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Analysis of Load Balancing Algorithms in Cloud Computing

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Abstract: Cloud Computing refers to the delivery computing resources over the network. User can access the cloud service and pay based on the usage of resource. Balancing the load is major task of cloud service provider with minimum response time, maximum throughput and better resource utilization. Many load balancing algorithms are proposed to assign a user request to cloud resource in efficient manner. In this paper three load balancing algorithms are simulated in Cloud Analyst and results are compared.

Keywords—Cloud Computing, Cloud Analyst, Virtual Machine, Load Balancing Policy, Data Center

I. INTRODUCTION

Cloud computing is an innovative and emerging technology, which enables the user to access the software and service over the network. Services may be storage, software's, applications and computing resources. User can access super computer power in cloud computing. Cloud services are popular because it helps in reducing the cost of purchasing operating networks and computers. Cloud users can avoid unnecessary investment in purchasing hardware, infrastructure, information technology or buying of software licenses. The benefits are rapid return on investment, low upfront costs, customization, rapid deployment, flexible use, solutions that can make use of new innovations. The benefits to users include reliability, scalability and efficiency.

The cloud is reliable; it enables access to documents and applications anywhere in the world via the Internet. Scalability means that the cloud computing offers unlimited storage capacity and processing. Cloud computing enables improvements and more flexible IT acquisition, which will permit adjustments to a procedures based on a sensitivity of the data.

The services provided by cloud computing are mainly divided into three basic service models as Software as a service (Saas), Platform as a service (Paas), Infrastructure as a service (Iaas). The cloud computing domain is divided into four categories such as Private, Public, Hybrid and Community Cloud [1].

Figure 1 shows the three important factors of Cloud computing such as characteristics, deployment model and service model. Cloud computing is a fastest growing technology; the number of users of cloud computing service are increasing rapidly. To balance the load is the major task of cloud service provider with minimum response time, maximum throughput and efficient utilization of resource. The primary objective considered here is efficient utilization of resources i.e., resource should not be over utilized and underutilized.

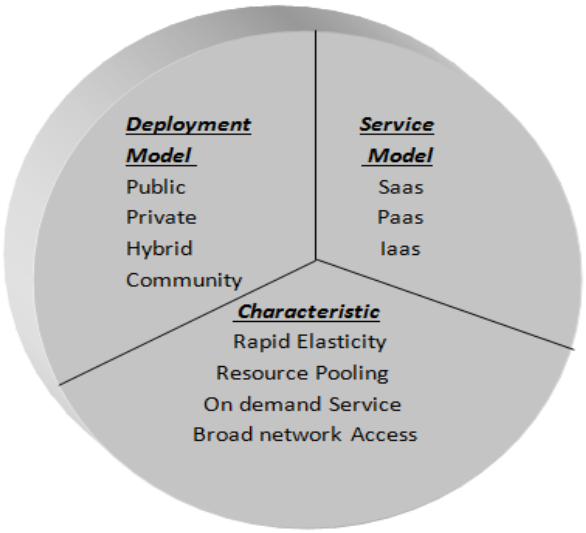

Figure 1: Cloud Computing

II. LOAD BALANCING

Load Balancing is a method to distribute workload on the multiple computers or a computer cluster through network links to achieve optimal resource utilization for maximizing throughput and minimizing overall response time. As the number of users in cloud computing technology is increasing very rapidly, it is becoming very difficult to manage and fulfill the user requirements. So load balancing has come into picture to spread the user request to all the resources (virtual machine in data center) without under or over utilization. Load balancer is not only used in cloud but it is also used in database and website.

Load balancing has two major tasks, one is the resource allocation or resource provisioning and other is scheduling in distributed environment. Efficient provisioning of resources and scheduling of resources as well as tasks will ensure:

- Resources are available easily.
- Resources are efficiently utilized under condition of low/high load.
- Reduction in cost of using resources.
- Load balancing increases throughput to maximum level and minimum response time.

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The load balancing is an efficient and critical concept in cloud computing and it helps in utilizing the resources optimally, therefore minimizing the consumption of resources. Thus load needs to be distributed over the nodes in cloud-based architecture, so that each resource does the equal amount of work at any point of time that is performed by a load balancer. The load balancer determines the various request allocation to different servers. The load balancer uses various scheduling algorithm which server should take the request.

2.1 Classification of load balancing algorithm

Load balancing algorithms in cloud computing are classified based on state and behavior of the system. There are two types, named as Static and Dynamic load balancing algorithm [2].

Static Load Balancing Algorithm

In static algorithm load does not depend on the current state and behavior of the system, but requires a prior knowledge about the resource and application. It divides the traffic equally among all available server or virtual machine. It aims to minimum execution time and limits communication overhead and delay. This algorithm has drawback of low reliability and no fault tolerance. Examples of static load balancing algorithms are Round robin and Random load balancing algorithm.

Dynamic Load Balancing Algorithm

Dynamic algorithm is more flexible than static algorithm. It depends on the current state and behavior of the system, but does not require prior knowledge about the resource. It divides the traffic according to capacity of all server and virtual machine. It aims to reduce the fault tolerance and improve reliability. This algorithm has drawback of less stable and high utilization of resource. Examples of dynamic load balancing algorithms are Active monitoring and Throttle load balancing.

III. EXISTING LOAD BALANCING IN CLOUDANALYST

3.1 Round Robin Load Balancing Algorithm

Round robin is one of the most simple and straight forward algorithm with static nature, it allocate the user requests to virtual machine in rotation manner. When first request arrives, it selects virtual machine randomly then next requests are allocate in rotation manner shown in Figure 2. The main aim of this algorithm is to distribute the load equally to all available virtual machine. Drawback of this algorithm is without checking the capacity of server (Virtual machine) or resource it allocates the request. Also the algorithm will not consider the state and behavior of previous allocation of VM.

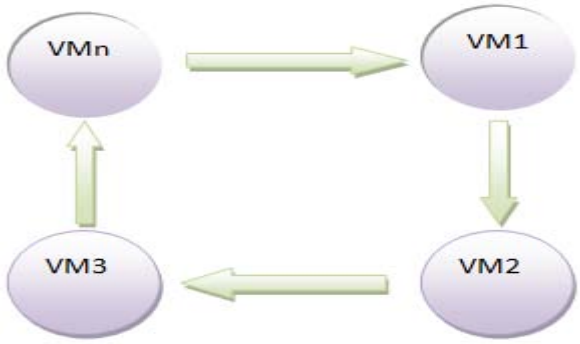

Figure 2: Round Robin Load Balancing

3.2 Active Monitoring Load Balancer

Active load balancing algorithm is a dynamic approach. It keeps the information of number of requests currently allocated in each virtual machine in table. Using this information table next request is allocated to virtual machine shown in Figure 3. When request arrives it checks the information table to know which virtual machine is least loaded and then allocates the request. Drawback of this algorithm is that it does not check whether virtual machine is previously utilized or not because of this under/ over utilization of virtual machine will occur.

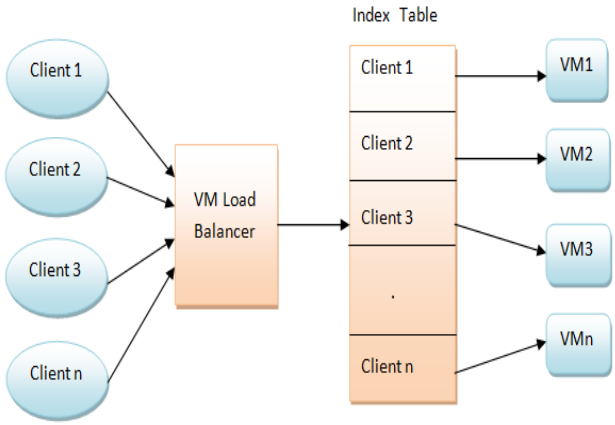

Figure 3: Active Monitoring Load Balancing

3.3 Throttled load balancing algorithm

Throttled load balancing algorithm is also dynamic in nature, in which at a time one virtual machine execute only one user request. It maintains a table to store the state of each virtual machine (Busy/Available) is shown in Figure 4. When the request arrives load balancer checks the table which virtual machine is available to execute the user request. Drawback of this algorithm is that it checks table from first index every time to allocate. Virtual machines available at the bottom of the table will not be utilized so under and over utilization of virtual machine is occur.

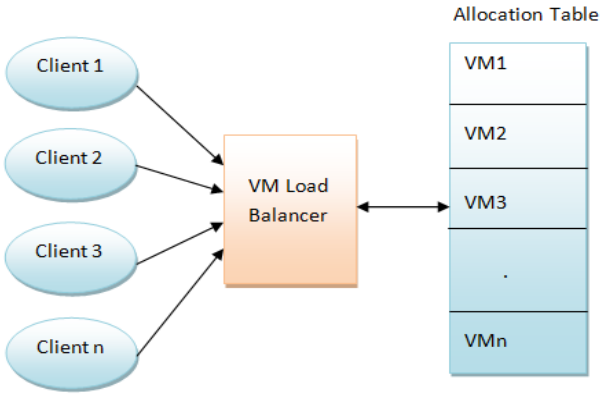

Figure 4: Throttled Load Balancing

IV. CLOUDANALYST SIMULATOR

The Cloud Analyst is built on top of CloudSim tool kit[7], by extending Cloud Sim functionality with the introduction of concepts that model Internet and Internet Application behaviors. Figure 5 shows the block diagram of Cloud Analyst simulator. Basic component of Cloud Analyst are

- *GUI Packages:* It is mainly responsible for the graphical user Interface.
- *User Base* - A User Base models a group of users that is considered as a single unit in the simulation and generates traffic for the simulation.
- *Internet*- It models the Internet traffic routing around the globe by introducing transmission and data transfer delays.
- *DataCenterController*-It generally controls Data center activities.
- *VmLoadBalancer*- The Data center controller generally uses a VmLoadBalancer to determine which VM should be assigned the next Cloudlet for processing and models load balancing policies
- *Simulation*-This is used for creating and executing the request.
- *CloudAppServiceBroker* – This component model service brokers that handle traffic routing between user bases and data centers.

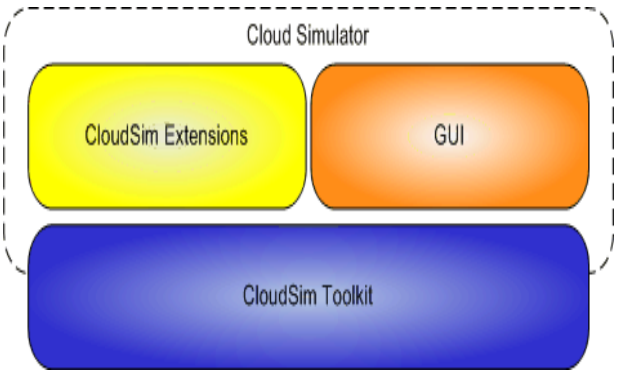

Figure 5: Cloud Analyst

Feature of Cloud analyst simulator

Features of Cloud analyst simulator are listed below.

- Ease of setting up and executing a simulation experiment.
- Ability to define a simulation with a high degree of configurability and flexibility
- Graphical output in the form of tables and charts is highly useful to summarize the potentially large amount of statistics that is collected during the simulation.
- Ability to save the simulation setup (the set of input parameters) as a file and allowed to load the file for further simulation and also be able to save the results of an experiment as a file.
- Ease of extension which means we can evolve the existing load balancing policy with minimal effort with suitable configuration.

V. SIMULATION RESULT AND COMPARISON

Now we will analyze the various load balancing policies by setting the configurations of the various components of the cloud analyst tool. We have set the parameters for the application deployment, user base configuration, Data center configuration and load balancing policy as shown in Figure 7 and 8 respectively. Snapshot of cloud analyst as shown in Figure 6.

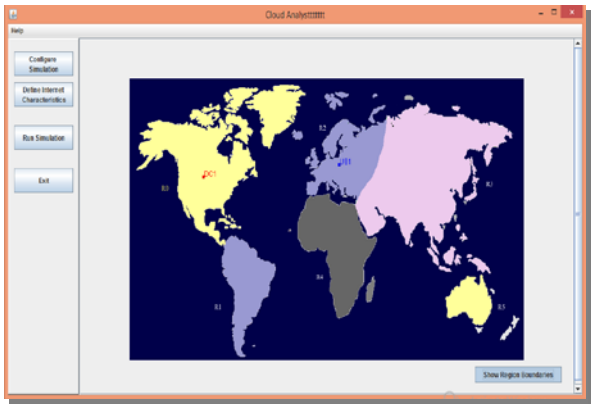

Figure 6: Snapshot of Cloud Analyst

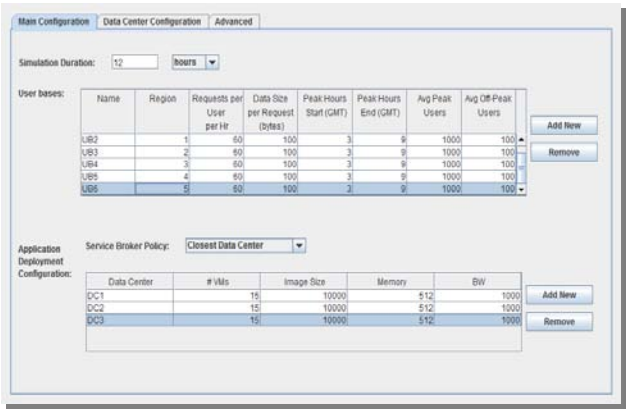

Figure 7: Userbase Configurations

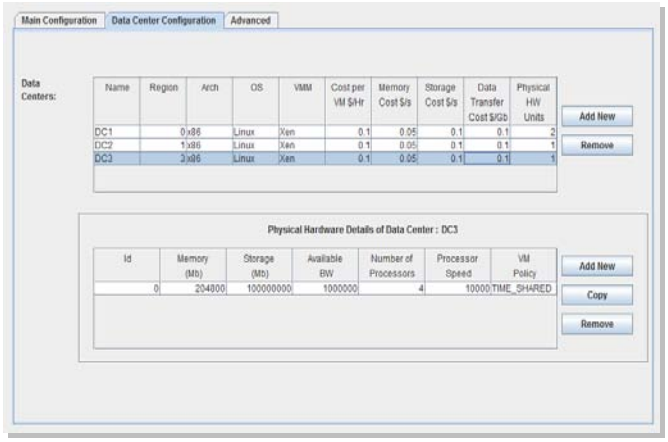

Figure 8: Datacenter Configurations

Results of three load balancing algorithms containing overall response time of request and data center processing time is presented in Tables 1, 2 and 3 respectively. Active Monitoring algorithm has better response time and data processing time compared to round robin and throttled load balancer algorithm.

Table 1: Result of Round Robin

	Avg(ms)	Min(ms)	Max(ms)
Overall Response time	**192.61**	**36.84**	**667.88**
Data center processing time	**0.60**	**0.03**	**1.85**

Table 2: Result of Active Monitoring

	Avg(ms)	Min(ms)	Max(ms)
Overall Response time	**142.34**	**36.66**	**401.01**
Data center processing time	**0.54**	**0.02**	**1.54**

Table 3: Result of Throttled Load Balancing

	Avg(ms)	Min(ms)	Max(ms)
Overall Response time	**192.54**	**36.79**	**667.63**
Data center processing time	**0.52**	**0.02**	**1.32**

VM usage of the three load balancing algorithms for execution of user requests is shown in Table 5. In round robin algorithm requests are distributed equally to virtual machines, as it does not consider the state and behavior of virtual machine. Active monitoring and Throttled load balancing policies show imbalance of load distribution, which may be due to the dynamic nature of the algorithms. VMs are over and underutilized in Active and Throttled load balancers.

Table 5: Virtual Machine usage

Sl. No	Round Robin Load balancer	Active Load Balancer	Throttled Load Balancer
VM0	**254**	**1174**	**1182**
VM1	**254**	**78**	**76**
VM2	**254**	**10**	**8**
VM3	**254**	**4**	**2**
VM4	**254**	**2**	**0**

VII. CONCLUSION

The main role of a load balancing algorithm in cloud computing is to ensure efficient utilization of cloud resource, minimum response time, better client satisfaction and increased performance of cloud service. In this paper we present comparative study of load balancing algorithms for cloud computing. The simulations are done in Cloud Analyst which is built on Cloudsim. We also mention the approaches to improve the performance of three load balancing polices. In this paper we bring out the importance of load balancing in cloud computing which helps in better resource utilization to gain high performance and better response time of a system.

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