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Comparative Analysis On Various Workload Balancing Algorithms With The Proposed Time Based Load Balancer (Tblb) Algorithm For Efficient Resource Management In An Academic Cloud Computing Environment

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Abstract: Resource Management plays a vital role in Cloud Computing. Especially in an academic scenario, the usage of cloud must be in an optimum manner. Effective usage of cloud resources helps to avoid the underutilization and overutilization of the virtual machines at an IAAS (Infrastructure as a Service) level.

Workload must be analysed and need to be distributed evenly among all virtual machines available on host machines. Proper balancing and distribution of workload helps to attain the effective resource management in an Academic Cloud Environment. In an academic scenario, usage of resources are predefined. Hence allocation of resources could be done in an effective manner.This paper deals with the analysis of various load balancing algorithms that is used to load and schedule a workload in an academic cloud environment. Based on the performance metrics, analysis of various load balancing algorithms carried out using Cloud Analyst Simulator. Various performance metrics of each load balancing algorithm is discussed and analysed in a simulated environment.

Keywords: Resource Management, Load Balancing, Academic Cloud, Workload Scheduling, User's Requirements.

1. INTRODUCTION:

Cloud Computing is a model that enables on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction [1].

Cloud computing provides three different services such as Infrastructure-as-a-service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). Apart from this, it has three types of deployment models such as Private Cloud, Public Cloud and Hybrid Cloud.

The Academic institute can choose from any of the above models and its services based on user's requirements. When it comes for a private cloud or hybrid cloud the organization by itself develops its own cloud based on user's requirements. But when it comes for a public cloud there are numerous cloud service providers such as Google Cloud Platform (GCP), Amazon Web Services (AWS), Microsoft Azure, VMware, IBM Cloud, Alibaba Cloud etc. are available. Hence we need to select the optimum cloud package offered by the cloud service provider.

Virtualization and Cloud Computing goes hand-in-hand. In Physical Layer i.e. Host machines
are virtualized using the Hypervisors such KVM, XEN, Microsoft Hyper-V and we arrive at the virtualized layer i.e. Virtual Machines. These Virtual Machines are used by the end-user as per their requirements.

In an Academic Scenario, selection of virtual machines as per user's requirements is a herculean task. Hence selection of an optimum cloud package by an academic institute plays a predominant role. Therefore various load balancing algorithms need to analysed to find the efficient load balancer for academic institutes.

1.1 Types of workload Balancer

In an academic scenario, user's requirements were already known in advance. The end users of the academic institute request a virtual machine. Based on contextualization the necessary applications required by the end users of the academic institute were bundled and placed in the Virtual machines. Based on the end-user's request and the availability of virtual machines, they were provided to them.

In the allocation of Virtual machines based on the end user's request, Load Balancer plays a predominant role. There are three types of load balancer as shown in Fig.1. They are [2]

a) Hardware based Load Balancer
b) Software based Load Balancer
c) Virtual Machine based Load Balancer

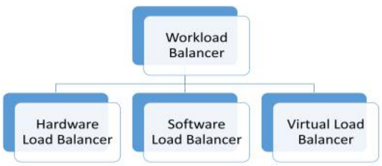

Figure 1. Types of load balancer

a) Hardware based Load Balancer

These are the physical devices used to distribute the load evenly among the client machines.

b) Software based Load Balancer

These are the applications used to distribute the load evenly among the client machines.

c) Virtual Machine based Load Balancer

The workload is distributed to virtual machines evenly based upon the user's request.

1.2 Load Balancing Techniques (or) Algorithms

There are various load balancing techniques (or) algorithm available. Some of them are, [3]

a) Round Robin Algorithm:

User's request for virtual machines are sent to the data centre and from the data centre the available virtual machines at equal intervals are placed in host machines for the access to the users.

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b) Throttled

Based on the status of VMs, the user's request or work load is distributed to the virtual machine.

c) Equally spread Current Execution Load:

User's request for virtual machines are spread equally among all virtual machines and the virtual machine is placed in the host machines for access to the users.

d) Proposed Time Based Load Balancer:

Based on the LastVMExecutedDate and Time (LVMEDT), the workload is placed in the host machine.[4]

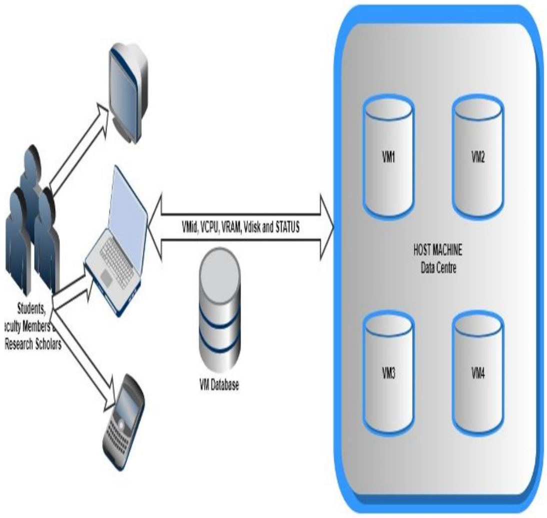


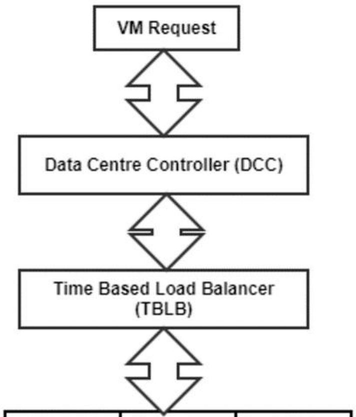
Figure 2: TBLB Architecture

User Groups such as students, Faculty members and research scholars request such as VMid, VCPU, VDisk, VRAM and status of virtual machines were maintained in VM Database and the corresponding virtual machine is selected from the available host machine ie DataCentre as shown in Fig.2.

Based on the user's request from the available virtual machines the optimum VM is selected and it is placed in host machine. Virtual Machine monitor is used to monitor the activities carried out in Virtual machine.

Time Based Load Balancer (TBLB) Algorithm Framework

In this framework of TBLB algorithm Virtual machines are selected based on last VM Executed date and time (LVMEDT).



VM Index	No.of request currently allocated to VMs	Last VM Executed Date and Time (LVMEDT)
VM0	300	12/08/2021
VM1	400	10/08/2021
VM2	200	08/08/2021
VM3	100	04/08/2021
VM4	300	02/08/2021
VM5	500	13/08/2021

Figure 3: Proposed TBLB Framework

The proposed TBLB framework as in Fig.3 illustrates the selection of Virtual machine from the virtual machine is based upon its last VM Executed Date and Time. End users sends the

Experimental setup and analysis

The Cloud Analyst simulator is used to setup the experiment and analyse the results [8].

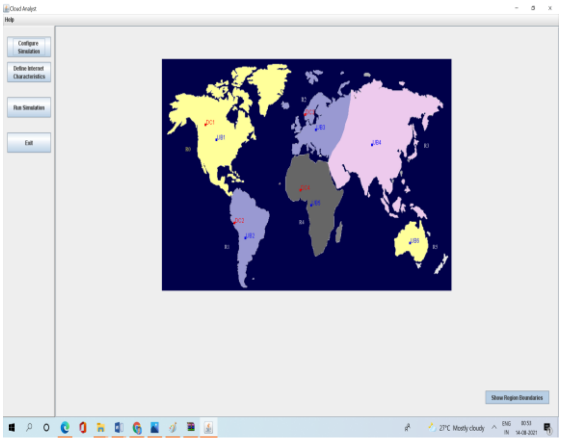


Figure 4: Graphical user Interface (GUI) of Cloud Analyst.

In order to compare various load balancing algorithms, first the user base is set in six different regions as follows UB1, UB2, UB3, UB4, UB5 and UB6. The four data centres were allocated

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in each region and DC1 is allocated with 25 VM request, DC2 is allocated with 50 VM requests, DC3 is allocated with 75 VM
requests and finally DC4 is allocated with 100
VM requests as shown in fig.4

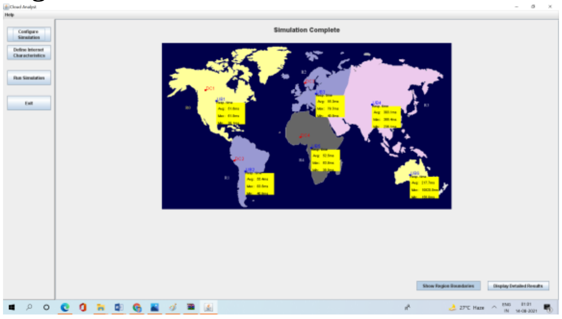

Figure 5: Cloud Analyst GUI of Average

Response Time after simulation

VM request. Data Centre controller passes the request to the Time Based Load Balancer (TBLB). Then it searches the VM database for appropriate and optimum VM both based on no. of. VM request received and the LVMEDT.

The proposed TBLB algorithm is compared with the other load balancing algorithms such as round robin (RR) and Throttled algorithm [5, 6, 7]. The average response time, Data Centre Processing time and total cost were simulated using the Cloud Analyst and the appropriate results were obtained and proves TBLB is more efficient and Optimum than other two algorithms.

The simulation configuration such USER BASE (UB), Data Centre (DC) were set the Round Robin algorithm was first selected and then for the same UB and DC configurations Throttled algorithm was selected and finally with the same UB and DC Configurations, the proposed TBLB algorithm was loaded inside the cloud Analyst and simulations were done and corresponding results were exported and compared with other existing load balancing algorithms in cloud analyst simulator. After the simulation of the RR algorithm the GUI is represented as shown in Fig.5.

The userbase (UB) and Data Centre (DC) configurations were represented as shown in Fig. 6

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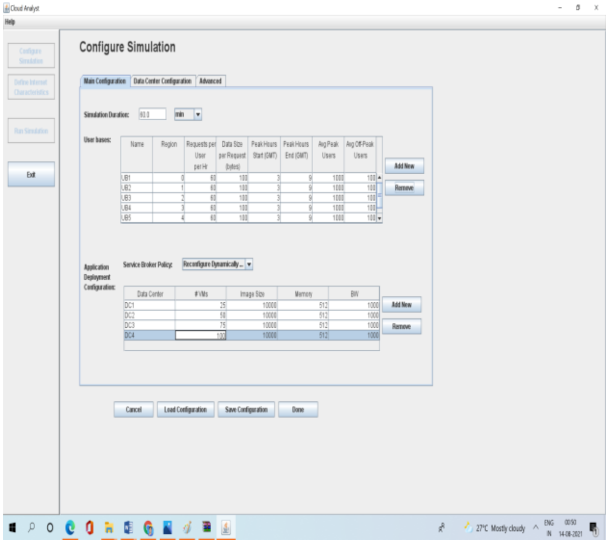

Figure 6. Simulation configuration of UB and DC

After loading the configurations simulation was carried out using the cloud analyst simulator and the corresponding results for average response time is obtained for each load balancing algorithm as shown in Table.1.

USERBASE (UB)	RR	Throttled	Proposed TBLB	USERBASE (UB)	RR	Throttled	Proposed TBLB
UB1(1000)	51.51	50.73	49.82	UB1(1000)	51.51	50.73	49.82
UB2(2000)	55.35	51.68	47.39	UB2(2000)	55.35	51.68	47.39
UB3(3000)	55.38	52.10	50.10	UB3(3000)	55.38	52.10	50.10
UB4(4000)	303.22	303.07	302.33	UB4(4000)	303.22	303.07	302.33
UB5(5000)	52.43	50.73	48.62	UB5(5000)	52.43	50.73	48.62
UB6(6000)	217.70	200.59	192.38	UB6(6000)	217.70	200.59	192.38

Table.1 Comparison of Average Response time of Load Balancing algorithms such RR, Throttled and Proposed TBLB.

By comparing the results tabulated in table.1, it is evident that the average response time of our proposed TBLB algorithm is slightly lower than the remaining load balancing algorithms such as RR and Throttled [9] [10].

The results obtained after simulation were taken and compared graphically as shown in fig.7 which clearly depicts lower response time than other algorithms [11].

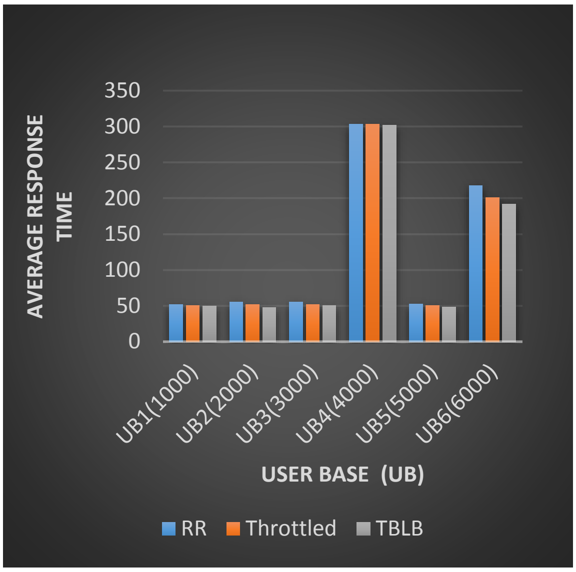

Figure 7. Results showing the average response time of Load Balancing algorithms such RR, Throttled and Proposed TBLB.

After the comparison of average response time of three algorithms and its graphical representation, the comparison of average Data centre request servicing time of three algorithms were noted down as shown in Table.2

DataCentre (DC)	RR	Throttled	Proposed TBLB
DC1	9.74	0.82	0.50
DC2	5.86	2.81	1.19
DC3	4.28	2.55	0.59
DC4	2.83	1.09	0.94

Table.2 Comparison of Average Data Centre Request Servicing time of load balancing algorithms such as RR, Throttled and Proposed TBLB.

The results obtained after simulation were taken and compared graphically as shown in fig.8, which clearly depicts lower average data centre request serving time than other algorithms.

Both the average response time and average data centre request servicing time were lower for our proposed TBLB algorithms compared to Round Robin (RR) and Throttled algorithms which were already present in cloud analyst simulator.

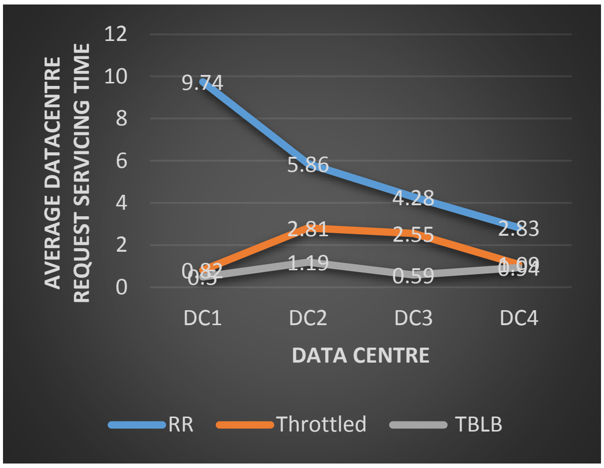

Figure. 8 Results showing the average data centre request servicing time of load balancing algorithms such as RR, Throttled and proposed TBLB.

Finally, the parameters such as Overall response Time, Overall Datacentre Processing time and total cost for the load balancing algorithms such as RR, Throttled were compared with the proposed TBLB algorithm as shown in table.3.

Parameter	RR	Throttled	Proposed TBLB
Overall Response Time	122	117.54	106.23
Overall Datacentre Processing Time	6.12	1.66	1.54
Total Cost	$25.55	$25.55	$25.55

Table 3. Comparison of Overall Response time, Overall Datacentre Processing time and total cost of the load balancing algorithms such as RR, Throttled and proposed TBLB.

By comparing and analysing the results obtained, we can come into a conclusion that the proposed TBLB has lower response time, Data centre processing time compared with the other load balancing algorithms but the total cost of VM remains the same for all the load balancing algorithms.

By using our proposed TBLB algorithm, end users response time in selecting the Virtual machine was lowered. Thus optimum VM was selected and efficient resource utilization was obtained.

2. CONCLUSION

Thus the proposed TBLB algorithm based on LVMEDT was used to select the optimum VM and reduce the response time of the users and thereby exhibits efficient and optimum utilization of cloud resources when compared with the other available load balancing algorithms or techniques in cloud analyst simulator such as Round Robin and throttled. The simulation results of each load balancing algorithm were tabulated and were represented graphically which clearly depicts that the proposed algorithm TBLB was much efficient than the other two available algorithms.

Future Enhancement

The proposed TBLB algorithm was only compared with the existing load balancing algorithms in cloud analyst simulator but it could also be compared with the other load balancing algorithms such as Honey bee, Max-min, Equally spread current execution load etc and thereby we could attain the efficiency of our proposed TBLB algorithm in an elegant manner.

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