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SLA Aware Cost based Service Ranking in Cloud Computing

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ABSTRACT

Cloud Computing is very powerful tool for different service providers to implement their services. Various companies are working to possible exploration to find the best cloud to implement their services. Not only finding the best cloud but detection and analyzing of best service is also a high trend. Therefore this works examines ranking of the services with keeping cost as important parameters. We explore the latency of the user's requests and finally schedule the requests with best possible combinations. Therefore in this work we evaluate the cost of the service as parameter to find the best available service among equals taking into other parameters like processing time, latency, suitability, reliability.

Keywords: Cloud Computing, QoS, SLA, Ranking,Services

1. INTRODUCTION

The field attracting most of organizations is Cloud Computing (CC) and has created a buzz in the world by expanding its services in no time. Companies like Google, Microsoft are the main providers of services nowadays. Every organization is trying to expand itself and get benefits of emerging Cloud computing [1]. Different service models of Cloud Computing offers different services. Infrastructure as a Service provides services like storage, Ram etc. Platform as a service provides a platform such as operating systems to user for deployment[8]. Software as a service model provides user with software on a single machine instead of installing on every user machine [2]. Nowadays, many service providers are there and it is difficult to choose the best available one. Due to lack of standardization of computing services it makes it more difficult to choose, as different service providers uses different formats, protocols, technologies [7]. These factors make it difficult to migrate from one service to another. There are various examples of services in cloud computing which provide the efficient way to the best possible service to the users. The different ways to evaluate a cloud provider can be based on performance, price, services, security.

1.1 SLA

Service level agreement refers to a contract that is between a customer and a provider. This is a legal contract, which contains type of service to be delivered, time, price, performance, warranties, termination and penalty to be paid if there is a violation in the SLA [3]. Every service level agreement flows through a queue of steps called SLA life cycle. Life cycle of service level agreement has following stages:

Contract Definition

In the initial phase of SLA ,provider of cloud service defines a list of services to be offered and equivalent SLAs using traditional templates. The offerings of provider are presented in a catalog and individuals can customize SLAs by customization of the base templates.

Publication and Discovery

Different service providers adopt the method of publication media to advertise their services so that the customer can find the provider and locate in order to avail the services via catalog searching. Customers can shortlist few services according to basis of the provider fulfilling their requirement [16].

Negotiation

When customer has found out the provider who provides services to host applications which are required by customer and the terms and conditions written in the service level agreement are commonly agreed upon before signing the document of agreement. The services which are the standard application of provider generally has automated phase.There is a need to consider application's conduct while considering performance and scalability before signing the SLA. In the last step of negotiation phase, the Service Level Agreement is mutually signed by provider and the customer. This phase uses the WS-negotiation specification[16].

Operationalization

Service level agreement operation consists of monitoring, accounting and enforcement. Parameter values are measured and metrics are calculated according to what is defined in service level agreement is done in Service level agreement monitoring phase and deviations are determined. Concerned parties are informed when deviations are identified. Accounting of service level agreement is concerned with archiving the service level agreement for compliance. In accounting, actual performance as compared to that was guaranteed in Service Level agreement for application is reported. If there is any SLA violation then information regarding penalities to be paid should be mentioned except breaches in frequency and duration. Appropriate actions should be taken when SLA violation is detected at run time monitoring. Policies that are different can be expressed using a subset of Common Information Model (CIM) [4][16].

De-commissioning

All activities are terminated which perform under a particular Service level agreement while relationship ends which is hosted in between service provider and consumer. Terms and conditions for termination of contract are specified in SLA and conditions under which relation will be terminated by provider and consumer be ended legally is specified [16].

1.2 Ranking

Ranking can be defined as categorizing and assigning weight to some choices. Ranking is a new concept in Cloud Computing field which attracts the attention of users. Ranking of services in cloud computing is a different concept from other fields as in this field is due to existing infrastructure. The infrastructure is connected through Internet to different components that are having a different connection speeds [6]. This leads to the different level of QoS received by users for same service. Therefore a framework is required to rank services such that different users can get service according to the QoS. Ranking needs to done in order to select the best possible service which is effective and efficient. Quality of service parameters are used by companies in order to rank the different services, and customer can select the service by comparing the rank of the different services. Also, it is needed to consider following items for ranking of selected services [6].

1) Which attributes should be selected for ranking?
2) How the value of each attributes is determined?
3) Which algorithm should be applied for ranking?
4) How to get the received result? How to present them to the user?

The different approaches used for ranking of cloud services are described below:

1.2.1 Service Mapper Approach

Service Mapper uses the technique Singular Value Decomposition, which is used for ranking of cloud services in a statistical way. This approach uses a mapping technique to map services through a service mapper which is known as a Cloud service provider mapper for ranking services. The layers of mapper are divided into three as shown in the Figure 1.1. The layer at the lowest level is known as information gathering layer whose main responsibility is to collect information from a service provider and attributes represented by different providers. This layer gets requirement from the user and finds out the services which are capable of satisfying them. Through information collected by this layer, services are passed to the layer above it and the layer is known as applied SVD.

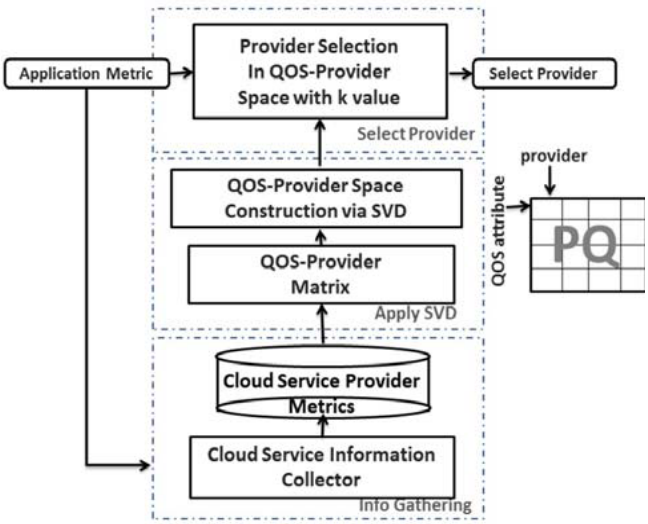

Figure 1.1 Architecture of Service Mapper Approach[11]

The second layer is responsible for making a matrix, Provider Quality. In the matrix rows are filled with the provider's information. The columns are filled with the qualitative attributes of providers. This layer applies Singular Value Decomposition technique on the matrix. After this, three singular values are extracted from the matrix and this is sent to the third layer. This layer receives singular values and qualitative values of user requirements. After this it is capable of selecting the best service among the services selected by first layer. After this, the application of user is mapped to the selected service. Advantage of Service Mapper approach is the appliance of Singular Value Decomposition. This technique helps in bringing together the service providers according to the user requirements. It makes really easy to select the optimal service. Though its has some limitation too. In the last phase, only one service is selected according to the requirements of the user. On the other hand, the ranking of all services is a better option. This provides the user with knowledge about priority of the services and selects a service more knowingly. But this technique doesn't take into consideration all qualitative attributes of a service and comparison of services is based on few attributes only. SVD technique is time consuming for large matrixes and therefore is sometimes infeasible. Therefore it may not give correct results. Also this technique can be used only when the cloud service providers are few and measures for comparison are limited.[11]

1.2.2 SRS Approach

The service ranking system is used in SRS approach. Two states of cloud service ranking are taken into consideration in this approach that is the static state and the dynamic state. Cloud providers are ranked in a static state without considering the needs of the users. The services are searched and ranked according to the requirements of the user in the dynamic state. For service comparison and ranking seven key attributes are used. These attributes are used for comparison. The main attributes are availability, throughput, cost, response time, security, reliability and user feedback. The phases of dynamic ranking of cloud services are as follows: The very first phase involves presenting the key attributes to the user. Then the user is made to specify the attributes. The next phase involves the selection of services that give the information about user requirements and for measuring the qualitative values of attributes by service monitoring. The third phase involves the user is made to enter the attributes in weight format. The weight of attributes entered should be equal to one. The last phase services are ranked and are represented with the help of formulas according to the weights entered by the user. The formula is used to multiply the weights with the value of each attribute. After this the numbers which are calculated are sorted and are presented in the form of ranking result. The other state that is the static state includes only the second and the fourth phases which are performed. The second phase in this involves the qualitative value of all services and are measured without taking into consideration the requirements of the user. But, it is good to have a component for searching all available services and maintaining the information based on the approach's assumption, before performing the ranking process. The main advantage of this approach is that the attributes which are important are used in the form of weights. The ranking of static and dynamic states is possible through this approach. The ranking of all services is obtained with the execution of this technique. The limitation of this algorithm is that this approach is not suitable for finding the rank of dynamic state as the comparison is performed on the basis of seven attributes. Also, forcing the user to enter the weights is a major drawback of this approach as weight should not increase the total of 1, in case this condition is not fulfilled, then the user will not be able to obtain the correct results [11].

1.2.3 SLA Matching Approach

The SLA matching approach tends to define the process of identifying the service provided by matching against the parameters written in the Service Level Agreement. There are four steps involved in this approach: The first one is to define the cloud model RDF file which is known as 'Model C' which contains resources of cloud, properties, resource quantity, etc. and a requirement model called 'ModelR' that contains application's required resources and its quantity. The next step is to convert the models into the graphs. These RDF models are converted to graphs with the help of Jena APIs. The next step is to find Pairwise Connectivity Graph (PCG) and Induced Propagation Graph is calculated using this PCG equation.The last step is to find the initial mapping between two models using RDF Schema. For initial mapping nodes of two models are compared as if they are of a subclass, super class or equivalence in the RDF Schema file [11].

1.2.4 Aggregation Approach

In the aggregation approach benchmarks are used. User feedback is applied for ranking of services. The aggregation approach gets information of two types from the user and benchmark and aggregates them for the purpose of comparing and ranking the services. Objective assessment is the information received from the benchmark and subjective assessment is the other information. The architecture used for ranking of services is as depicted in the Figure 1.2.

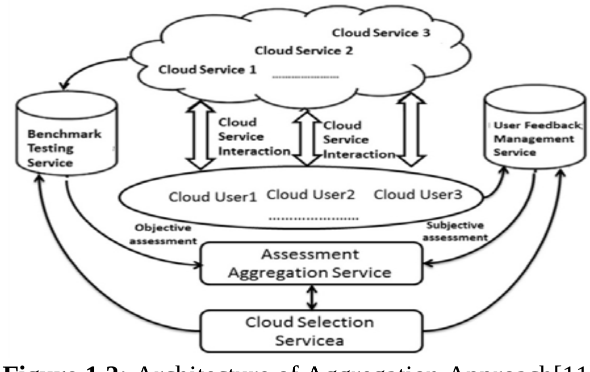

Figure 1.2: Architecture of Aggregation Approach[11]

The lower part of the architecture is known as cloud selection service. Some services are selected which gives information about the requirements of user without taking into account the qualitative values. Then this information is sent to the other two sections that is the benchmark testing service and user feedback management service. Analysis and test services are performed in the benchmark testing service section. After that qualitative values are obtained via benchmarks. User requirements are received in the User feedback management service and it also try for producing a series of fuzzy numbers for qualitative measures by applying fuzzy method. User feedback and requirements are given in the language of the user. This information is transformed into scientific and comparable data only with the help of fuzzy method. The information on these sections is sent to the assessment aggregation section which selects services required by user by receiving performed assessments. Usage of benchmarks and feedback from users is the strong point of this approach and straightforward approach for performing ranking. The weakness of aggregation approach is that comparison and ranking of services is done with the limited qualitative measures [11].

1.2.5 CloudRank Approach

CloudRank approach ranking of services is based on prediction of qualitative values. This approach suggests that the qualitative value of services should be measured before service comparison. In traditional methods which are based on components, calling the components was applied for measuring the values. But the process of calling is not possible in the cloud environment as it involves time and cost complexity. Internet's unpredictable speed will not allow getting correct results by calling. The calling in cloud computing and each client-server environment can be performed in two different places, that is, one at Service provider side and another on the client side. Good values for qualitative measures are usually received at the service provider side. The values are very much near to the values which the provider claimed to offer. Fewer values are achieved in the case of calling on the user side as the speed of internet connection is hard to predict and also the physical distance between the user and provider is large. The qualitative values from different users will be different. So the better way to get the real picture is the calling of service at the client site. Based on this the calling of services in the cloud environment which is impossible and need to be performed in different way. This approach exploited from personalized services in calling service model. The CloudRank approach applies qualitative value of service prediction in client-side. Whenever user demands for ranking of services the system selects the similar users for which ranking was done in past. The system with the help of past experience applies the ranking process for new user. Figure 1.3 depicts the architecture of the CloudRank framework. The active user is the one who is requesting for ranking of service from the system. The CloudRank architecture has three main components. The database contains information about users and the ranking done in the past by the users. This information about the user is known as train data and the user as train user. Different components of the system perform different tasks. The similarity computation component is responsible for calculation of similarity between all the active users according to the comparison done with the train user. The other component is responsible for separating and classifying similar users based on the calculated similarity value. The third component performs the ranking by applying two algorithms on similar users and presents the result to the user. The strong point of CloudRank approach is that it considers different received qualitative values for the user. Furthermore, all services are ranked only in a single execution. The negative side of this approach is that it depends upon the train data. In case the data present in the database is wrong then the ranking will be done according to the wrong data and also it does not consider all the qualitative values for the comparison process[11].

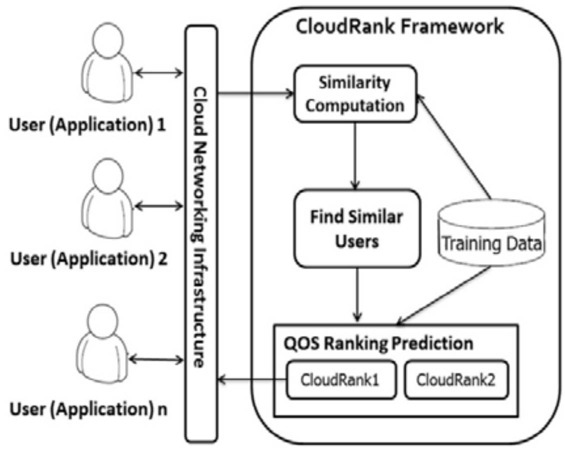

FIGURE 1.3: ARCHITECTURE OF CLOUDRANK[11]

2. RELATED WORK

Buyya et al.(2009)[7]

proposed a detailed information about the different brokers. Different infrastructure available is provided as a list to the brokers and the amount of processing power required. Also the consumers require faster response time which are at far places and when requests are distributed to multiple Clouds at different places at same time helps in saving time.

Computing atmosphere is required for interconnecting and provisioning clouds dynamically through number of domains within and outside enterprises.

Garg et.al (2012) [9]

proposed framework in which different cloud providers are compared which can satisfy Service level agreement . Proposed framework SMICloud helps customer in selecting the best provider for services according to the number of dimensions like suitability, security, interoperability, sustainability, reliability. Proposed system solves many problems in existence that is how SMI attributes are measured, how services are ranked according to the attributes. It also proposed AHP system for ranking providers according to Quality of service requirements.

Ostermann et al.(2010) [10]

proposed performance metrics which uses benchmarks. In proposed work ,based on type of instance ,efficiency is defined and used for a real virtual cluster as ratio between benchmark performance and real environment performance formed with only one instance of same type in terms of percentage.

Li et al.(2010) [11]

proposed CloudCmp that helps in comparing performance and cost of services provided by Cloud service providers. Proposed system measures networking services, persistent storage and elastic computing along with the metrics that linear reflects impact on customer application's performance. Popular cloud providers are compared in the paper that stated the difference in the performance of and costs. Proposed system helps customer in choosing the provider that best fits their requirement.

Bawa et al. (2011)[12]

proposed formulas for ranking jobs and according to the rank of job obtained, job with higher rank is send to the scheduler for further processing. The resource which has higher rank is given the high priority over the jobs which has low rank. The scheduler used for scheduling resources according to rank uses a straight forward technique of match making algorithm. The usual scheduler is not concerned about the service history but only is concerned about usage score. The criteria that is followed is that the resource with higher usage score is chosen again and again over the other with low usage score. This leads to attitude of ignorance towards success rate, affordability, bandwidth as it does not consider past service history. This results in low quality resources and user disappointment. In order to rank resources factors like past history of service, bandwidth, feedback, affordability needs to be given due considerations. In the proposed work if any resource fails to fulfill the rank criteria, it falls quickly and reaches the point of lower trust and will not be chosen by users thereafter.

Simarro et al. (2012)[13]

proposes a cloud architecture suitable for different cloud environments. Proposed architecture acts a management software for cloud for scheduling of services according to different criteria like optimization of performance or cost, or can be based on user constraints like cost, performance etc or can be environmental conditions like dynamic or static. This proposed work provided architecture to help users in distributing services among the clouds transparently that are present. Cloud scheduler of the presented architecture helps in decision making based on user demands available dynamically, dynamic cost schemes. The proposed work demonstrates the profits while deploying services on a different environment under different conditions.

Xiong et al.(2009)[14]

proposed criteria for evaluating the performance of service in cloud computing. In particular, in order to deliver Quality of service that are guaranteed, relation is established between maximum number of customers, minimum resources required by service and the highest point of service. In the paper, relation between level of QoS services guaranteed and service resources is given, also number of customers and relation between services required is stated, moreover it states service resources and number of customers who can be efficiently provided the service. A queuing network model is proposed for evaluating the computer service's performance and developed an estimation technique for computing response time distribution of Laplace transform in cloud computing. The output provides help in designing new computing paradigms. The following Section 3 explains the system model of our proposed framework followed by Experimental Setup in Section 4 and we finally concludes and present future work in Section 5.

3. METHODOLOGY

We implement our proposed algorithm on a NetBeans IDE 8.0 with a CloudSim as a simulator to simulate the results. We proposed an algorithm that with cost function as prime parameter which is compared with non-cost based algorithm and the overall efficiency of the cloud services is find out. We tried to evaluate the number of requests which are failed to get processed under a desired cost. Costing in cloud computing are essential parameter in scheduling requests and the some of the existing rank based technique ignoring this fact. In this algorithm we are trying to make groups of the requests according to the rank of each of the service and cost the service offering as shown in Figure 1.

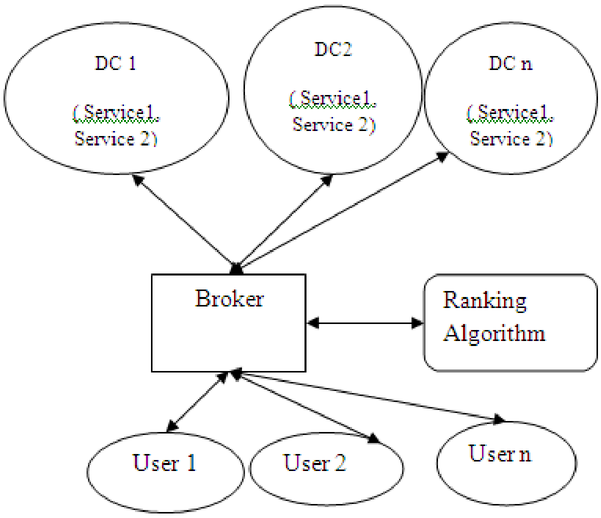

Figure 1: Schematic Framework

3.1 Flow chart of proposed work.

Figure 2 depicts the flowchart of the proposed work.

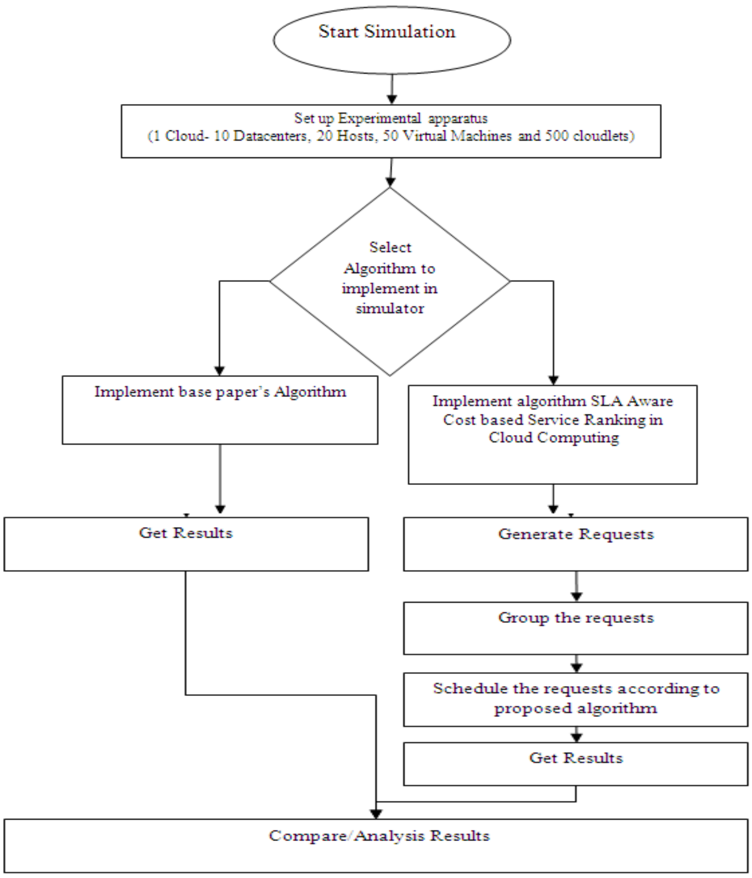

Figure 2. Flowchart of Proposed Work

3.2 Parameters

Parameters that are used are Latency, Suitability, Reliability, Cost that are defined as follows:

3.2.1 Latency

Latency can be defined as the total time taken by the request to reach the virtual machine and to respond back to the user.

$LATENCY = Time\ taken\ from\ user\ request\ to\ reach\ cloud\ virtual\ machine + time\ taken\ from\ cloud\ virtual\ machine\ back\ to\ user.$

3.2.2 Reliability

It depicts how a service operates without failure during a given time and condition. Therefore it is defined based on the mean time to failure promised by the cloud provider and previous failures experienced by the users. It is measured by:

Reliability=probability of violation* p_{mttf}

$$= (1 - \frac{numfailure}{n})* p_{mttf}$$

Where numfailure is the number of users who encountered a failure in time interval less than promised by the Cloud provider, n is the number of users, and p_{mttf} is the promised mean time to failure.[9] Reliability of storage can be defined in terms of durability, that is the chance of failure of a storage device.

3.2.3 Suitability

It is defined upto which the requirements of user are fulfilled by cloud provider. In case there are a number of providers who can fulfill both essential requirements and non essential requirements, then any provider can be selected as all are suitable. In another case if there is no provider who can fulfill both essential and non essential requirements, then a provider who fulfills essential requirements is selected. Therefore in the second case, suitability is the extend to which services match up with user requirements.[9]

$$Suitability = \frac{\text{Number of non essential features provided by service}}{\text{Number of non essential features required by the customer}}$$

If only essential requirements are fulfilled

= 1 if all requirements are fulfilled.

= 0 otherwise.

3.2.4 Cost

Cost is the main parameter which is used by customers to compare the different service providers. As different providers offer virtual machines at different cost. So the cost can be evaluated as Cost = (Total number of Virtual Machines × Cost per Virtual Machine) + (Power usage per Virtual Machine × Total number of Virtual Machine).

3.3 Proposed Algorithm

```
// Rank Services
A = get_latency();
B = get_processingtime();
C= get_Suitability();
D = get_Reliability();
list = rank_para(A,B,C,D);
get_cost() // get cost range from user
map =list * get_cost();
allocate(vm);
// method for fetching latency
get_latency() {
return ping_to_service();}
// method for getting suitability
get_processingtime(){
return
(start_processingtime-stop_processingtime)
}
```

4.. EXPERIMENTAL SETUP AND RESULTS

To implement our proposed algorithm we use cloudsim as simulator. In this case we have assumed 5 services and each service are hosted in a virtual machine. Therefore there are 5 different virtual machines having different configuration as shown in Table 1:

Table 1: Services Details

Configuration Details	SV1 (VM1)	SV2 (VM2)	SV3 (VM3)	SV4 (VM4)	SV5 (VM5)
MIPS	400	800	600	200	1000
RAM (GB)	1	1	1	1	1
B/W (kbps)	1000	1000	1000	1000	1000
IMAGE SIZE(mb)	10000 (mb)	10000 (mb)	10000 (mb)	10000 (mb)	10000 (mb)
CPU cores	2	4	2	1	4
Hypervisor	Xen	Xen	Xen	Xen	Xen

Hence these configurations represent the service capabilities to response users requests (cloudlets). We generate three types of Cloudlets (requests) which sends to broker for execution as shown in Table 2.

Table 2: Cloudlets Configuration

Set No.	Cost($/request)	PesNo	File Size	O/P size	Model
1	20	4	10000	10000	Utilization
2	30	2	12000	1000	Utilization
3	25	4	9000	1000	Utilization

4.1 SLA violations by each service

In this case we randomly sends requests to each of the service and each service behavior is noticed as shown in Figure 3. Here we can observe that each service is behaving differently if we see the SLA violations. Hence from the Figure 3 we can conclude that the number of MIPS and CPU cores is directly related to the SLA violations of the system. Figure 4,5,6,7,8 shows the individual service response time of the services located in a different datacenter. Therefore in these figure we can evaluate the service behavior located in different geographical location have significant impact on the behavior of the service. Therefore in this experiment we have separately identified the behavior of the service on the basis of SLA violations and latency. Figure 3 shows SLA violations and that depicts that Service 4 has maximum number of violations and for Service 5 is least. Service 5 is capable of fulfilling the service requests with the least amount of violations.

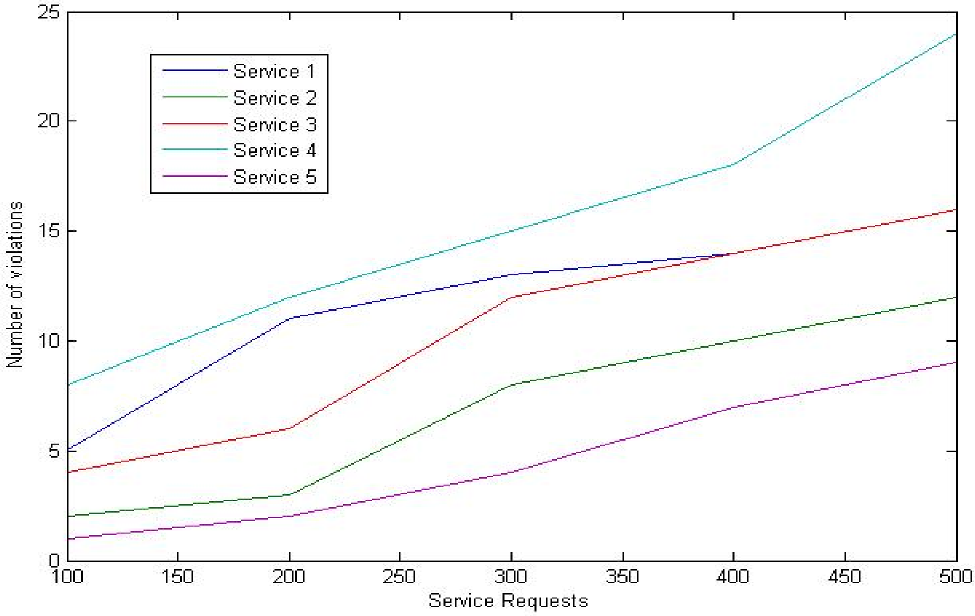

Figure 3: SLA violations by each service

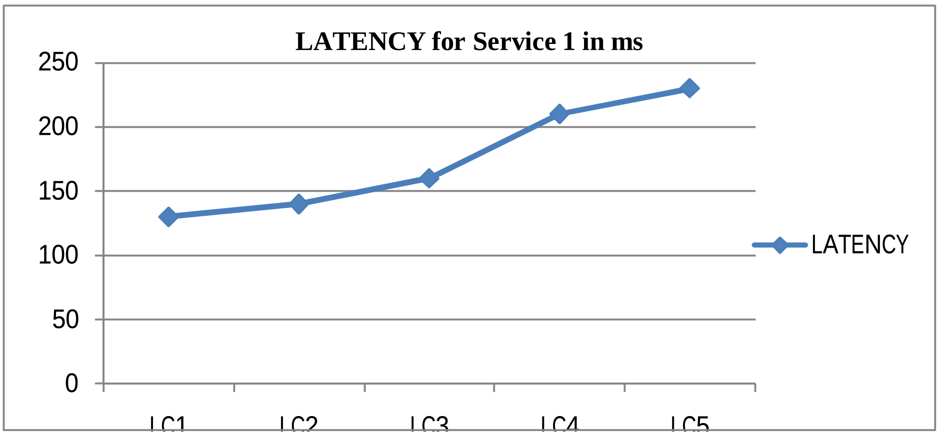

Figure 4: Latency of Service 1 from different Locations

Figure 4.shows the latency of service 1 at five different locations that is LC1, LC2, LC3, LC4, LC5. The latency for Service 1 at LC1 is least and for the LC5 it is maximum that is around 230ms

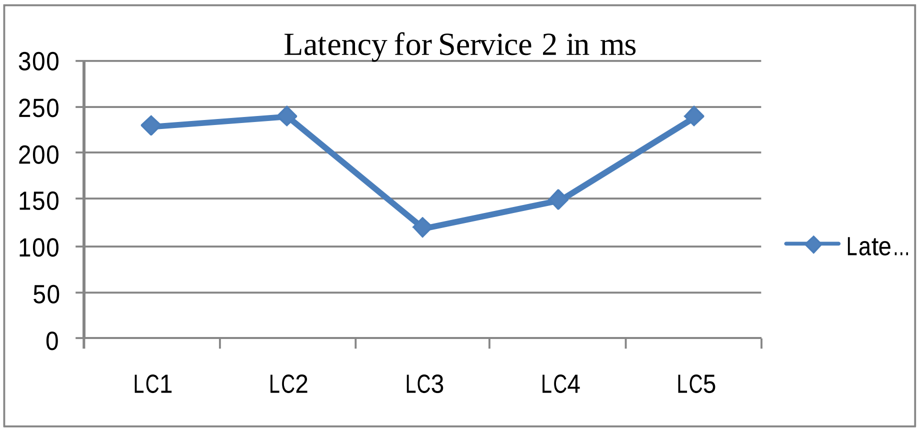

Figure 5: Latency of Service 2 from different Locations

Figure 5 shows the latency of service 2 at five different locations that is LC1, LC2, LC3, LC4, LC5. The latency for Service 2 at LC1 is around 230 ms and for the LC2 it is maximum that is around 240ms. Least latency is for LC3 that is 120ms, with a slight increase for LC4.

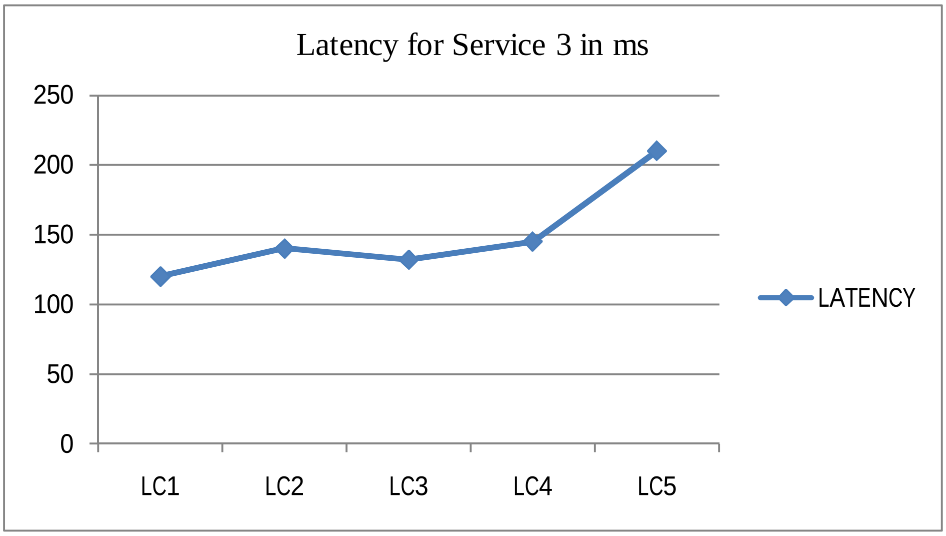

Figure 6: Latency of Service 3 from different Locations

Figure 6 shows shows the latency of service 3 at five different locations that is LC1, LC2, LC3, LC4, LC5. The latency for Service 1 at LC1 is least which a slight increase for LC2 and then again falls for LC3 at 132ms, after that rise of approximately 13 ms and for the LC5 it is maximum that is around 210ms.

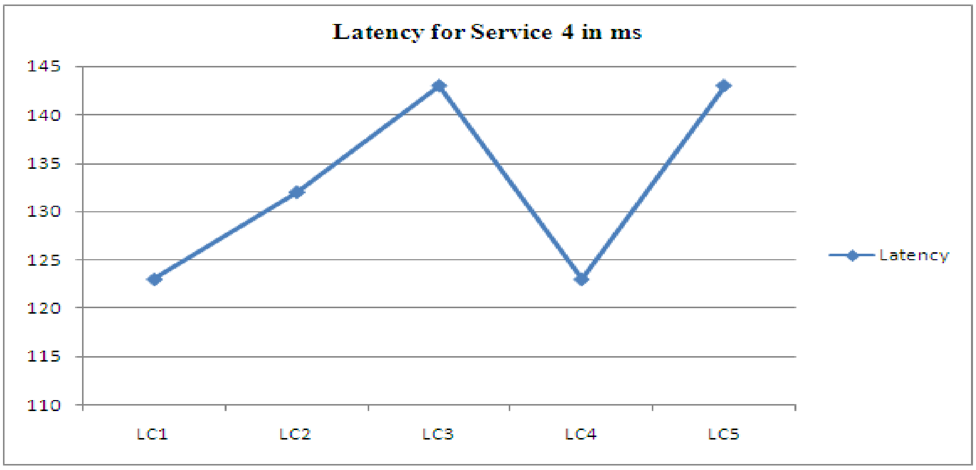

Figure 7: Latency of Service 4 from different Locations

Figure 7 shows the latency of service 4 at five different locations that is LC1, LC2, LC3, LC4, LC5. The latency for Service 4 at LC1 is least that is around 123ms and for the LC3 and LC5 it is around 143ms.

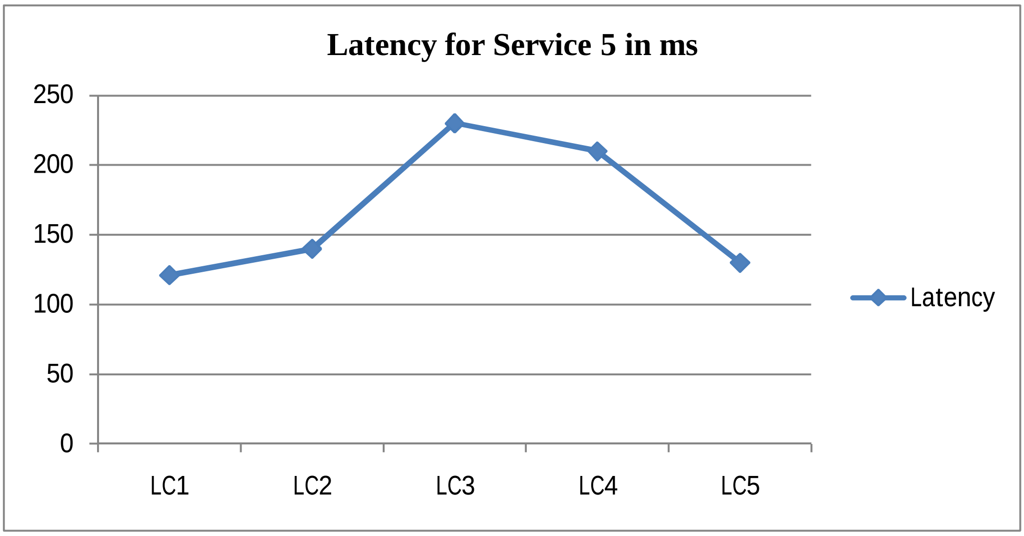

Figure 8: Latency of Service 5 from different Locations

Figure 8 shows the latency of service 5 at five different locations that is LC1, LC2, LC3, LC4, LC5. The latency for Service 5 at LC1 is least and for the LC3 it is maximum that is 230ms. Till LC3, latency increases, but after LC3 it decreases.

The Table 4.5 depicts the location and Latency of different services in ms in a tabular form.

Table 4.5: Latency of Service vs Location

Latency of Service vs Location	Location 1 (LC1)	Location 2 (LC2)	Location 3 (LC3)	Location 4 (LC4)	Location 5 (LC5)
Latency of Service 1	130ms	140 ms	160 ms	210 ms	230 ms
Latency of Service 2	230ms	240 ms	120 ms	150 ms	240 ms
Latency of Service 3	120ms	140 ms	132 ms	145 ms	210ms
Latency of Service 4	123ms	132 ms	143 ms	123 ms	143ms
Latency of Service 5	121ms	140 ms	230 ms	210 ms	130ms

4.2 Number of Requests failed by Ranking of Service without cost vs ranking of service with cost.

In this experiment we took the existing techniques with the addition of the cost factor and find out how cost based ranking is effective when we see the overall functioning of the services. In the Figure 9 we can observe that the failure of the requests is high with base algorithm (non-cost based). This is due to the fact that base algorithm has only the limited capability to find the best ranked service, but this will lead to overloading of that particular service as all the service requests would go towards that service only irrespective of the cost. If that service is offering higher cost than all the service requests with low cost necessity have to pay higher cost hence lead to requests drop. Therefore ranking of the service with cost as deciding parameters have very low requests drops.

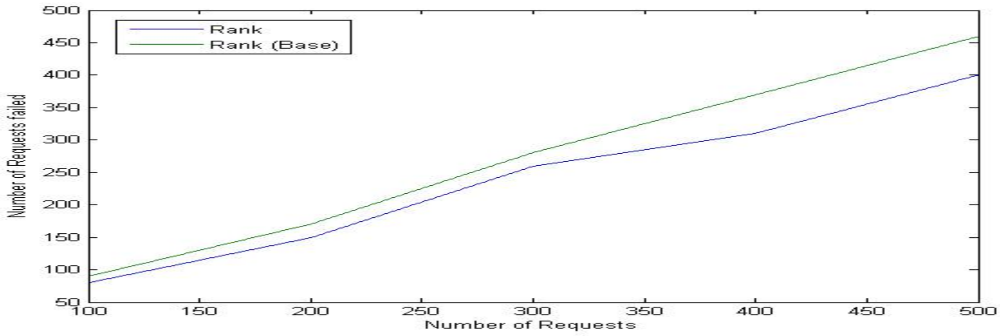

Figure 9: Number of Requests failed by Ranking of Service without cost vs ranking of service with cost.

5. CONCLUSION

In this paper we evolved the different factors like latency and cost of the service. It is evident for the services provider to develop a system which evaluates the service and provides the detailed information of the consequences when a lot of varieties of services are presents. The feedback system would be the future step for this work. This feedback will be provided by the users of the service as a parameter for further allocation of that service to the users.

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