

CLOUD COMPUTING AND LOAD BALANCING IN THE CLOUD COMPUTING

Abstract

The Cloud Computing is a major area of research. A vast use of applications are emerging day by day in cloud computing. As the use of the cloud computing is increasing, the load of the cloud servers are also increasing gradually. As a result of this, distribution of the load balancing in cloud servers is not in a balanced way. Therefore, the concept and technique of load balancing is introduced to uniformly distribute the load amongst the cloud servers. In this chapter, we are discussing about the goals of load balancing, its aim towards the cloud computing. The challenges of load balancing are also discussed in this chapter. Along with that we have also discussed the various algorithms used in load balancing.

Keywords: Cloud Computing, Load Balancing, Cloud server, Virtual Machine, Data Center

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I. INTRODUCTION

The Cloud computing is an emerging technology. It is an on-demand access, via the internet, to computing resources like applications and servers, data storage, development tools, networking capabilities hosted at a remote data center managed by cloud service providers.

Cloud Computing is invented with four deployment models that are stated below [3] (Balaji K., 2021)-

1. **Public Model:** This model is suitable for the general public.
2. **Private Model:** This model is available for multiple users.
3. **Community Model:** This model is best suited for a specific level of community.
4. **Hybrid Cloud:** This model is the combination of 3 or more cloud models.

Based on the delivery model, cloud computing is divided into three models

1. **Infrastructure as a cloud (IaaS):** This service supplies infrastructure oriented resources as a service of cloud computing. For example, Amazon Web Services (AWS) etc.
2. **Platform as a service (PaaS):** This model provides inbuilt configuration as a service to users. For example, Google App Engine, Microsoft Azure etc.
3. **Software as a service (SaaS):** It provides a set of programs and data as a service to the users. For example, Cisco Webex etc.

Load Balancing is a methodology which offers methods to maximise throughput, optimized utilisation of resources and better execution of the system. The Load Balancing technique creates a method to store the data for the users based upon its availability. The main objective of Load Balancing is to distribute the load in the entire cloud computing system. Load balancing, in the cloud computing environment is the process of equivalently administering the functions, on virtual machines for usefulness of all the hardware and software systems used. There are different types of algorithms used based on different metrics. The aim of load balancer is to help in resource assignment for resource allocation and also to fulfil the need of the users in optimum price. As the demand of cloud computing is increasing, therefore the workload of this system is also affecting and as a result, the load balancing plays a very major role in the cloud computing system.

The two types of load balancing algorithms are used, namely, static and dynamic. The static load balancing algorithms are used for predefined environments where the systems are not going to adapt new environment. Dynamic-based balancing algorithms are flexible in nature and functional in all kinds of environment [15] (Mishra S.R., 2020). The Distributed Load Imbalance System occurs when a number of users make a request to access to the same server while other servers are sitting idle. To overcome this situation, Distributed Load Balance System is introduced for better performance of resource utilisation and also can reduce the time limit of a task execution.

II. THE EASE OF USE

Related works: Afzal et. al [1] (Afzal S., 2019) presented in this paper a review of the load balancing techniques. The authors pointed out the benefits and challenges of the algorithms in this paper. However, the essential QoS metrics are not discussed in this paper.

Ansar et. al. [2] (Ansar K., 2019) proposed a hybrid algorithm based on K-Mean unsupervised learning and harmony search algorithm (HSA) in this paper and the results depicted the efficiency of the proposed algorithm. However, the authors stated that their proposed algorithm is not implemented in the real time environment. They also suggested for other optimisations for future work of the algorithm.

Balaji et.al.[3] (Balaji K., 2021), illustrated different load balancing algorithms and compared the algorithms based on various factors.

In this paper, the authors [4] (Belkhouraf, 2015) proposed an approach for a semi centralized and multi cluster scheme. They suggested that the method results in a better performance providing better fault tolerance. However, the authors suggested to use more simulation tools for checking various factors of performance of their proposed system.

The authors Bhandari et. al. [5] (Bhandari A., 2019) designed a modified-throttled load balancing algorithm to consider the virtual machine availability. The authors considered availability index in every virtual machines for a given time period. They also compared their proposed algorithm with the other load balancing algorithms and the performances are evaluated using CloudAnalyst. However, the authors have challenges to execute their proposed algorithm in the real time situation which may vary the results.

The authors Chawla et. al. [6] (Chawla A., 2018) proposed an algorithm in this paper on Packet based Load Balancing Algorithm with the objective to replicate the packets in Virtual Machines during the unavailability of requested packets by grouping of packages together. As suggested by the authors, the main aim of this algorithm is to balance the load in Cloud Computing Environment with minimum cost, execution time and waiting time. However, the authors have not tested the algorithm in the real time situation; it was tested using cloud sim toolkit. They have also mentioned that their proposed algorithm works smoothly if the Virtual Machines work without any fault. The authors have suggested working on the automatic creation of the migration tools for the future enhancement.

In this paper, the authors Ebadifard et. al., [7] (Ebadifard F., 2020) proposed an algorithm based on honeybee technique for successful task scheduling in load balancing. They suggested that this algorithm can be used to reduce make span and fault tolerance and waiting time of virtual machines, increasing the system's reliability. However, the authors suggested to reduce the cost of this algorithm.

Ghomi et al.[8] (Ghomi E. J., 2017) surveyed several metrics for load balancing techniques that considered in future load balancing mechanisms. The authors presented various new classification of load balancing techniques and presented the results in the form of metrics.

In this paper, the authors Grover et. al [9] (Grover J., 2013) suggested their proposed algorithm reduces the communication cost accelerating the price of load balancing which indirectly improves the production and response time of the cloud environment.

Gupta et.al. [10] (A., Load Balancing in Cloud Computing., 2017), in this paper, discussed MSLB (Managed Server Load Balancing) techniques for load balancing. The author considered two data-centers and four Virtual Machines for research and for presenting the result paradigm. The authors illustrated response time by various regions in this paper. The cost efficiency of the proposed system is also mentioned in this paper in a graphical representation.

The authors Kapoor et. al [12] (Kapoor C., 2015) proposed an algorithm by modifying the unsupervised K-means clustering to divide the Virtual Machines into clusters. They discussed the working of their proposed work in Heterogeneous environment. The experimental results have shown that the proposed approach in this paper gives better results than throttled and modified throttled algorithms when compared with various factors based on the number of matrices.

The Authors Kaur et. al. [13] (Kaur A., 2019) discussed about the paired tree algorithm to improve the performance of the virtual machines based on their overall task computation time. They also mentioned the use of scheduling of workflow algorithms. As suggested by the authors, the paired tree mechanism is used to adjust the load of virtual machines dividing the conditions of the machines. The proposed model suggested by the authors, acts in active state whenever the server gets exhausted and divides the load using subordinate splits recording in the paired tree. However, the authors also mentioned that the proposed system can be enhanced with optimum consumer experience and also suggested to restructure the algorithm including QoS parameters.

The author Kumar P. Et. al. [14] (Kumar P., 2019) suggested many objectives of Load Balancing along with comparisons of various algorithms.

Mishra et.al. [15] (Mishra S.R., 2020), have described the homogeneous and heterogeneous load balancing techniques in cloud computing environments. Various performances and parameters are listed and evaluated the system performance. The authors proposed a method of the load balancing algorithm in the cloud environment and the simulation is carried out in the CloudSim simulator technique. However, the authors suggested evaluating the proposed algorithms in a real-world cloud deployment.

Mukundha et. al. [16] (Mukundha C., 2017), surveyed multiple algorithms for the load balancing with Genetic algorithm. However, the limitations are also mentioned in this paper and suggested for the efficient load balancing techniques.

In the present paper, the authors Panwar et. al. [17] (Panwar R., 2015) proposed a dynamic load management algorithm whose performance is analysed using Cloud Analyst simulator based on various parameters.

In this paper, the authors Rahman et. al.[18] (Rahman M., 2014) mentioned about the importance of load balancing and a comparative study is made amongst different load

balancing algorithms. However, authors suggested that technologies need to be manipulated in the real world with more matrices.

The authors Ren et. al. [19] (Ren H., 2012) proposed in this paper a dynamic migration algorithm. As mentioned by them, the algorithm is used to analyse the technique of finding the proper time of virtual machine migration. However, the authors also mentioned about a challenge of peak load transformation during this algorithm processing.

In this paper, the authors Sarma et. al. [20] (Sarma P., 2019) compared different load balancing algorithms. The simulation results of all the discussed algorithms are also shown in this paper. The authors come to a conclusion that on the basis of the results that amongst Load balancing algorithms, Honey Bee Load balancing algorithm shows significant improvement over the other algorithms. Future work is associated to designing a new dynamic load balancing algorithm for better resource utilization & fast throughput.

The authors Sharma et. al. [21] (Sharma S.C.M., 2022) proposed the two multi center two-phase adjustment techniques with the objective to make a better make-span by distributing the load in Virtual Machine (VM)s. The authors discussed the various features of the cloud milieu and focused on the bandwidth and delay of the resources rather than resource utilisation feature. The authors stated simulation of the proposed algorithm is performed using MATLAB. They however suggested extending their work by considering the criteria on multiple task allocation features.

The authors Singh et. al. [22] (Singh H., 2018) discussed the various challenges of cloud computing include reliability, some of the legal and compliant factors, security, ownership, performance, interoperability, multi platform support, data management issues and most importantly load balancing. However, the shortage of tools for geographical distribution of servers and users is also mentioned in this paper.

Singh et. al. [23] (Singh H. G. R., 2014), made a comparison study of the average response time of active, throttled and proposed Virtual Machine load balancing algorithm. However, the authors suggested that the TLBA (Throttled Load Balancing Algorithm) can be further improved so that cloudlets can be assigned as per customer need which can improve the pay per use feature.

Sui et. al. [25] (Sui X., 2019) proposed in this paper a machine learning algorithm for virtual machine, intelligent scheduling strategy to achieve load balancing of cloud data center.

Tong et. al. [26] (Tong Z., 2021) proposed a model to decrease the contrast in load of virtual machines using an algorithm named as DRL-based dynamic load balancing task scheduling algorithm. The authors stated that this algorithm also reduces the task rejection rate. However, they compared their proposed algorithm with the OLB algorithm and it was discovered that the DDMTS algorithm can be improved in the field of task rejection rate for further modifications.

Tripathi et. al [27] (Tripathi A., 2018) proposed a hybrid algorithm of Ant Colony Optimization and Bee Colony algorithm obtaining good performance rate of the hybrid algorithm after combining both bee colony algorithm with ant colony optimization algorithm.

Weinhardt et. al. [28] (Weinhardt C., 2009) discussed in this paper the limitations of an Application Program Interface on Cloud Computing Technology.

Wickremasinghe et. al. [29] (Wickremasinghe B., 2010), mentioned the simulation settings and experimental results in this. However, as per authors' suggestion, the service quality can be increased with the application of load balancing across the data centers, which are supposed to be managed in different strategies with the various levels of virtual machines.

1. Major goals of load balancing

- To build up the efficiency and performance of the system.
- To set up a fault tolerant system.
- Provide support for the balancing of the system.
- Making a better system using limited resources.
- Provide better optimisation of user satisfactory level.
- Reducing the time of waiting and job execution.

2. Aim of load balancing

- The load balancing provides constant service with suitable resource utilisation.
- The load balancing raises the performance in optimum price.
- It also provides the scalability service without interrupting the existing system.
- The load balancing technique reduces energy utilisation and carbon emission and balances all the resources with equal distribution of load.
- Load balancing prepares the provision to issue the function uniformly on accessible materials.
- To provide simultaneous assistance on non-successful condition of any part of facilities. Equipping and dispossessing request cases in fulfilment of materials it can be done.
- Load balancing also performs at a lower cost by reducing the latency of its scheduled jobs and improve the resource fulfilment.
- Load balancing contributes extensibility and elasticity for the dynamic applications in varying size.
- To decrease energy utilisation and carbon emission.

3. Challenges of load balancing: Load balancing is useful technique to balance the load of cloud servers; it still has challenges to face. Some of the challenges are mentioned in the following [10](A., Load Balancing in Cloud Computing., 2017)

- **Throughput:** Calculating the execution time to process by CPU.
- **Overhead:** Improved overhead at the execution time.
- **Fault tolerance:** faults to be decreased for better performance.
- **Migration time:** Time taken by the processor to transfer one process.
- **Response time:** More time is consumed to the reaction of the process.
- **Resource utilisation:** The ability to efficiently utilise the resources.
- **Scalability:** Load balancing on a Virtual Machine with multiple clients may cause problem.
- **Performance:** Utilised to evaluate the carrying out of the processor.
- **The point of failure:** The other nodes are not fully dependent on the central node, so the failure of the central node does not cause the failure of the entire system.

- **Geographically distributed nodes:** The nodes are distributed based on geographically distant features.

4. Algorithms used in load balancing: There are mainly three types of load balancing algorithms used in cloud computing and they are:

Round Robin Algorithm
Active Monitoring Algorithm
Throttle Load Balancing Algorithm

- **Round robin algorithm:** The Authors, Shukla S. and Suryavanshi R. S. (2019) [24] (Shukla S., 2019) proposed the Round Robin algorithm used in load balancing. They also mentioned that there are two types of Round Robin algorithm used in Load Balancing and they are- i. Classic Round Robin Algorithm and ii. Weighted Round Robin Algorithm.

- **Classic round robin algorithm:** The authors mentioned the steps of Classic Round Robin Algorithm which are illustrated below [24] (Shukla S., 2019):

Step 1: Distribute the client information across a group of servers.

Step 2: Multiple servers and multiple clients can be involved.

Step 3: The servers are identical and configured to provide the same services to users.

Step 4: All are configured to use the same domain name with different IP Addresses.

Step 5: Load balancing has the list of all the IP Addresses with associated Internet Domain Names.

Step 6: When the request for the sessions is linked with the Domain Names, they are allocated in a circular sequential form.

Step 7: The first server is allocated the request as the client initiates the request and passes to the server.

Step 8: The same process continues to the second and the third servers.

Step 9: In case of the fourth request, it is allocated to the first server again creating a ring of allocating resources.

- **Weighted round robin algorithm:** This algorithm has the following steps:

Step 1: The network administrator assigns a fixed number of weights to each server in the pool.

Step 2: The most efficient and powerful server can be assigned as Weight= 100.

Step 3: The servers with a bigger number of weight can be assigned on more requests.

Step 4: The ring is formed based on the requests.

Step 5: It is considered with the system that the higher weightings being assigned on more requests in each cycle.

- **Active monitoring algorithm:** This dynamic algorithm follows the steps as given below [11] (V., 2019):

- Step 1:** The controllers maintain an index table.
- Step 2:** The servers are identified based on their loading in current time.
- Step 3:** If any server is detected with the minimum load or in idle state, then the load is allocated to that server.
- Step 4:** The index table is updated when the load is allocated to a server.
- Step 5:** The First Come First Served (FCFS) technique is used to allocate the load.
- Step 6:** The unique server id is used to assign the tasks to every server.
- Step 7:** Every task completion allows the controllers to update the index table once again.
- Step 8:** Based on the request of the user on the Internet usage, the load balancer allocates the load to particular server by checking the index table.

- **Throttle load balancing algorithm:** The Throttled Load Balancing Algorithm steps are given below (Singh H. K. H., 2018):

- Step 1:** It is dependent on Virtual Machine status.
- Step 2:** The Virtual Machine allocation is in binary form as yes or no and it defines the status of it.
- Step 3:** The status information is stored in an index table at the load balancer.
- Step 4:** The index table consisting of two parameters- first is the ID of the virtual machine and the second is the status whether the virtual machine is available or busy.
- Step 5:** Initially, all the virtual machine status is set to 'Available'.
- Step 6:** Once the Load balancer gets the forward request from the Data center, it searches for the available virtual machine.
- Step 7:** If it gets the virtual machine with the available status, then it sends the respective VM_ID (Virtual Machine ID) to the data center.
- Step 8:** The Data center makes the status of that virtual machine as 'Busy' and sends the request of updating it to the Load balancer.
- Step 9:** The Load balancer updates the index table as it gets the update request.
- Step 10:** In case of all the virtual machine's status is busy, the Load balancer sends a signal of -1 to the data center.
- Step 11:** The data center sends a negative feedback notification if it does not get any response from the Load balancer. At that time there will not be any update in the index table.

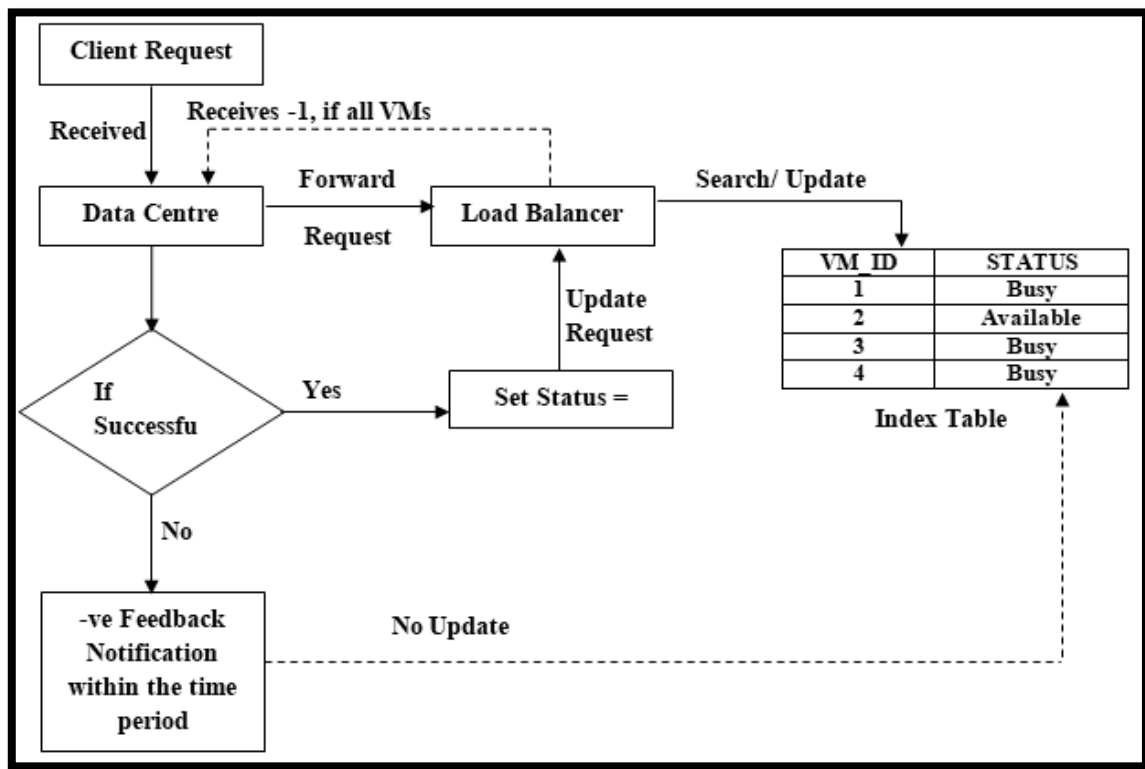


Figure 1: Working Principle of Throttled Load Balancing Algorithm

III. THE CONCLUSION

In this chapter we came to know about the cloud computing and the importance of the load balancing in cloud computing. The challenges of load balancing are also mentioned here. The main three types of load balancing algorithms are discussed in this chapter. However, there are many hybrid algorithms combining the mentioned three algorithms, used for balancing the load which is not discussed in this chapter. There are also various pros and cons of the mentioned three algorithms. Those are kept for the future discussion.

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