Virtual Machine Allocation Policy for Load Balancing

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Abstract. This paper focuses on the VM allocation policies for load balancing in cloud computing environment. Intermittent nature of balancing the load scheme into the cloud computing becomes a challenging job and it also affects the load balancing of the cloud. The suggested proposed model generates and step-up the VM allocation policies but also transforms the generated cloud workload. Furthermore, to improve the workload distribution of workload and stability of the overall cloud computing environment the load balancing algorithm is most important for load balancing. The work of load balancing is equally effective in the cloud computing environment and it is most essential one for load balancing algorithms to take care of all issues at the time of the work load. The researchers studied different algorithms to solve the problems of load balancing that generate problems during the distribution of workloads. The analysis VM allocation policies are tested on CloudSim environment and the results, and discussion is about to which one VM allocation policy is superior. Keywords—Load Balancing, Grid-computing, Cloud Computing, VM allocation policies, Fuzzy

1. Introduction

Cloud computing has become one of the famed fields of Computer science and because of its flexibility and backing a wide range of users to available distributed resources/ infrastructure over the Internet. Cloud computing has become a standout amongst most fascinating specialized fields in the modern era. It has shown its effect on data stockpiling, information technology, programming designing, and organizations. The National Institute of Standards and Technology (NIST) characterizes cloud computing as: “the cloud computing is a paradigm to enable access for resources pooling, convenient, on-demand, ubiquitous, which can be easily delivered with different types of service provider interaction” [1].

Cloud computing is a new paradigm in field of computing and is considered as the fast growing new advent, which is quickly developing at a greater pace and attracting increasingly new consumers and vendors. The fast development of cloud computing is further expanded by the rising computing innovations, which are being made at moderate and sensible expenses of infrastructure and capacity capabilities. The term cloud computing implies the data are put away and go through Internet and not
from customary path from PC's hard drive. Cloud computing [2] has this inception in the days when flowcharts and presentations, they speak to the servers infrastructure of the Internet. Local storage and computing are the points at which a data are put away or projects are kept running from the hard drive, thus enabling clients to have simple and quick access to data. The way that there is a committed equipment server in a habitation, does not necessarily imply the presence of cloud computing. [3] The information should be accessible over the Internet, or possibly the information should be synchronized with data over the Internet. Cloud computing includes outsourcing of the computing assets with the abilities of superfluous asset adaptability, on-request provisioning with moderate expenses.

![CloudSim structure](image-url)

The major advantage of cloud computing is the reduction of heavy investment costs in the IT infrastructure. According to [4] and [5] the definition of cloud: “A Cloud is a sort of parallel and conveyed framework comprising of an accumulation of interconnected and virtualized PCs that are progressively provisioned and introduced as at least one brought together computing assets in view of administration level understandings set up through arrangement between the administration provider and clients.” Cloud computing considered to be highly beneficial in small businesses [6] since, it admits innovations that weren't before in term of expenditures available for them as far as cash spending; and it offers leverage for them by helping them with contending with other independent ventures or even with huge ones. The cost of somebody coming and settling/introducing an application is reduced and cash can be spared by the organization. Using software that are on the cloud is often less costly than purchasing new ones. Thus, to utilize one multi-application cloud benefits everyone in the organization.

The applications that live on the cloud can fully integrate into the organization in the light of the API that finds the application that is good for the organizational objectives. The organization does not have to burn cash for this because cloud computing is regularly overhauled. For organization, cloud computing is a means of reducing the costs of the enterprise [7].

In Cloud Computing in order to guarantee economic benefits distributed among cloud customers [08] scalable resources are provisioned with dynamism as a service. Various layers of cloud are operational
based on the type of service assured by the cloud server of which three layers from the basic core [8]. The first layer Infrastructure-as-a-Service (IaaS) consists of basic hardware requirements such as the Memory and Storage resources. The most common example of IaaS is the Amazon Elastic Compute Cloud (EC2). The next layer, second from the last is the Platform-as-a-Service (PaaS) which provides the design and deployment of applications using Python, Java, etc. The best example of PaaS is the Google App Engine.

The topmost layer namely Software-as-a-Service (SaaS) is the universally accepted and trustworthy service that supports users to access the applications without the need for hardware or software knowledge. Internet browsers and search engines are the fundamental tools required for accessing cloud services.

As cloud can be accessible from any location anytime via primary commodity hardware its desire is more or more day by day. Due to this more or more demand it requires to provide security to data as well as high performance so that it can be advantageous for the users as well as for the service providers. To reach the above purposes Load balancers are used in clouds. Load balancing is a way to efficient manner distributes workload/traffic to the available nodes/resources over the network. It optimizes the resource utilization by distributing work load effectually, reduces response time and maximizes the throughput; it is also required for it to be fault tolerant and secure. Therefore load balancing is one of vital parts of the cloud to enhance its performance. Cloud computing operates in a distributed manner which comprises a large number of service nodes that performs several specific tasks collectively in coordination with the other nodes. These systems and environments are highly stable and also can handle requests from multiple users concurrently. But the explosive rise in data in current trends attracts more service requests and hence the load on the cloud imposes a performance challenge on the service provider. Various load balancing algorithms has been proposed for load balancing, here we are try to solve issue of load balancing by using CloudSim and WorkflowSim. [9]

Figure -1 (CloudSim core simulation engine) showing the CloudSim structure that is three-layer structure. In CloudSim simulator is the lower layer that is, known as simulation engine. The functionality of this layer is to create real cloud environment and can't be modified by users. The lower to upper layer is work as an interface between the cloudlets and VMs, VM allocation policy algorithm. [16-21]

2. Challenges in Cloud Computing

From the beginning of the cloud computing history, certain challenges have remained unattended for industries and the clients [10]. The most important issues are: interoperability between clouds, generation of standards, security, fault tolerance and organizational aspects. Cloud computing has generated a paradigm shift in the application and management of information technology infrastructure, changing the enterprise and technology aspects of IT [11].

Yet, as with any significant change ever, there are both supporters and skeptics. Transferring IT to cloud is a challenging process assignment which incorporates both authoritative and specialized difficulties [12].

The cloud is different worldview which doesn't have a suitable one-sentence definition; it includes numerous variables, and in this way change to a cloud-based process might confounding [13].

This multifaceted nature combined with instability throws up various hierarchical cloud-selection barriers, which pose, specialized and authoritative difficulties. [14] Though the significance of hierarchical difficulties is hard to measure; they are fundamental to the decision making process [15] and therefore, need to be addressed.

Cloud computing is a service oriented model for providing IT infrastructures and applications. Models and the way in which interoperability has taken account of the arrangements put forward by distinctive merchants is a guide for achieving the objective. A key obstacle to the collection of cloud
figures is the way in which the vendors are safe. The customers are unable to turn to another contender because the vendor is safe. In fact, as specified in the agreement, a fee should be paid and a measure of time should be retained.

3. Deployment Models of Cloud Computing

The following four are the most commonly used types of cloud:

3.1. Public Cloud
A public cloud provides open access to its resources publically to every user [10]. It serves multiple users in which the cloud providers can either set up their own infrastructure or utilize third party infrastructure for allowing access to the resources. These resources are provided either free of cost or on pay-per-usage. Public cloud is considered to the cost-efficient due to shared usage of resources and some of the most popular cloud providers are Google, Amazon Ec2, etc.

3.2. Private Cloud
Private cloud is also identified as internal cloud employed in closed communities to provide higher security and privacy with complete fulfillment of customer needs [11]. Private clouds enable business organizations to utilize the cloud as the centralized access to its resources from various places simultaneously, the different departments of the organization. Private cloud is installed either as on-site or is out-sourced. On-site clouds are installed at customer locations while the out-sourced clouds are installed in the host organizations. Some of the most common private cloud providers are VMware Cloud Infrastructure Suite, Amazon VPC (Virtual Private Cloud), and Microsoft ECI datacenter.

3.3. Community Cloud
This cloud model is shared mutually among multiple companies, which have like-to-like policies and norms. Organizations like banks and chits have related services such as privacy, security and obligations and hence can be share the single clouds for cost efficiency. This model is also installed either as on-site or out-sourced community clouds. Two most common examples of community clouds are Google Apps for Government [9].

3.4. Hybrid Cloud
Hybrid cloud is the mixture of the private, public and community cloud which integrates various benefits of all other deployment models such as cost efficiency, security, privacy, etc. of all the deployment models [09]. This model is specifically used by organizations for withholding delicate hidden information. However, due to limitations involved in taking care of requests, this model uses open cloud for less sensitive data to deal with the loads.

4. Merits and Demerits of Cloud Computing

Cloud computing has a variety of advantages [23], some of which are discussed below:

4.1 Cost efficient
Since desktop programming is cost expensive for companies, it may be appropriate to pay charges for various customers. However, cloud computing can be used at a lower price, thus reducing the company's costs.

4.2 Abundant storage
The use of the cloud offers access to a vast amount of storage space for data.

4.3 Backup and recovery
It is much simpler to provide a backup and restore essential documents and save them on a physical device.
4.4 Automatic software integration

The integration of software appears to take place promptly while using a cloud, which ensures that the client has to endeavor to integrate the application into its system.

4.5 Easy access to information

The customer can access the data at any point it likes, the area or gadget it needs in any case, after the customer has been enrolled in the cloud.

4.6 Faster deployment

After choosing the correct utility technique, all frameworks are prepared to work within minutes.

Though this environment has many advantages, there are some disadvantages of using cloud computing paradigm [23], and they are discussed as follows:

4.7 Technical issues

Though cloud services can be accessed anytime from any location, there are certain times when the systems have some dysfunctions, thus reducing its access.

4.8 Security issues

As mentioned in the previous sections, there are plenty of security problems due to non-availability of strict regulations. Further the data in cloud are also prone to multiple attacks.

4.9 Performance issues

The issues such as load, task allocation, resource Utilization, energy management, etc., significantly tend to minimize the efficiency of cloud paradigm.

5. CloudSimToolKit

CloudSim[16] is simulation software that is helping out the researcher for validate performance of their propose algorithms result as real environment. This simulating tool is written in Java. This is Java Library that is help out to creating the simulation environment. In this simulation environment easily researcher can add their propose work and can evaluate the propose work performance evaluate impact of strategies from various performance parameter, from cost/profit to speed up of various VM allocation policy algorithms execution time. This simulation tool is having a Datacenter. The DataCenter functionality is working as an IaaS provider. Figure 1 (CloudSim core simulation engine) showing the CloudSim structure that is three layer structure. In CloudSim simulator is the lower layer that is, known as simulation engine. The functionality of this layer is to create real cloud environment and can't be modified by users. The lower to upper layer is work as an interface between the cloudlets and VMs, VM allocation policy algorithm.
5.1. DataCenter

Datacenter working as on requests for VMs from brokers. In this process Datacenter create the VMs in hosts.

5.2. Datacenter Broker Simple

This is simple java class CloudSim, this will responsible for only submits a list of VMs to be created, schedules Cloudlets sequentially on them. When we want to implement the proposed scheduling policy and/or policy for generation of VM requests and Cloudlets. The basic requirement is the need to create own Broker.

Then to implement the VM allocation policies or algorithms, need to follows these steps:

1. First step is to need extend DatacenterSimple class
2. Afterward, for the purpose of describe periodic event need to define a new tag.
3. Next step is to override process Other Event. This is regarding to find out the periodic event, and there is a need to call handler for it. Next step is for the handler and we use handler method implement in cloud simulator for implement purpose. Finally, this will help to schedules the next call for the event. Figure -1 showing the cloudsim engine, this image is showing how to simulator working

Figure -2 showing the class diagram, according to figure-2 in CloudSim having total of 12 packages that has containing several classes. The most important package out of 12 packages is org.cloudbus.cloudsim. The cloudsim class having codes for modeling variant cloud entities. In the cloud entities are a Datacenter, a Host, a Cloudlet and VMs. In this package we can overwrite or extend these classes to define the new cloud computing algorithms. This package will play a vital role for validate the new propose algorithm performance.[22-24]

The CloudSim package further divided into two categories

1) Core entity classes
   - Cloudlet
   - Host
   - Datacenter
   - VM

2) Associated classes.
   - VmScheduler
   - VmAllocationPolicy
   - CloudletScheduler
   - UtilizationModel
   - DatacenterBroker

A Datacenter, a Host, a Cloudlet and VMs. In this package we can overwrite or extend these classes to define the new cloud computing algorithms, this package is play a vital role for validate the new propose algorithm performance.[25]

6. Virtual Machine Allocation

In cloud computing field, particularly within cloud allocation area, virtual machine provisioning can be very challenging. A client on the host machine demands every virtual machine assigned to a compliant host. This implies that the virtual machine relies on the resources of the real machine to operate the virtual machine, such as storage and memory (Ezugwu, Buhari and Junaidu, 2013).
It can go through multiple stages when a virtual machine is allocated. The first step in the process is the client/end-user request, including details like the virtual hardware specifications, operating system, and amount of time needed for VM (Virtual Machine), including a SLA (The customer and host service level agreement is decided during the first stage. Second, the application must go through automatic or manual phase duration. The request is finally executed. This part of provisioning provides access to the VM to the client.

As the cloud provider must have the ability to handle this when a client submits a request for a VM, whether the order does not need to be rejected, this may be passed on to a cloud broker while necessary resources outweigh cloud provider's capacity.

The SLA is kind of deal between client and cloud provider; there are service level goals (SLO) under the Service Level Agreement; these are the metrics of performance that cloud provider must follow in order not to violate the SLA between customer and cloud provider. Bandwidth, network strength, and response time include all examples of SLOs.

Usually, if SLA is formal, it would be a formal document written in contractual agreement that will have each SLO specification. Hence SLA can be either informal or formal between cloud provider and client. For a violation between the cloud provider and the client, the document may also have a penalty or fines in negotiated SLA. Nevertheless the SLA for which there are no SLA records available could be informal. In the service given to them, consumers would expect a certain degree of quality, regardless of whether the SLA is formal or informal. If cloud provider keeps failing to satisfy SLA agreement, a provider may face harm to company's credibility, resulting in the loss of profit for cloud provider.

Biggest care is taken to help reduce power usage when it comes to VM role of cloud provider, because if the specification does not require 100% host utilization, spinning up a host for each order, several VMs can be run on the same host, another priority is to provide more than one data centre in one place or around the world to the cloud provider. Because if the client wanted low latency, placing the VM in a centre far away from the client might have a significant impact on the experience of the end user and potential violation of the SLA.

7. Allocation OF Virtual Machine: Architecture

Architecture consists of several mechanisms under virtual machines that can be partitioned into two major areas:

Front End- This consists of software, such as a web browser like Internet Explorer or similar, that relates to the customer/client face that is necessary to access the cloud.

Back End: This includes a large data storage facility, security system, services, models for implementation, rules, monitoring, virtual machines, and cloud servers themselves.

7.1. Cloud Computing Monitoring

In order to optimize performance and minimize overhead costs, close monitoring is needed when implementing virtual machines, because getting hosts running idle without assigned tasks will be a wastage of power, there are several kinds of software that can control virtual machines like Paessler, solarWinds and Veeam One (PC & Network Download-www.PCWDLD.com, 2018).
And with monitoring, if a host is overused, the virtual machines may be migrated to another host to ease CPU, storage resources and memory, in addition, if hosts experience anyone potential hardware malfunction, all virtual machines might be moved to other host by using migration and necessary hardware/software is placed. With no need for power down virtual machine for concluding migration, a live migration is feasible, or if there are restricted resources, virtual machine might have been moved as a temporary step to another cloud provider, but if that was to migrate to a various cloud provider, it might have a possible effect on the client/customer SLA.

7.2. Features of Front and Backend

The cloud provider handles features such as networking, storage, servers, virtualization and protection, and features such as security are extremely essential as several virtual machines can be run on the same host, as only those individuals need to guarantee the correct access rights.

8. VM Allocation Policies Algorithm

In this section our focus on CloudSim’s VM allocation Policies and doing simulation in CloudSim tool. VM allocation is spin-off/provision of a VM on a physical host in which a certain predetermined memory, CPU/vCPU, VLAN, storage, IP address, etc. may be allocated to the VM as part of the cloud initiative or as part of the virtualization initiative. The following may be more general allocation of cloud computing resources: Allocate additional private cloud resources to a VM (vertical scale-up) (CPU, memory, storage, network, VFW, VLB, etc.) Allocate additional private cloud VMs where VMs are considered a resource (horizontal scale-out) as part of the bursting of workload, allocate additional external public cloud/IaaS resources DBaaS Note: Resource allocation for cloud computing is typically automated for faster processing time and minimum human error by its orchestrator. Figure-2 is describing the flow of VM allocation policies algorithm. Our algorithms are performance measure by memory utilization, CPU utilization and bandwidth utilization, as these all are playing most important role for cloud computing service faster performance[26].

8.1. Simple VM allocation policy

This is a simple VM allocation policy and these results are standard. This is default policy in cloudsim environment.

8.2. Round Robin VM allocation policy

Round Robin VM allocation policy is VM allocation is based on time slices principle. This VM allocation policy, time scheduling method enhances performance by utilizing less time to schedule virtual machine.

8.3. Best Fit Host VM allocation policy

This VM allocation policy selection the host available according to the host's bandwidth, CPU and memory resource information to allocate incoming VMs to balance the overall load of the data centre. This algorithm effectively optimize the bandwidth, memory and CPU utilization of the data centre and achieve the reduce energy consumption.

8.4. Fuzzy VM allocation Policy

This VM allocation policy is combination of best fit VM allocation policy with fuzzy logic to allocate VMs using information about available CPU, bandwidth and memory resources and additional feature weights to balance with the computational resource, memory and bandwidth. This fuzzy algorithm carried out the finest optimizing the computational resource utilization of the data centre but didn't impact on energy consumption. Our Experimental Results based on experiments performed on all three algorithm and compares which VM allocation policy is best. According to graphs Fuzzy based VM allocation policy are the best policies [27].
For the purpose of simulation we need to set parameter in cloudsim environment. For the purpose for all algorithms we set the simulation parameter about host information setting, data center information setting. After that simulation provide all the running information to the cloud simulator and the given below information is Host parameter setting and data center parameter setting that is set into the cloudsim simulator.

9. Simulation Parameter

These are the simulation parameters which are set for the comparative analysis carried out:

Host Information
- Ram = 36000;
- Storage = 1000000
- Bandwidth = 40000;

The Properties of a data center: architecture, OS, list of
Machines, allocation policy:
- Operating System: CentOs
- System architecture: x86
- VM: Xen

In this analysis simulation and setup for VM allocation based on fuzzy sets, advanced VM allocation and simple VM allocation. We simulate three policies Simple, Advance, and Fuzzy allocation based. In this work studied and examined numerous load balancing policies for the cloud environment. These load balancing algorithms basically depend on VM allocation to the host. The simulation of various VM allocation policy algorithms and testing of algorithms has been developed in CloudSim environment. The simulation results shown Best Fit VM allocation policy makespan is better than others VM allocation policy algorithm. The load balancing was completed in context of availability of RAM and necessities of hosts and VMs, respectively. We simulate these algorithms in CloudSim environment. These algorithms comparison based on various parameters is given in table-1. The comparison table is showing the information about performance of algorithms. We evaluate the result of above define algorithms based on CPU utilization, Memory utilization and bandwidth utilization. This is simulation result that we get after the simulation has been carried out.

10. Result Analysis

Results for Simple VM allocation Policy
SD of Mean of CPU utilization 2661.0649068541006
SD of Mean of Bandwidth utilization 6036.022047093209
SD of Mean of memory utilization 1788.3977508373248
Average no of hosts 24

Results for Advanced VM Allocation Policy
SD of Mean of CPU utilization 3184.266757631668
SD of Mean of Bandwidth utilization 7151.87080037969
SD of Mean of memory utilization 2131.2980157641036
Average no of hosts 13
Results for fuzzy set based VM allocation Policy

SD of Mean of CPU utilization 2661.0649068541006
SD of Mean of Bandwidth utilization 6036.022047093209
SD of Mean of memory utilization 1788.3977508373248

Average no of hosts 24

These graphs are showing the result of VM allocation policy experimental result. The Figure 3-6 is showing performance. The overall performance metrics are CPU utilization, memory utilization, bandwidth utilization and average host for VM allocation policy. These results are cumulative in performance table. This comparison table showing the result value for each algorithm. The results of algorithms are showing the information about the average hosts for each algorithm. Figures are showing the comparison information of each algorithm. According to simulation result Fuzzy algorithm results are better than other algorithm. The simulation of VM allocation policies we set the Number of VM = 500 and cloudlet = 1000.

| Performance Parameter | Simple VM allocation Policy | Advanced VM allocation policy | Fuzzy set based VM allocation Policy |
|-----------------------|----------------------------|------------------------------|-------------------------------------|
| Mean of CPU utilization | 2661.064907                | 3184.266758                  | 2661.064907                        |
| Mean of Bandwidth utilization | 6036.022047              | 7151.8708                    | 6036.022047                        |
| Mean of memory utilization | 1788.397751              | 2131.298016                  | 1788.397751                        |
| Average no of hosts | 24                        | 13                           | 24                                  |

This figure 3 is showing the overall performance of all VM allocation algorithms. This figure 4 is showing the CPU utilization, memory utilization and Bandwidth utilization. This graph is showing one additional information i.e. Average number of host.

This figure 5 is showing the mean of CPU utilization used by each VM allocation policy algorithm after the simulation, we calculated the standard deviation that is representing as SD(standard deviation). This chart is showing the fuzzy VM allocation is the best among policies algorithm.

![Figure 3. CloudSim Classes](image)
Figure 4 is showing the use of CPU utilization for different VM allocation policy. This figure 5 is showing the Bandwidth utilization used by each VM allocation policy algorithm. This chart is showing the fuzzy VM allocation is the best among policies algorithm.

This figure 6 is showing, standard deviation of memory utilization for different VM allocation policy.

In our experimental result we calculate the standard deviation of memory, CPU and bandwidth utilization by the VM allocation policies.

This comparison table information gathered from simulated results and CPU, Bandwidth and memory utilization in the form of standard deviation of values. These all values are showing in the table and graph for all three VM allocation policies algorithms results. According to the graph and result, comparison table, fuzzy logic is best policy.
11. Conclusion

In this research paper we studied and carried out the analysis of the VM allocation policies in the CloudSim environment. We simulate the environment for the VM allocation policies and according to simulation result fuzzy VM allocation policies is best explained in literature. In this paper we evaluate different parameter for each VM allocation policy algorithm. According to simulation results, in this research paper VM allocation policy if done through fuzzy based approach is yielding good results.

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