Load Balancing in cloud computing

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***Abstract*-cloud computing is a structured model that defines computing services, in which data as well as resources are retrieved from cloud service provider via internet through some well formed web-based tool and application. Cloud Computing is nothing but a collection of computing resources and services pooled together and is provided to the users on pay-as-needed basis. Sharing of the group of resources may initiate a problem of availability of these resources causing a situation of deadlock. One way to avoid deadlocks is to distribute the workload of all the VMs among themselves. This is called load balancing. The goal of balancing the load of virtual machines is to reduce energy consumption and provide maximum resource utilization thereby reducing the number of job rejections. As the numbers of users are increasing on the cloud, the load balancing has become the challenge for the cloud provider. The aim of this paper is to discuss the concept of load balancing in cloud computing and how it improves and maintain the performance of cloud systems and also contains comparision of various existing static load balancers as well as conventional dynamic load balancer also.**

***Keywords:* Cloud Computing; Load Balancing; Deadlock; Scheduling; Resource Allocation**

I. INTRODUCTION

Cloud Computing or the future of next generation computing provides its clients with a virtualized network access to applications and or services. No matter from wherever the client is accessing the service, he is automatically directed to the available resources.

Sometimes our system gets hanged up or it seems to take few decades for pages to come out of printer. All this happens because there is a queue of requests waiting for their turn to access resources which are shared among them. But these requests cannot be serviced as the resources required by each of these requests are held by another process or request by virtual machines. One cause for all these problems is called deadlock.

Load balancing is a new approach that assists networks and resources by providing a high throughput and least response time [5].In cloud platforms, resource allocation (or load balancing) takes place majority at two levels.

- At first level: The load balancer assigns the requested instances to physical computers at the time of uploading an application attempting to balance the computational load of multiple applications across physical computers.
- At second level: When an application receives multiple incoming requests, each of these requests must be assigned to a specific application instance to balance the computational load across a set of instances of the same application [1].

The following sections discusses about the concept of load balancing, its needs and goals, types and comparision between traditional computing environment and cloud computing environment and different algorithms. After that it discusses the conclusion and the references.

II. LOAD BALANCING

Load balancing is the process of improving the performance of the system by shifting of workload among the processors. Workload of a machine means the total processing time it requires to execute all the tasks assigned to the machine. Balancing the load of virtual machines uniformly means that anyone of the available machine is not idle or partially loaded while others are heavily loaded. Load balancing is one of the important factors to heighten the working performance of the cloud service provider. The benefits of distributing the workload includes increased resource utilization ratio which further leads to enhancing the overall performance thereby achieving maximum client satisfaction [2].

In cloud computing, if users are increasing load will also be increased, the increase in the number of users will lead to poor performance in terms of resource usage, if the cloud provider is not configured with any good mechanism for load balancing and also the capacity of cloud servers would not be utilized properly. This will confiscate or seize the performance of heavy loaded node. If some good load balancing technique is implemented, it will equally divide the load (here term equally defines low load on heavy loaded node and more load on node with less load now) and thereby we can maximize resource utilization. One of the crucial issue of cloud computing is to divide the workload dynamically.

2.1 Goals of Load Balancing

- Goals of load balancing as discussed by authors of [6],[7] include:
- Substantial improvement in performance
- Stability maintenance of the system
- Increase flexibility of the system so as to adapt to the modifications.
- Build a fault tolerant system by creating backups.

2.2 Classification of Load Balancing Algorithm

Based on process orientation they are classified as:

a) Sender Initiated: In this sender initiates the process; the client sends request until a receiver is assigned to him to receive his workload
b) Receiver Initiated: The receiver initiates the process; the receiver sends a request to acknowledge a sender who is ready to share the workload
c) Symmetric: It is a combination of both sender and receiver initiated type of load balancing algorithm.

Based on the current state of the system they are classified as:

1. **Static Load Balancing**

In the static load balancing algorithm the decision of shifting the load does not depend on the current state of the system. It requires knowledge about the applications and resources of the system. The performance of the virtual machines is determined at the time of job arrival. The master processor assigns the workload to other slave processors according to their performance. The assigned work is thus performed by the slave processors and the result is returned to the master processor.

Static load balancing algorithms are not preemptive and therefore each machine has at least one task assigned for itself. Its aims in minimizing the execution time of the task and limit communication overhead and delays. This algorithm has a drawback that the task is assigned to the processors or machines only after it is created and that task cannot be shifted during its execution to any other machine for balancing the load.The four different types of Static load balancing techniques are Round Robin algorithm, Central Manager algorithm, Threshold algorithm and randomized algorithm.

2. **Dynamic Load Balancing**

In this type of load balancing algorithms the current state of the system is used to make any decision for load balancing, thus the shifting of the load is depend on the current state of the system. It allows for processes to move from an over utilized machine to an under utilized machine dynamically for faster execution.

This means that it allows for process preemption which is not supported in Static load balancing approach. An important advantage of this approach is that its decision for balancing the load is based on the current state of the system which helps in improving the overall performance of the system by migrating the load dynamically.

2.3 Traditional Computing V/S Cloud Computing Environment

There are many similarities as well as differences between traditional scheduling algorithms and the scheduling of VM resources in cloud computing environment.

First of all the major difference between cloud computing environment and traditional computing environment is the target of scheduling. In traditional computing environment, it mainly schedules process or task so the granularity and the transferred data is small; whereas in cloud computing environment, the scheduling target is VM resources so the granularity is large and the transferred data is large as well.

Secondly, in cloud computing environment, compared with the deployment time of VMs, the time of scheduling algorithm can almost be neglected.

2.4. Need of Load Balancing

We can balance the load of a machine by dynamically shifting the workload local to the machine to remote nodes or machines which are less utilized. This maximizes the user satisfaction, minimizing response time, increasing resource utilization, reducing the number of job rejections and raising the performance ratio of the system.

Load balancing is also needed for achieving Green computing in clouds [5]. The factors responsible for it are:

1. Limited Energy Consumption: Load balancing can reduce the amount of energy consumption by avoiding over hearting of nodes or virtual machines due to excessive workload.
2. Reducing Carbon Emission: Energy consumption and carbon emission are the two sides of the same coin. Both are directly proportional to each other. Load balancing helps in reducing energy consumption which will automatically reduce carbon emission and thus achieve Green Computing .

III. LOAD BALANCING ALGORITHMS

The paper describes about three load balancing algorithms which are Round robin algorithm, equally spread current execution load and Throttled Load balancing[11].

- **Round Robin:** Round robin use the time slicing mechanism. The name of the algorithm suggests that it works in the round manner where each node is allotted with a time slice and has to wait for their turn. The time is divided and interval is allotted to each node. Each node is allotted with a time slice in which they have to perform their task. The complicity of this algorithm is less compared to the other two algorithms. An open source simulation performed the algorithm software know as cloud analyst, this algorithm is the default algorithm used in the simulation. This algorithm simply allots the job in round robin fashion which doesn't consider the load on different machines.
- **Equally spread current execution load**: This algorithm requires a load balancer which monitors the jobs which are asked for execution. The task of load balancer is to queue up the jobs and hand over them to different virtual machines. The balancer looks over the queue frequently for new jobs and then allots them to the list of free virtual server. The balance also maintains the list of task allotted to virtual servers, which helps them to identify that which virtual machines are free and need to be allotted with new jobs. The experimental work for this algorithm is performed using the cloud analyst simulation. The name suggests about this algorithm that it work on equally spreading the execution load on different virtual machine.

- **Throttled Load balancing**: The Throttled algorithm work by finding the appropriate virtual machine for assigning a particular job. The job manager is having a list of all virtual machines, using this indexed list, it allot the desire job to the appropriate machine. If the job is well suited for a particular machine than that job is, assign to the appropriate machine. If no virtual machines are available to accept jobs then the job manager waits for the client request and takes the job in queue for fast processing.
- **ARA(Adaptive Resource Allocation)**:In ARA algorithm for adaptive resource allocation in cloud systems, which attempts to counteract the deleterious effect of burrstones by allowing some randomness in the decision making process and thus improve overall system performance and availability [1]. The problem with this strategy is that it only considers the Poisson arrival streams as well as the exponentially distributed service time and the fixed number of choice.

The following figure shows the diagrammatical representation of the algorithm used for load balancing in cloud computing environment [8], [9].The figure also shows the three algorithms which are studded in this paper using the cloud analyst simulation tool, this tool is based on cloud sim , the cloud sim provides a GUI inter face which helps to perform the experimental work.

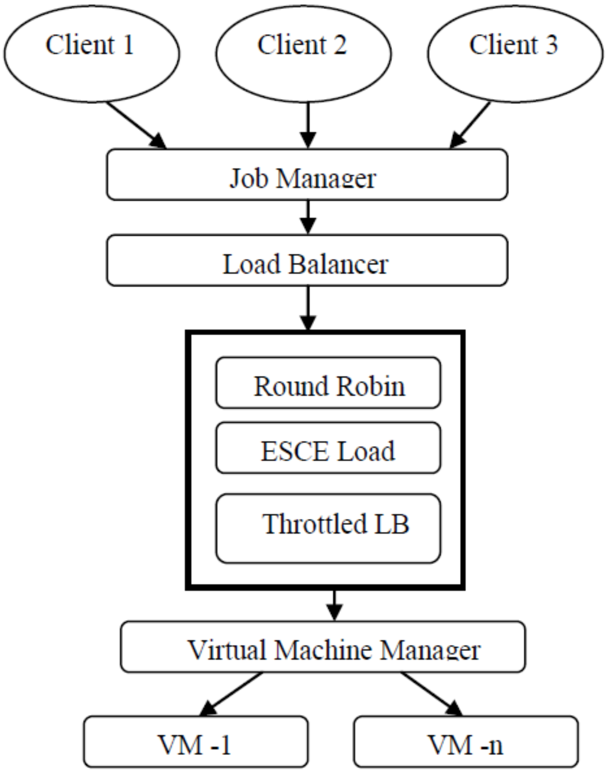


Fig.1 Load Balancing Algorithms Execution

Source: [8]R. Mata-Toledo, and P. Gupta, “Green data center: how green can we perform”, Journal of Technology Research, Academic and Business Research Institute, Vol. 2, No. 1,May 2010, pages 1-8.

IV. DYNAMIC LOAD BALANCING POLICIES AND STRATEGIES

The different policies as described in [2], [3] are as follows:

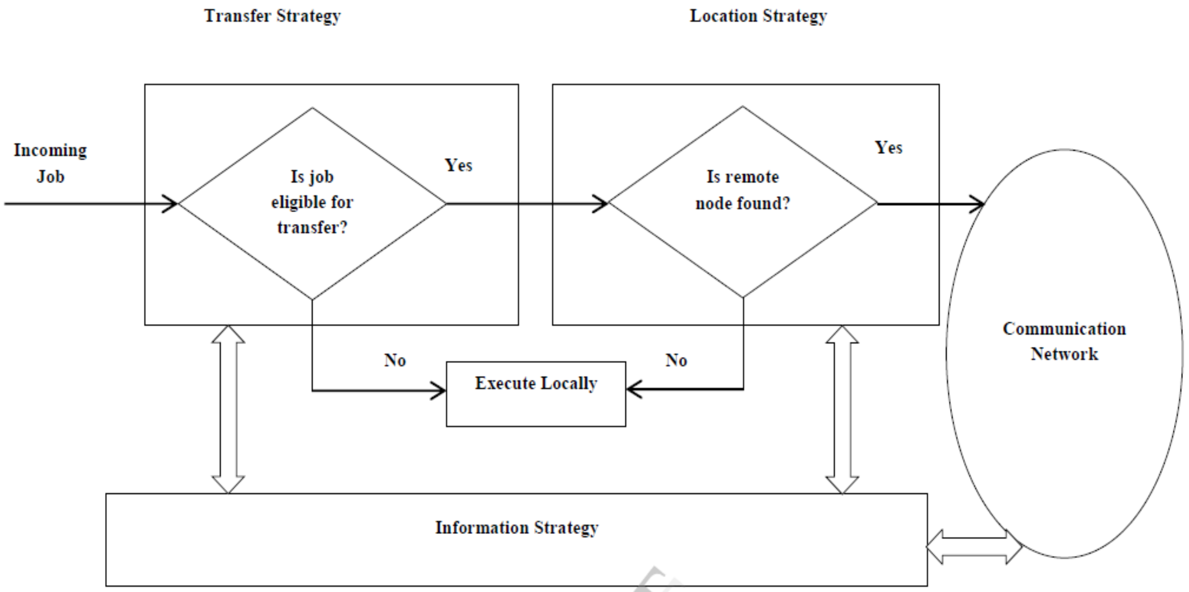
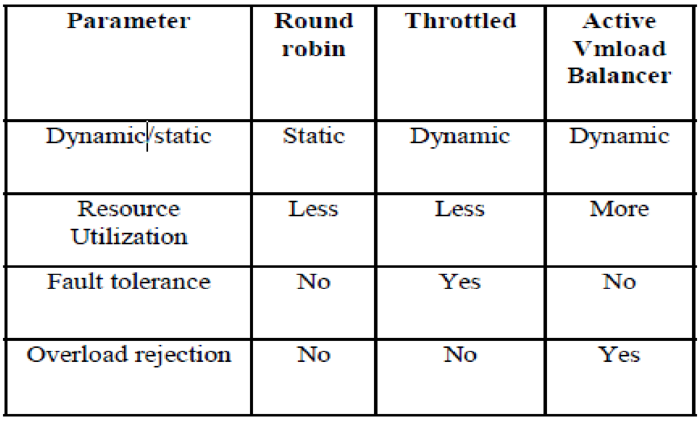


Fig.2 Interaction between different components of Dynamic Load Balancing Algorithm
Source: [2]Ali M Alakeel, “A Guide To Dynamic Load Balancing In Distributed Computer Systems”, International Journal of Computer Science and Network Security, Vol. 10 No. 6, June 2010.

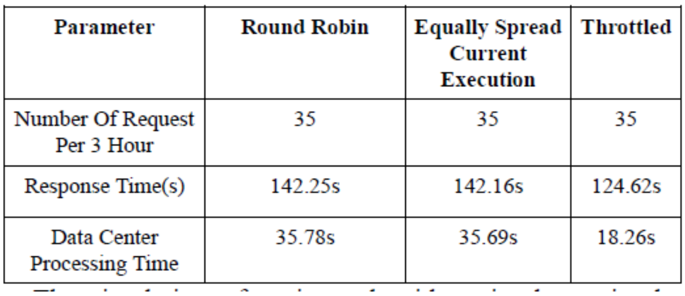
1. Location Policy: The policy used by a processor or machine for sharing the task transferred by an over loaded machine is termed as Location policy.
2. Transfer Policy: The policy used for selecting a task or process from a local machine for transfer to a remote machine is termed as Transfer policy.
3. Selection Policy: The policy used for identifying the processors or machines that take part in load balancing is termed as Selection Policy.
4. Information Policy: The policy that is accountable for gathering all the information on which the decision of load balancing is based id referred as Information policy.
5. Load estimation Policy: The policy which is used for deciding the method for approximating the total work load of a processor or machine is termed as Load estimation policy.
6. Process Transfer Policy: The policy which is used for deciding the execution of a task that is it is to be done locally or remotely is termed as Process Transfer policy.
7. Priority Assignment Policy: The policy that is used to assign priority for execution of both local and remote processes and tasks is termed as Priority Assignment Policy.
8. Migration Limiting Policy: The policy that is used to set a limit on the maximum number of times a task can migrate from one machine to another machine.

V. COMPARISION CHART



Parameter	Round robin	Throttled	Active Vmload Balancer
Dynamic/static	Static	Dynamic	Dynamic
Resource Utilization	Less	Less	More
Fault tolerance	No	Yes	No
Overload rejection	No	No	Yes

Fig.3 Comparison of various algorithms
Source: [10] Jitendra Bhatia, Tirth Patel, Harshal Trivedi, Vishrut Majmudar,” HTV Dynamic Load Balancing Algorithm for Virtual Machine Instances in Cloud”,18,Dec2 012,Pages 15-20 IEEE.



Parameter	Round Robin	Equally Spread Current Execution	Throttled
Number Of Request Per 3 Hour	35	35	35
Response Time(s)	142.25s	142.16s	124.62s
Data Center Processing Time	35.78s	35.69s	18.26s

Fig.4 Response time of various algorithms
Source: [10] Jitendra Bhatia, Tirth Patel, Harshal Trivedi, Vishrut Majmudar," HTV Dynamic Load Balancing Algorithm for Virtual Machine Instances in Cloud",18,Dec2 012,Pages 15-20 IEEE.

We have used the number of requests as shown in above table for each load balancing policy one by one and depending on that the result calculated for the metrics like response time, request processing time has been shown. It can be seen from the table that the overall response time of Round Robin policy and ESCE policy is almost same while that of Throttled policy is low as compared to other two policies.

VI. QUALITATIVE MATRIX FOR LOAD BALANCING

The different qualitative metrics or parameters that are considered important for load balancing in cloud computing are discussed as follows:

1. Throughput: The total number of tasks that have completed execution is called throughput. A high throughput is required for better performance of the system.
2. Associated Overhead: The amount of overhead that is produced by the execution of the load balancing algorithm. Minimum overhead is expected for successful implementation of the algorithm.
3. Fault tolerant: It is the ability of the algorithm to perform correctly and uniformly even in conditions of failure at any arbitrary node in the system.
4. Migration time: The time taken in migration or transfer of a task from one machine to any other machine in the system. This time should be minimum for improving the performance of the system.
5. Response time: It is the minimum time that a distributed system executing a specific load balancing algorithm takes to respond.
6. Resource Utilization: It is the degree to which the resources of the system are utilized. A good load balancing algorithm provides maximum resource utilization.
7. Scalability: It determines the ability of the system to accomplish load balancing algorithm with a restricted number of processors or machines.
8. Performance: It represents the effectiveness of the system after performing load balancing. If all the above parameters are satisfied optimally then it will highly improve the performance of the system.

VII. CONCLUSION

As such cloud computing being wide area of research and one of the major topics of research is dynamic load balancing, so the following research will be focusing on algorithm considering mainly two parameters firstly, load on the server and secondly, current performance of server.

The goal of load balancing is to increase client satisfaction and maximize resource utilization and substantially increase the performance of the cloud system and minimizing the response time and reducing the number of job rejection thereby reducing the energy consumed and the carbon emission rate.

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