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Profit Based Data Center Service Broker Policy for Cloud Resource Provisioning

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ABSTRACT: Hiring of Cloud resources establishes a business association between Provider and Consumer. In cloud, consumer wants to cut down costs and provider wants to earn more profit even on that cost. Here a symmetric arbitration plan by broker realizes the relationship between buyer and provider. In federated cloud computing environment resources are traded as a commodity and cloud users can migrate between providers without a glitch. This will opens up prospects for brokers to penetrate in the market, acting as mediator between users and providers. Cloud Provider and consumer agree on mutually agreed prices. Still, broker is constantly negotiating providers for optimal or fair costs and provisions the provider's resources to consumer to earn more profits. Alike financial market brokers, it matches consumer demand with provider's supply. First this work briefly describes the Cloud Data Center Service brokering and it's Architecture. Then it surveys Data Center Service Broker policies. The main aim of this work is to suggest and propose a Cloud Brokering Framework that supports all the brokering steps along with proposed 'profit optimization' consideration. The framework worked fine as the evaluation shows successful execution of simulation test and the results are promising for the same. The framework reduces the overall cost of running the resources over cloud while complying with Quality of Service (QoS) parameters. This is efficiently done through effective provisioning of DC resources to consumer by broker on the basis of dynamic pricing obtained after negotiating. The framework benefits all parties. The work is simulated using CloudSim based tool. The simulation scenario is carefully generated to show the effectiveness of algorithm. The results are significant in terms of Cost (profit) and Cloudlet execution.

I. INTRODUCTION

The Cloud Computing (CC) [1, 4] is a new computing model which comes from grid computing, distributed and parallel computing, virtualization technology, utility computing and other related technologies. Technically, this computing model is a technological way of managing large numbers of highly virtualized resources in such a way that they resemble a single large resource from management perspective. The access to these resources or delivery is dynamic, convenient and on-demand. CC allows customers to dynamically scale their applications, software platforms, and hardware infrastructures according to negotiated Service Level Agreements (SLAs) [2]. Cloud computing gave rise to many public and private Cloud infrastructures to provide different services that can be classified as: Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) [3, 4]. Now the challenge for the Cloud Providers is to deal with necessary requirement of power-performance trade-off by satisfying high Quality of Service (QoS) and Service Level Agreements (SLA) requirements while maximizing their profits.

The current public cloud computing architectures and infrastructures differs from one another in obtainable QoS, cost, and access interfaces, which raises the challenge of provisioning services through multiple Clouds [2] (also known as multi-Cloud). So to obtain high availability and cost reductions, users are moving towards multiple Clouds for deploying their services and resources. With growing market the number of IaaS providers and users increasing. Now the users and providers have to deal with many market complexities including different pricing schemes, interoperability and other issues. So, here the Cloud Service Broker comes into the picture.

The efficient cloud brokering schemes are essential to change the heterogeneous cloud market into a commodity-like service.

Cloud Service Brokering (CSB) is a cloud business model where services are provided to the consumer through a mediator or third party entity or company called a Broker. The task of mediating between users and service providers depending on users' QoS requirements and deployed service tasks across Clouds is called Data Center Service Brokering.

The Service Brokering Life Cycle for Cloud consists of the following steps (**Fig. 1**) [5]:

Request Formulation: In this service step, functional & non-functional SLA requirements are defined.

Discovery & Monitoring: The candidate Cloud resources are discovered & monitored in this step.

Match Making: Here, SLA requirements are mapped to Cloud resources.

Deployment: Deployment of matched Cloud resources is done.

Execution: Execution & monitoring of the services is carried out then.

Termination: The service execution is terminated.

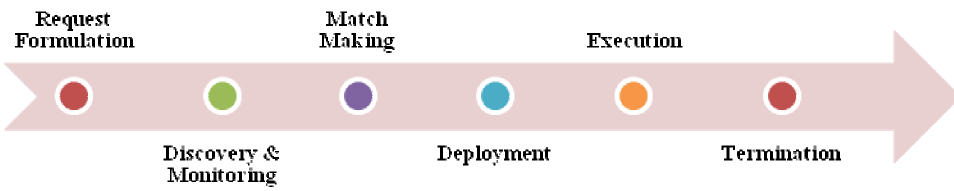

Fig. 1. Service Brokering Life Cycle.

Two of the basic services provided by Cloud Service Brokers are:

(i) The scheduling mechanism that is essentially required for optimal placement of VMs amongst multiple clouds. These mechanisms must take into account requirements such as configuration of VMs and other resources, aggregated service performance, cost, etc. The cloud scheduler has to find a suitable deployment plan for DC allocation to virtual resources and adheres to the other constraints also.

(ii) To offer a uniform interface for management of operations, like deployment, monitoring, and termination of VMs, independent of the underlying technology used by cloud providers.

A service broker decides which Data Center (DC) should provide the service to the requests coming from each user base. The main task of Cloud Service Broker is to find a proper target infrastructure platform for running the requested user applications on Cloud for optimal performance and profit.

Despite the availability of various frameworks for cloud service brokering and policies to choose right infrastructure in literature, the issue of profit is less addressed.

The goal of this work is to find a proper target infrastructure platform (DC) for running the requested user applications on Cloud for optimal performance and profit. For finding proper target DC, a service broker policy is proposed which is based on 'profit earning' approach by provider by reducing the overall cost of running the applications or tasks over cloud. The idea is to consider the dynamic value of profit offered by cloud provider to the broker just before deploying the application.

The section 2 of work discusses and surveys the cloud service brokering, its policies and need. In section 3 the work proposes a cloud brokering framework that supports all the brokering steps as described above along with proposed 'profit optimization' consideration. The simulation results and analysis are presented in section 4, followed by the conclusion and future work in section 5.

II. LITERATURE SURVEY

Cloud Service brokering is a cloud business model where services are provided to the consumer through a mediator or third party entity or company called a Broker. The task of mediating between users and service providers depending on users' QoS requirements and deploys service tasks across Clouds is called Data Center Service Brokering. A service broker decides which DC should provide the service to the requests coming from each user base. The main task of Cloud Service Broker is to find a proper target infrastructure platform for running the requested user applications on Cloud for optimal performance and profit.

The market research company Gartner [6] has defined three opportunities to use a Cloud broker:
-Cloud Service Intermediation: It means Building services like management and security capabilities on top of an existing Cloud platform.
-Cloud Service Aggregation: This means deployment of customer services over multiple Cloud platforms.
-Cloud Service Arbitrage: Brokers offers flexibility and opportunistic service choices and promote competition among Clouds.

The authors [7] provided a survey on monitoring the Cloud. They analyzed motivations behind monitoring systems, their properties, issues arising from such properties and way of tackling them. Current platforms, both commercial and open source are also described. Also open issues, challenges and future directions in the field of Cloud Monitoring are identified.

Sometime DCs resources are oversubscribed, resulting performance differences or SLA violations [8, 9]. To handle the situation applications are scaled across multiple, independent Cloud DCs following market-based trading and negotiation of resources between providers and brokers in InterCloud project [10]. In this approach Cloud DCs and Brokers dynamically negotiate resources between themselves to fulfill needs of elastic applications' and prevent SLA violation. The broker facilitates users by selecting the cloud and managing multi-Cloud services by hiding the technical details of the underlying Cloud infrastructures. Though, there are still many unsettled technical and research challenges regarding the design and use of Cloud brokers. A lot of works are focused on recommendation system realization to assist and advice end users to select the appropriate DC.

The work [2] focused on the architecture and design of the Cloud Coordinator. Cloud Coordinators or agents allows for an increase in performance, reliability, and scalability of elastic applications. The work put together aspects of market making, protocol negotiation, and buying and selling decision on the moment and the price for them [12] to leverage in the InterCloud scenario.

The authors [11] discussed 3 different implementations of Service Broker Algorithms. The Service Broker Algorithms are discussed below:

1. Service Proximity Service Broker Policy: Here by proximity, authors means a quickest path to the DC from a user's site in terms of network latency. Data center service broker just routes user traffic to the closest data center in terms of least transmission latency. In this broker maintains an index list of all Data Centers indexed by their region.

On receiving an Internet request from a user base it queries the Proximity Service Broker for the destination Data Center Controller. The Broker retrieves the region of the sender of the request and queries for the region proximity index list for that region. The index list is maintained in order of lowest network latency first from the given region. The broker then locates the first DC from the proximity list. If more than one data center is located in a region, one is selected randomly. This policy does not consider any processing time and response time by the data center.

2. Best Response Time Service Broker Policy: It uses Performance Optimized routing where the Broker aggressively monitors the performance of all DCs and directs traffic to the DC it estimates to give the best response time to the end user at the time it is queried.

In it an index of all available DCs is maintained. On receiving an Internet request from a user base it queries the Service Broker for the destination Data Center Controller. Then this Service Broker identifies the closest (in terms of network latency) DC using the Service Proximity Service Broker algorithm. Then the Best Response Time Service Broker scans through the list of all DCs and estimates the current response time at each DC by referring the last recorded processing time. The network delay also includes delay of the steps above.

3. Dynamic Service Broker Policy: This policy is not fully implemented.

All the algorithms above are initial versions of algorithms and having lot of improvement scope in perspective of Service Broker and Provider. Also, the issue of profit of Cloud Broker is ignored. However, the QoS and other legal issues are ultimately the issues of Cloud Provider also; the issue of Broker's profit is less addressed. Algorithms are needed to address broker's profit while fulfilling the QoS needs.

The authors [13] explored the variety in a novel cloud brokering approach that optimizes placement of VMs across different multiple clouds and also abstracts the management of infrastructure components in these clouds. The feasibility check is done in a high throughput computing cluster case study. In [14] the performance comparison of three service broker policies, namely, Round Robin (RR), Equally Spread Current Execution (ESCE), and Throttled Load Balancing (TLB) is done. Cloud Sim and its extensions are used for simulation. The results reveal that the RR under proximity service broker policy is most cost-effective due to less migration overheads.

III. PROPOSED ARCHITECTURAL FRAMEWORK FOR CLOUD DATA CENTER SERVICE BROKERING

In this work a generic framework (architecture) for Cloud Data Center Service Brokering is proposed. The framework supports all the brokering steps along with proposed 'profit optimization' based on dynamic pricing consideration. Here, in Figure 2 the primary steps of a cloud service brokering are shown. The figure shows the designated place where Dynamic Pricing is applied. The actual dynamic pricing is applied with deployment policy.

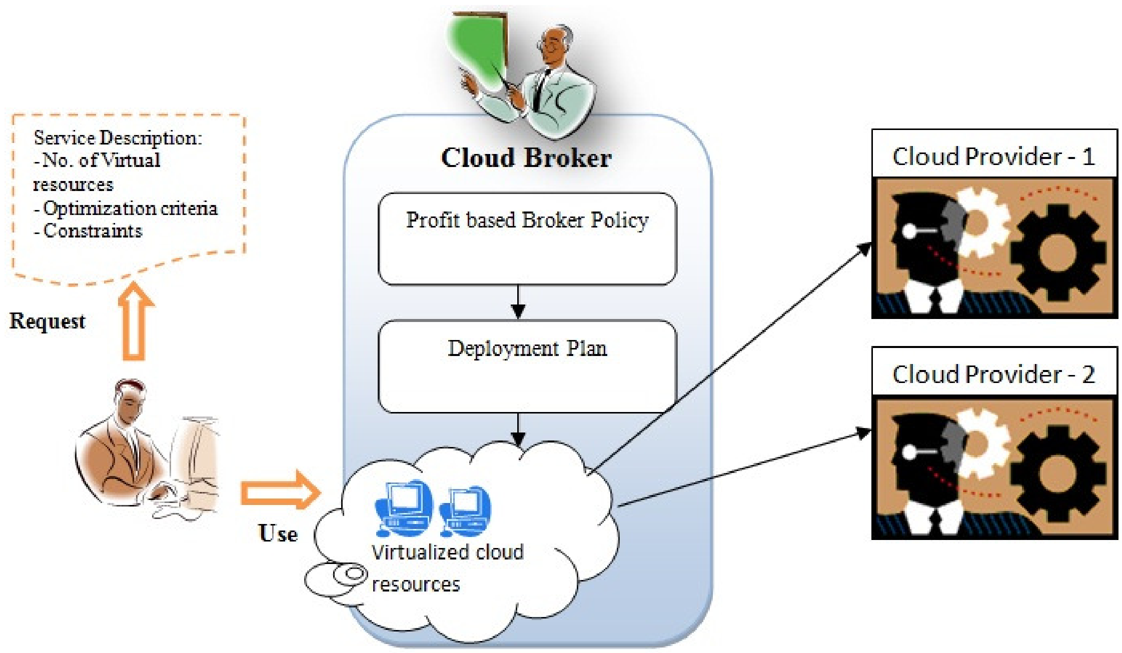

Fig. 2. High Level Architecture for Proposed Cloud Data Center Service Brokering with Dynamic Pricing.

At the first step broker formulates the functional & non-functional SLA requirements by consumer. After formulation, it discovers and monitors the candidate cloud resources at provider's end. Next, it maps SLA requirements of consumers to cloud resources.

Finally it allocates the Provider's resources for serving client requests and the step also known as deployment. The deployment can be done on various bases like Service Proximity, Random, Best Response time, Round Robin etc. Here, the deployment is based on dynamic pricing scheme. The Execution, Monitoring and Termination of the services are carried out then.

After mapping SLA requirements the broker monitors one more factor, i.e. pricing offered by provider. The provider with low costs is preferred to increase the profits by running more tasks. Although there are several factors that may influence cost but there may be some hours in a day when load on Cloud resources is less and providers may decrease their resource cost. Here, a variable 'profit' is defined for dynamic price consideration and deployment is done on the cloud with lesser cost.

IV. SIMULATION RESULTS AND ANALYSIS

The tool CloudSim [2, 15, 16], is used for simulation purpose of proposed Data Center Broker policy. The extension developed is then integrated in tool. CloudSim uses Sun's Java version 1.7.0 as platform and Apache Ant [17] as compilation tool. CloudSim provides a simple and extensible simulation framework that facilitates seamless simulation, modelling and experimentation of emerging cloud computing services.

A. Simulation Scenario

The simulation scenario is created with utmost care so that the each host at each DC will get chance of serving VMs. The VM migrations for consolidation are allowed to optimize the power at DC. Only one customer is created having choice of two DCs. VMs are created at DCs as per price optimization and customer submits the cloudlets (tasks) to VMs at some fixed rate.

Table 1: Simulation Parameters.

Datacenter	DC 1	2 Hosts each with two processing elements (PEs) & processing capacity equal to 2400MIPS per PE, Storage capacity 12 TB. Total RAM 8 GB,
	DC 2	1 Hosts each with 4 PEs with capacity 2400MIPS per PE. Storage capacity 11 TB. RAM 4 GB
	Architecture	x86
	Operating System	Linux
	Virtual Machine	Xen
	VM Migrations	Enabled
Hosts	VM Allocation policy	Single Threshold
	VM Scheduler	Time Shared
	Bandwidth	10 Mbps
Virtual Machine	MIPS	1000
	PE	1
	RAM	512 MB
	Storage	10, 000 MB
	Bandwidth	100 Kbps
	Cloudlet Scheduler	Dynamic Workload
	V M M (Hypervisor)	Xen
Cloudlet / Task	Number of Cloudlets	50 in 1 minute
	File size	500MB
	Output size	500 MB
	PE	1
DC Broker Policy		Round Robin and Profit Based

IaaS Provider Profile: For experimentation purpose, two DCs are characterized at different locations owned by an IaaS provider, with two hosts at first DC and one host at second DC. Other simulation parameters are shown in Table 1.

Customer Profile: Simulation is configured with single customer. Customer is having 13 VMs to execute. Each requires 1 PE and 512MB RAM to execute. Other common simulation parameters are mentioned in Table 1.

The same experiment runs twice with only change in DC Broker Policy. It is possible to evaluate number of parameters using the logs obtained after experiment execution. Here, the evaluation is done on various key performance parameters. The results are then analyzed and compared with existing Data Center Policy. The successful execution of experiments validated the proposed framework also.

B. Result Evaluation on basis of Key Performance Parameters

For discussing results in detail, we discuss key performance parameters along with results. The primary parameters considered for this work are Cost, Number of Cloudlets executed.

Cost Analysis: Here cost analysis is done to show the profit earned (in $) by DC provider and thus Broker. The overall cost a reduction is obtained by applying Profit based policy. The Figure 3 showing graph of cost incurred by DC and profit earned using proposed work and existing Round Robin policy.

Number of Cloudlets Executed: Cloudlets are also known as tasks. More the number of tasks scheduled and executed more will be the benefit to customer. The total number of tasks executed on VMs at each DC is shown in Figure 4.

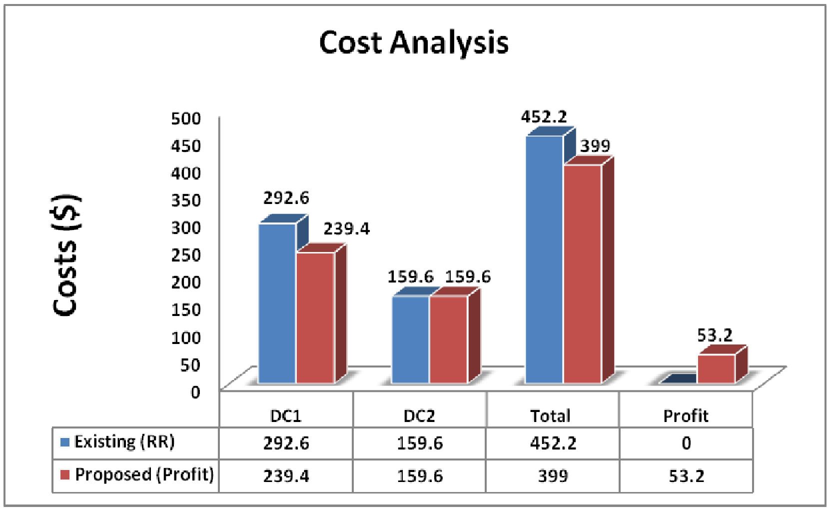

Fig. 3. Cost Comparisons for Both Policies.

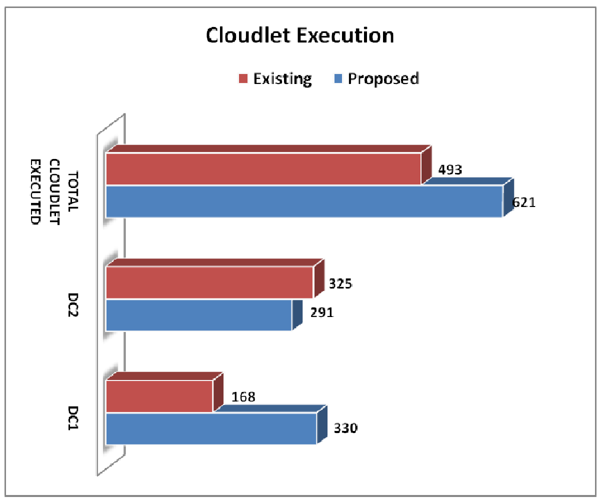

Fig. 4. Total Number of Cloudlets Executed at each DC using Both Policies.

V. CONCLUSION AND FUTURE WORK

Although CPs offers usual pricing to consumers, still they offer negotiable prices for brokers at downtime. Cloud brokers modify their deployment policies and may follow other techniques to enhance their profits for offered resources. In turn, this will open lot of opportunities for brokers to increase the profits and establish themselves in the market.

The featured aims of this work include: Surveying the Data Center Service Brokering frameworks and policies; and Proposing and implementing a cloud brokering framework that supports all the brokering life cycle steps along with 'profit optimization' consideration. So for the same a service broker policy based on dynamic pricing of DC resources is proposed. It finds a proper target infrastructure platform (DC) for running the requested user applications on Cloud for optimal performance and profit. The efficacy of proposed framework (solution) on basis of two parameters is demonstrated by comparing it with Round-Robin policy, using CloudSim tool. The experimental results show considerable increase in user tasks (cloudlets) execution while minimizing cost. The work ultimately benefits the consumers and brokers both. As a future scope of work, the framework can be extended with more effective policies at each level of lifecycle. The policies can be applied with different objectives like improving energy and power optimization. Furthermore the proposed framework and policy can be tested for more scenarios and more QoS parameters. Also the work can be extended for evaluation of Service Level Agreements (SLAs).

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