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Comparative Study of Load Balancing Algorithms in Cloud Environment

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***Abstract*—**Cloud computing technology is changing the focus of IT world and it is becoming famous because of its great characteristics. Load balancing is one of the main challenges in cloud computing for distributing workloads across multiple computers or a computer cluster, network links, central processing units, disk drives, or other resources. Successful load balancing optimizes resource use, maximizes throughput, minimizes response time, and avoids overload. This paper presents the comparative study of load balancing algorithms based on the parameters: response time, data centre processing time and cost is reduced. The results discussed in this paper, based on existing round robin, throttled load balance and active monitoring load balancing algorithm.

Keywords*—cloud computing, load balancing, simulation, cloudSim.*

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I. INTRODUCTION

Over the past few years, Cloud computing technology drawn the attention of IT world and is the changing the focus of enterprises. Cloud computing can be defined as a style of computing where IT-related capabilities are provided to consumer as "service" rather than a product using the internet. Cloud stands as a metaphor for internet. Cloud computing has gained attention due to the growth of internet technologies, reduced costs in storage, growth technologies of visualization and advancement in internet security. Cloud computing is, at its core, about delivering applications or services in an on-demand environment. Cloud computing providers will need to support hundreds of thousands of users and applications/services and ensure that they are fast, secure, and available. Along with visualization, infrastructure like load balancer, which does load balancing are key component to a successful cloud-based implementation. The following figure.1 shows the load balancing in cloud computing environment.

Load balancing is a computer networking method for distributing workloads across multiple computers or a computer cluster, network links, central processing units, disk drives, or other resources. Successful load balancing optimizes resource use, maximizes throughput, minimizes response time, and avoids overload. A variety of scheduling algorithms are used by load balancer to determine which back-end server to send a request to data center. Choosing the right load balancing algorithm is imperative to the success of cloud computing. The right load balancing will be able to provide the basics required to lay the foundation for more advanced cloud computing architectures. The following figure.2 shows the diagrammatical representation of the algorithm used for load balancing in cloud computing environment.

The remainder of this paper is organized as follows: A brief review of Cloud Computing is given in section II. Section III describes existing load balancing algorithms. Section IV describes the methodology. Section V describes the research setup and analysis. Section VI gives the comparative study . Paper is concluded in section VII.

II. CLOUD COMPUTING

A. Brief Literature Survey

The Cloud Computing, a forefront research channel in computer science, has the potential to change the face of the IT industry. There has been a significant amount of disagreement in how cloud computing is defined. Buyya et.al [1] have defined it as follows: Cloud is a parallel and distributed computing system consisting of a collection of inter-connected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements (SLA) established through negotiation between the service provider and consumers. Due to the recent emergence of cloud computing research in load balancing this is in the preliminary stage. N J Kansal Jiyan [2] has proposed a service models are provided by the cloud. Rimal B.P. et. al [3] discussed the existing issues like Load Balancing, Virtual Machine Migration, Server Consolidation, Energy Management etc. Bhathiya. et. al [4] present execution environment considers Datacenter, Virtual Machine (VM), host and Cloudlet components from CloudSim for execution analysis of algorithms.

Zenon Chaczko. et. al [5] gives an idea about the basic concepts of Cloud Computing and Load balancing availability and load balancing in cloud Computing. R P Padhy et. al [6] studied about some existing load balancing algorithms, which can be applied to clouds. In addition to

that, the closed-form solutions for minimum measurement and reporting time for single level tree networks with different load balancing strategies were also studied. The user or researcher can actually analyse the proposed design or existing algorithms through simulation. They can check the efficiency and merit of the design before the actual system is constructed.

Rajkumar Buyya et. al [7],in this paper he has studied the features of a CloudSim simulator to compare the performance of three dynamic load balancing algorithms. Bhathiya. et. al [4], have illustrated CloudSim architecture. W.Bhathiya et. al,"Cloud Analyst: A cloud sim-based visual modeller for analysing cloud computing environments and applications" [8], which present how cloud analyst can be used to model and evaluate a real world problem through a case study of a social networking application deployed on the cloud. The cloud analyst is a GUI based tool which is developed on CloudSim architecture. How the simulator can be used to effectively identify overall usage patterns and how such usage patterns affect data centres hosting the application. M.Sharma et. al [14], have discussed performance evaluation of adaptive virtual machine load balancing algorithms for cloud computing.

B. Cloud Computing

Buyya have defined cloud computing as follows: "Cloud is a parallel and distributed computing system consisting of a collection of inter-connected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements (SLA) established through negotiation between the service provider and consumers"[1].

Any cloud computing system consists of three major components such as clients, datacenter and distributed servers [3].

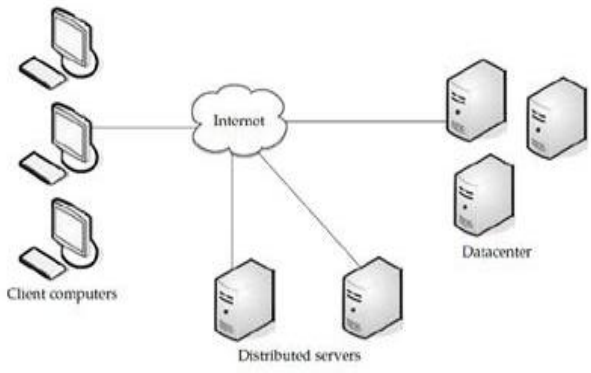

Fig. 1. Components of Cloud [9]

Client: End users interact with the clouds to manage information related to the cloud. Clients generally fall into three categories-Mobile: windows mobile smart phone like a blackberry or an I Phone. Thin: They don't do any computation work. They only display the information. Servers do all the work for them. The clients don't have any internal memory. Thick: These use different browsers like internet explorer or Mozilla fire fox or Google chrome to connect to the different cloud environment.

Datacenter: Datacenter is nothing but collection of servers hosting different applications. An end user connects to the datacenter to subscribe different applications. A datacenter may exist at a large distance from the clients.

Distributed Servers: A server, which actively checks the services of their hosts, known as Distributed server. It is the part of a cloud which is available throughout the internet hosting different applications. But while using the application from the cloud, the user would feel that they are using this application from its own machine [9].

III. LOAD BALANCING

Load balancing is a methodology to distribute workload across multiple computers, or other resources over the network links [10].Load balancing achieve optimal resource utilization, maximize throughput, minimum response time, and avoid overload. Cloud vendors are based on automatic load balancing services, which allow clients to increase the number of CPUs or memories for their resources to scale with increased demands. Load balancing serves two important needs, first to promote availability of Cloud resources, second to promote performance [14].

A. Load balancing algorithm

We use four existing algorithms to distribute the load.

1. Round Robin Algorithm (RR)[11]:

Round Robin algorithm distributes jobs evenly to all slave processors. Each process is assigned to the processor in a round robin order. The process allocation order is maintained locally independent of the allocations from remote processors. The work load distributions between processors are equal but the job processing time for different processes is not same. So at any point of time some nodes may be heavily loaded and others remain idle. This algorithm is mostly used in web servers where Http requests are of similar nature and distributed equally. This algorithm simply allots the job in round robin fashion which doesn't consider the load on different machines.

2. Active Monitoring Algorithm(AM)[8]:

This algorithm just keeps track of the number of connections attached to each server, and selects the one with the smallest number to receive the connection. This load balancing policy attempts to maintain equal work loads on all the available VMs. This load balancing policy attempts to maintain equal work loads on all the available VMs. Active

VM Load Balancer maintains information about each VMs and the number of requests currently allocated to which VM. When a request to allocate a new VM arrives, it identifies the least loaded VM. If there are more than one, the first identified is selected none of the VM load balancing algorithms considers these facts.

3. Throttled Load Balancer(TLB)*[15]:*

In this algorithm the throttled load balancer (TVLB) maintains an index table of VMs as well as their state of the VM (Busy/Available). At the start all VM's are available. The data center controller (DCC) receives a new request from client/server to find a suitable virtual machine (VM) to perform the recommended job. The data centre queries the load balancer for the next allocation of VM. The load balancer parses the allocation table from top until the first available VM is found or the table is parsed completely. If the VM is found returns the VM id to the DCC. Further, the data centre acknowledges the load balancer of the new allocation and the data centre updates the allocation table accordingly. While processing the request of client, if appropriate VM is not found, the load balancer returns -1 to the data centre. The DCC queues the request with it. When the VM finishes processing the request, and the DCC receives the response, it notifies the load balancer a request is acknowledged to data centre to de- allocate the same VM whose id is already communicated. The DCC checks if there are any waiting requests in the queue. If there are, it continues.

4. Fastest Response Time(FRT)[16]:

The Fastest method passes a new connection based on the fastest response time of all servers. The load balancer looks at the response time of each attached server and chooses the one with the best response time. Fastest VM Load Balancer (FLB) maintains a table which contains VMs and the response time of the VM. At the start all VM's are available. Datacenter receives a new request and queries the FLB for the next allocation.FLB scans the table from top until the first available the fast available VM is found. If the VM is found the data centre communicates the request to the VM and returns the VM id to the datacenter. Further, the data centre acknowledges the load balancer of the new allocation and the data centre revises the index table accordingly. While processing the request of client, if appropriate VM is not found, the load balancer returns -1 to the data centre. The data centre queues the request with it. When the VM completes the allocated task, a request is acknowledged to data centre, which is further apprised to load balancer to de-allocate the same VM whose id is already communicated.

IV. METHODOLOGY

This algorithm is a combination of the logic used in the Least Connections and Fastest algorithms. With this method, servers are ranked based on a combination of the number of current connections and the response time. Servers that have a better balance of fewest connections and fastest response time receive a greater proportion of the connections. The main aim of this algorithm is to find the expected Response Time of each Virtual Machine, which is calculated as:

$$\text{Response Time} = \text{Fint} - \text{Arrt} + \text{TDelay} \quad (1)$$

Where, Arrt is the Arrival time of user request. Fint is the user request finish time. TDelay is the transmission delay.

$$\text{TDelay} = \text{Tlatency} + \text{Ttransfer} \quad (2)$$

Where, T latency is the network latency.T transfer is the time taken to transfer the size of data of a single request (D) from source location to destination.

$$\text{Ttransfer} = \text{D} / \text{Bwperuser} \quad (3)$$

$$\text{Bwperuser} = \text{Bwtotal} / \text{Nr} \quad (4)$$

Where, Bwtotal is the total available bandwidth. Nr is the number of user requests currently in transmission.

Research Setup & Analysis

These load balancing algorithm is implemented through simulation package CloudSim based tool [7][8][13]. Java language is used for implementing all these load balancing Algorithm. Assuming the application is deployed in two data centre having 50 virtual machines running on 6 user base; then the Parameter Values are as under:

TABLE 1. PARAMETER VALUES

PARAMETER	VALUE
Data Center OS	Windows 7
Data Center Architecture	X86
Service Broker Policy	Optimize Response Time
VM Memory	1024 Mb
VM Bandwidth	1000 Mb

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V. Comparison of Overall Average Response Time of 3 VM Load Balancing Algorithms

Simulations are conducted to analyze the Response time and cost of propose algorithm. For all simulations we use the same set of default parameters which are given in the table 1 Response times and total cost are two measurement criteria to measure in the experiment. Comparison of Average Response Time of Active, Throttled and round robin VM Load Balancing Algorithm are also shown as follows by taking the 1,2,and 3 data center. The purposed algorithm implemented through simulation packages like CloudSim and cloudsim based tool. Java language is used for implementing VM load balancing algorithm. Assume that each datacenter have 25,50 75 virtual machine.

TABLE 2 COMPARISON OF AVERAGE RESPONSE TIME OF ACTIVE, THROTTLED AND PROPOSED VM LOAD BALANCING ALGORITHM WITH GRAPHICAL REPRESENTATION

Scenario	Average response time with Round Robin VM Load Balancing Algorithm(ms).	Average response time with Active Monitoring VM Load Balancing Algorithm (ms).	Average response time with Throttled VM Load Balancing Algorithm(ms).
1 Data Center with 50 Virtual Machine	262.25	287.73	261.66
2 Data Center with 25 Virtual Machine	246.34	264.97	223.58
2 Data Center With 50 Virtual Machine each	219.35	223.37	171.43
2 Data Center With 50 Virtual Machine each with peak load sharing	151.15	212.40	150.70
3 Data Center With 50 Virtual Machine each with peak load sharing	112.78	126.62	112.18

Below figure shows the graphical representation of the average response time of three VM load balancing algorithm.

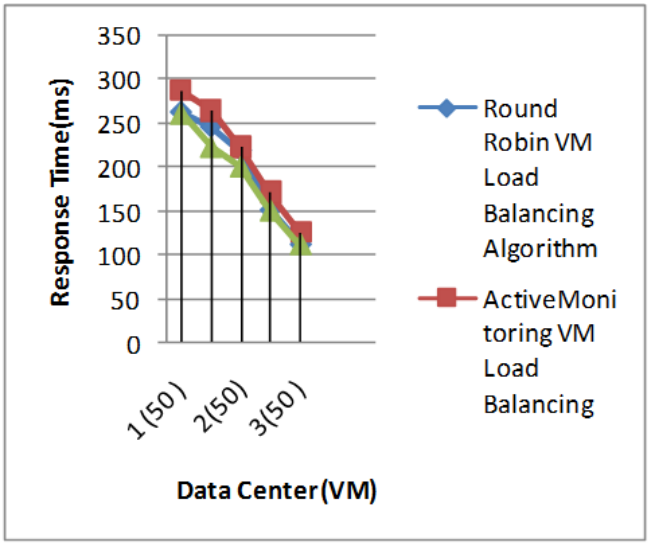

Figure 2 Shows the graphical representation of 3 VM Load Balancing Algorithms

Experimental results are conducted to analyze the performance of 3 VM load balancing algorithm and to find the overall average response time and cost of our algorithm. We recorded response time and cost to demonstrate the validity of algorithm. We make a conclusion that the whole system can reduce the response time, and not to increase the total cost if we select an efficient virtual machine, one more condition we have find that if we increase the data center it will effect the overall performance. Analysis of the simulation we get the desire outputs for the entire 3 load balancing algorithms.The above shown tables clearly indicates that the parameters: response time, data processing time and processing cost is almost similar in round robin, throttled and active monitoring algorithms . The following figure.3 shows the analytical comparison of various algorithms. Therefore, we can easily identify that which one is best among all.

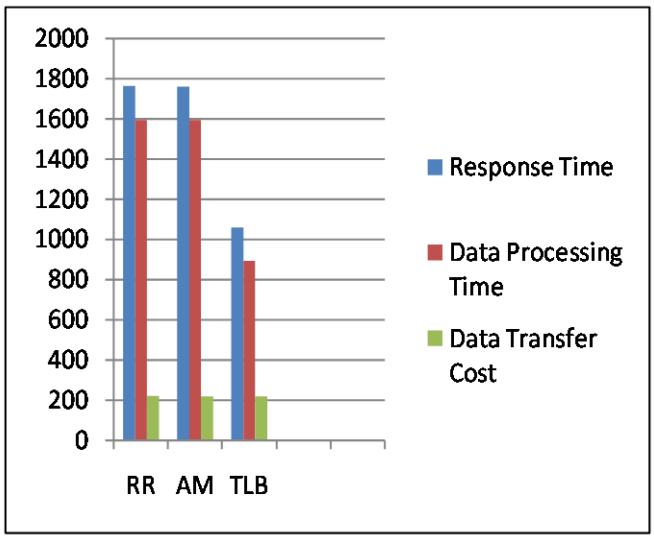

Fig. 3.Analytical Comparison of Various Algorithms

VI. Conclusions and Future Scope

The performances of three existing algorithms are studied in this paper. The results evaluate are based on existing round robin, throttled load balance and active monitoring load balancing algorithm, experimental result conclude that if we increase the number of datacenter this leads to decrease in overall average response time and increase cost based on the above results we also conclude that throttled VM load balancing algorithm is best among others.

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