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A Comparative Performance Analysis of Load Balancing Policies in Cloud Computing Using Cloud Analyst

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ABSTRACT: Cloud computing is an emerging trend in IT environment which provides a pool of computing resources to customers through Internet. The fundamental principle of cloud computing is to shift the computing done from the local computer in to the network. There is a rapid increase in cloud's users day by day. So, load balancing is a big issue in cloud computing environment. Load balancing is a method of distributing workload among all nodes to minimize the response time, maximize throughput, provide maximum resource utilization and avoid overload. Many algorithms have been proposed for load balancing in cloud environment. This paper present the performance study of some popular load balancing algorithms based on the parameters: response time and data center processing time using the Cloud Analyst Simulator.

KEYWORDS: Cloud Computing, Load balancing, Cloud Analyst, RR , ESCE, TLB.

I. INTRODUCTION

Cloud computing allows hosting of multiple services on a globally shared resource pool where resources are allocated to services on demand [1]. Cloud computing allows hosting of multiple services on a globally shared resource pool where resources are allocated to services on demand [1]. Resources are requested on-demand without any prior reservation and hence eliminate over provisioning of resources and improve resource utilization. Cloud Computing have different types of capabilities, which includes SaaS (Software as a service), PaaS (Platform as a service), IaaS (Infrastructure as a service).

Virtualization technique plays important role in cloud environment. It provides abstraction of computing element such as hardware, storage and networking. By virtualization, a single machine can be virtualized into number of virtual machines (VMs).Virtualization helps cloud providers by enabling better resource utilization, energy saving and less management overhead [2].

However, there are many issues in cloud computing. Load balancing is one of them. Load balancing is a mechanism that distributes the workload evenly among all the nodes in cloud to avoid a situation where some nodes are overloaded while other nodes are under-loaded or idle [4]. Efficient load balancing algorithm results better response time and data center processing time.

In this paper we present a performance analysis of the current load balancing algorithms. We provide a brief overview of these algorithms and compare these algorithms based on the response time and data center processing time using the simulation tool called Cloud Analyst.

II. EXISTING LOAD BALANCING ALGORITHMS

Load balancing policy determines which Virtual machine should be assigned to the current user request for processing to achieve optimal resource utilization, minimum response time and avoid overload [5]. Figure-1 shows the load balancing approach in cloud environment.

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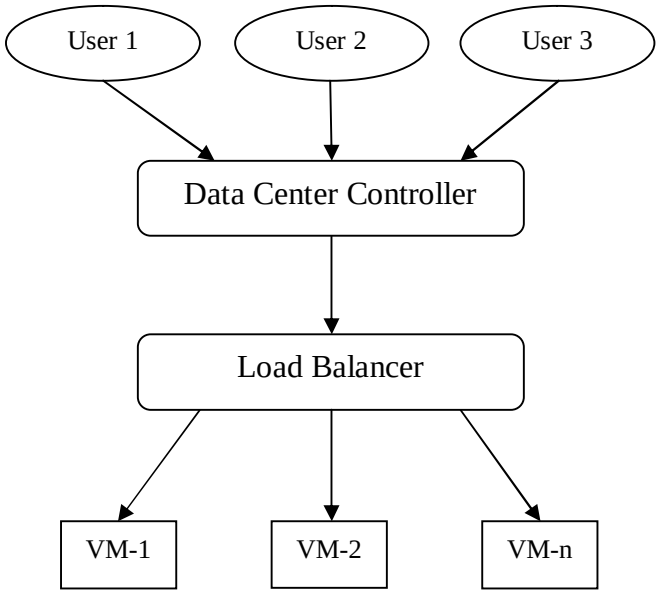

Figure 1. Load Balancing Approach in Cloud Environment

In This paper we are going to analyse three popular load balancing algorithms.

A. Round Robin Algorithm (RR):

Round Robin [3], [7] is the traditional and simplest load balancing technique. Each user request is assigned to the virtual machine (VM) in a round robin manner. Here when the Data Center Controller gets a user request it notifies the RR load balancer to allocate a new VM for processing of that request. RR load balancer picks a VM randomly from the group of VMs and returns this VM id to Data Center Controller for further processing. In this manner the subsequent user request are processed in circular order. This algorithm doesn't consider the load on different VMs. So, at any point of time some virtual machines may be overloaded and others remain idle or under-loaded.

B. Equally Spread Current Execution Algorithm (ESCE):

This algorithm [3] is also known as Active Monitoring Load Balancing (AMLB) algorithm. This algorithm tries to maintain equal workloads on all the available Virtual machines. Here the ESCE load balancer maintains an index table of VMs as well as the number of requests currently allocated to each VM (initially all VMs have 0 allocations). When the request arrives at Data Center Controller it notifies the ESCE load balancer. ESCE load balancer then parses the index table of VMs from top to bottom and identifies the least loaded VM. If there are more than one VMs are found, the first identifies VM is selected. After finding the least loaded VM, ESCE Load balancer returns the VM id to Data Center Controller. Then the Data Center Controller sends the current request to identified VM as well as acknowledges the ESCE load balancer about the new allocation. After acknowledgement, ESCE load balancer updates the index table by increasing the allocation count by 1 for that VM. When the allocated VM finishes processing the request, it sends the response to Data Center Controller. After receiving the response from that VM, Data Center Controller notifies the ESCE load balancer about the VM de-allocation. Then the ESCE load balancer revise the index table by decreasing the allocation count by 1 for that VM.

C. Throttled Load Balancing Algorithm (TLB):

In this algorithm [3], [7] TLB Load balancer maintains an index table of all VMs along with their current states- Busy or Available (initially all VMs are in available state). When the request arrives at Data Center Controller it queries the TLB load balancer for the allocation of suitable VM. TLB load balancer parse the index table of VMs from top to bottom until the first available VM is identified or the index table is parsed completely. If available VM is found then the TLB load balancer returns the VM id to Data Center Controller. The Data Center Controller sends the current

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request to identified VM as well as acknowledges the TLB load balancer about the new allocation. After acknowledgement, TLB load balancer revise the index table accordingly. On the other hand, if all the VMs are in Busy state, the TLB load balancer returns -1 to Data Center Controller. The Data Center Controller queues the request. When the VM finishes the request it sends the response to Data Center Controller. After receiving the response from the VM, Data Center Controller notifies the TLB load balancer about the VM de-allocation. Then Data Center Controller checks the queue for waiting request. If it finds the waiting request, it continue.

III. CLOUD ANALYST

It is very difficult and time consuming to analyse the performance of proposed policies in real world environment. In this situation Simulation tools becomes very helpful for users or researcher to test the policies. In order to analyse the performance of the load balancing algorithm discussed above, we use the simulation tool called Cloud Analyst.
Cloud Analyst is a GUI based simulation tool derived from CloudSim and extends some of its features [3]. It is based on Java. It separates the simulation experimentation from a programming exercise. It allows users or researchers to perform number of simulation experiments with slight change in parameters.
The basic entities of Cloud Analyst tool are:

GUI Package – This package is responsible for the graphical user interface. The GUI of Cloud Analyst is shown in figure 2.

Figure 2. GUI of Cloud Analyst

Region – The world is divided into six 'Regions'. These six regions coincide with six continents in the world.

Internet - This entity is the abstraction for real world internet and models the traffic routing behaviour.

User Base - A User base represent the group of users. The group of users considered as a single unit. Its responsibility is to generate traffic.

Cloud Application Service Broker - This entity models the service broker which is responsible for traffic routing between User bases and Data centers.

Data Center Controller – This entity manages the data center management activities. For example- VM creation and destruction, routing of client requests to the VM etc.

VM Load Balancer - This entity models the load balancer. The Data Center Controller uses a load balancer to decide which VM should be assigned to next request for processing.

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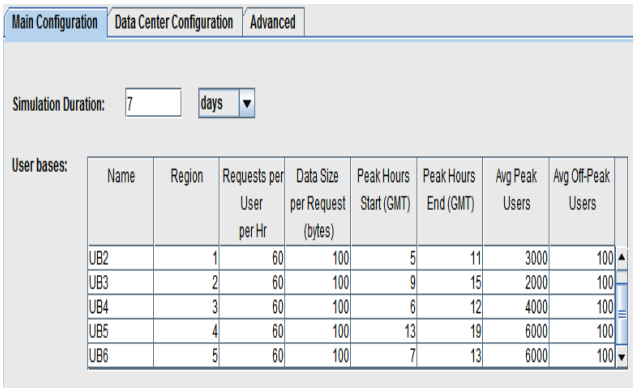
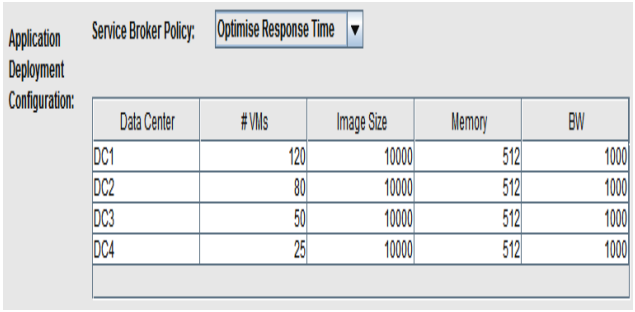
IV. SIMULATION CONFIGURATION

To analyse the various load balancing algorithms, we need to set the configuration of the various components of Cloud Analyst tool. We have set the parameters for user base configuration, application deployment configuration, data center configuration. As shown in figure.3 we have defined six user bases located in six different region of the world. We have taken four data centers i.e. DC1, DC2, DC3, and DC4 having 100, 80, 50, and 25 numbers of VMs respectively. Here VMs having unequal number of processors i.e. DC1 & DC3 having 1 dual core and 1 quad core processors, whereas DC2 having 1 dual core and 2 quad core processors and finally DC4 having 1 dual core, 1 quad core and 1 octa core processors. As shown in figure.6 you can choose a load balancing policy. The duration of the simulation is 7 days (168 hours).



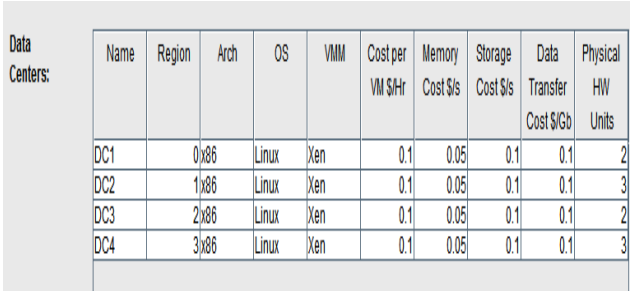
Name	Region	Requests per User per Hr	Data Size per Request (bytes)	Peak Hours Start (GMT)	Peak Hours End (GMT)	Avg Peak Users	Avg Off-Peak Users
UB2	1	60	100	5	11	3000	100
UB3	2	60	100	9	15	2000	100
UB4	3	60	100	6	12	4000	100
UB5	4	60	100	13	19	6000	100
UB6	5	60	100	7	13	6000	100

Figure 3. User Base Configuration



Data Center	# VMs	Image Size	Memory	BW
DC1	120	10000	512	1000
DC2	80	10000	512	1000
DC3	50	10000	512	1000
DC4	25	10000	512	1000

Figure 4. Application Deployment Configuration



Name	Region	Arch	OS	VMM	Cost per VM $/Hr	Memory Cost $/s	Storage Cost $/s	Data Transfer Cost $/Gb	Physical HW Units
DC1	0	x86	Linux	Xen	0.1	0.05	0.1	0.1	2
DC2	1	x86	Linux	Xen	0.1	0.05	0.1	0.1	3
DC3	2	x86	Linux	Xen	0.1	0.05	0.1	0.1	2
DC4	3	x86	Linux	Xen	0.1	0.05	0.1	0.1	3

Figure 5. Data Center Configuration

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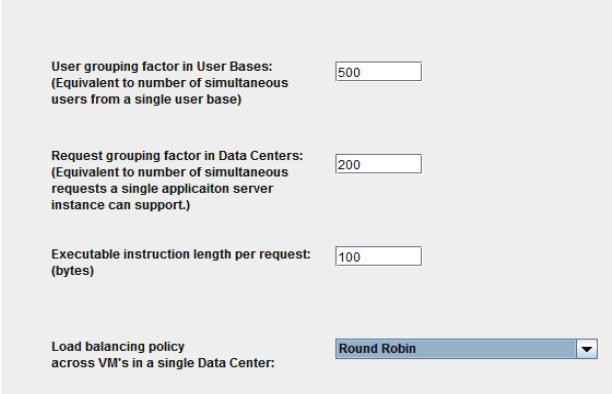

Figure 6. Load Balancing Policy

V. RESULTS AND ANALYSIS

Simulations are conducted for performance analysis of three load balancing policies based on the above defined configuration by Cloud Analyst. The results calculated for the metrics like response time and data center request servicing time in fulfilling the request has been shown in Table I, II, III, IV.

A. Response Time

The response time for each user base and overall response time calculated by Cloud Analyst for each load balancing algorithm as can be seen from the Table I, II.

TABLE I
RESPONSE TIME BY REGION

USER BASE	RR (ms)	ESCE (ms)	TLB (ms)
UB1	78.64	65.77	65.76
UB2	58.87	57.08	57.07
UB3	61.44	56.91	56.91
UB4	52.06	51.57	51.57
UB5	311.16	307.65	307.63
UB6	227.40	217.99	217.92

TABLE IIIII
OVERALL RESPONSE TIME

	RR (ms)	ESCE (ms)	TLB (ms)
Overall Response Time	156.00	150.90	150.87

B. Data Center Request Servicing Time

Data center request servicing time for each data center and data center processing time for each load balancing policy calculated by Cloud Analyst has been shown in the Table III, IV.

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TABLE IVVVI
DATA CENTER REQUEST SERVICING TIME

Data Center	RR (ms)	ESCE (ms)	TLB (ms)
DC1	27.95	17.04	17.01
DC2	9.17	7.38	7.36
DC3	11.51	7.56	7.55
DC4	2.36	1.86	1.86

TABLE VIIV
DATA CENTER PROCESSING TIME

	RR (ms)	ESCE (ms)	TLB (ms)
Data Center Processing Time	14.91	9.62	9.60

VI. CONCLUSION

The biggest issue in cloud based sector is minimization of response time and processing time in order to balance the load and increase the efficiency of business performance with customer satisfaction. Considering these things we have analyse the performance of three popular load balancing algorithm namely, Round Robin (RR), Equally spread current execution (ESCE) and Throttled load balancing (TLB). We have found that the parameters: response time and data center processing time are much better in case of ESCE and TLB when we compared to Round Robin (RR) policy. We have also found that these parameters are almost similar in case of ESCE and TLB algorithms. However, these parameters are slightly better in case of Throttled load balancing (TLB). So, we conclude that Throttled load balancing algorithm is best amongst them.

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