ANALYSIS OF SERVICE BROKER AND LOAD BALANCING IN CLOUD COMPUTING

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Abstract— Cloud computing can be defined as computing in a remote location or location independent with shared and dynamic resource availability on demand. It typically involves over-the-internet provision of dynamically scalable and often virtualized resources. Many people are moving to cloud because of reduction in cost and dynamic allocation of resources. The infrastructure underlying cloud is hosted and maintained by cloud providers. Cloud Computing is the most wanted technology today but there is much more to come up with. Availability of services, Performance unpredictability, Resource sharing, availability of resources as per requirements, storage capacity, data confidentiality and many more are the problems/Issues faced with cloud. Here in this paper we have given a brief idea about the various existing service broker and load balancing algorithms. Also we have compared these load balancing algorithms and come up with some conclusions. Different simulation tools like cloud Analyst have been devised to test the execution of existing algorithms, using which we can compare their performance based on various metrics.

Keywords—Cloud Computing, Cloud Analyst, Infrastructure Performance, Service Broker and Load Balancing Algorithms.

I. INTRODUCTION

The term 'Cloud Computing', is famous for its pay-per-usage basis. As everyone is moving to cloud, performance in cloud computing today is becoming very challenging issue. There are number of performance parameters of concern in cloud like application performance, network performance, infrastructure performance, etc. Network and application performance are not in the sole control of cloud provider. Cloud provider can only manage infrastructure performance. In spite of the research being carried out, cloud computing performance is still an area of concern. Service Brokering and Load Balancing are two key areas where we can focus to improve performance of computation. Various algorithms have been proposed in these areas by researchers to improve performance. Aim of our project is to identify, analyze and compare the existing algorithms and come up with the experimental results of the same.

The remainder of this paper is organized as follows: In section II, we have provided the background knowledge and about routing of user requests in Cloud Analyst tool. In section III, we have discussed about the need for evaluation of cloud performance. In section IV, we have discussed about related work done in this area. Section V discusses the simulation configuration, results and performance analysis, and finally we have concluded our work.

II. BACKGROUND

Cloud Computing is the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer. The cloud system is an on demand "just in time" provisioning involving a no upfront cost, pay-as-you-go system having infinite and elastic resource scalability.

Cloud computing is a concept used to describe a variety of computing concepts that involve a large number of computers connected through a real-time communication network such as the Internet. In science, cloud computing is a synonym for distributed computing over a network, and means the ability to run a program or application on many connected computers at the same time. The phrase also more commonly refers to network-based services, which appear to be provided by real server hardware, and are in fact served up by virtual hardware, simulated by software running on one or more real machines.

Presently, many software based algorithms are proposed to improve the overall performance of cloud. Factors governing Cloud performance highly depend on geographical distribution of data centers, number of users, and number of data centers, service broker policy and load balancing algorithms being used. Many changes have been done in the existing algorithms and many new algorithms are proposed to improve the performance.

For experimenting the performance of cloud environment in a repeatable manner, actual deployment of cloud becomes costly and not an easier task, therefore not preferable. For this reason various simulation tools are used to model and analyze cloud computing environment and applications, graphically analyze the results before the actual deployment of clouds. The simulation tools available are Cloud Reports, cloud Analyst, MR-Cloud Sim and Network Cloud Sim etc. The underlying platform for these simulators is Cloud Sim.

III. SIMULATION

It is not easy to perform experimentation in a real cloud environment because,

1. It involves high purchase cost as it requires huge amount of resources for a long period of time.
2. Does not support repetition of experiments.
3. Does not provide the flexibility to reconfigure the parameters easily and quickly.
4. Conditions prevailing in the Cloud-based environments are not in the control of developers of application services [1].

A more viable approach to use cloud simulation tools. It enables the Cloud providers to evaluate the different kinds of resource provisioning scenarios under varying load and pricing distribution [2]. It allows the customers to test their services in a repeatable and controllable environment free of cost and identify the performance issues before actual deployment on real cloud.

A. Cloud Sim [3]:

Different simulators have been proposed for modeling of Grid based environments [6]. Cloud Sim is a self-contained simulation application which enables seamless modelling, simulation, and experimentation of cloud computing and application services. Cloud Sim was developed at the University of Melbourne. The Cloud Sim toolkit supports system and behavior modelling of cloud system components such as data centers, virtual machines (VMs) and resource provisioning policies. It implements generic application provisioning techniques that can be extended with ease and limited efforts. Cloud Sim aids the researchers and developers to focus on specific system design issues without getting concerned about the low level details related to cloud-based infrastructures and services.

Features:

1. Modelling and creating a huge data center, unlimited number of virtual machines, applications, users, computational resources, and policies for management of diverse parts of the system.
2. Availability: open source.

3. Java is being used in Cloud Sim, because of OOP feature
4. Simulation time in seconds.

B. Cloud Analyst [4]:

Cloud Analyst is a graphical toolkit which separates the simulation experiment set-up exercise from a programming activity. The modeller can focus on the simulation parameters rather than technicalities of programming. The simulator is developed using Java SE, Swing, Cloud Sim toolkit and Sim Java framework.

Features:

1. Easy to Use:

The simulator provides an intuitive and comprehensive GUI which facilitates setting up and executing experiments easily.

2. High degree of configurability and flexibility:

It is possible to enter and change the simulation parameters quickly and easily.

3. Graphical output:

The detailed results in the form of tables and graphs summaries the large amount of statistics and also help to identify the important patterns of output parameters.

4. Repeatability:

The simulation is controllable and repetitive execution of the same experiment yields the same results. The configuration can be saved as a .sim file. The results of the experiment can also be saved as a .pdf file.

5. Ease of extension:

The simulator supports extensions with minimal efforts and thus it can evolve continuously.

Components:

1. Region:

The world is geographically divided into 6 Regions (0 to 5) which correspond with the 6 main continents.

2. Internet:

The Internet models the Internet traffic routing around the world by introducing suitable transmission latency and data transfer delay, which can be configured.

3. Cloud Application Service Broker:

The Cloud Application Service Broker determines which data center should service the requests from each user base. Cloud Analyst implements 3 types of Service Brokers:

3.1. Service Proximity based routing
3.2. Performance Optimized routing
3.3. Dynamically reconfiguring routing

4. User Base:

The User Base represents a group of users who are responsible to generate traffic for the simulation.

5. Internet Cloudlet:

A number of requests from the users are grouped into a single Internet Cloudlet based on the ‘User Grouping Factor’

6. Data Center Controller:

Data Center Contoller manages VM creation and VM destruction and handles the routing of requests received from User Bases via the Internet to the VMs.

7. VMLoad Balancer:

The Data Center Controller decides which VM should be allocated to a particular Cloudlet using the VMLoad Balancer. Cloud Analyst implements 3 types of VMLoad Balancers:

7.1. Round Robin Load Balancer
7.2. Active Monitoring Load Balancer
7.3. Throttled Load Balancer

8. GUI:

It displays the GUI and acts as a front end controller for the simulator. It enables the user to define the simulation parameters, save and load simulation configuration, execute simulation and save the results of the experiment.

IV. ROUTING OF USER REQUEST IN CLOUD ANALYST

In cloud, from user’s end the important factors are cost optimization and provider that provides utility to the user’s need. Thus routing of user’s request is a very important aspect in cloud. Figure 1 shows the routing of user request in one of the Simulation tools i.e. Cloud-Analyst [5].

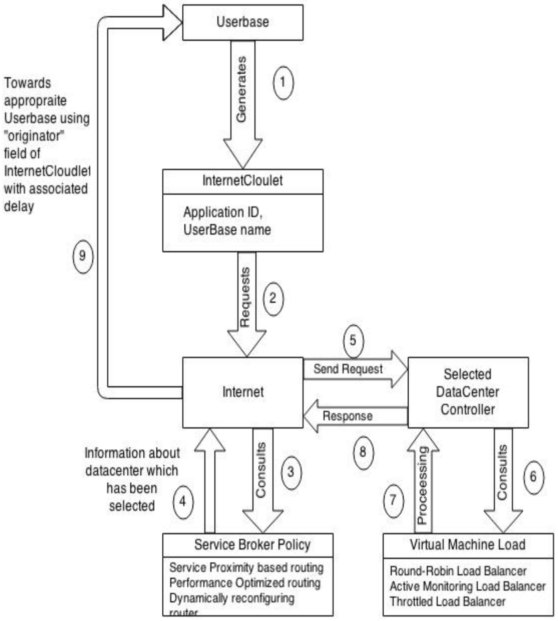

Userbase
Generates
1
Towards appropraite Userbase using "originator" field of InternetCloudlet with associated delay
InternetCloulet
Application ID,
UserBase name
9
Requests
2
5
Send Request
Internet
Selected DataCenter Controller
Response
8
Information about datacenter which has been selected
4
Consults
3
7
Processing
Consults
6
Service Broker Policy
Service Proximity based routing
Performance Optimized routing
Dynamically reconfiguring router
Virtual Machine Load
Round-Robin Load Balancer
Active Monitoring Load Balancer
Throttled Load Balancer

Fig. 1: Routing of User Request in CloudAnalyst

1. User base generates an Internet Cloudlet, with application id for application and also includes name of the user base itself as originator for routing back the RESPONSE.
2. REQUEST is sent to the Internet with zero delay.
3. Internet consults the service broker for the data center selection. The service broker uses any one of the service broker policy based on the REQUEST information.
4. Service broker sends information about selected data center controller to the Internet.
5. Internet adds appropriate network delay with the REQUEST and sends to the selected data center controller.
6. Selected data center controller uses any one of the virtual machines load balancing policy.
7. Virtual machines load balancer assign the virtual machine to the user request.
8. Selected data center sends the RESPONSE to the Internet after processing the REQUEST.
9. Internet uses the originator field of the Cloudlet information and adds appropriate network delay with RESPONSE and sends to the user base.

V. EXISTING ALGORITHMS IN CLOUD ANALYST

A. Service Broker Algorithms:

1. Service Proximity Based Routing:

   It selects the Data Center with least network latency i.e. the closest DC. If two or more closest Data Centers are available then selection is done randomly. It does not take the load and cost into the consideration.

2. Performance Optimized Routing:

   In this routing policy, service broker actively monitors the performance of all data centers, and based on that, routes the traffic to the data center with best response time. It does not take cost into consideration.

3. Dynamically Reconfigurable Router:

   This is an extension to proximity based routing, where the routing logic is similar, but the service broker has additional responsibility of scaling the application deployment based on the load it is facing. This policy increases and decreases the number of virtual machines allocated in the data centers.

B. Load Balancing Algorithms:

1. Round Robin Load Balancer:

   In this algorithm, a queue is maintained and when the request arrives the first Virtual Machine is given request and is correspondingly moved to end of queue. Here no load checking is done, so this method fails in giving the best data processing time Virtual Machine.

2. Active Monitoring Load Balancer:

   In this algorithm, an index table of Virtual Machines is maintained which contains the numbers of requests allocated to each Virtual Machine. Initially all the Virtual Machines have zero allocation. When the request arrives, the index table is parsed and the least loaded Virtual Machine is assigned the request and correspondingly the table is updated regarding new allocation. There is overhead of parsing the index table before assigning the request.

3. Throttled Load Balancer:

This algorithm also prepares an index table as that of previous algorithm but notes whether a particular VM is available or not. When the request arrives the index table is parsed and the first available VM is selected.

VI. EXPERIMENTATION

A. Main Configuration:

1. Simulation Duration: 24 Hours
2. User bases:

Table 1:

Name	Region	Request per User per Hr	Data size per Request (bytes)	Peak Hours Start (GMT)	Peak Hours End (GMT)	Avg Peak Users	Avg Off Peak User
UB1	0	60	100	12	14	5000	500
UB2	1	60	100	14	16	1000	100
UB3	2	60	100	19	21	3500	350
UB4	3	60	100	0	2	1500	150
UB5	4	60	100	20	22	500	50
UB6	5	60	100	10	12	800	80

3. Application Deployment Configuration:

Table 2:

Data Center	#VMs	Image Size	Memory	BW
DC1	5	10000	512	1000
DC2	5	10000	512	1000
DC3	50	10000	512	1000

4. Data center configuration:

Table 3:

Name	Region	Arch	OS	VMM	Cost per VM $/Hr
DC1	0	x86	Linux	Xen	0.1
DC2	1	x86	Linux	Xen	0.1
DC3	2	x86	Linux	Xen	0.1

Table 4:

Name	Memory Cost $/s	Storage Cost $/s	Data Transfer Cost $/Gb	Physical HW Units
DC1	0.05	0.1	0.1	1
DC2	0.05	0.1	0.1	1
DC3	0.05	0.1	0.1	1

5. Physical Hardware Details of individual Data Center:

Table 5:

Id	Memory (Mb)	Storage (Mb)	Available BW	Number of Processor	Processor Speed
0	204800	100000 0K	1000000	4	10000

B. Advanced Configurations:

1. User grouping factor in User Bases (Equivalent to number of simultaneous users from a single user base): 500
2. Request Grouping Factor in Data Centers (Equivalent to number of simultaneous requests a single application server instance can support.): 250
3. Execution instruction length per Request (bytes): 200
4. Select any Load Balancing Policy across VM's in single Data Center

C. Internet Characteristics:

1. Delay Matrix:

The transmission delay between regions. Units in milliseconds.

Table 6:

Region /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

2. Bandwidth Matrix:

The available bandwidth between regions for the simulated application. Units in Mbps.

Table 7:

Region/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

Using the above all configuration the experimentation is done and the result for various combinations of Service broker and Load balancing algorithm is obtained.

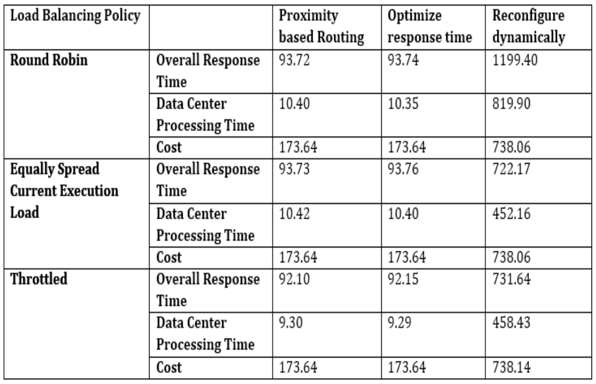
The following is the combination of Service broker algorithm and Load Balancing algorithm used to come up to results:

Table 8:

Service Broker Policy	**Load Balancing Algorithm**
Proximity based Routing	Round Robin Load Balancer
Proximity based Routing	Active Monitoring Load Balancer
Proximity based Routing	Throttled Load Balancer
Performance Optimized Routing	Round Robin Load Balancer
Performance Optimized Routing	Active Monitoring Load Balancer
Performance Optimized Routing	Throttled Load Balancer
Dynamically Reconfiguring Router	Round Robin Load Balancer
Dynamically Reconfiguring Router	Active Monitoring Load Balancer
Dynamically Reconfiguring Router	Throttled Load Balancer

VII. COMPARISON OF RESULTS

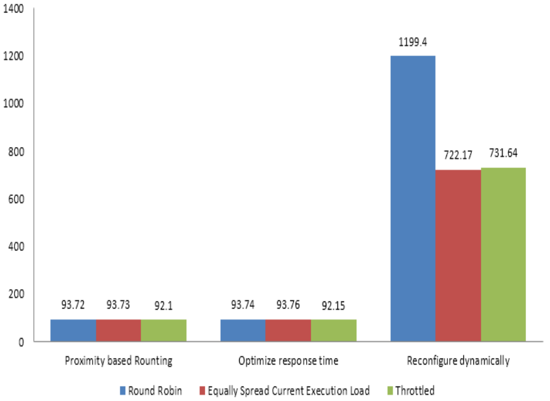
We have analyzed and compared the results obtained by executing the above set of algorithms. The metrics on which we have compared the results are Overall Response Time, Data Processing time and Cost.



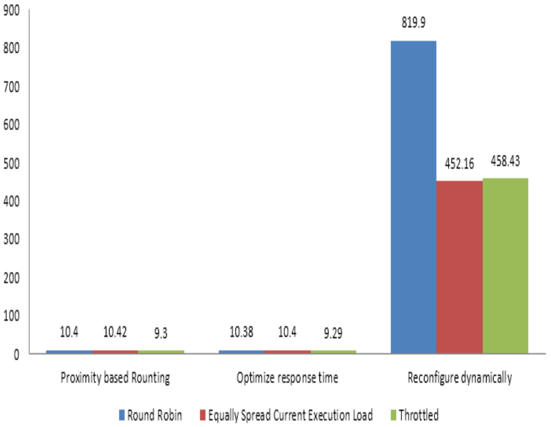
Load Balancing Policy		Proximity based Routing	Optimize response time	Reconfigure dynamically
Round Robin	Overall Response Time	93.72	93.74	1199.40
	Data Center Processing Time	10.40	10.35	819.90
	Cost	173.64	173.64	738.06
Equally Spread Current Execution Load	Overall Response Time	93.73	93.76	722.17
	Data Center Processing Time	10.42	10.40	452.16
	Cost	173.64	173.64	738.06
Throttled	Overall Response Time	92.10	92.15	731.64
	Data Center Processing Time	9.30	9.29	458.43
	Cost	173.64	173.64	738.14

Figure 2: Output Values of various parameters from CloudAnalyst Tool by running all the combinations

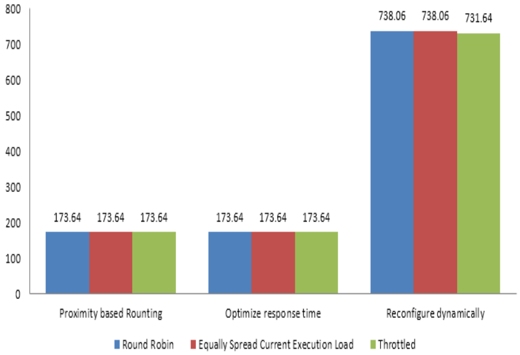
Graph 1: Overall Response Time



Graph 2: Data Center Processing Time



Graph 3: Cost



VIII. ANALYSIS

The results compare the three load balancing algorithms by considering the overall cost and average response time for each of the three service broker policies.

Response time:

We observe that the three load balancing algorithms perform almost the same for Proximity based Service broker policy with respect to response time. They produce similar results for Optimized response time based service broker policy; however the values of response times are slightly lower than those of Proximity based Service broker policy. This is because Proximity based policy passes all the requests to the closest data center, while Optimized response time based policy sends most of the requests to the closest data center and selects the data center with the least response time for remaining requests. The dynamically reconfigurable service broker policy involves additional overhead of scaling the VMs up or down depending on the peak load. Thus the values for response time obtained in this scenario are greater than those of the other two service broker policies and they vary significantly for the three load balancing algorithms.

Cost:

From the results of the simulation, we find that the cost for implementing Proximity based and Optimized response time based service broker policies differs by a very small amount for the three load balancing algorithms. However, the cost for implementing the dynamically reconfigurable service broker policy is much higher as the number of VMs used fluctuates.

After a meticulous analysis of the experimentation results, the Optimized response time based service broker policy along with the throttled load balancing algorithm achieves the best response time within a reasonable cost.

IX. CONCLUSION

The major advantage of cloud computing is that the clients are free from the worry of knowing about the underlying hardware that is servicing their requests. In order to maintain this feature, it is necessary to efficiently utilize the available resources. Proper understanding and analysis of existing algorithms and the factors governing the same are highly considered while doing the further research work. The various factors are influenced by different combination of Service broker and Load balancing algorithms.

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