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Cost Effective Approach for Automatic Service Provider Selection in Cloud Computing

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ABSTRACT

In today's advanced age the reason for the high success of cloud computing can be easily understood. The present high tech generation demands huge amount of computing resources and processing power. Cloud computing with the help of pay as you use model provides an excellent solution to the above issue. Easy availability and cost effective nature further make cloud much more exclusive and popular than other traditional computing paradigms. However, as the popularity of cloud computing increases, the number of provider offering cloud services also increase expeditiously. Thus it becomes quite challenging for a user to select the best cloud manually. Wrong decision would harm both the consumer and provider as it would lead to wastage of money for a consumer and imperfect utilization of resources of a provider. Thus keeping the above issues in mind this paper proposes a framework that selects the best and the most profitable cloud for a given user.

Keywords **-** cloud computing, cost effective, Cloud Provider, Cloud consumer, service level agreement,

I. INTRODUCTION

Cloud computing is a new computing concept with the help of which end users have an easy and on demand network access to shared computing resources that can be rapidly allocated and released with minimum service provider interaction.[1] Cloud computing has successfully occupied an unequalled position in the today's IT industry. It has a number of enhancements over the traditional technologies which have helped it to dominate or excel over other technologies. Firstly, the cost effective nature of cloud computing attracts large number of consumers towards it. There is absolutely no need for cloud consumers to spend huge amount of money to purchase any software or hardware. Then there is low initial start up cost and the maintenance costs are also nullified. Easy to access option of cloud has further made life of a number of consumers much easier. One only needs an Internet connection to access anything over cloud. Easy scalability of resources, automatic software update, no overhead of disaster recovery, unlimited storage, quick deployment are some other positive points of cloud computing paradigm. However, like every technology cloud also comes with its own pros and cons. There are certain serious issues such as possibility of outages, security concerns, inaccessibility to knowledge, lack of privacy and dependency on network connectivity concerning cloud paradigm.[2][3] However from the success of cloud computing it can be seen that advantages have superseded its drawbacks and have made it one of the most successful present day technologies.

Service level agreements have an important role to play in cloud computing. They are legal documents that enlist various technical performance promises made by the provider. They also contain the penalties that a provider would legally have to pay in case of service level agreement violations. [1] Thus they save the user from any kind of fraud or cheat of the provider by making him legally responsible for the same. [4]

A cloud consumer must make sure that the contract between provider and consumer includes following cases [5]:

1. SLA must include all the parameters that are important for a user, minimum level of service that a user expects for those parameters and the maximum service that a provider guarantees for those parameters.
2. They must attest the consumer's ownership of the data and ensure that a consumer has full right to get it back also in case of early termination of contract.
3. The SLA should list the security policies that a provider adopts in order to prevent any kind of data breach or data loss. The consumer should be well aware of these policies.
4. SLA should document the right of a user to continue or discontinue the service and total cost incurred if a user decides to terminate contract before the specified time.

Since in a SLA, providers clearly list all the services they intend to provide, hence consumers can conveniently match service level agreement with their requirements at the time of selecting the most useful cloud. However as the numbers of providers offering cloud services are increasing rapidly in the market this manual process of matching is becoming very tedious and time consuming to be performed by a user. [6] It is quite possible that a user may waste money on a cloud

that does not satisfy his requirements or offers resources that are not required by him. For example, consider a user requires **maximum** 500 GB storage for his application. Now, suppose there are 2 clouds offering service in the given range in market. 1st cloud offers 2040 GB storage and the 2nd cloud offers 960 GB storage. However, 2nd cloud offers 960 GB storage at price that is much less than 1st cloud for offering 2040 GB. High price of 1st cloud can be due to various other factors that are of no use to a given user. Since the user requires **maximum** of 500 GB storage, therefore both clouds satisfy the given user but the 2nd cloud would prove to be more cost effective and profitable for the above user. Moreover it will also provide optimal usage of resources possible. Hence, keeping the above example we propose a model that would select the best and most profitable cloud for the user as per his requirements.

II. REALTED WORK

Similar work of selecting the best cloud has been done previously also. Recently (2011) an algorithm was developed by Tejas Chauhan et al for the purpose of selecting the best provider automatically by matching user's requirement (requirement model) with cloud's Service Level Agreement (Cloud Capability Model). The above process of matching two models was done on the basis of various service level agreement parameters. Total nine parameters namely Virtual machine, Storage Capability, Memory capability, Ethernet, Availability, Processor speed, response time Server reboot, Service Credit were considered. [7]However in that approach no cost attribute was taken. They selected that cloud that was best as per the user requirements. Hence, it is quite possible that by using that approach a costly cloud is selected for a user that offers much more service than what is actually required by the user thus leading to loss of resources as well as money. Here, however it is not mentioned that the user requirements are maximum a user expects or not. However, in our approach user requirements would take into account maximum that a user expects.

Then, a framework named SMICloud was developed by Saurabh Kumar Garg, Steve Versteeg and Rajkumar Buyya in their paper titled "SMICloud: A Framework for Comparing and Ranking Cloud Services". In this framework they ranked various clouds on the basis of service measurement index using AHP based ranking mechanism [8]. While ranking, they take into account maximum cost that a user is willing to pay. But here also it is possible that the cloud that is ranked best for a given user requirement is much more expensive than another cloud that is less expensive and moreover also satisfies all the user requirements. Since the other cloud is less expensive, it is thus more cost effective. (Here, however it is not mentioned that the user requirements are maximum a given user expects or not. But our approach would take into account maximum value that a user demands for every requirement.) For example, consider a case where the user needs **maximum storage** of 10 GB and his budget is less than $1 per hour. Assume that there are two providers offering service in this range. Cloud 1 provides 20 GB storage for $0.76 per hour and Cloud 2 provides 11 GB storage at $0.60 per hour. So it is possible that using the above approach that the 1st cloud is given better rank, however since maximum storage required by him is 10 GB, the 2nd cloud would serve him equally well and would also save money as well as resources.

III. PROPOSED WORK

The main motive of this work is to provide the user with the cloud that would fulfil all his requirements and simultaneously also be the most profitable cloud. E.g. if a user needs maximum 2.1 GHz speed or maximum 8 processor cores for his requirements then there is no need for him to spend money on clouds that offer more speed or cores. Similarly, if he does not require very high memory storage or very high response time for his application, then there is no need for him to pay extra for above requirements, since, that would lead to waste of money for the user and resources for the provider. There could be many expensive clouds in market that offer service much above the user requirements. Selection of the above clouds would lead to improper utilization of money as well as resources For example if a user purchases a cloud that offers 64 GB RAM and 8 processor cores but his requirement is only of 30 GB RAM and 4 processor cores, than 34 GB RAM and 4 cores would be wasted.

Using our approach all the clouds that are eligible (meet all user requirements) are ranked according to the costs offered by providers and then best cloud is selected.

IV. ALGORITHM

This work has been implemented in JAVA using My SQL as backend. Regarding this work two tables have been used: user requirement table and cloud provider table.

The algorithm works as follows:

1) Select those clouds that provide service above the maximum user requirement. This is done by matching service offered by clouds (listed in cloud provider table) with the maximum service required by user (listed in requirement table).
2) Only the above selected clouds will be eligible for a given user requirement. All other clouds will be non eligible.

3) Rank all the eligible clouds according to their costs.
4) The cloud that has the first rank would be the best cloud foe the given user requirement.
5) Repeat the above steps for all the requirements.

Following service level agreement parameters are considered:

1) Security
2) Availability
3) Processor cores
4) Processor speed
5) RAM
6) Cost (hourly/monthly basis)
7) Storage
8) Service credit

V. TABLES USED IN ALGORITHM

This algorithm makes use of two tables: cloud provider table and requirement table.

1. Cloud provider table contains amount of service that each provider guarantees to provide for the above mentioned SLA parameters. All the above information is collected from websites of the providers. Since no information about security was provided hence it is assumed. [6][9]

Table I (Cloud provider table) [6] [9]

Cloud Provider	Security	Availability	Processor speed(per core)*(approx)	Processor Cores	Cost (per hour basis)	Cost (monthly basis)	RAM	Storage	Service credit
Google Compute storage	22 hours	99.95%	Not Mentioned	8	$1.06	Not Mentioned	30 GB	3540GB	50%
Rackspace	23 hours	100%	2.3 GHz	8	$1.20	$876.6	30 GB	1228GB	100%
Hp	22 hours	99.95%	2.7 GHz	8	$1.12	$817.6	32 GB	960 GB	30%
GoGrid	24 hours	100%	2.9 GHz	24	$1.92	$870	24 GB	1228 GB	10,000%
OpSource	22 hours	100%	2.1 GHz	8	$2.17	$1584.10	64 GB	2500GB	100%
Nephoscale	22 hours	99.95%	2.4 GHz	8	Not Mentioned	$1499	144 GB	1000 GB	25%
Bitrefinery	23hours	100%	2.1 GHz	4	Not Mentioned	$246.2	8 GB	150 GB	100%
Windows Azure	22 hours	99.95%	1.6 GHz	8	$1.80	$1399	56 GB	2040 GB	25%
Savvisdirect	22 hours	99.9%	2.67GHz	8	Not Mentioned	$329.87	8 GB	500 GB	20%
Joyent	22 hours	100%	Not Mentioned	16	$2.80	$2044	80GB	2048GBs s	100%

2. The user requirement table [6] lists the maximum service each user requires for each SLA parameter. Only those clouds that provide service above that mentioned in requirement table are considered as eligible while others are considered as not eligible. Even if a cloud fails to provide service above that mentioned in requirement table for a single parameter, it would be considered not eligible. The fields that contain not required means that the user does not require service for that parameter.

For example, In Requirement 1, 20 Hours of security means maximum security required by user is 20 hours. Similarly 99% Availability means user requires maximum 99% availability and hence clouds that offer this much or more availability are considered eligible.

Table II (user requirement table)

Requirements	Security	Availability	Processor cores	Processor speed(per core)*(approx)	Cost	RAM	Storage	Service Credit
Requirement1	20 hours	99%	4	2.1 GHz	Per month	25 GB	800 GB	25%
Requirement 2	20 hours	99.9%	8	1 GHz	Per month	8 GB	400 GB	20%
Requirement 3	Not Required	99%	4	2GHz	Per month	Not Required	500 GB	Not Required
Requirement 4	Not Required	90%	4	2 GHz	Per month	16 GB	800 GB	Not Required
Requirement 5	15 Hours	100%	4	2.0GHz	Per Hour	30GB	800GB	10%
Requirement 6	21 Hours	90%	4	1.5 GHz	Per month	16 GB	400 GB	10%
Requirement 7	Not Required	Not Required	8	1.2 GHz	Per hour	Not Required	Not Required	50%
Requirement 8	20 Hours	90%	4	2 GHz	Per month	8 GB	100 GB	20 %
Requirement 9	20 hours	99%	8	1.5GHz	Per hour	32 GB	400 GB	25%
Requirement 10	20 hours	Not Required	4	Not Required	Per month	10 GB	400 GB	Not Required
Requirement 11	Not Required	100%	4	2.1GHz	Per Month	20GB	Not Required	20 %
Requirement 12	Not Required	Not Required	Not Required	Not Required	Per hour	Not Required	600GB	20 %
Requirement 13	Not Required	Not Required	8	Not Required	Per hour	Not Required	1000 GB	Not Required
Requirement 14	Not Required	100%	8	2.1 GHz	Per month	16 GB	100 GB	50%

VI. RESULT

The following table shows the results of the above algorithm.

Table III (Result table)

REQUIREMENTS	Google Compute engine	Rackspace	HP	GoGrid	Opsource	Nephoscale	Bit Refinery	Windows Azure	Savvisdirect	Joyent
Requirement 1	Not Eligible	2nd	1st	Not Eligible	4th	3rd	Not Eligible	Not Eligible	Not Eligible	Not Eligible
Requirement 2	Not Eligible	4th	2nd	3rd	7th	6th	Not Eligible	5th	1st	Not Eligible
Requirement 3	Not Eligible	4th	2nd	3rd	6th	5th	Not Eligible	Not Eligible	1st	Not Eligible
Requirement 4	Not Eligible	3rd	1st	2nd	5th	4th	Not Eligible	Not Eligible	Not Eligible	Not Eligible
Requirement 5	Not	1st	Not	Not	2nd	Not	Not	Not	Not	Not

	Eligible		Eligible	Eligible		Eligible	Eligible	Eligible	Eligible	Eligible
Requirement 6	Not Eligible	3rd	1st	2nd	6th	5th	Not Eligible	4th	Not Eligible	Not Eligible
Requirement 7	Not Eligible	1st	Not Eligible	2nd	3rd	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible
Requirement 8	Not Eligible	5th	3rd	4th	7th	6th	1st	Not Eligible	2nd	Not Eligible
Requirement 9	Not Eligible	Not Eligible	1st	Not Eligible	3rd	Not Eligible	Not Eligible	2nd	Not Eligible	Not Eligible
Requirement 10	Not Eligible	3rd	1st	2nd	6th	5th	Not Eligible	4th	Not Eligible	7th
Requirement 11	Not Eligible	2nd	Not Eligible	1st	3rd	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible
Requirement 12	1st	3rd	2nd	5th	6th	Not Eligible	Not Eligible	4th	Not Eligible	7th
Requirement 13	1st	2nd	Not Eligible	4th	5th	Not Eligible	Not Eligible	3rd	Not Eligible	6th
Requirement 14	Not Eligible	2nd	Not Eligible	1st	3rd	Not Eligible	Not Eligible	Not Eligible	Not Eligible	Not Eligible

For Requirement 1, Google compute engine, GoGrid, Bit Refinery, Windows Azure, Saavisdirect and Joyent are ineligible. The reasons are explained as follows:

Google Compute Engine is considered as ineligible since it offers does not offer services on monthly basis as required by requirement1. It also has no mention of processor speed and Requirement 1 demands 2.1 GHz processor speed. GoGrid is not eligible for the requirement 1 since it does not provide the required (25 GB) RAM. Bit refinery does not provide required RAM and Storage (150 GB and 800 GB). Windows Azure does not provide required RAM (25 GB) and processor Speed (2.1 GHz). Savvisdirect provides an 8 GB RAM whereas Requirement1 demands 25 GB RAM. It also does not provide required storage (800 GB) and service credit (25%) Joyent has no mention of processor speed in its SLA

Thus the only eligible clouds are Rackspace, HP Nephoscale and Opsource. These clouds fulfil all the requirements. The ranks are provided to these clouds on the basis of their costs, thus giving HP 1st rank.

In requirement 2 google compute engine, Bitrefinery and joyent are ineligible. The reasons for the same are explained as follows

Google compute engine has not mentioned Processor speed in its SLA. and it also does not provide services on monthly basis. Bitrefinery does not provide required 8 cores and 400 GB storage. And Joyent has not mentioned processor speed in its SLA.

Hence, the eligible clouds are Rackspace, HP, GoGrid, Opsource, Nephoscale, and Savvisdirect and windows azure. These clouds meet all the requirements. Among these clouds Savvisdirect is ranked as best cloud since it provides all services in the least price.

Similarly the results of all other can be obtained. From the above ranks HP can be considered as best cloud since it achieves highest number of 1st positions

VII. CONCLUSIONS

In this paper an effort was made to automate provider selection using service level agreements in order to simplify the work of selection of a provider for a cloud customer. This approach tries to find the best as well as the most cost effective cloud for a cloud customer. The cloud selected is the one that meets all the user requirements in minimum cost. User requirements for each parameter contain the maximum value that a user requires. If a user can get the required service at much less cost than there is no need for him to spend extra money on those services offered by a cloud that are not required by him. This approach also benefits the provider by making optimal use his resources. Further it helps a provider to compare their services with other clouds and further improve and thus provide better services. We hope that this effort of ours would help those working in the area of cloud computing with their future works.

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