International Journal of Engineering & Technology, 7 (2.24) (2018) 92-101

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Dynamic Selection of Optimal Cloud Service Provider for Big Data Applications

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Abstract

Big data analytics and Cloud computing are the two most imperative innovations in the current IT industry. In a surprise, these technologies come up together to convey the effective outcomes to various business organizations. However, big data analytics require a huge amount of resources for storage and computation. The storage cost is massively increased on the input amounts of data and requires innovative algorithms to reduce the cost to store the data in a specific data centers in a cloud. In Today's IT Industry, Cloud Computing has emerged as a popular paradigm to host customer, enterprise data and many other distributed applications. Cloud Service Providers (CSPs) store huge amounts of data and numerous distributed applications with different cost. For example Amazon provides storage services at a fraction of TB/month and each CSP having different Service Level Agreements with different storage offers. Customers are interested in reliable SLAs and it increases the cost since the number of replicas are more. The CSPs are attracting the users for initial storage/put operations and get operations from the cloud becomes hurdle and subsequently increases the cost. CSPs provides these services by maintaining multiple datacenters at multiple locations throughout the world. These datacenters provide distinctive get/put latencies and unit costs for resource reservation and utilization. The way of choosing distinctive CSPs data centers, becomes tricky for cloud users those who are using the distributed application globally i.e. online social networks. In has mainly two challenges. Firstly, allocating the data to different datacenters to satisfy the SLO including the latency. Secondly, how one can reserve the remote resource i.e. memory with less cost. In this paper we have derived a new model to minimize the cost by satisfying the SLOs with integer programming. Additionally, we proposed an algorithm to store the data in a data center by minimizing the cost among different data centers and the computation of cost for put/get latencies. Our simulation works shows that the cost is minimized for resource reservation and utilization among different datacenters.

Keywords: *Storage issues, CSPs, Optimal Selection, Service Level Objectives.*

1. Introduction

Since its beginning, information technology has been only accessible for innovation and extensive organizations, government and educational organizations. The democratization of Information Technology has not only influenced the cloud storage it also affected the big data as well. Innovation of open source Hadoop is developing at a quick pace and the capability to perform analytics on non-proprietary and affordable resources is ending up more pervasive. Alongside this wonder, we are currently seeing an explosion of data produced through web based social networking, messaging, electronic mails and many more. The unstructured data does not fit to the conventional RDBMS structure Approximately 3 billon GB of data is generating daily consisting of 250 million of tweets and 35 billion pieces of content shared on Facebook every months [1]. How one can imagine to store this huge amount of data. On the other hand cloud computing is another technology where numerous organizations are providing unique services to their customers and many other organizations to store data and process it further. Cloud computing and big data, while still in constant evolution and are proving to be an ideal combination. These two technologies together provide a cost-effective and scalable infrastructure to support big data, business analytics. In this paper, we concentrated minimizing the storage cost in cloud applications and which is in turn have an advantage of the big data applications. Our work is contributed majorly on cloud storage services, but it can be applicable in different applications which are used to store their information using different data centers [2].

In the cloud computing system, each user can access their data from remote server by making use of the internet instead of using their personal computer storage. Cloud computing is differentiated into three different categories such as Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software- as-a-Service (SaaS). In IaaS model, it always allows the user to use their server and storage as per their requirement. In PaaS model, it always allows the user to develop their application over the service provider framework (i.e. Google Apps) [14, 15].In SaaS model, it always allows the user to use an application via internet browser (i.e. Gmail). Cloud computing has been differentiated into major three categories such as public cloud, private cloud and hybrid cloud. Public cloud also called as external cloud, which is available over the internet and provided by third parties such as google, amazon etc. A private cloud environment, as we can refer it as corporate or internal organization cloud. A private cloud environment always provides services within the private network. In the current IT industry, achieving the data confidentiality will prefer private cloud. In hybrid cloud environment multiple organization can share their data internally [1]. The primary concern of the customers in the perspective of cloud services is the ease of use and outsourced administration should be in a good appeal [16]. The manager of a company can give an instant access of the applications to their employee. For this employees simply by signing up in to the system they can continue with their works by getting the remote data stored in a remote data center. Since the CSP hosts the complete data and applications, the users assume that the data is secure and safe.CSPs are growing rapidly and requires the scalability and management otherwise there will be a large effect on the computations and networking due to load balance [3, 4].

1.1 Challenges in Big data and Cloud Computing

It is a fact that, valuable enterprise and personal data will reside in remote organizations outside the company will raises serious issues and poses many challenges. Data Storage, Quality of data, security and privacy, service delivery, billing, reliability, availability, performance are the typical examples are to be considered in a first glance. We considered one of the issue here i.e. Data Storage. Storing and Analyzing bulk amounts of data and is essential for large enterprises and requires a large infrastructure for storage and computation for various analysis [5]. With the continuous growth of data it is essential to develop algorithm to store the data in a place i.e. cloud service provide which incurs the less computational cost and this problem has been given a good solution in our work.The rest of paper is described as follows. In section 2, we have discussed the preliminaries of cloud and data center, features of CSPs and related work done prior on cost based resource allocation. In section 3 we have covered the work proposed in this paper. Section 4 covers our experimental results and discussion. Conclusions are drawn in Section 5.

2.Related Work

In this section, we just described few fundamentals related to the Cloud and datacenters along with security and the cost in the current IT Industry.

2.1 Role of Data center

2.1.1 Cloud vs. Datacenter

There exists two equivalent terms namely “cloud” and “data center” which refers to the similar infrastructure. But these dual computing systems have not more in common other than that they both are for data storing. Cloud is an outward form of computing where the data stores in internet, while a datacenter is an inward hardware where data stores in organizations LAN [6]. One more difference is that the cloud services are offered by third party while the datacenters hosts by internal IT department. To store data like physical entity is a common goal of cloud and the servers and other related infrastructure is used in datacenter. A typical questions raise for organizations as whether to continue with cloud or construct their self-data center. The opinion relies on three factors like business essentials, data security and data storage cost [8].

2.1.2 Cloud security vs. data center security

As cloud is an outward way of computing there will be less security when compared with datacenter. In datacenters, there is possibility of providing security by our own and there is no involvement of third party in this. If your cloud exists on various datacenters in varied locations, every location requires certain security measures. A datacenter is connected with a local network physically, which gives an easy way of company-approved credentials and equipment would access apps and data that are stored [13]. However a cloud can be accessed by anybody with certain credentials from anywhere in presence of internet connection.

2.1.3 Cloud vs. data center costs

The cloud is more cost-effective choice than a datacenter for very small businesses. Since you will build an infrastructure and are the responsible for your self-maintenance and administration, a datacenter takes more time to start and cost-oriented around $30 million per annum [18]. In contrast with a datacenter, a cloud computing there is no need of time or capital to start and run. Alternatively many cloud providers gives a range of incurred subscription schemes to reach your budget and measure the service of your performance essentials. While datacenters consumes time to form, relying on your provider. There is also availability of using cloud services immediately when registration done [7].

2.1.4 Single vs Multi Computing Model

The use of cloud computing have increased in several organizations. It provides many benefits in terms of cost and availability. The Cloud computing is also known as pay per use model. One of the conspicuous administrative offer by cloud computing is storage of data, in which the users or clients no need to store in their own servers, but instead they can store in CSP. This facility is not only providing the adaptability and versatility to our data but also provide the users to store their data to a specific timeframe with reasonable cost. Notwithstanding these advantages client can get to their information from anyplace as long as they are associated with web. Since CSPs are numerous marketing bodies, data integrity, security are the well-known issues in distributed computing and to be addressed further [4] despite the fact that the CSP have standard control and the infrastructure to guarantee the client information security and give a superior accessibility. The fundamental issue here is that availability of the data. In this plan we can watch that single CSP is not sufficient and exceptionally don’t provide the better availability and hence data stored cannot be guaranteed. For instance if CSP goes down by any technical fault, at that point nobody will get to the information and as a penalty in the availability. This structure is shown in Figure 1.a. Later a new idea is acquainted to address this problem called multiple CSP, in which we can store the client information in to different data centers, if any CSP failed due to technical faults then we can retain the information from other nearest CSP, since we have maintained redundant copies of same information and this structure is shown in Figure 1.b.

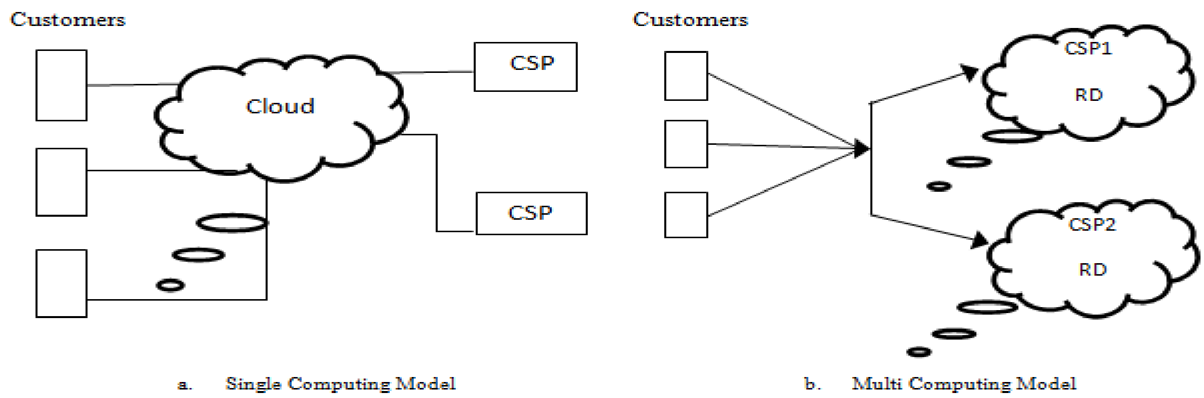


Fig. 1: Cloud Computing Provider Model

2.2 Features of Various CSPs

CSPs provide services to the users based upon their request through the wireless medium i.e. the internet. It is contrasted with the services that are provided from the company's private on premise services.The services provided by the CSPs are easy to use and scalable to access the remote data and other hardware resources. In this section, we have illustratedfew of the widely used CSPs and the services offered by them based on, either by initiation of this technology, offering best and widest and strongest set of cloud services. The Computing, Storage, Networking Technology and Management Services of Top 5 Current Cloud Service Providers are listed in Table 1.

Table 1: Features of Widely Used Cloud Service Providers.

CSP	Computing	Storage	Networking	Management
Amazon Web Services	EC2, Elastic Beanstalk	Amazon S3, Amazon Glacier	Amazon Virtual Private Cloud, AWS Direct Connect	Amazon Cloud Watch, AWS Cloud Formation
Microsoft Azure	Virtual Machines, Cloud Services	Azure Storage, Azure Backup	Virtual Network, Express route	Operational Insights Scheduler
Google Cloud	Computing Engine, App Engine	Cloud Storage, Cloud Data Store	Load Balancing, Cloud DNS	Cloud Deployment Manger, Cloud Monitoring
IBM Cloud	Cloud Servers, IBM Blue Mix	Object Storage Back Up	Load Balancing, Network Appliances	Controls Server Monitoring and Reporting
Rack Space	Rack Space Cloud Servers, Rack Space On Metal Cloud Servers	Cloud Files, Cloud Backup	Rack Connect Global, Rack Connect Hybrid	Cloud Monitoring

Among these few of the Cloud Storage Providers are Providing features free of cost and these can be used to share files with family, friends and colleagues and keep documents synchronize between your personal devices. The premium offers includes more cost providing more storage space and many other cloud related services. Some of the CSPs that are listed in Table 2 are providing sufficient storage for the customers to store and send data to the other computers with free of cost [11,12].

2.3 Selection Criteria

Once you have decided to store and process data using cloud computing, the next step is to select the CSP.It is vital to assess the reliability and capability of a service provider that you plan to entrust with your organization's applications and data. The things to consider are Business health and processes, Administration support, Technical capabilities and processes and Security practices [9, 10] and are shown in Figure 2.**Business health and processes:** Financial health, Organization, governance, planning and risk management, Trust, Business knowledge, Compliance audit. **Administration support** includesService Level Agreements (SLAs), Performance reporting, Resource monitoring and configuration management, Billing and accounting. **Technical capabilities and processes** such as Ease of deployment, management and upgrade, Standard interfaces, Event management, Change management, Hybrid capability. **Security practices** includes security infrastructure, Security policies, Identity management, Data backup and retention, physical security etc.

Table 2: Free Storage Space of numerous CSPs

CSP	Storage Space (Giga Bytes)
MEGA	50
Hubic	25
Google Drive	15
pCloud	10
Media Fire	10
Box	10
Flip Drive	10
Yandex	10
Drobox	2 – 8
One Drive	5
Hi Drive	5
Sync	5
Amazon	5
Jump Share	2
My Drive	0.1

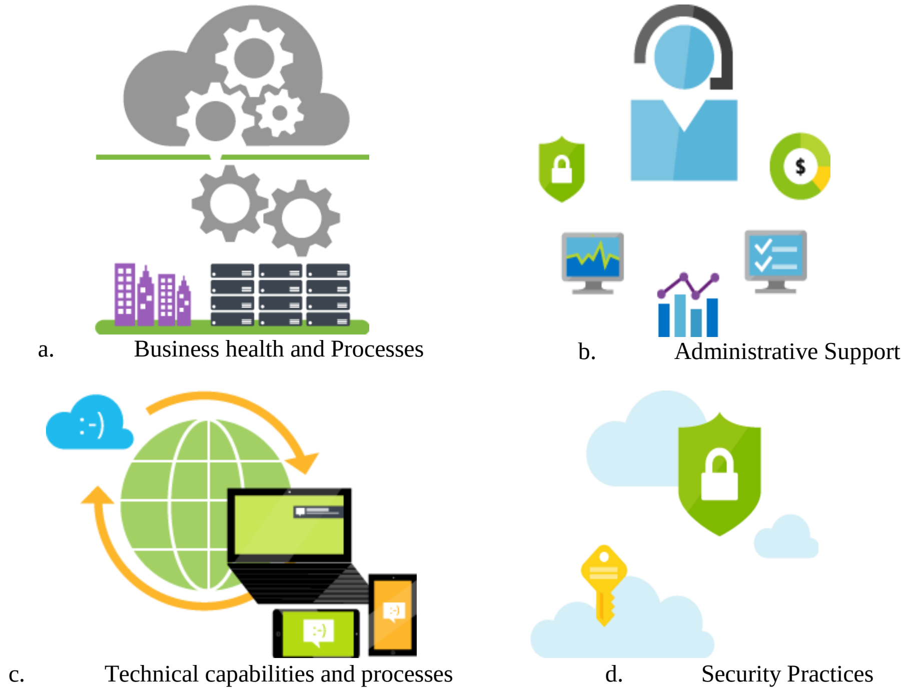


Fig. 2: Selection criteria for CSP

2.4 Dominant Cost Based Data allocation

In our work, we used the concept of DAR. It has two stage. In the first place, a dominant cost based data allocation algorithm is utilized. Secondly optimal resource reservation algorithm can be used to reserve a specific resource up to a specific period. The corresponding algorithms are shown in Figure 3 and Figure 4 [13,14].

Algorithm 1:DCBA Algorithm
for*each* c_i in D_c**do**
$L^s_{c_i}$,$L^g_{c_i}$ and $L^g_{c_i}$ are $S^g_{c_i}$ are sorted in an increasing order of unit Storage/Get/Put price, respectively.
for*each*$d_l$with∃t_k d_l∈ $G^{t_k}_{c_i}$**do**
H=100 **switch**d_l*with*$H^{d_l}_{c_i}$=*H* **do**
case*dominant*
L=$L^s_{c_i}$*or* $L^g_{c_i}$ *or*,$L^p_{c_i}$ according to the dominant cost is Storage or Get or Put
case*balanced*
Find p_j∈ $S^g_{c_i}$∩$S^p_{d_l}$with the smallest $C^{d_l}_{c_i,p_j}$ and satisfies all constraints
for*each*p_j*with* p_j∈ L ∩$S^p_{d_l}$**do**
if ($X^{d_l}_{p_j}$=1 → $\phi^p_{p_i}$<0)∨($\phi^g_{p_i}$=0) **then**
Continue;
Find the largest $H^{d_l}_{c_i,p_j}$ satisfying

$\phi^g_{p_i}$ ≥0 ∧ H ≥ $H^{d_l}_{c_i,p_j}$;
if$C^{d_l}_{c_i,p_j}$ ≤ $C^{d_l}_{c_i,p_{k(k=j+1,\dots,j+c)}}$*when*
H_{c_i,p_k}=H_{c_i,p_j}**then**
$X^{d_l}_{p_j}$=1;H=H-$H^{d_l}_{c_i,p_j}$;
else
$H^{d_l}_{c_i,p_j} = 0$;
if$\Sigma_{p_j \in S^g_{c_i}} X^{d_l}_{p_j}$ ≥ β ∧ H=o **then**
break;

Fig. 3: DCBA Algorithm

Algorithm 2: BSRR Algorithm
Sort **A**={$A^{t_1}_{p_j}$,$A^{t_2}_{p_j}$, … , $A^{t_n}_{p_j}$} in ascending order;
N1=$\lfloor n * (1-\propto) \rfloor + 1$; $N_2 = \lceil n * (1-\propto) \rceil$+1;
x_1= the N_1^{th} smallest value of **A**;
x_2= the N_2^{th} smallest value of **A**;
if$F_{p_j}(x_1)$ ≥ $F_{p_j}(x_2)$**then**$R^g_{p_j}$= x_1;
else $R^g_{p_j}$= x_2;

Fig. 4: BSRR Algorithm

3. Proposed Work

In this paper, we present a resource allocation mechanism essentially useful in big data Applications. For this we have provisioned distributed clouds where all the computation resources are available very close to the customers i.e. within the routers itself. A requirement and the necessity of the new algorithms are must to store the data in a cloud service providers with less storage and computational cost. As a solution to this problem, we have proposed geo distributed cloud storage system to store the data, allocating the request and reservation of a specific resource for example memory over multiple CSPs using DAR algorithm. It straightforwardly helps to the clients to limit their payment cost while ensuring their SLOs and this also avoid the vendor lock-in problem since client won't obliged to an obsolete provider and can simply pick the optimal

CSPs to store their data. Webriefly illustrated our work here. First the data centers can be added from the organization in various locations worldwide. The clients can purchase different data centers owned by different CSPs. There is a chance to the client to store the data in a specific data center and consequently it incurs the storage cost to the user. Our method automatically select the optimal data center to store the client's data among different CSPs owned by the client for a stipulated time. For this we have adopted cost based data allocation algorithm in which it finds the predominant cost based on size of the data, get or put requests etc. along with we can also reserve a resource to a specific time period using a resource reservation algorithm as PAYG manner. The system architecture is shown in Figure 5, the model of the system get/Put requests is shown in Figure 6, and the process of our work is shown in Figure 7. We have adopted our work from Guoxin Liu et.al [14].

The complete work is summarized here. Customer Data Center (CDC) indicates a data center which operates the Customer's application. A Customer can register in to multiple customer data centers denoted by D_n. The customer can use $c_i \in D_n$ which represents i^{th} datacenter of the customer. D_{all} , indicates all the data centers provided by all the CSPs. Assume $p_j \in D_{all}$ represents the storage data center (SDC) 'j' belongs to any of the CSP. The customers Put/Get requests can be forwarded from CDC to SDC. Two main Service Level Objectives considered in this work are Get/Put latency and Data availability. We are going to store the data in a data center locally and other replicas can be stored in remote data center. The problem definition here is that, there exists 'p' number of data centers for each CSP. The main goal of our work is to select the optimal data center to store the data for a customer with minimal cost. Data Storage and Transfer are charged based upon pay as you go (PAYG) manner and Get/Put operations among the two hosts are based upon PAYG manner and reservation. In our work we have considered Get Requests, Put Requests, Reservation Period, Size of the data are the key factors to compute the total cost to store the data in a specific data center.

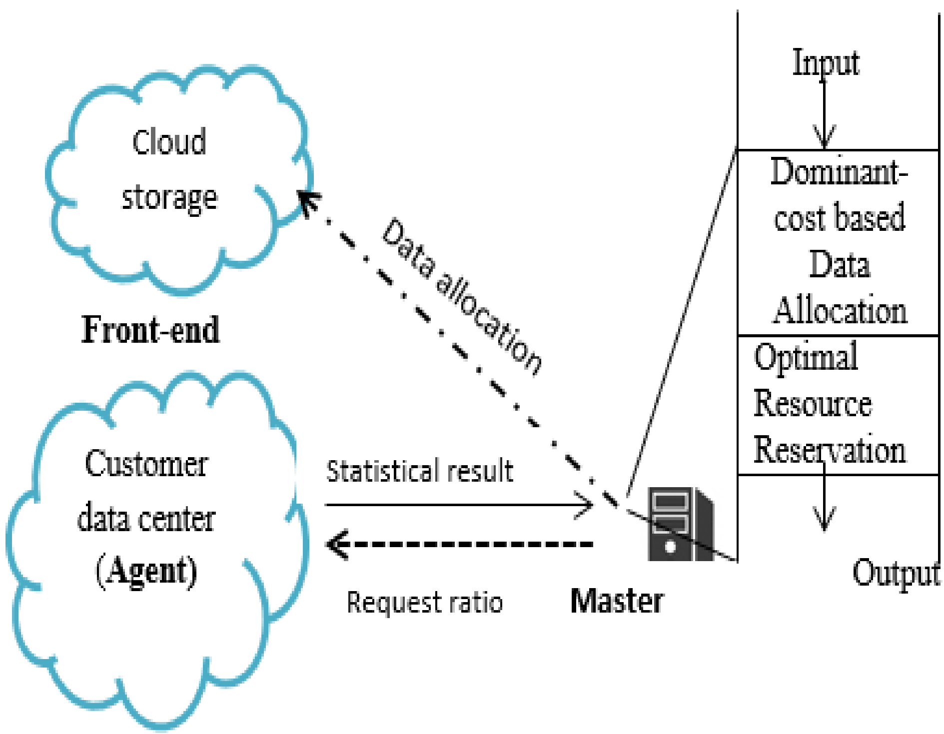


Fig. 5: Overview of DAR's Structure

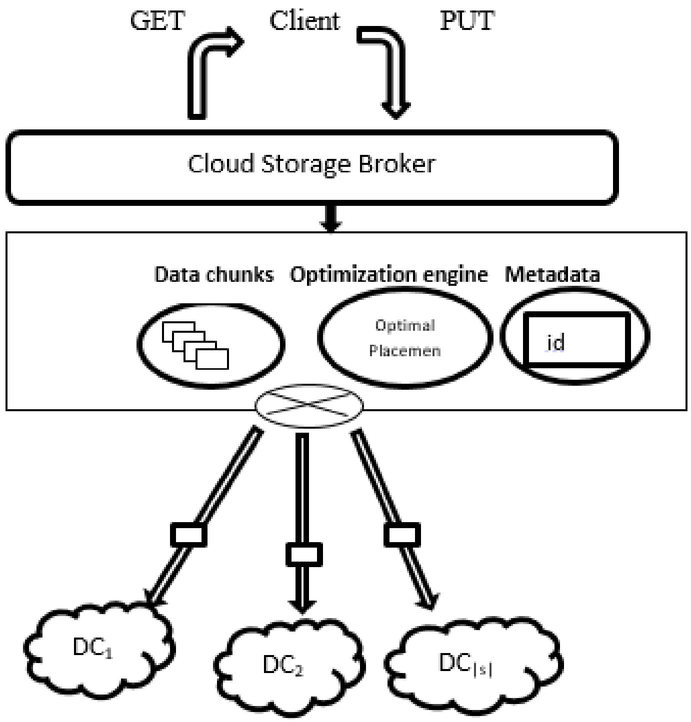


Fig. 6: System model: GET and PUT requests

The main merit of our proposed work is we have taken a small file and observed the storage cost of each service provider and minimized the storage cost by picking the optimal storage service, which is essentially useful in Big Data Applications. In such kind of applications, the storage cost is the major factor that affects the profit of IT industries and moreover where the replication is used, at such kind of situations our work gives the outstanding result with minimal cost.

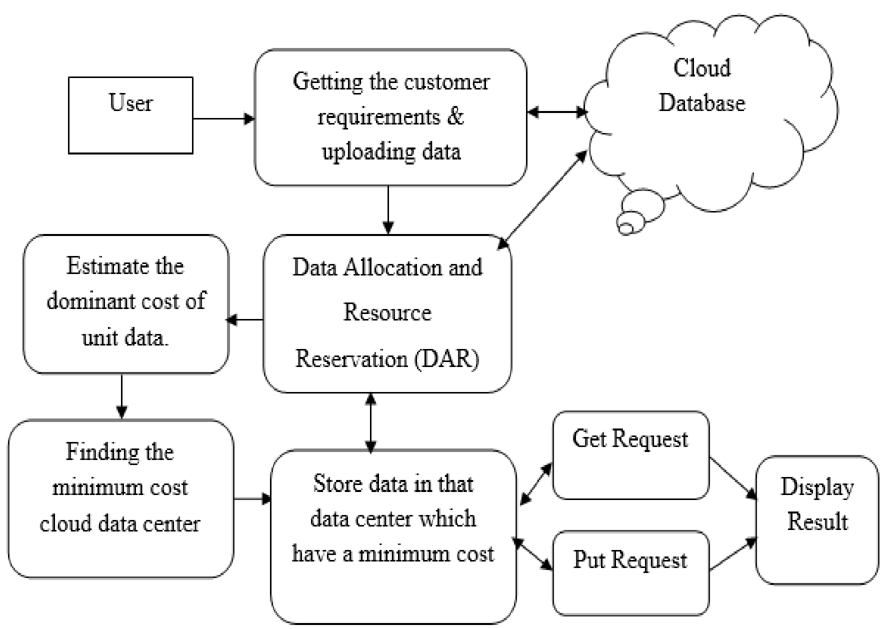


Fig. 7: Process flow of our work

4. Results and Discussion

Our Simulation work is done in Java and My SQL as the back end to store the data. We used Java Server Pages as a front end for designing the web application. Initially we can store the files in a remote computer and hence the concept of cloud is introduced here. More over our main motto of this work is to reduce the storage cost in an application where the data is need to be stored or the number of replications are more. In Cloud, with the help of Data Centers it is possible to store the replicated copies in the nearest centers of the customers. The problem with this is the storage cost is increased according to the size of the data. We proposed a new concept using

DAR algorithm, where one organization can establish 'n' number of data centers. The customers can request a specific number ranging from 1 to n among these data centers. When the customer is stored the data in a data base our system automatically stores this data with in a data center which gives least cost storage. We have manually stored the data in different data centers and compared this result with our proposed work. We considered different parameters to compute the total cost for storing the file for example, number of gets, number of puts etc.

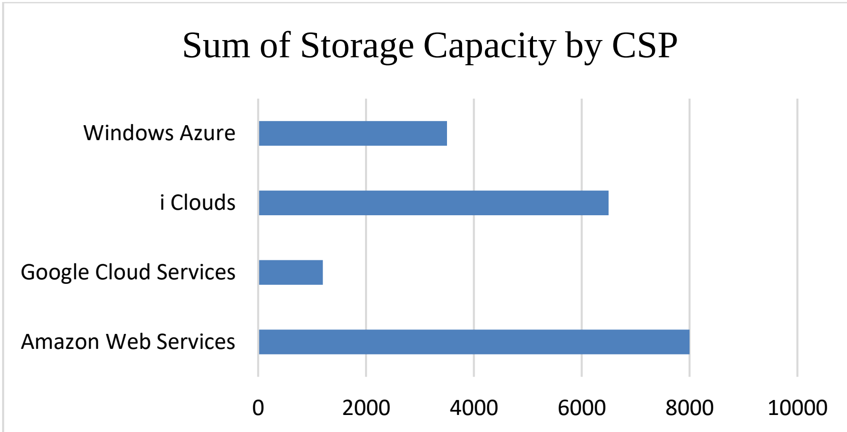
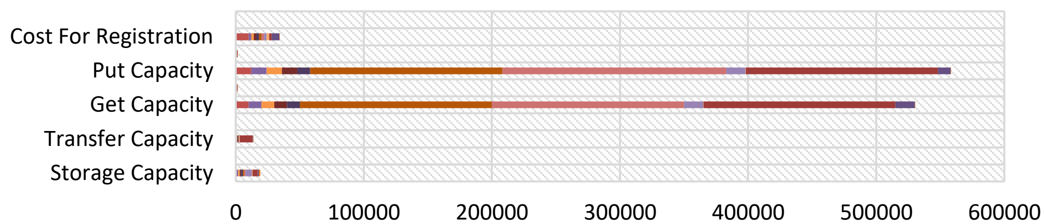


Fig. 8: Storage Capacity of each CSP in our model

The complete list of attributes are shown in Figure 9 and the total storage capacity of our data centers which are taken for simulation are shown in Figure 8 and storage comparison is shown in Figure 10.



	Storage Capacity	Cost for Storage/GB	Transfer Capacity	Cost for Transfer/KB	Get Capacity	Cost For Get/Request	Put Capacity	Cost For Put/Request	Cost For Registration	Months of valid
Amazon Us East Amazon Web Services	1000	5	200	10	10000	105	12000	150	10000	3
Amazon Us East Amazon Web Services	1000	6	500	10	10000	175	12000	145	2000	1
Amazon India Amazon Web Services	1000	6	500	10	10000	150	12000	125	2000	1
WA US Windows Azure	1000	6	500	15	10000	175	12000	150	2000	2
WA India Windows Azure	1500	5	500	15	10000	165	10000	200	2000	2
Gcs India Google Cloud Services	1200	5	100	12	150000	200	150000	200	2000	3
iCloud India i Clouds	1000	5	200	10	150000	210	175000	200	2000	3
iClouds Us i Clouds	5000	6	100	10	15000	100	15000	100	2000	1
GoDaddy i Clouds	500	10	400	10	100	20	100	20	2000	3
kishan Amazon Web Services	4000	10	10000	12	150000	5	150000	5	2000	1
Sud_DC Windows Azure	1000	10	500	5	15000	20	10000	15	6000	2
CS1 Amazon Web Services	1000	5	5	2	4	10	20	10	200	2

Fig. 9: List of the attributes and the sample data

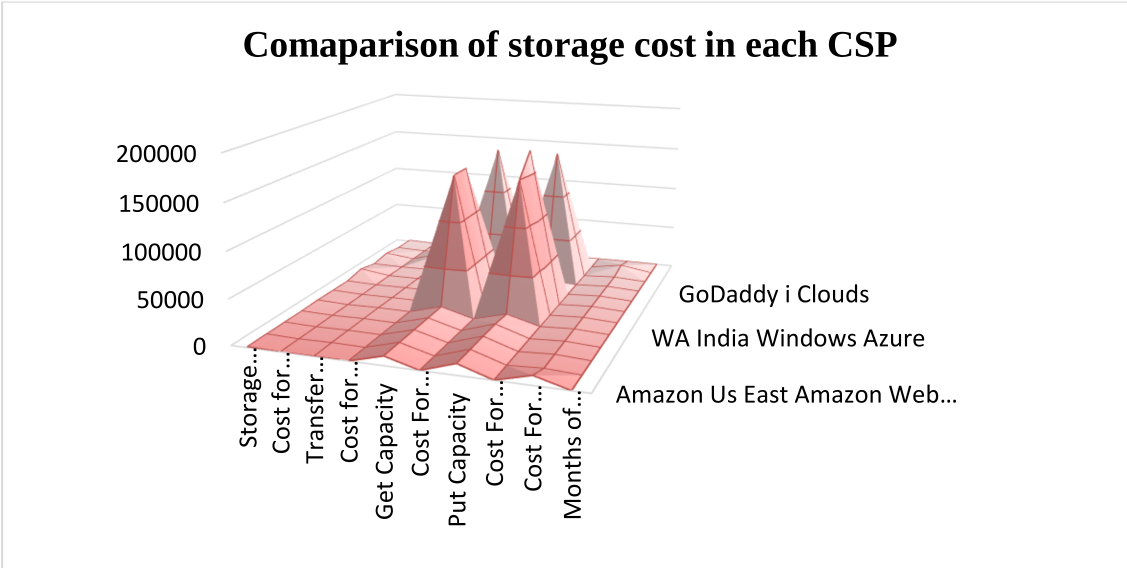


Fig. 10: Comparison of Storage Cost in each CSP

Our method effectively selecting the CSP which takes minimum cost based on the size of the data , number of Gets/Puts. We have also computed the total cost manually by selecting three data centers and observed that the data stored in AWS data center for the different values of attributes which are shown in Table 3. Our algorithm automatically selecting the AWS which is highlighted in Table 3 when a data file is to be stored in a data center. The analysis is shown in Figure 11 and the comparison results are shown in Figure 12.

Table 3: Cost Computation in 3 different CSPs using same data file

CSP	No. of Gets	No. of Puts	Total Cost
Windows Azure	2	2	112830.0056
AWS	**2**	**2**	**56415.0460**
I Clouds	2	2	112830.7999
Windows Azure	3	3	112830.0085
AWS	**3**	**3**	**56415.0689**
I Clouds	3	3	112831.2000
Windows Azure	10	10	112830.0283
AWS	**10**	**10**	**56415.23**
I Clouds	10	10	112834.0

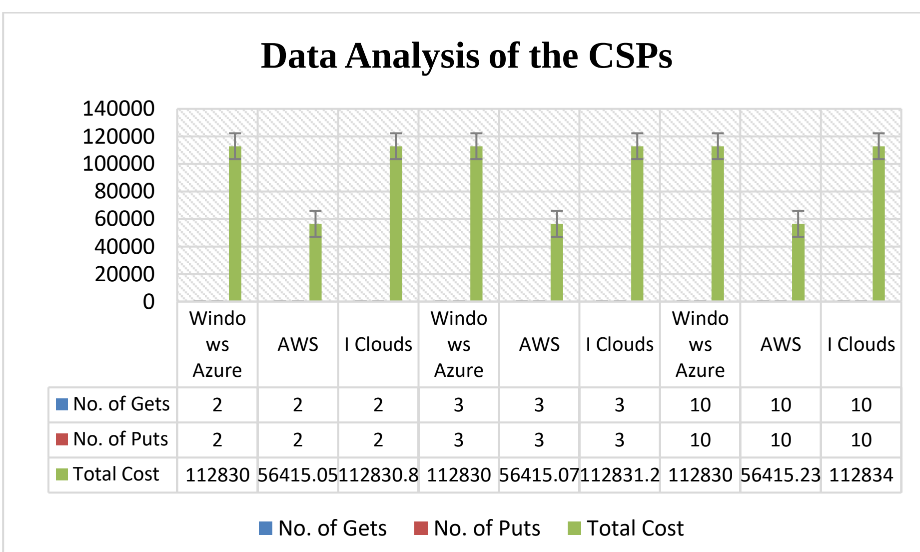


Fig. 11: Analysis of no. of Puts/Gets and Total Cost

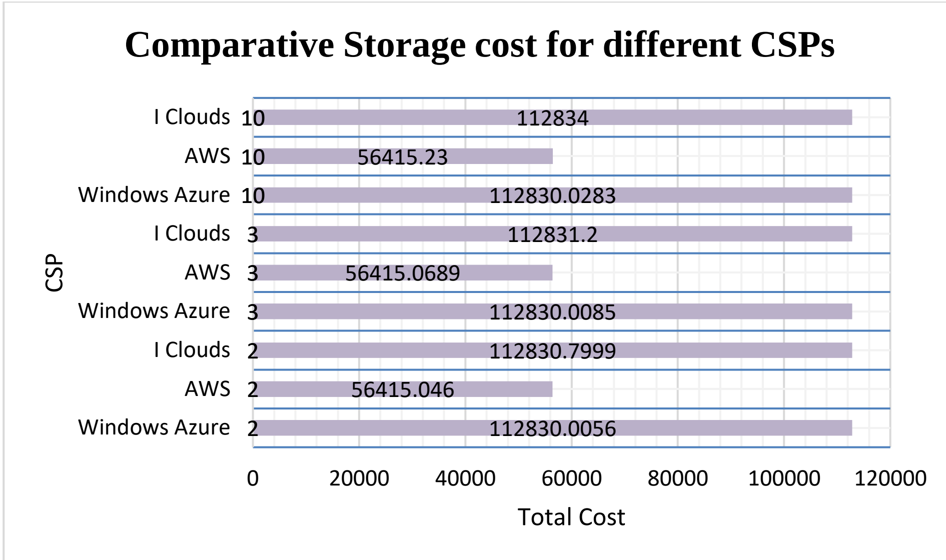


Fig. 12: Comparison of Storage cost in each CSP

5. Conclusion

In the cloud computing system, each user can access their data from remote server by making use of the internet instead of using their personal computer storage. Cloud computing is differentiated into three different categories such as Infrastructure-as-a-Service, Platform-as-a-Service, and Software- as-a-Service. In IaaS model, it always allows the user to use their server and storage as per their requirement. Many cloud service carriers (CSPs) provide information garage services with datacenters disbursed international. These datacenters provide different get/placed latencies and unit expenses for resource usage and reservation. In this paper we implemented the algorithm with minimum cost requirement for selecting the optimal data centers. In addition to this we also considered the latency. These works are extended based on the methods derived from coefficient-based totally statistics reallocation, multicast-primarily based information moving and request redirection-based congestion manipulate.

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