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Efficient Data Center Selection Policy for Service Proximity Service Broker in CloudAnalyst

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ABSTRACT
Cloud Service Providers offer flexible, on demand and measured infrastructure services. In Public Cloud, tenants have control over OS, storage, and deployed applications. Resources are provisioned in different geographic regions. For organizations, performance of an Application deployed in multiple regions is a matter of concern in Public Cloud deployment model. Proof of Concepts in Public Cloud environment gives better understanding but it costs organization heavily in terms of capacity building and resource usage.
To study such dynamic and massively distributed environment, simulation of Cloud environments and Applications to evaluate application performance can provide useful insight. CloudSim is a toolkit for modeling and simulation of Cloud computing Environments and assessment of resource provisioning algorithms. CloudAnalyst is built upon CloudSim with user friendly GUI. In this paper, we have applied Round-Robin load balancing policies for distributing load among multiple Data Centers available in same region. This policy results into efficient resource utilization from the Cloud Service Provider's perspective.

Key Words: Cloud computing, Data Center, Region, Service Broker Policies, Simulation.

INTRODUCTION:
Study of such distributed, virtualized, and elastic resources can be carried out in a controlled manner with simulation to gain insight of Application performance. Cloud computing is revolutionary innovation in the field of IT where resources are provisioned and de-provisioned on the basis of pay-as-you-go chargeback model. Cloud-based environment allows the computing resources and infrastructure to be provisioned with complete flexibility - elastically consuming them in an on-demand way to allow the project to proceed with less overhead and zero CapEx model.
Cloud Computing is a Best-Fit for applications where users have heterogeneous, dynamic, and competing QoS requirements; and applications have varying performance, workload and dynamic application scaling requirements but these Characteristics, Service Models and Deployment models create a fuzzy situation when we use Cloud to host applications. It creates complex provisioning, Composition, Configuration and deployment requirements. CloudSim, "A Toolkit for Modeling and Simulation of Cloud Computing Environments" comes to rescue. It provides system and behavioral modeling of Cloud Computing Components. CloudAnalyst introduces a comprehensive GUI which can be used to configure the simulation at a high level of detail. The GUI enables users to set up and execute simulation experiments easily and in a repeatable manner which also benefits from highlighting the performance and accuracy of simulation logic thus automatically leading to overall improvement [1].
In **section II**, we have discussed about CloudSim and CloudAnalyst with some of their components.
In **section III**, service proximity based routing of traffic from user base to data center has been discussed.
In **section IV**, enhancements that we have proposed with the use of load balancing in service proximity routing policy are detailed with the help of implemented algorithm.
In **section V**, We have specified various simulation scenarios and also stated simulation configuration for each scenario.

1. CLOUDSIM AND CLOUDANALYST

A. CLOUDSIM

CloudSim: a new, generalized, and extensible simulation framework that allows seamless modeling, simulation, and experimentation of emerging Cloud computing infrastructures and application services. By using CloudSim, researchers and industry-based developers can test the performance of a newly developed application service in a controlled and easy to set-up environment [2].

CloudSim framework is built on top of GridSim framework also developed by the GRIDS laboratory. And cloud analyst is a tool built on top of CloudSim. The prominent features offered by CloudSim are:

i. Support for modeling and simulation of large scale Cloud computing infrastructure, including data centers on a single physical computing node

ii. Self-contained platform for modeling data centers, service brokers, scheduling, and allocations policies.

iii. Availability of virtualization engine, which aids in creation and management of multiple, independent, and co-hosted virtualized services on a datacenter node.

iv. Flexibility to switch between spaces shared and time-shared allocation of processing cores to virtualized services

B. CLOUDANALYST

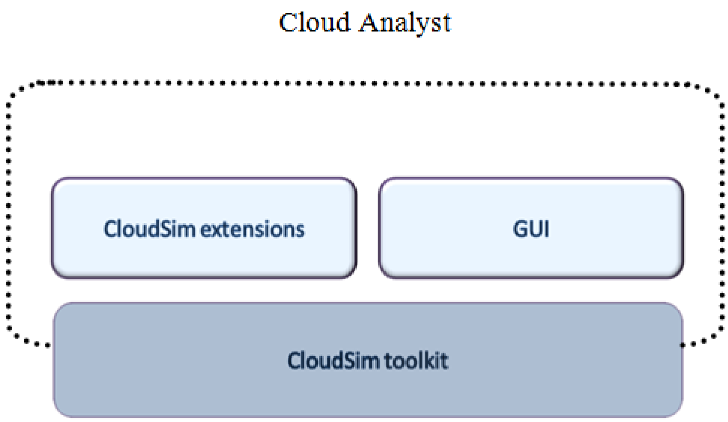

Figure 1: CloudAnalyst built on top of CloudSim

One of the main objectives of CloudAnalyst is to separate the simulation experimentation exercise from a programming exercise, so a modeler can focus on the simulation complexities without spending too much time on the technicalities of programming using a simulation toolkit. The CloudAnalyst also enables a modeler to repeatedly execute simulations and to conduct a series of simulation experiments with slight parameters variations in a quick and easy manner. The main features of CloudAnalyst are Easy to use Graphical User Interface (GUI) and Ability to define a simulation with a high degree of configurability and flexibility [3].

- REGION. In cloud analyst there are 6 regions that correspond to 6 continents in the world.
- USER BASE (UB). A User Base models a group of users considered as a single unit in the simulation and its main responsibility is to generate traffic for the simulation.
- INTERNET. It is used to simulate the data transfer across the internet with latency and bandwidth parameters.
- CLOUDLET: It specifies set of the user requests. It contains application id, name of the user base as originator for routing back the responses as well size of request execution commands and input and output files.
- DATA CENTER (DC). It encapsulates a set of computing hosts or servers that are either heterogeneous or homogeneous in nature based on their hardware configurations. The data center provides various policies for allocating bandwidth, storage and memory to virtual machines and hosts.
- INTERNETCHARACTERISTICS. This is used to determine characteristics of the Internet during the simulation, including the network delays and bandwidth between regions.
- SERVICE BROKER. The service broker decides as to which data center should be selected to provide the services to the requests from the user base.
- Service proximity based routing policy: It simply follows the closest data center strategy. This policy routes the requests to the data center which has the best response time among all data centers. Initially traffic is routed to the Datacenter Controller closest to the requests originating User Base in terms of network latency. Then if the response time achieved by the closest Data Center starts deteriorating, this service broker searches for the data center with the best response time at that time and shares the load between the closest and the fastest data centers.

In this paper, we have proposed the enhancement in this policy to achieve better resource utilization by allocating data centers in Round-Robin manner when multiple data center exists in single region.

2. WORKING OF SERVICE PROXIMITY BASED ROUTING

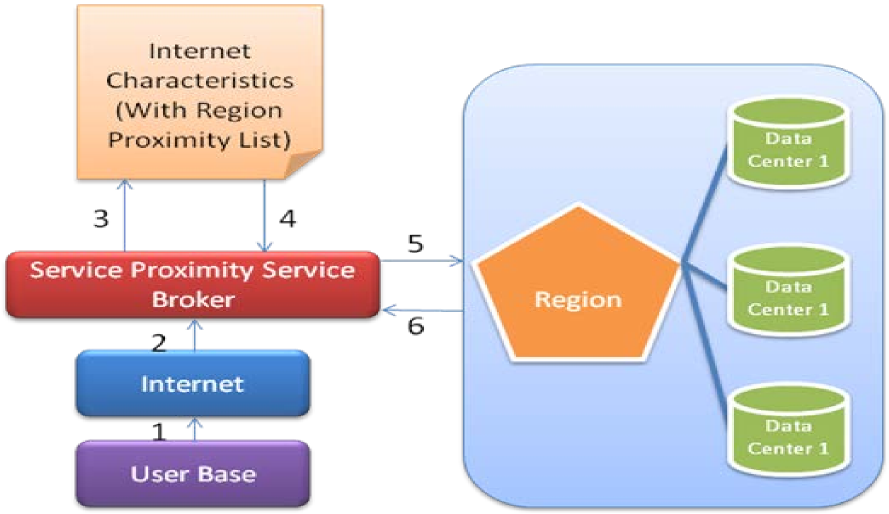

Figure 2: Routing of users requests to data centers

This is the simplest Service Broker implementation. The region selection is based on the earliest/ highest region in the proximity list and any data center of the selected region is then selected randomly for the user requests to be processed.

As soon as the Internet gets the message from the User Base, it queries to the service proximity service broker. The service broker asks for the region proximity list to the Internet Characteristics based on the region of the User Base. The region proximity is ordered based on the latency (region with lowest latency first). Based on the information from the Internet Characteristics a data center is picked by the routing policy. If there are more than one data centers within the same region, it will be selected randomly [4].

Random selection of data center causes inefficient usage of the datacenter resources when more than one data center in the same region. Request processing is not controlled properly.

3. PROPOSED ENHANCEMENT IN SERVICE PROXIMITY BASED ROUTING

We have introduced an idea that is used to distribute load across datacenters on a continuous round robin selection basis as part of normal processing. Our objective is to develop policy that spread requests equally among all the Data Centers using this new proposed round robin procedure within single region. This is implemented in the service broker policy.

PROPOSED DATA CENTER SELECTION ALGORITHM:

This strategy gives efficient data center selection technique. It leads to more resource usage than random selection. Following is the procedure followed to select data center in round robin manner.

1) ServiceProximityServiceBroker maintains list of all data centers indexed by their region.

DC name	Region	VM per DC	Cost ($) per VM/hour
DC1	0	5	0.1
DC2	0	5	0.1
DC3	0	5	0.1

2) When the internet receives requests from user base, it requests service broker to select the destination data center controller.

3) Service Proximity Service Broker determines the region of user base and then asks for the region proximity list with respect to the region of the sender of the requests. The list is ordered according to the latencies (lowest to highest).

4) Based on the region proximity list, the data center is selected using routing policy. If there is single data center in the same region, then the data center is selected and used for further processing.

5) In case of multiple data centers in a single region then, we need to provide strategy for load balancing.

Following procedure is followed until round robin selection of Data Center

a) Data Center is selected.

b) A queue is maintained that keeps the list of selected data centers which have already processed requests. If queue contains the data center selected in 5(a) then the step 5(a) is repeated otherwise proceed.

6) If queue is full after recent Data Center selction then it means all available data centers have processed requests and so now it is a time for the next iteration in existing data centers hence poll the data center in the queue and so that can be made available for request processing next time.

4. SIMULATION SCENARIO- WHEN THERE ARE MULTIPLE DATA CENTRES WITHIN SINGLE REGION

This scenario states that when there are multiple Data Centers within the same region then how the requests are processed by those Data Centers with user requests being distributed in equal proportion to all Data Centers available in single region.

CASE 1: THREE DATA CENTRES IN SINGLE REGION

Simulation Configuration details:

We define one user base and its configuration details are stated in Table 1. Three data centers are defined in a single region and their configuration is specified in Table

- User base configuration

Table 1: Simulation parameters for user base

User base name	Region	Request per user per hour	Data size per request (bytes)	Peak Hours (GMT)	Avg. Users	Avg. off- peak users
UB1	2	60	100	3.00-9.00	1000	100

Table 2: Simulation parameters for three data centers

DC name	Region	VM per DC	Cost ($) per VM/hour
DC1	0	5	0.1
DC2	0	5	0.1
DC3	0	5	0.1

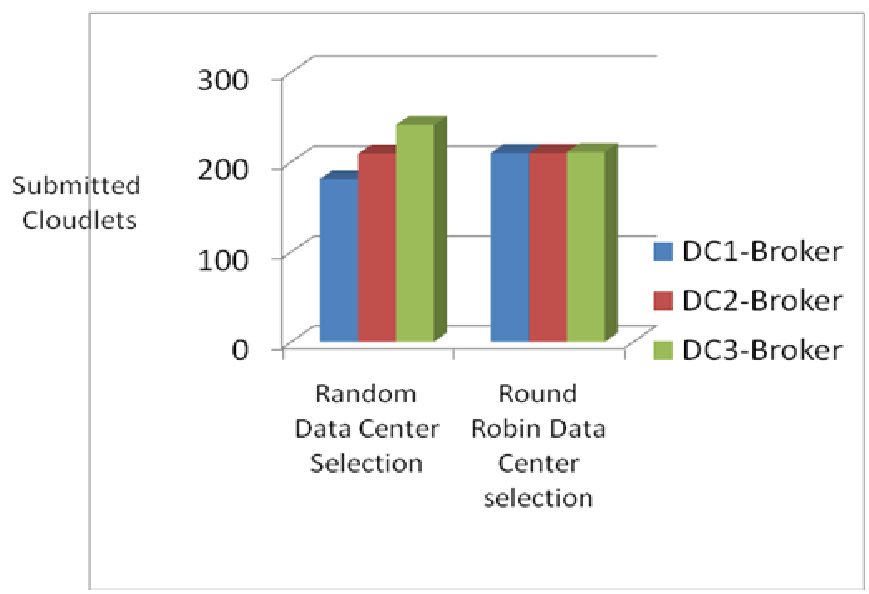

Figure 3: Comparison of submitted cloudlets on each of three DC in original and proposed policy

Figure 3 depicts that when user requests are distributed to the data centers selected on basis of round-robin method within single region then they are equally spread among the data centers in contrast to service proximity based routing which distributes the user requests among the randomly selected data centers in the single region thereby resulting into different numbers of requests for processing on all data centers present in that region Table 3 shows the difference.

Table 3: Comparison of submitted cloudlets on three dcs as per conventional and proposed algorithm.

	DC1-Broker	DC2-Broker	DC3-Broker
Random Data Center Selection	181	209	241
Round Robin Data Center selection	210	210	211

Similarly, it can be observed from Figure 4 that the line chart is representing the variations that were observed in number of requests processed by proposed algorithm as compared to conventional algorithm. It is illustrated in figure that when Random Data Center Selection policy is used, processed requests count was very uneven on three DCs which is also shown through table 4 and it is balanced with change of up to 14.6 percent in number of requests on each data center in single region when the proposed algorithm is implemented.

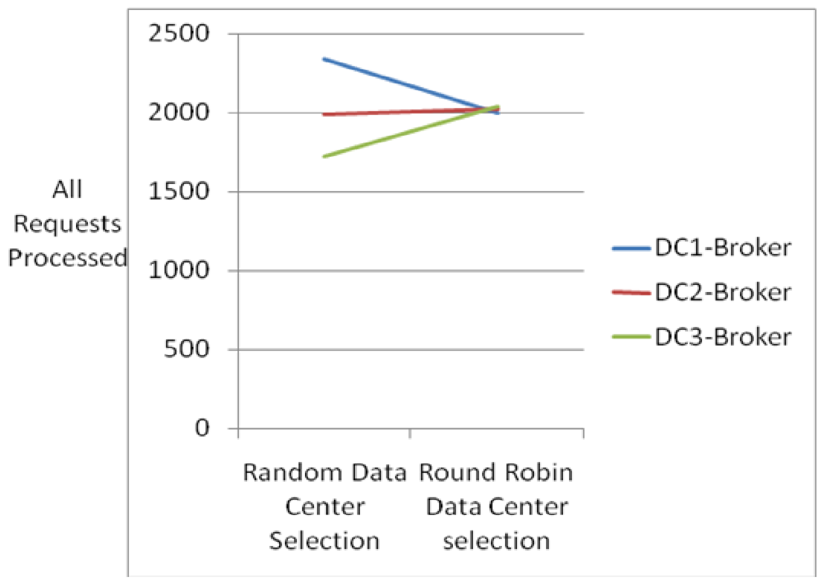

Figure 4: Variation in number of requests processed by three data centers

Table 4: Comparison of requests processed on three dcs in single region as per conventional and proposed algorithm

	DC1-Broker	DC2-Broker	DC3-Broker
Random Data Center Selection	**2340**	**1989**	**1729**
Round Robin Data Center selection	**1997**	**2022**	**2039**

CASE 2: SINGLE REGION 4 DATA CENTRES AND 4 USER BASES

Simulation Configuration details

We define four user bases with parameters described in Table 5. Configuration details for four data centers belonging to single region are mentioned in Table 6.

- User base configuration

Table 5: Simulation parameters for four user bases

User base name	Region	Request per user per hour	Data size per request (bytes)	Peak hours (gmt)	Avg. Users	Avg. Off- peak users
UB1	2	60	100	3.00-9.00	1000	100
UB2	2	60	100	3.00-9.00	1000	100
UB3	2	60	100	3.00-9.00	1000	100
UB4	2	60	100	3.00-9.00	1000	100

- Data center configuration

Table 6: Simulation parameters for four data centers

DC name	Region	VM per DC	Cost ($) per VM/hour
DC1	0	5	0.1
DC2	0	5	0.1
DC3	0	5	0.1
DC4	0	5	0.1

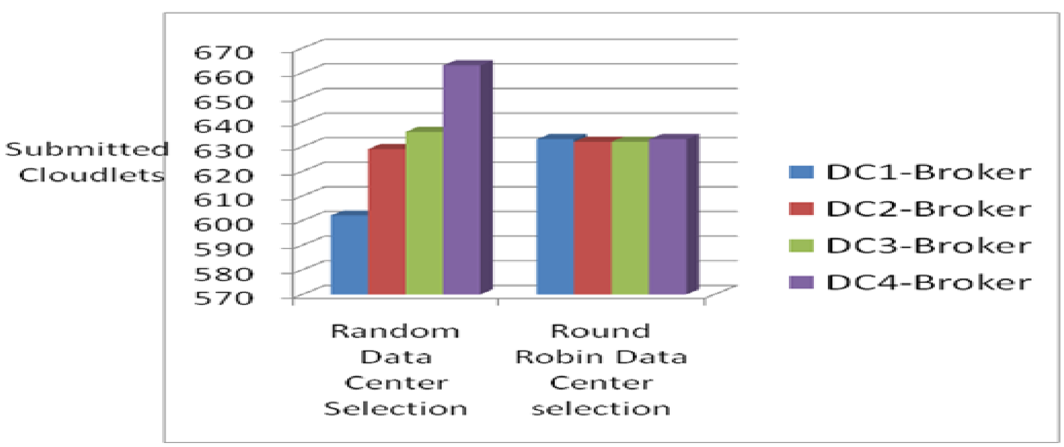

Figure 5: Comparison between number of submitted cloudlets on each of four DC in original and proposed policy

Figure 5 shows the scale for user requests from four user bases in single region for random data center selection and round- robin data center selection policy. As in scenario for three data centers, here in case of four data centers and four user bases in single region, the requests are also distributed almost in equal proportion to data centers when data center is selected according to proposed strategy that uses round robin selection in comparison to random data center selection.

Table 7: Comparison of submitted cloudlets on four dcs according to conventional and proposed algorithm.

	DC1-Broker	DC2-Broker	DC3-Broker	DC4-Broker
Random Data Center Selection	5695	6049	6117	6336
Round Robin Data Center selection	6066	6021	6038	6072

Table 8: also shows the difference in number of cloudlets on each data center after it is selected randomly to that when proposed algorithm is applied within multiple data centers in single region.

	DC1-Broker	DC2-Broker	DC3-Broker	DC4-Broker
Random Data Center Selection	5695	6049	6117	6336
Round Robin Data Center selection	6066	6021	6038	6072

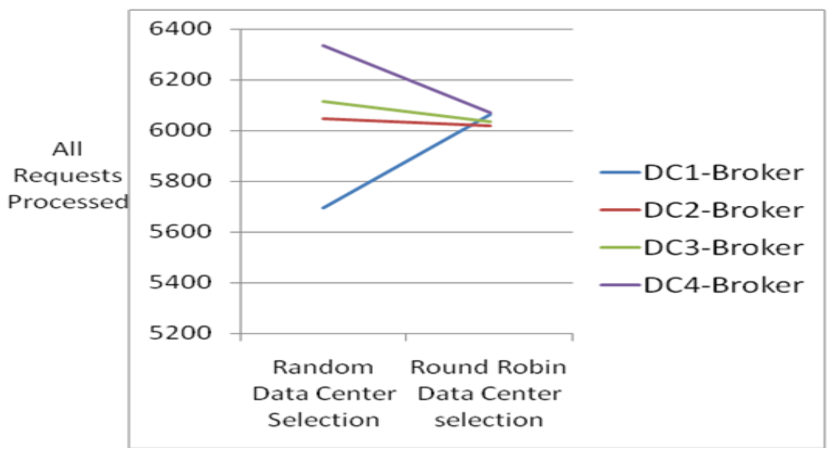

Figure 6: Variation in number of requests processed by four

Number of processed requests strikingly differs when cloudlets from four user bases are almost equally distributed among four data centers in a region and change of up to 7 % is observed than in original service broker policy where data centers are selected randomly.

Thus the proposed algorithm that implements the changes in data center selection policy in the single region offer more resource utilization than the original service broker policy and it also balance the number of requests at all available data centers in a region with negligible change in the cost when compared to random selection of data centers. If requests are processed on all data centers in same region in parallel, it would take nearly equal transfer costs on each data center.

CONCLUSION AND FUTURE WORK

It can be concluded from results of implementation that proposed round robin selection of data centers in service broker policy works efficiently when it comes to resource utilization. It can also be observed that the total cost is same for all data centers when proposed policy using round robin distribution is used in experimentation when compared to conventional data center selection algorithm.

In future, we can implement more effectual policy to select data center with maximum number of resources required for processing of user requests and to process requests based on priorities.

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