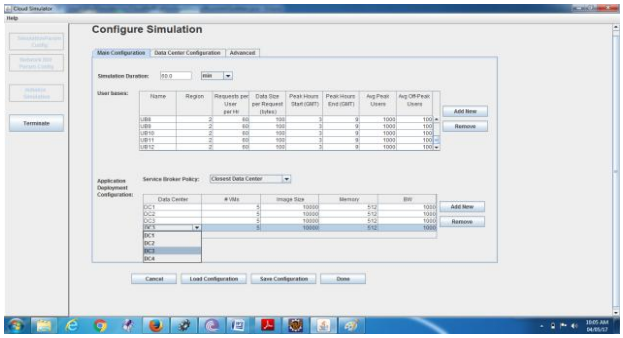

Fig 3:Main Configuration

The above fig shows the configuration simulation consisting of simulation duration, userbases and application deployment configuration. In Simulation Duration, it defines the interval taken by the simulation which is in mins, hours and days. Userbases table define a no of users along with their regions, request per user, data size per request etc. In Application deployment configuration, service broker policy provides 3 different policies namely closest datacenter, optimize response time and reconfigure with dynamically with load to be chosen. It also contains the details of the data like storage size, memory, bandwidth and virtual machines owed to each datacenter.

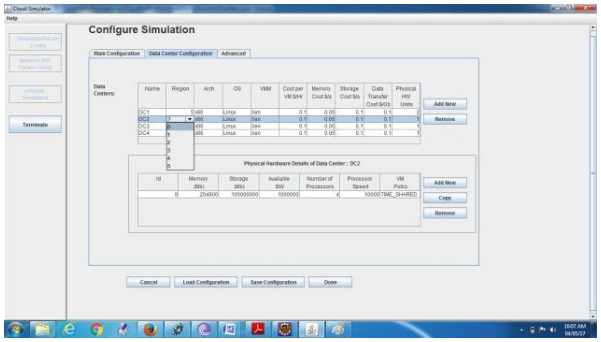

Fig 4 :Datacenter Configuration

Fig shows the datacenter configuration which defines a list of datacenters with the information like regions, OS, VMM, Cost per VMM, Storage cost etc.It also provide the details of the physical hardware of the datacenters with the information like Id,Memory,Storage, No of processors etc.

6. RESULTS AND DISCUSSION

In this three algorithms are compared with different policies. After Performing Simulation, results will show which policy is best for which algorithm and also calculates the average response time by region, overall response time and data center processing time.

6.1 Closest Datacenter Policy

The ClosestP policy simulates all three algorithms RR, Throttled, ESCE. Below Figure illustrates the complete details of userbase and datacenter which displays the average response time of all the userbases and datacenters.

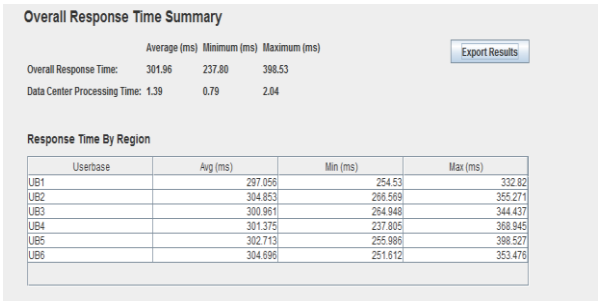

Figure 5:Response Time by Region(Avg ms under closest policy for Round Robin)

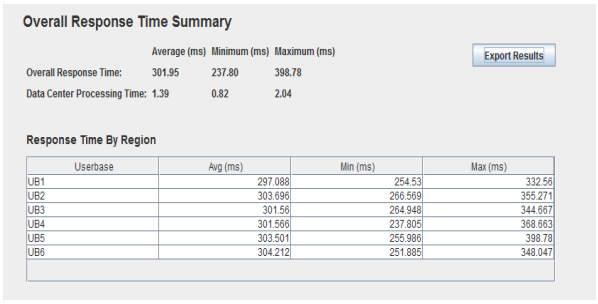

Figure 6: Response Time by Region(Avg ms under closest policy for Throttled

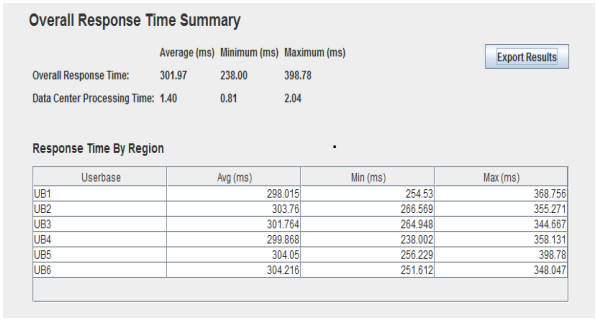

Figure 7: Response Time by Region(Avg ms under closest policy for ESCE)

6.2 Optimize Response Time Policy(Optp)

The OptP policy simulates all three algorithms RR, Throttled, ESCE. Below Figure illustrates the complete details of userbase and datacenter which displays the average response time of all the userbases and datacenters.

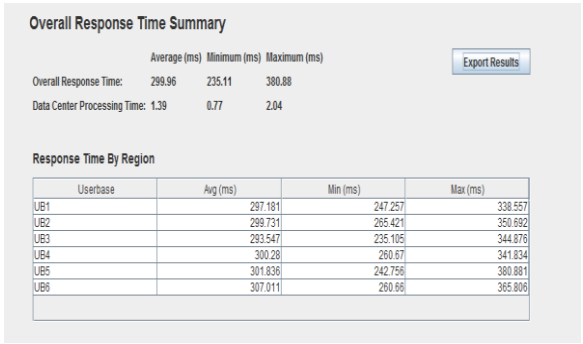

Figure 8: Response Time by Region(Avg ms under optp policy for Round Robin)

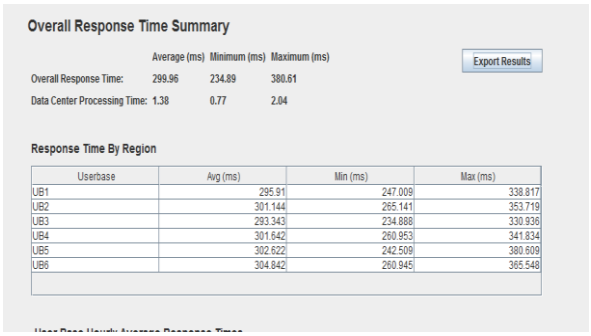

Figure 9: Response Time by Region(Avg ms under optp policy for Throttled)

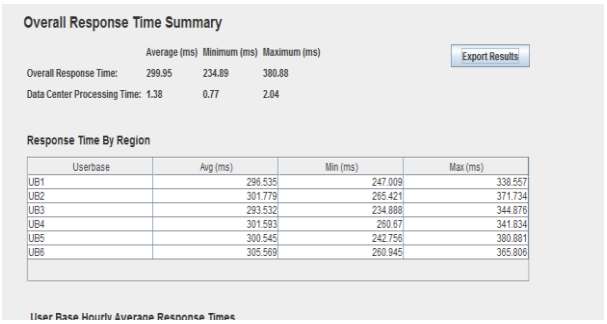

Figure 10: Response Time by Region(Avg ms under optp policy for ESCE)

6.3 Equally Spread Current Execution Load Policy(ESCE)

The ReconfigP policy simulates all three algorithms RR, Throttled, ESCE. Below Figure illustrates the complete details of userbase and datacenter which displays the average response time of all the userbases and datacenters.

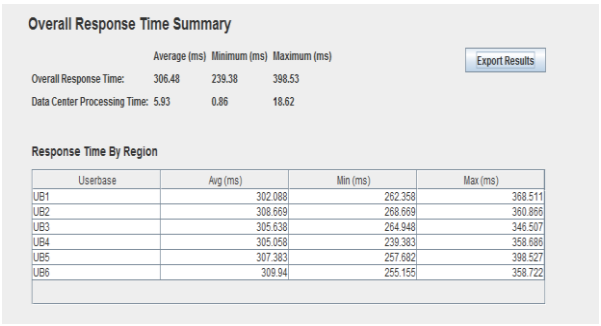

Figure 11: Response Time by Region(Avg ms under Reconfigp policy for Round Robin)

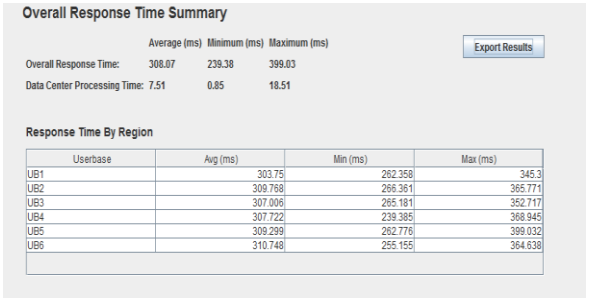

Figure 12: Response Time by Region(Avg ms under Reconfigp policy for Throttled)

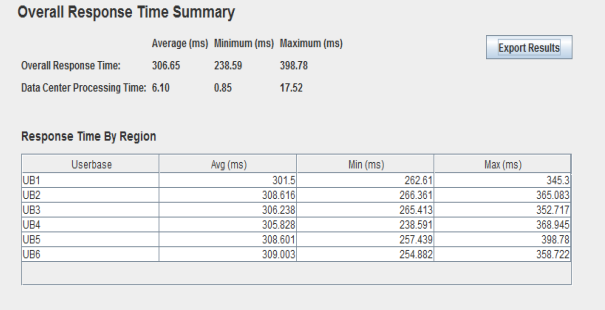

Figure 13: Response Time by Region(Avg ms under Reconfigp policy for ESCE)

Figure 14:Graph under ClosestP

The above graph shows the comparison of load balancing algorithms with datacenter broker policy ClosestP. After performing simulation, Throttled algorithm shows minimum average response time under closest p compared to other algorithms.

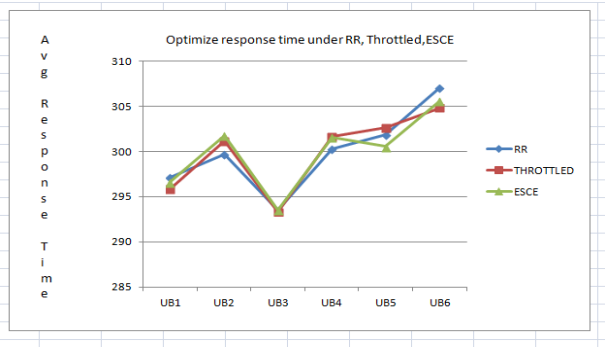

Figure 15: Graph Under OptP

The graph shows the comparison of load balancing algorithms with datacenter broker policy OptP. After performing simulation, Throttled algorithm shows minimum average response time under OptP when compared with other algorithms.

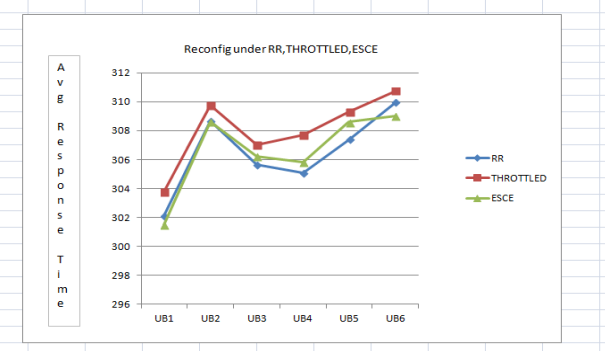

Figure 16:Graph Under ESCE

The graph shows the comparison of load balancing algorithms with datacenter broker policy ReconfigP. After performing simulation, RR algorithm shows 'minimum average response time' under ReconfigP when compared with other algorithms.

Table 1- Comparison among load balancing policies

VM Load balancing algorithm	Best Policy	Avg Response Time(ms) (Simulation Result)
Round Robin	ReconfigP	306.46
Throttled	Closest Data center policy, optimize response time	301.94 299.91
ESCE	Closest Data center policy	301.94

The above table shows the performance factors of load balancing algorithms with different policies. The desk shows that RR algorithm is best for ReconfigP policy; Similarly, Throttled algorithm shows the best average response time for ClosestP and for optimize response time. The ClosestP policy is best policy for ESCE algorithm.

Table 2- Performance factors of load balancing algorithms
(For Overall Response time and Data processing time)

VM Load Balancing Algorithm	Overall Response Time	Data center processing time
Round Robin	301.96	1.39
Throttled	301.95	1.39
ESCE	301.97	1.40

The above table shows the overall response time and data processing time for Round Robin, Throttled, and ESCE. Throttled algorithm shows better response time when compared with other algorithms.

7. CONCLUSION

The proposed effort mainly focused on implementing and analyzing different load balancing algorithms which are compared with datacenter broker policies. The proposed simulated scenario is used for evaluating performance factors. The performance factors are simulated on cloud analyst. The simulation outcome shows that Throttled algorithm has best average response time" for the policies ClosestP and Optimize Response Time, ESCE algorithm has minimum response time for the policy ClosestP and Round Robin algorithm has ReconfigP as best policy with minimum response time. In this manner three algorithms are compared with three different policies showing that which policy is best for which algorithm. The simulation outcome also shows that Throttled algorithm has improved performance since it uses a threshold value and prevents the virtual machine being overloaded, when compared with other algorithm.

As of future work, it can be expanded by examining these exploratory outcomes by assessing the more VM load balancers in cloud computing and under the diverse situations by considering the more evaluation factor and parameters for having a complete overview

8. REFERENCES

[1] Mohammad Reza Mesbahi, Mahnaz Hashemi,Amir Masoud Rahmani. "Performance evaluation and analysis of load balancing algorithms in cloud computing environments", 2016 Second International Conference on Web Research (ICWR), 2016

[2] Mesbahi, M., A.M. Rahmani, and A.T. Chronopoulos. Cloud light weight: "A new solution for load balancing in cloud computing". In Data Science & Engineering (ICDSE), 2014 International Conference on. 2014.IEEE.

[3] Jadeja, Y. and K. Modi, "Cloud computing-concepts, architecture and challenges". In Computing, Electronics and Electrical Technologies (ICCEET), 2012 International Conference on. 2012. IEEE.

[4] Jing Yao & Ju-hou He, "Load Balancing Strategy of Cloud Computing based on Artificial Bee Algorithm", ISBN: 978-1- 4673-0893-9, Pages: 185-189, IEEE, April 2012.

[5] Ram Prasad Padhy and PGoutam Prasad Rao, "Load balancing in cloud computing system", Department of Computer Science and Engineering National Institute of Technology, Rourkela Rourkela-769 008, Orissa, India May, 2011.

[6] Ray, S. and A. De Sarkar: "Execution analysis of load balancing algorithms in cloud computing environment". International Journal on Cloud Computing: Services and Architecture (IJCCSA), 2012. 2(5).

[7] Khiyaita et al," Load Balancing Cloud Computing: State Of Art", IEEE, 2010.

[8] Xiaona Ren, Rongheng Lin & Hua Zou, "A Dynamic Load Balancing Strategy for Cloud Computing Platform Based on Exponential Smoothing Forecast", 978-1-61284-204-2/11, IEEE, 2011

[9] Bhathiya, Wickremasingh, "Cloud Analyst: A CloudSim-based Visual Modeller for Analysing Cloud Computing Environments and Applications", IEEE, 2010.

[10] Martin Randles et al."A Comparative Study into Distributed Load Balancing Algorithms for Cloud Computing", IEEE 24th International Conference on Advanced Information Networking and Applications Workshops, 2010.

[11] Behal, V. and A. Kumar. Cloud computing: "Performance analysis of load balancing algorithms in cloud heterogeneous environment", In Confluence the Next Generation Information Technology Summit (Confluence), 2014 5th International Conference-. 2014. IEEE.

[12] Mohapatra, S., K. Smruti Rekha, and S. Mohanty, "A Comparison of Four Popular Heuristics for Load Balancing of Virtual Machines in Cloud Computing", International Journal of Computer Applications, 2013.68(6): p. 33-38.

[13] Nitika, M., M. Shaveta, and M.G. Raj, "Comparative analysis of load balancing algorithms in cloud computing". International Journal of Advanced Research in Computer Engineering & Technology, 2012. 1(3): p.120-124

[14] Nuaimi, K.A., et al. "A survey of load balancing in cloud computing", Challenges and algorithms. In Network Cloud Computing and Applications (NCCA), 2012 Second Symposium on. 2012. IEEE.

[15] Singh, A., P. Goyal, and S. Batra, "An Optimized Round Robin Scheduling Algorithm for CPU Scheduling",(IJCSE) International Journal on Computer Science and Engineering, 2010. 2(07): p. 2383-2385.