Role of Cloud Service Broker in Qualifying Teaching Skills

Ravi Khurana, Amandeep Singh

Abstract: ***In Cloud computing technology, Cloud Service Broker (CSB) is an entity that works as intermediator between Cloud Service Provider (CSP) and user. CSP provides Cloud services like SaaS (Software as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service). SaaS is "PAY-AS-YOU-GO" model. The user has to pay for the software service as per usage. PaaS gives environment for development as a service. User can develop his/her own program using third party equipment. IaaS provides requisite infrastructure to the user for carrying out the work. Instead of purchasing costly network devices including servers, software, datacenter space, the user just has to pay for these services as per usage. CSB ensures the quality of Cloud services delivered to user. Unfortunately, in most of the cases CSPs don't adhere to quality of service. In several events, the availability of Cloud service is not up to the mark, reliability is traded off and other quality factors are also compromised. Cloud service broker deals with above quality issues. In this research paper, we will discuss involvement of CSB in improving the teaching skills of the teacher. Cloud computing assists teachers in getting access of thousands of educational sites. Few of them are, National Institute of Technical Teachers Training and Research(NITTTR), Scilab, Virtual Labs, National Programme on Technology Enhanced Learning (NPTEL), DURASPACE etc. By incorporating, material from these websites, teachers can improve the quality of their teaching learning process. These sites are maintained by CSPs, whose quality can be ensured by CSB. CSB assures the availability, reliability and response time of these CSPs. By involving CSB in Cloud services, teachers could get hassle free services from service providers.***

Index Terms: CSB, CSP, IaaS, PaaS and SaaS.

I. INTRODUCTION

Computing technologies have evolved drastically from last couple of years. Different technologies like Parallel, Cluster and Grid computing are contributing so much in the Computing world. Nowadays, new computing technology has evolved, which completely changes the way the computing had done before. This new technology is Cloud computing. Cloud computing is an emerging computing paradigm of IT world. It is an Internet-based pay-as-you-usemodelin which resources, software and hardware are shared on-demand. Cloud computing is basically a fusion of latest network technologies like grid computing and traditional computing technologies.

It has different forms viz. Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS).Cloud user can get Cloud services from Cloud service provider. There are certain issues related with service delivery of CSPs. These issues are discussed in previous section. Cloud Service Broker (CSB) assists to achieve quality of service. User submits his/her request to CSB and it inturn contacts CSP to get those services for user. The deliveries of services are accordance with Service Level Agreement (SLA). SLA is a formal document signed by both the parties (user and CSP). In this document, all the terms and conditions are written; quality constraints on CSP are objectively mentioned. In the following section, we will give the formal definition of CSB and will mention other related issues.

II. CLOUD SERVICE BROKER

Cloud Service Broker (CSB) [1] is an intermediary between Cloud Consumer and Cloud service provider. It forms a layer of abstraction between consumer and provider so that consumers observe a solitary view of all offered services of CSP. So, CSB provides brokerage Services, consolidation and value addition services to its users.

III. DEFINITIONS

According to National Institute of Standards and Technology (NIST) [2]

CSB is observed as "an entity that manages the use, performance, and delivery of Cloudservicesand negotiates relationships between Cloud providers and Cloud consumers."

According to Gartner [3]

"Cloud consumers need brokerages to unlock the potential of Cloud services."

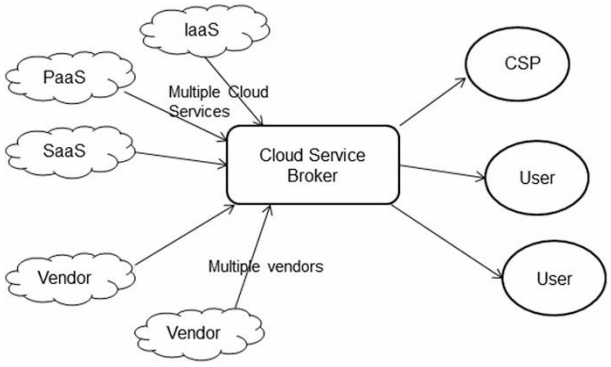

Figure 1: Structure of Cloud Service Broker [4]

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IV. CHARACTERISTICS

- Acts as intermediary between the user and the CSP.
- Single interface for getting multiple services from different Clouds.
- Negotiates and executes service level agreement between user and providers.
- It does not own any services; it just provides services as offered by provider.
- It does not direct actions of user and provider.
- Handles relationship between the user and the provider.
- Provides consolidation and value added services to users.

V. CATEGORIZATION[2]

There are different ways of categorizing CSB based on service provided and implementation.

- Service Aggregation: CSB consolidates and coordinates various administrations into atleast one new administration. The broker will give information mix and guarantee the safe information flow between Cloud Purchaser and various Cloud Suppliers.

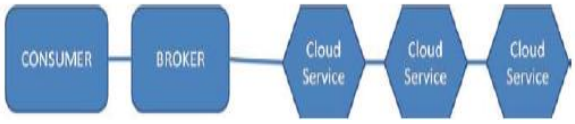


Figure 2: Service Aggregation [5]

- Service Intermediation: CSB upgrades a given administration by enhancing some particular capacity and gives the esteem added administration to Cloud customers. Cases incorporate identity and access management, execution announcing, and security upgrades.

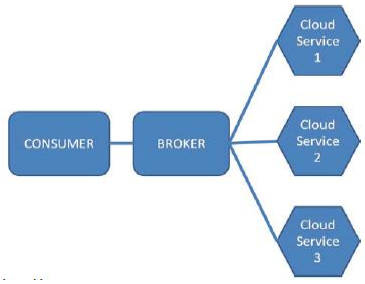


Figure 3: Service Intermediation [5]

- Service Arbitrage: It is like administration collection, with the distinction that the administrations being aggregatedare not settled. Benefit arbitrage permits adaptable and shrewd decisions for the service broker. For instance, the Cloud benefit representative can utilize a credit-scoring administration and select the best score from different scoring offices.

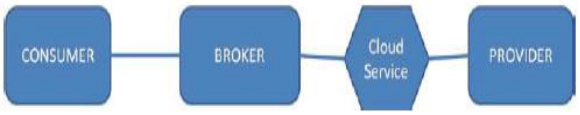


Figure 4: Service Arbitrage [5]

VI. QUALITY METRICS VII.

Selection of Cloud services is executed on the basis of quality metrics. These quality metrics are integral part of Service level agreement. Threshold values of these metrics are settled before starting off any Cloud services between user and Cloud service providers. In this section, we will discuss quality metrics which derive the Cloud services procedure.

a) Availability [6][7]: It is the time during which Cloud services are available to users. It can be measured as:

$$\alpha = \frac{t}{t_s}$$

Where $0 \leq \alpha \leq 1$, t and t_s denote uptime and total time period of Cloud service. As value of α approaches to 1, availability increases.

b) Reliability [7]: It calculates the degree of correctness such that Cloud services are free from hardware and software errors. It can be defined as

$$\rho = 1 - \frac{n}{n_s}$$

Where $0 \leq \rho \leq 1$ represents reliability. n and n_s represent failed and total number of operations.

As value of ρ approaches to 1, reliability increases. There are some measures through which reliability can be calculated like Mean time to failure, Mean time between failure, Mean time to recover, Mean time to discovery and Mean time to exploit.

c) Scalability [6]: Despite of change in the volume of Cloud services, if Cloud system still work according to the pre-designated order. It can be measured through Coverage of Scalability (COS) metric.

$$COS = \left(\sum_{i=1}^{k} \frac{(amountofallocatedresourcesofistrequest)}{(totalamountofrequestedresourcesofistrequest)}\right)/k$$

Where k is the number of requests.

d) Usability [7]: It measures the degree efficiency and easiness to use the Cloud services.

e) Reusability [6]: It measures the common characteristics of services. Following metrics can be used to measure it:

- Functional Commonality (FC): It calculates mean commonality of functional features.

$$FC = \left(\sum_{i=1}^{n} \frac{(numberofrequirementsapplyingithfunctionalfeature)}{(totalnumberofrequirementsanalyzedinthedomain)}\right)/n$$

n represents functional features count.

- Non-Functional Commonality (NFC): It measures the average non-functional featurescommonality.

$$NFC = \left(\sum_{i=1}^{m} \frac{(numberofrequirementsapplyingithnon-functionalfeature)}{(totalnumberofrequirementsanalyzedinthedomain)}\right)/m$$

m represents non-functional features count.

- Coverage of variability (CV): It calculates number of variation points covered in the Cloud service.

$$CV = \frac{(numberofvariationpointscoverinthecloudservice)}{(numberofvariationpointsinthedomain)}$$

$$Reusability = W_1 .FC + W_2 .NFC + W_3.CV$$

Where W_1, W_2 and W_3 are weights assigned to the above metrics. Note that $W_1 + W_2 + W_3 = 1$. Values for each metric are decided according to their due importance. The range of reusability varies from 0 to 1. The higher value indicates more reusability.

f) Elasticity [8][9]: It measures how any system can balance workload alteration by provisioning and deprovisioning resources.

$$Elasticity = \frac{timetakentoexpandorcontracttheservicecapacity}{maximumcapacityoftheservice}$$

g) Adaptability [8]: It is the time taken to adaptCloud service to next level by the user.

h) Security [8]: It calculates the level of security of Cloud services. For any organization, this is the major concern. Organization may incur huge losses, if its data is not kept in a secure fashion. To measure it, main factors are:

- Confidentiality: It measures the secrecy of data stored in the Cloud from any unauthorized access. In order to calculate this metric, following equation is used.

Confidentiality=

$$\frac{totalnumberofaccesstoservice - numberofunauthorizedaccesstoservice}{totalnumberofaccesstoservice}$$

- Data Integrity: It measures that data preserved in the Cloud could only be modified by an authorized user only. Data integrity maintains accuracy and consistency of data. In order to calculate this metric, following equation is used.

$$Data\ Integrity = \frac{percentageofaccuracyaftermodification}{percentageofaccuracybeforemodificaiton}$$

i) Cost [8]: Various kind of costs involved while the deployment of Cloud services, they mainly include hardware and infrastructure setup. Mainly two types of cost involved:

- On demand cost: It includes the cost of hiring VMs, data cost and storage cost

VM Cost = (VM cost per hour) × (Number of VMs uptime in hours)

Data Cost = (data in × data in rate) + (data out × data out rate)

Storage cost = storage rate × storage amount

- Reservation cost: It includes onetime fee and usage fee

Reservation cost = usage fee + onetime fee

j) Efficiency [6]: Cloud services efficiency can be measured through following metrics:

- Resource utilization(RU) = $\frac{amountofallocatedresources}{amountofpredefinedresources}$
- Time Behaviour(TB)= $\frac{executiontime\ (totalserviceinvocationtime - waitingtime)}{totalserviceinvocationtime}$

Efficiency = W_{RU} .RU + W_{TB} . TB, where W_{RU} and W_{TB} are weights of respective metrics, Note that W_{RU} + W_{TB} = 1. Value of efficiency varies from 0 to 1.

k) Throughput [10]: Number of jobs completed in a unit time is the throughput of the Cloud services.

$$Throughput = \frac{n}{Te(n,m) + To}$$

$T_e(m,n)$ is execution time of running n tasks on m machines and T_o is overhead delay time.

l) Service Response Time [11]: It measures the time delay between sending a request and getting a response. If SRT_i is a service response time of i^{th} user request.

$$SRT_i = T_{request} - T_{fulfilled}$$

Where $T_{request}$is a time when request is made and $T_{fulfilled}$ is a time when request is completed.

m) Easiness [8]: It calculates the user friendly feature of Cloud services.

$$Easiness = \frac{totalnumberofservicesusedbythecustomer}{totalnumberofservicesofferedbytheprovider}$$

n) Reputation [11]: It is defined as trust of CSP in the service community. It can be measured by average rank of CSP, which is assigned on the basis of users' feedback about the services. Reputation of the i^{th}CSP is calculated as follows:

$$Repu_i = \frac{\sum_j r_j^i}{\sum j}$$

Where r_j^i is a rank of i^{th} CSP assigned by j^{th}user.

o) Accuracy [11]**:** It is defined as number of times a CSP fails to fulfil the request of the user. Let $freq_{ij}$ is number of times CSP i fails to fulfil request of j^{th} user in time interval t. Then average-$fail_i$, which is a average failure of CSP i is defined as:

average-$fail_i$ = $\frac{\sum_j freq_{ij}}{n}$, where n is the total number of users.

p) Transparency [11]**:** It is defined as degree to which a user is affected by alteration in Cloud services.

$$Transp = \frac{1}{n}\sum_i \frac{T_i}{n'}$$

Where n is total number of Cloud users, n′ is total number of such occurrences.

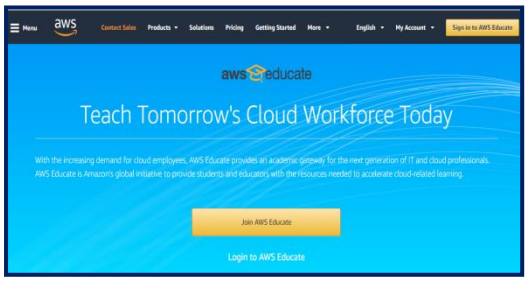
T_i is the total time for which the user 'i' is affected.

VIII. EDUCATION RELATED CSPS

In this section, we will list out some educational websites which assist teachers in all sectors in getting quality teaching material. By incorporating, ideas and concepts from these sites, teachers can qualify their teaching skills. These websites are designed and maintained by Cloud service providers. Cloud service broker helps the user in getting services from CSPs in an easy and efficient manner.CSB ensures the quality of Cloud services delivered to user. Unfortunately, in most of the cases CSPs don't adhere to quality of service. In several events, the availability of Cloud service is not up to the mark, reliability is traded offand other quality factors are also compromised. Cloud service broker deals with above quality issues. Before start of any Cloud services, Service Level Agreement (SLA) document has been established by CSB which is duly signed by both the Cloud parties that is both by CSP and user. SLA contains all the terms and conditions of service delivery. Quality metrics discussed above are the part of this document. Reliability, Availability, Throughput, Cost and other quality factors are agreed upon before start of any service.

- **AWS (Amazon Web Services) Educate** [12]: AWS Educate is a concede program for teachers, scholastic analysts and students. The program enlarges Amazon's endeavors to expand consciousness of its open cloud benefits in the educational community. Qualified students can procure a progression of Amazon Web Services (AWS) confirmations, increasing vital proficiencies as they enter the data innovation (IT) workforce.

Figure 5: AWS Educate Interface



- **Google for Education** [13]:Google for Education is an administration from Google that gives freely adjustable variants of a few Google items utilizing a space name gave by the client. It includes applications similar to well-known web applications like Gmail, Google Calendar, Hangouts, Docs, Drive,
- Slides, Sheets, Groups, Plays, News, and Vault.

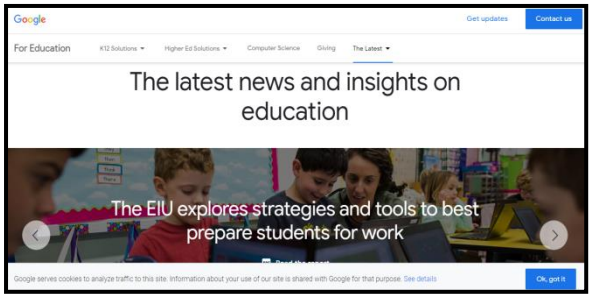


Figure 6: Google for Education Interface

- **National Institute of Technical Teachers Training and Research(NITTTR)** [14]: It is the technical teachers training and research institute established by Ministry of Human Resource and Development. It provides quality technical education to its users.

Figure 7: NITTTR GUI

- **Scilab**[15]: It is free open source numerical computation package. It has a rich characteristics of numerically oriented programming languages. It can be employed in different areas like statistical analysis, image enhancement, signal processing, numerical optimization and many more. It is the alternative of two well-known open sources packages MATLAB and GNU Octave.

Figure 8: Scilab Interface

- **Virtual Labs** [16]: They are the venture initiated by the MHRD, India under the mission on Education through ICT. The venture intends to give distant access to science laboratories. Students from different streams can be benefitted from this Learning Management System. They can work on different instruments for getting the hang of, including extra web-assets, video-addresses, vivified shows and self-assessment. Exorbitant

- hardware and assets that are generally accessible to limited number of users due to time and land separations are now shared among large community.

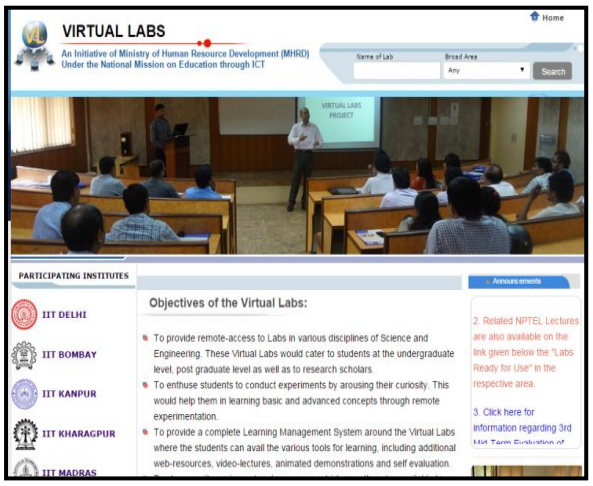


Figure 9: Virtual Labs Interface

- **National Programme on Technology Enhanced Learning (NPTEL)** [17]: It is the joint venture of 7 IITs and Indian Institute of Science (IISc) for framing course material in the field of science and designing. Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee based IITs are included in NPTEL. Material available on NPTEL is accordance with All India Council for Technical Education (AICTE) norms and the syllabi of leading universities in India.

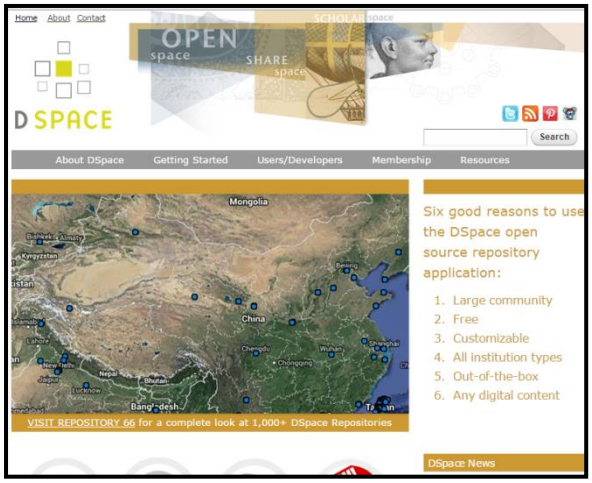


Figure 10: NPTEL GUI

- **DURASPACE**[18]: It is the repository, which is open for users and contain various research material that are accessible through Cloud. DuraCloud makes utilization of business Cloud framework to furnish associations with instruments for filing content over different cloud providers to guarantee that reports, symbolism and recordings are constantly backed up. Itprovides services for information access, change, digital preservation, and sharing. Different institutions throughout the Global use DuraCloud to save their digital assets, few of them are Columbia University, University of Michigan, MIT, State of North Carolina Library, Northwestern Universityetc.

Figure 11: DuraSpace Interface

IX.DISCUSSION

It is not easy for an invoice user to get Cloud services because there are number of CSPs available dissipating similar Cloud services to users. Every CSP claims that it delivers Cloud service according to quality standards and it follows Service Level Agreement terms and conditions. But, unfortunately this is not a situation, service quality breaches are there. Now to deal with such situations, Cloud service broker is an appropriate entity. As discussed, it is an intermediator between Cloud service providers and user. It enforces quality standards and ensures that user would get Cloud services as expected by him/her. In this research paper, teachers from Educational institutions are the users and they deal with Cloud service providers in the field of Education. We define various quality standards together with their equations like Availability, Reliability, Scalability, Usability, Reusability, Elasticity, Adaptability, Security, Cost, Efficiency, Throughput, Service Response Time, Easiness, Reputation, Accuracy and Transparency. By incorporating these quality standards, users can get quality services from Cloud service providers. Cloud service broker assist in enforcing and implementing these quality issues.

X.CONCLUSION

Cloud computing is an Internet based pay per use technology of 21st century. It has totally change the way computing was done before. CSP is an entity which provides Cloud computing services to users. It is not easy for a user to interact with CSPs. So, to deal with such situation, another entity called Cloud service broker was introduced, which works for both the Cloud parties that is for both user and Cloud service providers. User submits his/her quality requirements to CSB and CSPs publish their Cloud offering with CSB. CSB selects appropriate CSP for user according to his/her needs. In the beginning of the

research paper, we introduced CSB together with its characteristics and categorization. After that we defined quality metrics together with their equations. These metrics assist user in getting quality services from CSPs. Some major education related CSPs were also listed. These CSPs assist teachers in qualifying their teaching skills. By utilizing services of Cloud service brokers, teachers can get quality content from Cloud service providers which help their students in achieving higher objectives.

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