A Systematic Analysis of Load Balancing in Cloud Computing

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***Abstract* - Cloud Computing is an ever growing area in information technology. It is internet based technology which emphasizes its utility and follows pay-as-you-go model. It is at present turning into the favoured strategy for communication and computation over scalable networks because of various attractive qualities such as high accessibility, adaptability, scalability, simplicity of management, fault tolerance and minimal effort of possession. The data processing and storage volume is increasing rapidly in cloud environment, which prompts an uneven dissemination of overall work on cloud resources. So a legitimate balance of overall load balancing over the available resources is a major issue in cloud computing paradigm. It is a technique which uses multiple nodes and distributes dynamic workload among them so that no single node is overloaded. It enhances system performance and legitimate utilization of resources. It also limits the time and cost engaged with such huge computing models. Load balancing and better resource utilization is provided by many existing algorithms. This paper explores the various load balancing algorithms related to the cloud.**

Keywords - Cloud Computing, Load Balancing, Static Load Balancing Algorithms, Dynamic Load Balancing Algorithms.

I. INTRODUCTION

Load balancing is the process of distributing workloads among the servers and computing resources in a cloud environment. in which the number of clients where greater than the servers so that there can be burden on the servers so we need to balance the load so we distribute the tasks among the servers equally so it can't be bash with any other server and in this way we can increase the performance of server[1].load balancing allows companies or organizations to manage the applications or work load demands by allocating the resources among the various computer network or server, so load balancing in cloud computing that include hosting the distribution of workload traffic and demand over the network so first level all the clients are been organized ,In second level all the servers are been organized and in between these two a load balance rare used to balance the load among the server and is generally used by the company or organizations to manage there applications[2]. Generally without load balancing the problem with the existing system is that when client sends request incase if the server fails then there is no acknowledgement from the server so that clients continuously sends the request to DNS so to solve such type of problems we have introduced load balancing technique so that we can reduce traffic and increase the performance so client can get the response so client job will be processed immediately if in case any server fails ,the client would be aware of the failure here the problem faced by DNS is resolved by introducing load balancer which replaces DNS with virtual machine with IP address by Virtual Internet Protocol, these servers are connected by the virtual servers along with the load balancer. Load balancer allocates the workload and balances it between two or more could servers. It guarantees service continuity, Handle high traffic, be prepared for sudden request spikes [3]. The main objective of using a load balancer is to save or protect a website from sudden outages. When the work load is distributed among several servers or network units, even if one node fails the burden can be shifted to another active node. Therefore, with increased redundancy, scalability and other features load balancing easily handles websites or application traffic. These days, Cloud Computing is broadly utilized to deliver services over the cyberspace for both technical and economical purposes. The quantity of Cloud-based services is constantly increasing robustly in the last few years, and therefore improved the complexity of the infrastructures behind these services. In order to appropriately control and supervise such multifaceted infrastructures effective and efficient monitoring and scheduling is continuously needed [4].

A. Related Work

Cloud computing is a modern paradigm to give benefits through the Internet. Load balancing is a key part of cloud computing and avoids the circumstance in which a few nodes end up over-burden while the others are idle or have little work to do[38]. Load balancing can enhance the Quality of Service (QoS) measurements, including response time, cost, throughput, execution and resource usage. In computing, Load balancing enhances the distribution of workloads over different computing resources, for instance, PCs, a PC gathering, central processing units, network links, or disk drives.[39] Load balancing intends to enhance resource usage, maximize throughput, restrict response time, and avoid over-burden of any single resource. Utilizing various parts with load balancing instead of a single

component may increase reliability and availability through redundancy. Load adjusting normally includes committed software or hardware, for example, a multilayer switch or a Domain Name System server process.

II. CLASSIFICATION OF LOAD BALANCING ALGORITHMS

A. Necessity for Load Balancing

Load balancing in clouds provide a mechanism for distributing the excess dynamic local workload evenly across all the nodes. Load balancing is utilized for accomplishing a high client fulfillment and asset use proportion, ensuring that no single node is overpowered, which will enhance the general execution of the system. If load balancing used in a proper way then it can achieve optimal resource utilization which will minimize the resource consumption. Another imperative points of interest of utilizing load balancing are implementing fail-over, enabling scalability, avoiding bottlenecks, over-provisioning, reducing response time and achieving Green Computing in clouds. The factors responsible for it are:

A1. Limited Energy Consumption: Load adjusting diminishes the measure of vitality utilization by maintaining a strategic distance from overheating of nodes or virtual machines due to excessive workload.

A2. Diminishing Carbon Emission: Energy consumption and carbon emission are interconnected to each other since both are specifically corresponding. As load adjusting help in lessening vitality utilization it will consequently diminish carbon discharge helping in accomplishing Green Computing [27].

B. Objectives of Load Balancing

B1. Substantial improvement in performance
B2. Stability upkeep of the framework
B3. Increase adaptability of the framework in order to adjust to modifications.
B4. To have a reinforcement design to mitigate for the framework failure even partially.
B5. To keep the framework stable.

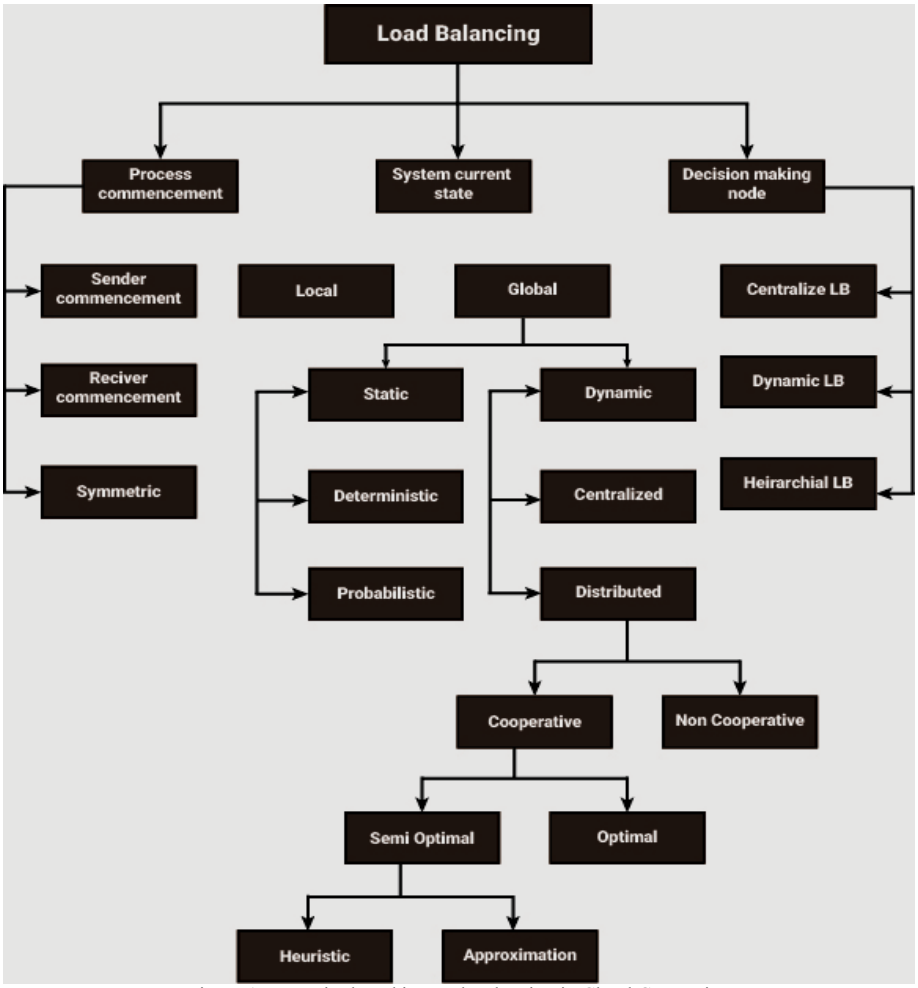

Figure 1. Issues invloved in Load Balancing in Cloud Computing

C. Three in View of Process Inception **WHAT IS THIS??**

C1. Sender Initiated: In this algorithm initially client sends request and then a receiver is assign to him to receive his workload i.e. the sender starts the procedure.

C2. Recipient Initiated: Algorithm firstly receiver sends a acknowledged request to a sender who is prepared to share the workload i.e. the recipient starts the process.

C3. Symmetric: It is a blend of both sender and receiver initiated type of load balancing algorithm.

On the bases of the present condition of the framework, Load balancers actualize type particular algorithms to make load balancing decisions [5].

The choice decides to which remote server to forward another job [6]. Contingent upon system state, load balancing algorithms can be isolated into two composes as static and dynamic [7]. A static load balancing algorithm does not consider the past state or conduct of a node while distributing the load. On the other hand, a dynamic load balancing algorithm checks the previous state of a node while appropriating the load, for example, CPU stack, and measure of memory utilized, postponement or network load [8].

III. STATIC LOAD BALANCING

Static algorithms are suitable for frameworks with low varieties in load [9]. In static algorithm the traffic is separated uniformly among the servers, prior knowledge about the system is definitely known which incorporates handling power, memory, execution and information about client's prerequisites. In Static algorithm the process are assigned to the processors at the compile time according to the performance of nodes. Once the process is assigned, no change or reassignment is possible at run time. Number of jobs in each node is fixed in Static load balancing algorithm, It does not collect any information about the node, The assignment of jobs is done to the processing nodes on the basis of mean execution time, incoming time, extent of resources needed, inter-process communication, Since these factors should be measured before assignment that is why static load balancing is called probabilistic algorithm [10]. These algorithms needn't bother with the data in regards to current state of the framework. This sort of algorithms has genuine disadvantages in the event of sudden disappointment of framework asset, undertakings tasks and also tasks can't be moved amid its execution for load balancing.

A. Round-Robin Load Balancing Algorithm

In this algorithm [11] the round robin component takes after a time cut while handling the information. Each procedure is going to execute in the time cut and afterward change to different process and take after on ring way. In round robin until the all procedures finished their errand, an adjust system is followed all together to balance the process in a group. The procedure is going to happen in round robin until the point that the all procedures finish their tasks with the end goal that a balance technique is implemented in order to balance the process in a group. This algorithm is generally utilized in web servers where http demands are of comparative in nature and dispersed similarly [12].

B. Weighted Round-Robin Load Balancing Algorithm

Weighted round-robin was produced to enhance the basic issues with round robin algorithm [13]. In weighted round robin algorithm, every server is allocated a weight and as indicated by the estimations of the weights, jobs are dispersed. Processors with more noteworthy capacities are assigned a bigger esteem. Consequently the most astounding weighted servers will receive more tasks. In a circumstance where all weights end up measure up to, servers will receive balanced traffic.

C. Shortest Job Scheduling Algorithm

In this algorithm briefest executable occupation is chosen first. The approach takes after to play out the total execution of short jobs to use the assets in finishing of overwhelming occupations. Shortest job had preference that the waiting time for the forms is less which makes it a powerful approach [14].

D. Min-Min Load Balancing

An approach for the load balancing where all the data identified with the job is accessible in earlier. Min-Min algorithm [15] starts with an arrangement of every single pending job. As a matter of first importance, a period taken to finish a task is computed. The job with least completion time is chosen. At that point, the node which has the least completion time for all jobs is chosen. At long last, the chosen node and they chose work are mapped. The ready time of the node is updated. This procedure is rehashed. The advantage of this algorithm is that job with the smallest execution time is executed. The drawback of this algorithm is that a few jobs may involvement starvation

E. Max-Min Load Balancing Algorithm

Max-min load balancing algorithm is alike to the min-min algorithm aside from the accompanying: after finding out the minimum execution times, the greatest esteem is chosen at which is the most extreme time among all tasks on the assets [16]. At that point as indicated by the greatest time, the task is scheduled on the relating machine. The execution time for every single other task is updated on that machine and the allocated task is expelled from the list of tasks that are to be assigned to the machines. Since the prerequisites are known already, this algorithm is expected to perform well [17].

F. Opportunistic Load Balancing Algorithm

Opportunistic load balancing algorithm endeavors to keep each node busy [18]. In this manner it doesn't think about the present workload of every PC. OLB dispatches unexecuted undertakings to right now accessible nodes in an irregular request paying little mind to the nodes present workload [19]. Since OLB does not ascertain the execution time of the hub, the task to be handled will be processed in a slower manner resulting in bottlenecks nevertheless some of the nodes being free [20].

G. Two-Phase (OLB + LBMM) Load Balancing Algorithm

It is proposed by S.- c. Wang et al. [21] that unions Astute Load Balancing (OLB) and Load Balance Min Min (LBMM).Planning calculations to accomplish better executing productivity of the framework [22]. Working principles of OLB algorithm is to put every last single node in working condition with the goal that the objective of distributed computing can be accomplished. Then again LBMM scheduling algorithm is utilized for limiting the execution time of the tasks on hub which diminish of generally speaking consummation time[23].

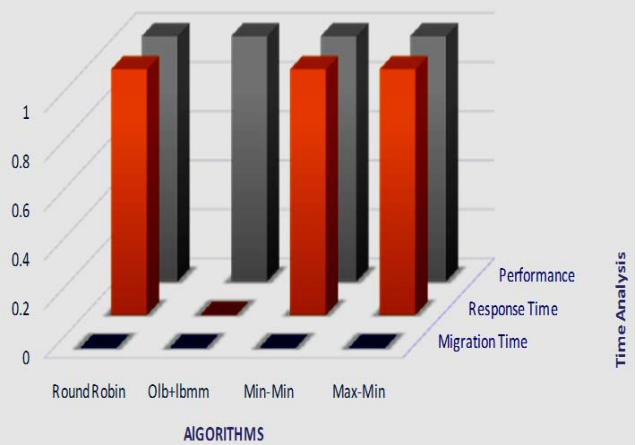

Fig. 2. Time Analysis of Algorithms

IV. DYNAMIC LOAD BALANCING ALGORITHMS

In dynamic algorithm the lightest server in the entire system or on the other hand framework is scanned and preferred for balancing a load. For this continuous correspondence with network is needed which can increase the traffic in the system [24]. Here, current condition of the framework is utilized to make decisions to manage the load. Dynamic algorithms respond to the actual current system state in making load transfer decisions. Since current condition of the framework is utilized to dynamic load balancing decisions, processes are permitted to move from an overused machine to an under used machine continuously progressively [25]. Dynamic algorithms are decision concerning load balancing in view of the present condition of the framework i.e. any earlier learning about the framework isn't required. This will defeat the downsides of static approach. This will overcome the draw backs of static approach [26]. The dynamic algorithms are complex, but they can provide better performance and fault tolerance.

A. Policies Used in Dynamic Load Balancing Algorithms

A1. Transfer Policy: Selection of a job in dynamic load balancing algorithm for exchanging from a local node to a remote node is known as transfer policy.
A2. Selection Policy: It determines the processors included in the load exchange.
A3. Location Policy: Selection of a goal node for a move undertaking in load balancing algorithm is eluded as location policy or location strategy.
A4. Information Policy: Collection of information about the node in the system in load balancing algorithm is referred to as information policy or information strategy.
A5. Load estimation Policy: Total measure of workload on a processor or machine is evaluated by this approach.
A6. Process Transfer Policy: It is used for deciding which task is to be executed locally or remotely.
A7. Priority Assignment Policy: In it priority are assigned to processes for executing them locally and Remotely.
A8. Migration Limiting Policy: It sets a point of confinement on the most extreme number of times a task can relocate starting with one machine then onto the next machine.

B. Algorithm Types of Dynamic Load Balancing

B1. Ant Colony Optimization: Distinctive ant colony algorithms likewise introduce to balance the load applying ant behavior for seeking nourishment. Larger weight implies that asset has high computation power [28]. Load balancing ant colony optimizations (LBACO) not only balances the load yet in addition limits make range. All tasks are assumed to be mutually independent and computationally intensive.

B2. Honey Bee Foraging Algorithm: Dhinesh et al. proposed an algorithm after detail analysis of behavior of honey bees [29]. At the point when an under loaded VM doles out an errand, it updates number of priority tasks and load of VM to other tasks in waiting list. This approach helps other procedures to pick their VM [30]. If a task has high priority, then it selects a VM having minimum number of priority tasks. It doesn't consideration only load balancing yet additionally keeps track of priorities of tasks which currently removed from heavy loaded machines [31]. It increases throughput and minimizes response time.

B3. Throttled Load Balancing: This algorithm relies on the hypothesis of suitable search of virtual machine [32]. The task manager makes a rundown of virtual machines. By utilizing the rundown, customer asks for allocated to the applicable machine. In the event that the size and capacity of the machine is appropriate for request, then the job is given to that machine. This algorithm is superior to round robin calculation [33].

B4. Carton: Carton [34] is a procedure that is combination of load balancing (LB) and distributed rate limiting (DRL). Through LB, jobs are reasonably allotted to the servers. While DRL guarantees the equivalent conveyance of assets. Work load is progressively allotted to enhance the execution and spread the load similarly to every one of the servers. This algorithm can easily be implemented as low communication required [35].

-C. Load Balancing Issues in Different Routes

C1. Task allocation- The random distribution of a finite number of tasks into different Physical Machines (PMs) which again allocated to different VMs of respective PM. The efficiency of task allocation to the cloud determines the 45 effectiveness of the load balancing algorithm [36].

C2. VM/Task Migration Management-In Cloud Computing Environment, VM Migration is is nothing but the movement of a VM from one PM to another PM to improving the resource utilization of the data center for which the PM is overloaded. Likewise, the migration of the current state of a task from one VM to another VM or VM 50 of one host to VM of another host is referred to as task migration. This is the reason; the VM or task migration plays a major role in load balancing of cloud computing scheduling [37].

TABLE 1. ADVANTAGES AND DISADVANTAGES OF ALGORITHMS

S.No	Algorithm	Advantage	Disadvantage
1	Round Robin	1.it is extremely simple to implement 2. Requires a single scheduler. 3. Suitable for small and no dynamic system.	1. During task VM mapping, it neither considers the size of the task nor considers the processing capacity of VM. It also doesn't consider the present load on the VM. 2.Centralized and static in nature, so not suitable for cloud environments
2	Weighted Round Robin	1.The most commonly used criterion is the server's traffic-handling capacity	1. Does not consider the advanced load balancing requirements such as processing times for each individual request.
3	Min-Min	1. Easy to implement. 2.Dynamic in nature as it considers the VM capacity, task size and present load on the VM	1. Centralized in nature. 2. Task buffering results in increase of response time. 3. Not ideal when a large number of tasks are expected to arrive. 4. May cause starvation of maximum execution time tasks.
4.	Min-Max	1. Easy to implement. 2. Dynamic in nature as it considers the VM capacity, task size and present load on the VM.	1. Centralized in nature. 2. Task buffering results in increase in response time. 3. Not ideal when a large number of tasks are expected to arrive.

V. APPLICATIONS OF LOAD BALANCING

One of the most commonly used applications of load balancing is to provide a single Internet benefit from numerous servers, at times known as a server farm. Commonly load-balanced systems incorporate well known sites, Domain Name System (DNS) servers, and databases, extensive Internet Relay Chat systems, high-bandwidth File Transfer Protocol locales, Network News Transfer Protocol (NNTP) servers [40]. Distribution of incoming traffic over different servers in a system to give clients a smooth and quick access to contents of a site is named as load balancing. The client's requests can be in the form of application data, videos or images and the response to the demands has to be fast and reliable. The load balancer disseminates the different requests over various servers to determine that no single server is over burdened with traffic requests and face the risk of crashing and affect the performance of the website [41]. Load balancers divert the movement from a server that is down to the other active servers. At the point when another server is added to the network the load balancer naturally begins redirecting the activity to it [42]. The focal points with load balancers are that the client's requests are distributed evenly across multiple servers without burdening any one active server. The guests get access to their requests at fast speed. The client can increase or decrease the servers as the traffic demands. The load balancers can be implemented in both hardware and software [43]. The load balancing software can be loaded on to the physical PCs while the software based solutions run on the cloud servers and are offered as a service[44].Cloud Load Balancers handle the online movement by allocating the workloads over a few servers and also resources both consequently or on request premise[45]. They make the best utilization of your workload execution and in the meantime prevent over-burden keeping in order offering users a flawless experience [46].

The quick rise in online traffic can offer an enormous challenge to even the most competent websites as well as applications [47]. During the course of online sales, even a small outage can lead to a lot of damage. Cloud load balancing is all about distributing the workloads over a wide array of computing resources [48]. This limits the costs connected with report administration systems. It even boosts usability of resources [49].

TABLE II. ANALYSIS OF LOAD BALANCING ALGORITHMS USING VARIOUS PARAMETERS, Cloud Environment

S.NO	Parameters	Static Load	Dynamic Load
1	Reliability	less	More
2	Performance	Less	More
3	Complexity	Less	More
4	Flexibility	More	Less
5	Stability	More	Less
6	Implementation	Easy	Difficult
7	Communication Overhead	Less	More
8	Resource Utilization	Less	More
9	Adaptability	Less	More
10	Response Time	Less	More

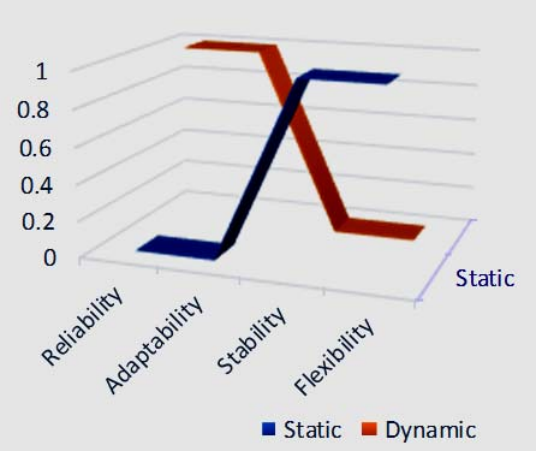

Fig 2: Performance Analysis of Static and Dynamic Load balancing Algorithm.

-VI. CONCLUSION

On the whole, appropriately dividing the workload is vital to maximizing performance. Toward this objective, we should think about the same number of the stage (e.g., computational speed) and problem characteristics (e.g., cost of data transmission) as possible. Dynamic load balancing refers to a large collection of algorithms that perform or modify load assignments online, i.e., during the execution of a program. Static load balancing, on the other hand, refers to algorithms that assign workload offline i.e., either, before the start or at the specific beginning of the execution. Dynamic load adjusting is characterized by the ability to adjust to changes to the execution stage (e.g., nodes going disconnected, communication links getting to be congested, and so on.) but at the expense of additional coordination overhead. Static load balancing can provide a near-optimum solution to the load-partitioning problem, the trade-offs being the inability to adjust to run-time changes and the need to establish intimate knowledge about the performance characteristics of the individual components making up the execution stage. Cloud load balancing takes help of cloud's scalability and agility to maintain website traffic. By using efficient load balancers, we can easily match up the improved user traffic and allocate it among many servers or network devices. It is especially important for e commerce websites, who deals with thousands of websites visitors per second.

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