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Optimize Load Balancing using cloud analyst tool for Workflow Scheduling in Data Centres Environment

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Abstract —

Efficient allocation of tasks is a crucial process in cloud computing due to the restricted number of resources/virtual machines. IaaS is one of the models of this technology that handles the backend where servers, data centres, and virtual machines are managed. Cloud Service Providers should ensure high service delivery performance in such models, avoiding situations such as hosts being overloaded or under loaded as this will result in higher execution time or machine failure, etc. Task Scheduling highly contributes to load balancing, and scheduling tasks much adheres to the requirements of the Service Level Agreement (SLA), a document offered by cloud developers to users.

The improvement of ITA is because of selecting virtual machines in an index table that is available but in order of priority. It helps response times and processing times remain stable, limits the idling resources, and cloud costs are minimized compared to selected algorithms.

With cloud computing, new facilities in the information technology (IT) emerge from the convergence of occupational and technology viewpoints which furnish users entrance to IT resources anywhere and anytime by pay-per-use fashion. Consequently, it should source eminent operative gain to the user and instantaneously ought to be beneficial for the cloud service provider

Load Balancing is an important aspect of cloud computing environment. Efficient load balancing scheme ensures efficient resource utilization by provisioning of resources to cloud user's on-demand basis in pay-as-you-say-manner. Load Balancing may even support prioritizing users by applying appropriate scheduling criteria. This paper presents various load balancing schemes in different cloud environment.

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Index terms

Cloud computing, load balancing, optimization, QoS, SLA, task scheduling. Cloud Computing, Load Balancing, Distributed computing, Resource Provisioning, Resource Scheduling.

1. Introduction

As shift more towards online storage and services, Cloud Computing technology becomes an essential part of the business. This technology provides services through various kinds such as in software via web browsers. In the Infrastructure, the backend is managed by Cloud Service Providers (CSPs) such as maintaining Data Centres, servers, etc. Although there exist many other service delivery models in this technology, however, in this research, the focus is on the Infrastructure as a Service (IaaS) model. It deals with the server-side of this technology for resource allocation [1].

Three years later, in 2009, Google App Engine was born and became one of the historic milestones of electricity development in cloud computing. However, along with the constant development, this will also lead to some problems on cloud computing, especially the problem of overload on cloud computing. Therefore, many load balancing algorithms are appeared to solve the overload problem.

The entire execution time is valued in three stages. In the first stage the formation of the VM and they will be idle to come for the scheduler to schedule the jobs in the line, once jobs are payable, the VM in the cloud computing will start processing, which is the second stage, and lastly in the third stage the clean-up or the obliteration of the virtual machines. The quantity of the computing model can be valued as the entire number of jobs executed inside a time span lacking considering the VM destruction time and formation time[1]

Cloud infrastructure has hardware and software in the DCs to provide these services. Moreover, these computing resources are supported on heterogeneous platforms such as desktop, laptop or any other mobile devices. The cloud services are categorised as Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS).

The simulation of this study was compared to Overall Response Time and the datacentre Processing Time.

2. Related Works

This section includes the literature review of this paper. The concept of Load Balancing will be explained, highlighting its model, metrics, and existing standard algorithms. Leading to the recent literature on Load Balancing, where researchers' proposed algorithms are explained.

This subsection explains Task Scheduling and Load Balancing's concept to highlight how they relate to each other to optimize cloud resources. Load balancing is a method for optimizing the resources of virtual machines in the Cloud Computing environment. Load balancing in the cloud environment is one of the critical techniques used to ensure an equal distribution of workload and efficient resource utilization.

Decent load balance will recover the presentation of the whole cloud. Though, there is no common technique that can familiarize to all possible dissimilar situations. Various methods have been developed in improving existing solutions to resolve new problems. Every particular technique has benefit in a specific area but not in entirely circumstances. The present study integrates numerous approaches and switches among the load balance techniques based on the system position. A relatively simple method can be used for the partition idle state with a more complex method for the normal state.

It is important to measure the performance of proposed algorithms using inerrant metrics. Mishra et al. [2020] discussed various load balancing techniques in both homogeneous and heterogeneous Cloud environments. It also presents some of the important performance metrics to evaluate the system performance.

The paper provides in depth analysis of the divergent load algorithms along with their merits and demerits. S.Yakhchi et al. (2015) discusses that the energy consumption has become a major challenge in cloud computing infrastructures. Finally, consider other hosts as underutilized host and if it is possible, migrate all of their VMs to the other hosts switch them to the sleep mode.

Performance **-** It can be defined as the efficiency of the system. It must be improved

Resource Utilization - It is used test the utilization of resources. It should an efficient load balancing system.

Scalability - In the quality of service should be same if the number of users increases. The more number of nodes can be added without affecting the service.

Response Time - It is defined as the amount of your time taken to respond by a load balancing algorithmic rule in a very distributed system. For well presentation, this parameter should be shortened.

Fault Tolerance –In spite of the node failure, the capability of system to performed uniformed load balancing. The load balancing is the best fault-tolerant technique.

Point of Failure - Designed the system in such a way that the single point failure does not affect the provisioning of services. Like in federal system, if single central node is failed, then the entire system would fail, so load balancing system must be intended so as to overcome these difficulties.

3. Challenges of Load Balancing

Overhead Associated**-** It is define the amount of above involved though applying a load-balancing system. It is collected of the overhead due to drive of tasks, interposes communication. Overhead should be abridged so that a load balancing algorithm achieves good.

Throughput **-** It is the number of task executed in the fixed interval of time. To improve the performance of the system, throughput should be high.

Performance **-** It can be defined as the efficiency of the system. It must be improved

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4. Benefits of cloud computing

Some common benefits of cloud computing are:

• Reduced Cost**:** Since cloud technology is implemented incrementally (step-by-step), it saves organizations total expenditure.

• Increased Storage: When compared to private computer systems, huge amounts of data can be stored than usual.

• Flexibility**:** Compared to traditional computing methods, cloud computing allows an entire organizational segment or portion of it to be outsourced.

• Greater mobility: Accessing information, whenever and wherever needed unlike traditional systems (storing data in personal computers and accessing only when near it).

• Shift of IT focus**:** Organizations can focus on innovation (i.e., implementing new products strategies in organization) rather than worrying about maintenance issues such as software updates or computing issues.

5. Cloud computing: Service models

Cloud computing can be accessed through a set of services models. These services are designed to exhibit certain characteristics and to satisfy the organizational requirements. From this, a best suited service can be selected and customized for an organization's use. Some of the common distinctions in cloud computing services are Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), Infrastructures-a-Service (IaaS), Hardware-as-a-Service (HaaS) and Data storage-as-a-Service (DaaS). Service model details are shown in the Fig 5.1 as follows:

• Software as a Service (SaaS)[4]: The service provider in this context provides capability to use one or more applications running on a cloud infrastructure. These applications can be accessed from various thin client interfaces such as web browsers. A user for this service need not maintain, manage or control the underlying cloud infrastructure (i.e. network, operating systems, storage etc.). Examples for SaaS cloud's are Salesforce, NetSuite.

• Platform as a Service (PaaS)[5]: The service provider in this context provides user resources to deploy onto cloud infrastructure, supported applications that are designed or acquired by user. A user using this service has control over deployed applications and application hosting environment, but has no control over infrastructure such as network, storage, servers, operating systems etc. Examples for PaaS cloud are Google App Engine, Microsoft Azure, Heroku.

• Infrastructure as a Service (IaaS): The consumer is provided with power to control process, manage storage, network and other fundamental computing resources which are helpful to manage arbitrary software and this can include operating system and applications. By using this kind of service, user has control over operating system, storage, deployed applications and possible limited control over selected networking components. Examples for IaaS cloud Amazon EC2.

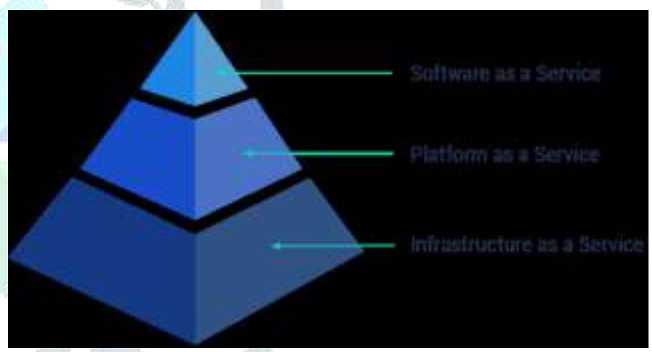

Figure 5.1 Cloud Computing Service Model

6. Cloud computing: Deployment models

Among the service models explained above, SaaS, PaaS and IaaS are popular among providers and users. These services can be deployed on one or more deployment models such as, public cloud, private cloud, community cloud and hybrid cloud to use features of cloud computing. Each of these deployment models are explained as follows:

- Public cloud: This type of infrastructure is made available to large industrial groups or public. These are maintained and owned by organization selling cloud services.
- Private cloud: This type of cloud deployment is just kept accessible to the organization that designs it. Private clouds can be managed by third party or the organization itself. In this scenario, cloud servers may or may not exist in the same place where the organization is located.
- Hybrid cloud**:** With in this deployment model there can be two or more clouds like private, public or a community. These constituting clouds (combinations of clouds used, such as `private and public', `public and community', etc.) remain different but yet bound together by standardized or preparatory technology that enables application and data portability.
- Community cloud**:** This type of cloud infrastructure is shared by several organizations and supports a specific community with shared concerns. This can be managed by an organization or third party and can be deployed off or in the organizational premise.

Usage of deployments models and services modelled provided by CC changes how systems are connected and work is done in an organization. It adds up dynamically expandable nature to the applications, platforms, infrastructure or any other resource that is ordered and used in CC.

7. Load Balancing based on Spatial

Distribution of Nodes

Nodes in the cloud are highly distributed. There can be three types of algorithms that specify which node is responsible for balancing of load in cloud computing environment.

Centralized Load Balancing

In centralized load balancing technique all the allocation and scheduling decision are made by a single node. This node is responsible for storing knowledge base of entire cloud network and can apply static or dynamic approach for load balancing.

Distributed Load Balancing

In distributed load balancing technique, no single node is responsible for making resource provisioning or task scheduling decision. There is no single domain responsible for monitoring the cloud network instead multiple domains monitor the network to make accurate load balancing decision. Every node in the network maintains local knowledge base to ensure efficient distribution of tasks in static environment and re-distribution in dynamic environment.

8. Weighted Round-Robin model

Figure 8.1 shows the weighted Robin algorithm for load balancing in the cloud environment. The Weighted Round-Robin algorithm performs circular distribution based on the Round-Robin algorithm and relies on the capacity of each virtual machine through its weight table to distribute the load to the virtual machines respectively. Advantages of this algorithm: improved Round-Robin algorithm, operating in a rotation manner but combined with the weight-table of the processing capacity of virtual machines, more efficient than original Round-Robin in case the virtual machines' processing power is different. Besides, the disadvantages are: no flexibility and expansion, do not save the previous allocation state of virtual machines.

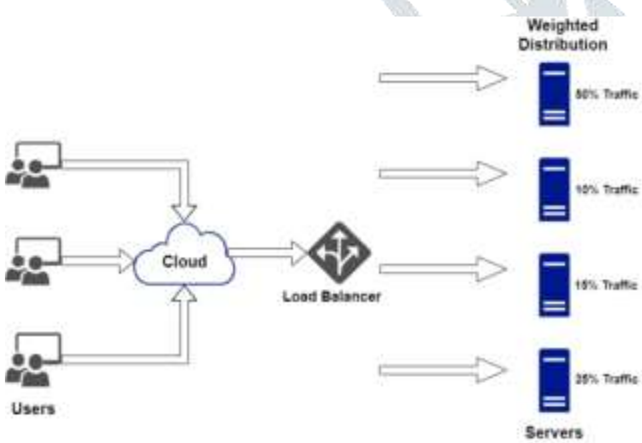

Figure 8.1 Weighted Round-Robin Model

9. Research contribution

This subsection highlights the contribution made by the authors in this paper.

The research mainly aims to optimize the cloud resources by enhancing the Load Balancing process through efficient Task Scheduling procedures. Our contribution to the study can be summarized as follows:

_ A survey of existing Load Balancing and Task Scheduling algorithms.

_ A proposed Load Balancing algorithm addresses the VM violation issue in the cloud and provides high-quality service in terms of workload scheduling and balancing.

_ Additionally, the proposed algorithm includes the migration of load to balance VMs, which is still not fully addressed yet.

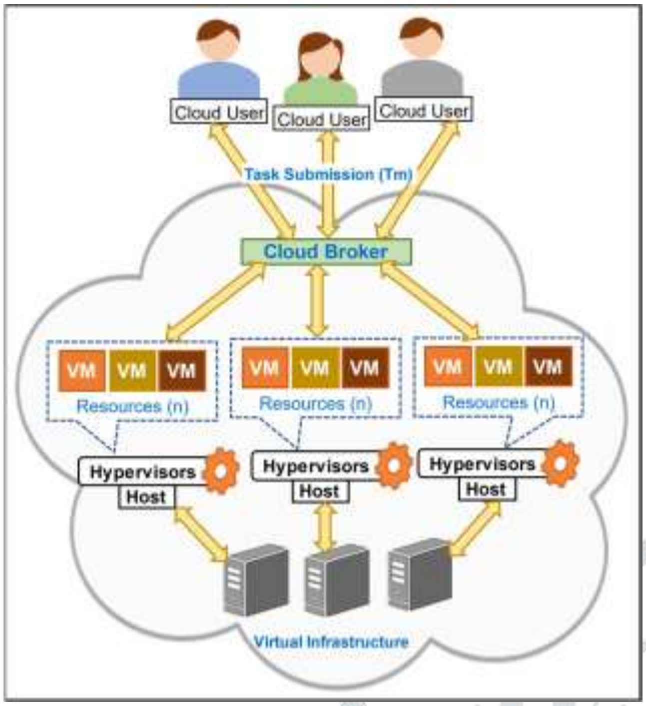

Figure 9.1. Task scheduling in IaaS cloud computing

Task Scheduling is a process that highly relates to work load balancing. As illustrated in figure 9.1 above, as users send requests, the task is submitted through a cloud broker; this is where researchers should focus on providing an efficient algorithm. The proposed algorithm should efficiently submit jobs to appropriate VMs following essential parameters such as deadline [10] to maintain a high quality of services and ensuring the requests sent by users are executed and completed within these specific requirements provided in the Service Level Agreement (SLA) document. The user sends requests via the Internet. These requests are stored in Virtual Machines (VMs), and CSP in every delivery model must maintain the QoS by ensuring the users' requests can be executed and completed within a specific deadline. This process depends highly on the scheduling policy's efficiency (Data Broker) which should be programmed to result in a high technique for balancing workload among the machines and servers.

10. Problem statement

This section highlights the problem statement which is extracted from the review made in this research. Following the solutions to these problems, the new algorithm is proposed.

Dealing with incoming user requests/tasks and keeping a balanced workload in cloud systems can be challenging due to inappropriate allocation to VMs. One cause of this is the limited task factors considered; for example, if the arrival time is not considered, all tasks would arrive simultaneously, which does not work in a dynamic environment such as cloud systems since the requests are not prioritized. With the increasing number of requests, more problems could occur if the requests are not assigned to their designated VM or when the CPU is not fully utilized or insufficient to handle the requests, leading to performance issues due to an unbalanced load in the cloud.

11. Proposed framework

This section explains the proposed and improvised Load Balancing in Cloud Computing Environment. This algorithm's primary goal is to provide services of high quality to clients in Cloud Computing applications. The method consists of both processes:

In this subsection, describe this research's objective in an illustrative diagram to explain the problem in Load Balancing and the role of the proposed LB algorithm, as seen in figure12.1 below.
This proposed model's main goal is to provide efficient resource allocation in a cloud environment whereby it avoids unbalanced workload in Cloud Computing applications. This model resolves issues related to workload migration and task rejection in the cloud. The proposed framework consists of two layers:
_ Top Layer: deals with requests from multiple different clients (application's users) of both mobile and desktop. Clients can access the Internet using different devices to send requests to the cloud. DC receives requests and sends them to the active load balancer. In this layer of the model, the proposed algorithm is implemented

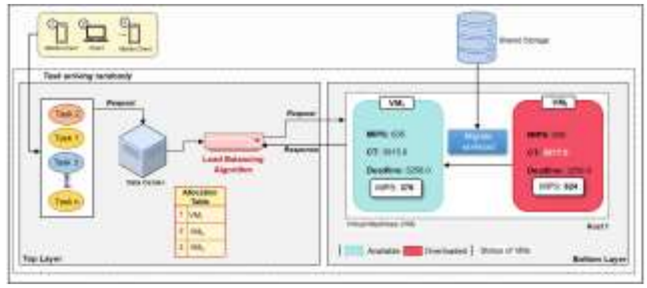

Figure 12.1. Proposed framework.

_ Bottom Layer: deals with allocation of user requests to Virtual Machines (VMs). As the figure 12.1 illustrates, a primary batch of VMs; VM2's status is set to high priority since it violates the SLA requirement, which means its Completion Time is higher than the Deadline. The allocation table is then updated whenever a Virtual Machine becomes violated or not, along with the number of requests it's been allocated. There is a case where there is no SLA violation. Suppose the Time to Complete (TTC) is less than SLA (Deadline) given for tasks to run on VMs. Then, no SLA violation occurs.

Figure 12.2 illustrates the simulated scenario in Cloud Analyst simulator. We use the same scenario for all different combinations of load balancing approaches to simulate under the same condition. As Fig. 1 shows the simulated scenario consists of two datacentres and three users which are placed in different geographical regions in the map. In region 0, there is datacentre 1 and there is no user base. R1 has just one user and no datacentre in this region while in region 5 there are one user and no datacentre and finally R4 which has one datacentre and one user base. By this kind of scenario configuration tried to cover all possible situations for simulation process.

Figure 12.2. The Cloud Analyst scenario on map

12. Implementation

Each of the regions is configured to have a single DC.

For the simulation study Cloud Analyst tool was used with the additional VM load balancing algorithms the load balancing algorithms are compared in terms of the average response time and service cost. The response time is the time gap from the submission of the user request to its completion. The total cost of the service includes cost per VM, memory cost, storage cost and data transfer cost. In all the experiments, the parameters such as VM cost, storage cost, memory size, processor speed and bandwidth for all the DCs were kept constant.

The scenarios details are discussed in the later part. The load on the system is varied from low to high. The transmission delay (in millisec) and bandwidth (in Mbps) between the regions are given in the Table 1 and 2 respectively and the configuration of the advance parameters is given in Table 3. The duration of simulation was set to 120 min.

These parameters were kept constant for all the scenarios.

Region	0	1	2	3	4	5
0	25	100	150	250	250	100
1	100	25	250	500	350	200
2	150	250	25	150	150	200
3	250	500	150	25	500	500
4	250	350	150	500	25	500
5	100	200	200	500	500	25

Table 1: Transmission delay(in ms) between the regions.

The aim is to check the performance of the VM load balancing algorithms and service broker policies when the load on the system is low and the DC configuration is homogeneous. Hence, six DCs in six divergent regions are created with the same configuration for the DC parameters.

Here, each of the six regions is configured with a single User base.

Comparative study on load balancing and service broker algorithms...

Region	0	1	2	3	4	5
0	2000	1000	1000	1000	1000	1000
1	1000	800	1000	1000	1000	1000
2	1000	1000	2500	1000	1000	1000
3	1000	1000	1000	1500	1000	1000
4	1000	1000	1000	1000	500	1000
5	1000	1000	1000	1000	1000	2000

Table 2: The available bandwidth (in Mbps) between the regions.

Parameter	Value
The executable instruction length per request	512 Bytes
User grouping factor in user base	10
Request grouping factor in DC	10

Table 3: Configuration of advanced parameter values.

Such a way that the number of users requesting the cloud service was kept low. The parameter for the user base is as shown in Table 3. Each DC has been configured with 4 CPUs and 25 VM

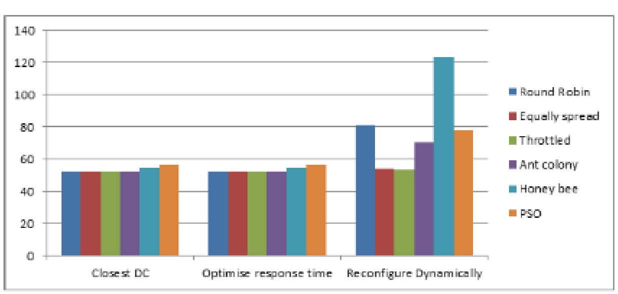

Figure 12.1. Avg response time (in ms) for scenario I

Algorithm	Closest DC	Optimize Response Time	Reconfigure Dynamically with Load)
Round Robin	134.06	134.06	193.69
Equally spread load	134.06	134.06	193.7
Throttled	134.06	134.06	193.34
Ant colony	134.06	134.06	193.63
Honey bee	134.06	134.06	193.54
PSO	134.06	134.06	192.91

Table 4: Comparison of cost of the service for scenario I.

The average response time for scenario I is as shown in the figur15.1 From the graph, it is clear that all the six VM load balancing algorithms show more or less the same response time for Closest DC and Optimize Response Time service broker policy. However, in case of Reconfigure Dynamically with Load service broker policy, Honeybee load balancing algorithm shows higher response time and

The Table 4 shows the comparison of the algorithms with respect to the cost of the service. There is no change in the cost of the service for service broker policies: closest DC and optimize response time. However, for Reconfigure Dynamically with Load broker policy, PSO algorithm gives minimum service cost.

13. Conclusion & Future work

This section concludes the paper by highlighting the findings and obtained results from the proposed LB algorithm. As we saw from the literature, task scheduling highly con-tributes to balancing the load in a cloud environment. Improvising the Load Balancing process through Task Scheduling can result in efficient utilization of cloud resources. The objective of this paper was to provide an enhanced Load Balancing algorithm.

The algorithm is also able to handle large size requests com-pared to the existing approach. The algorithm address SLA violation of VMs by reallocating resources to execute tasks efficiently. In the future, authors will work to optimize the cloud resources further and enhance cloud-based application performance, such as considering more SLA parameters. For example, the algorithm will be tested based on the number of violations and the migration count for better performance. Also, the algorithm will be comprehensively compared to other existing algorithms in the literature.

In this paper, surveyed various load balancing techniques for cloud computing. The main purpose of load balancing is to satisfy the customer requirement by distributing load dynamically among the nodes and to make maximum resource utilization by reassigning the total load to individual node. This ensures that every resource is distributed efficiently and evenly. So the performance of the system is increased.

Load Balancing in cloud computing is essential for efficient utilization of the resources. Hence, dynamic load balancing techniques in distributed or hierarchical environment provide better performance. However, performance of the cloud computing environment can be further maximized if dependencies between tasks are modelled using workflows.

This study also helps balance the load more effectively, compared with popular algorithms like Round Robin, Throttled and Equally Load. The datacentre cost of this proposal is always lower than the others, which shows that the ITA algorithm can be used in practice and potential for further development. In the real world, we can apply our ITA to a real datacentre for testing and further research.

The simulation results shows that throttled algorithm have a better performance than other load balancing algorithms, because it uses a threshold and available VM list for preventing serve the workload by overloaded VMs.

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Biography

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