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Optimal Resource Allocation and Reservation using DAR in Large Scale Applications

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----------**ABSTRACT**----------

In the current IT industry, big data analytics and Cloud Computing are the two most basic advancements. Amazingly these two innovations are come up together to give the best outcomes for different multinational business companies. In the former case, it requires huge amount of resources such as memory or hardware to store, process and other kinds of big data analytics. The cost to store this data is greatly expanded and requires innovative algorithms to reduce this complexity and this will be easy to process less information using machine learning algorithms. Distributed applications are using cloud service providers (i.e. Amazon AWS) to host and process this data with different cost to meet service level agreements. However, the customers are interested in reliable SLAs with minimized cost to store and process their data. The data centers maintained at different locations throughout the world are giving services with different get/put latencies. Allocation of data to multiple data centers and resource reservation are the two primary issues and yet to be solved. In this work, we proposed a method to reduce the cost by meeting the SLOs with integer programming. Also, we proposed an efficient method to store the data files by the optimal selection by minimizing the cost along with resource reservation. Our experimental study shows that our technique is giving the best result by selecting the optimal selection of data center along with resource reservation and its effective utilization.

Keywords: Big data, CSP, Resource reservation, Optimal Selection, SLOs

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1. INTRODUCTION

From beginning onwards Information Technology is capable of being used for innovation and wide organizations, government and educational institutions. The democracy concept of Information Technology was not only affects the cloud storage but also influences big data too. The innovation of Hadoop (an open source) is enhancing at rapid pace and ability to do analytics on non-proprietary and provided resources is putting an end more pervasively. Surprisingly by the side, in today's we are seeing data explosion provided by the social networking, messaging, e-mails and so on via web. The unstructured information does not match with the conventional RDBMS structure. Nearly 3 billion GB data is producing 250 million tweets every day and 35 billion fragments of data shared through Facebook every month [1, 2]. How one can imagine storing this huge data. From another point of view Cloud Computing is one more technology where several organizations are offering particular services to its customers and most of other organizations for storing data and process it further. Even though the cloud computing and big data are still in static evolution and are proving to be an ideal combination. These dual technologies jointly furnishes a cost-effective and infrastructure which is scalable in order to support big data, business analytics. In this paper, we focused on reducing the storage cost in cloud applications and so that it will have a benefit of the big data applications. In Our work we put up an effort especially on cloud services, but it is applicable in various applications that are used for storing their data by using multiple data centers [2].

In cloud computing system, every user can have accessibility over their data from remote server through internet instead of using their PC storage. Cloud computing is specialized into three distinct models such as Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). In IaaS model, every time it enables user to utilize their server and storage based on their requirement. In PaaS model every time it allows user to develop their application on service provider framework (i.e. Google Apps) [16, 17]. In SaaS model, anytime it allows user to utilize an application through internet browser (i.e. Gmail). Cloud computing is divided into three kinds mainly as public cloud, private cloud and hybrid cloud. Public cloud is otherwise known as external cloud, which has availability on internet and is provided by the third parties namely Google, Amazon and so on. We can consider a private cloud environment as corporate or internal organization cloud and it always offers services inside private network. In recent IT industry, Private cloud prefers attaining data confidentiality. In Hybrid model environment different organizations are able to share their information internally [3]. In cloud services perspective the customers mainly concerns with easier utilization and outsourced administration should have good appeal [18]. The company's manager must provide an instant access on applications for their employee as they directly sign up into the system and can continue with their works by retrieving the remote data from remote data center. The users will assume that the retrieved data is safe and secured because the entire data is hosted by CSP. CSP's

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are expanding faster and needs the scalability and management or else there will be a greater impact on computations and networking because of load balance [5, 6].

Challenges in Big data and Cloud Computing

The fact is that, important company's and personal data will stores in remote organizations outside the company there raises severe issues and raises more 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 took one of the issue here i.e. Data Storage. For large companies it is essential that to store and analyze huge data and need a high infrastructure for storing and computing for different analysis [7]. By this serial expansion of data it is needed to generate an algorithm for data storage in a place i.e. Cloud Service with least computational cost and this problem is being provided a good solution in our work. This paper is organized as below. Under section 2 we have described the preliminaries of cloud and data center, CSP's features and related work that is done prior on cost related resource allocation. Section 3 covers our proposed work in this paper. Our practical results and discussion are covered in section 4. Conclusions are drawn in Section 5. The following Figure 1 represents the applications of Big Data.

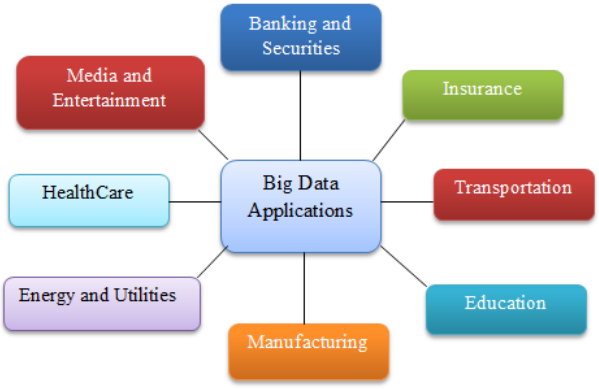

Figure 1: Applications of Big Data.

2. RELATED WORK

In this section, we only depicted a few basics regarding Cloud and datacenters including security and the cost in recent IT industry.

2.1 Role of Data center

2.1.1 Cloud vs. Datacenter

There are having two identical terms are "cloud" and "data center" which are related to the same infrastructure. But both the computing systems are especially for storing data as in common and not more. Cloud is an outermost form of computing where the information resides in internet, whereas the datacenter is an innermost hardware where the information resides in organizations LAN [8]. Another difference is that the cloud services are provided by third party since the interior IT department hosts the datacenters. The common objective of cloud and the servers is storing physical entity data and other relevant infrastructure is utilized in datacenter. There poses some typical questions for organizations such as whether to proceed with cloud or build their own datacenter. The opinion depends on three factors such as business requirements, data security and data storage cost [10].

2.1.2 Cloud security vs. data center security

Since cloud is an outer form of computing where there is less chance of security than in the datacenter. In datacenters we are able to provide security by our self and there is no presence of third party in this. If your cloud prevails on different datacenters in different locations, every location needs particular security measures. A datacenter is mapped with physical network at locally which makes easier to the company-approved credentials and equipment would access apps and stored data [15]. Nevertheless a cloud is accessible by anyone with specified credentials from anywhere by using internet.

2.1.3 Cloud vs. data center costs

A cloud is high cost-effective option than a datacenter for small scale businesses. Since you can construct an infrastructure and are responsible for managing and administration by yourself, a datacenter consumes more time for the start and more pricey approximately $30 million per year [20]. To distinguish with a datacenter, no time or capital is needed to start and run a cloud computing. Possibly most cloud providers provide a range of introduced subscription schemes to meet your budget and evaluate the service of your performance requirements. Whereas the datacenters takes time to form, depending on your provider. In addition to this there is availability of utilization of cloud services immediately after the registration is done [9].

2.1.4 Single vs Multi Computing Model

The utilization of cloud computing have been increased in various organizations. It gives more advantages in terms of cost and availability. Another name for cloud computing is pay per use model. The notable administrative service provided by the cloud computing is data storage. Here there is no need to have self-servers for clients/users since they are able store in CSP. Instead of providing data adaptability and its versatility it also makes user to store their information for a specific time period with minimal cost. Nevertheless these benefits user can retrieve their data from anywhere as long as they are connected with internet. As CSPs are the number of marketing bodies, data integrity, security is noticeable issues in distributed computing and to be described later [6] in spite of the known thing is that the CSP has good control and the

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infrastructure that guarantees the security for user data and provides greater accessibility. The data availability is the basic issue. In this strategy we can observe that a single CSP is not enough and do not provide availability bitterly and so that there is no guaranty on stored data. For suppose if CSP fails technically at that time we are not able to get the data. This structure is shown in Figure 2.a. Then a new notion is that to describe this issue known as multiple CSP, in which we can store user data in various datacenters. If CSP has technical failure we can access our data from the corresponding CSP, as we are maintaining CSP replications with similar data and this is shown in Figure 2.b. Critical system

Figure 2.a: Single Computing model

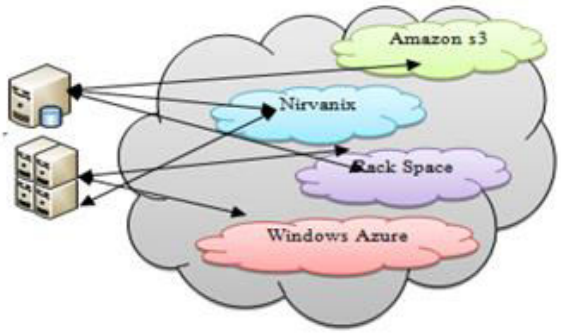

Figure 2.b: Multi Computing model

2.2 Features of Various CSPs

CSPs provide services to users on their request basis via wireless medium i.e. the internet. It is contrasted with the company's provided services private on proved services. These CSPs provided services are easy in usage and are scalable in accessing remote data and other hardware resources. In this section we illustrated some of the extensively used CSPs and its offered computer services, key cloud tools, pricing, pros and cons and are listed in Table 1.

Type	AWS	Microsoft Azure	Google
Computer services	EC2 Elastic container services for kubertness.	Virtual machines Container services	Compute engine Kubertness
Key cloud tools	Page maker to serverless AI and MI	Cognitive services Supporting MSFT Software	Big on AI IoT and serverless
Pricing	Cloud services pricing	Difficult to understand pricing structure.	Customer friendly pricing
Pros	Dominant market position Extensive, mature offerings supports for large organizatio ns Global reach	Second largest provider Hybrid cloud Supports for open source	Designed for cloud nature business Commitment to open source and portability Deep discounts and flexible contracts.
Cons	Difficult to use Cost management	Less "enterprise ready" Incomplete management tooling	Late entrants to IaaS market. Power features,services and w orld wide data centers.

Table 1: Comparison of Top 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

Table 2: Free Storage Space of numerous CSPs

2.3 Selection Criteria

Whenever you are confirmed to store and process data by using cloud computing, later you have to choose the CSP. It is important to assess the reliability and capacity of service provider that you make a plan to entrust with your company's applications and information. We need to consider the things are Business health and processes, Administration support, Technical capabilities and processes and Security practices [11, 12] and are shown in Figure 3. Business health and processes: Financial health, Organization, governance, planning and risk management, Trust, Business knowledge, Compliance audit. Administration support includes Service 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 comprises of Security infrastructure, Security policies, Identity management, Data backup and retention, physical security etc.

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Figure 3: Selection criteria for CSP

2.4 Dominant Cost Based Data allocation

In our work, we used the DAR concept. It involves with two phases. In the first phase, a dominant cost based data allocation algorithm is used. In the final phase, optimal resource reservation algorithm is used to reserve a particular resource for specific period.

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 $\exists\ t_k\ d_l \in G^{t_k}_{c_i}$ **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 $p_j \in S^g_{c_i} \cap S^p_{d_l}$ with the smallest $C^{d_l}_{c_i p_j}$ and satisfies all constraints
  for *each* p_j *with* $p_j \in L \cap S^p_{d_l}$ **do**
    if $(X^{d_l}_{p_j}=1 \rightarrow \phi^p_{p_i}<0) \vee (\phi^g_{p_i}=0)$ **then**
      Continue;
    Find the largest $H^{d_l}_{c_i p_j}$ satisfying $\phi^g_{p_i} \geq 0 \wedge H \geq H^{d_l}_{c_i p_j}$;
    if $C^{d_l}_{c_i p_j} \leq C^{d_l}_{c_i p_{k(k=j+1,\ldots,j+c)}}$ *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 $\Sigma_{p_j \in S^g_{c_i}} X^{d_l}_{p_j} \geq \beta \wedge H=o$ **then**
      break;

Algorithm 2: BSRR Algorithm

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

3. PROPOSED WORK

In this paper we represented a resource allocation algorithm particularly used in big data applications. To this we have induced distributed clouds in which the computational resources are very closely available to users i.e. inside the routers itself. It is very essential to have new algorithms for storing the data in CSP with lesser storage space and computational cost. As a solution to this solution, we proposed geo distributed cloud storage system for data storage allocates request and reservation of a particular resource for instance memory on multiple CSPs by using DAR algorithm. It directly helps the users to restrict their payment cost to ensure their SLOs and it also prevent the vendor lock-in issue as client would not constrain to an imperfect provider and can simply choose the optimal CSPs for storing their data. We clearly depicted our work here. Initially datacenters can be included from an organization in different locations globally. The clients can buy varied data centers owned by multiple CSPs. There have an opportunity to client for storing their data in a particular data center.

Our methods instantly select the optimal data center for storing user's data among various CSPs owned by the client for a specific time. To this we adopted a cost based allocation paradigm where if finds the predominant cost on the basis of data size, get or put requests etc. besides we also reserve a resource for a particular time by using resource reservation algorithm as PAYG manner. The Figure 4 represents the system architecture, the Figure 5 represents the system of get/put requests and our work process is shown in Figure 6 and is adopted from Guoxin Liu et.al [16].

The summary of our work is provided here. Customer Data Center (CDC) point outs a data center for operating Customer's application. A Customer can register in to various customer data centers represented by Dn. The customer will use $ci \in Dn$ which denotes ith datacenter of the customer. Dal , discover total data centers provided by all the CSPs. Consider $pj \in Dall$ represents the storage data center (SDC) 'j' relates to any of the CSP. The customers Put/Get requests can be forwarded from CDC to SDC. Two primary Service Level Objectives considered in this work are Get/Put latency and availability of data. We are going to store the data in a data center locally and other

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replicas can be stored in remote data center. The definition of the problem here is that, there is having 'p' number of data centers for every CSP. The primary objective of our work is to choose the optimal data center to store the data for a customer with minimal cost. Data Storage and Transfer are charged on the basis of 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 primary factors to evaluate the total cost to store the data in a specified data center.

DAR (Data Allocation and Resource reservation)

It is a mechanism to optimize the cloud services cost across multiple cloud providers. It performs-

a. Gathering the customer essentials when they storing the data.
b. Estimates the dominant cost of unit data.
c. Finding the optimum cost cloud data center.
d. Store data in that data center which have a minimum cost.

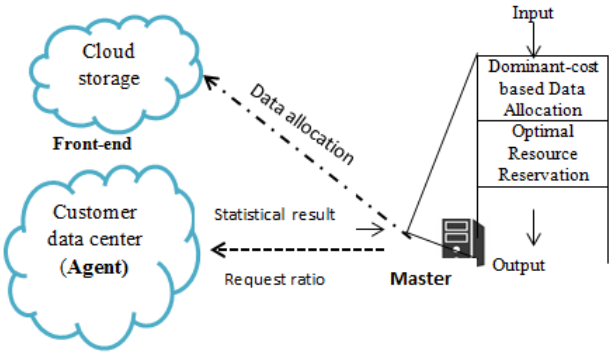

Figure 4: Overview of DAR's Structure

The main advantage of the work we proposed is that we took a small file and found storage cost of every service provider and optimized the cost for storage by selecting the optimal storage service which is mandatory in Big Data applications. In those types of applications, storage cost is an important factor that influences the growth of IT industries and further where the replication occurred; on those situations our work performs the outstanding outcomes with minimal cost.

4. EXPERIMENT WORK & COMPARATIVE STUDY

This section shows the experimental study of our work. We have taken a sample data set of data centers of four types of cloud service providers i.e. Azure, AWS, iCloud, Google Cloud services. The works is comprised using the set of languages Java as a front end and MySQL as backend to store the data files. The files are stored in remote location and the user can store any number of replicas of it. The primary goal of this work is to reduce the cost from the user end so that most of service level agreements should be minimized.

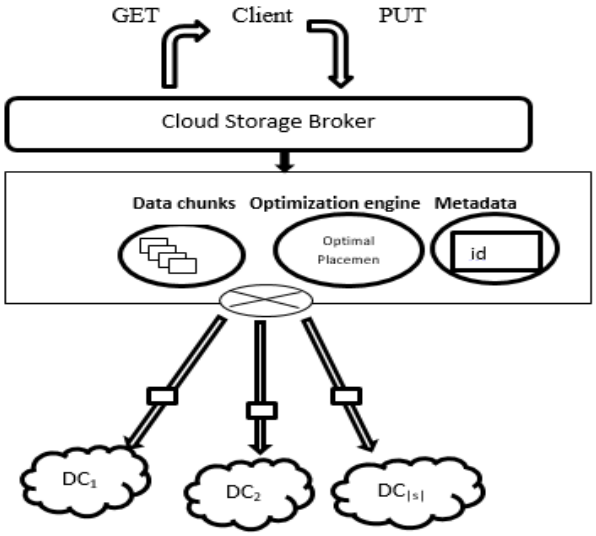

Figure 5: System model: GET and PUT requests

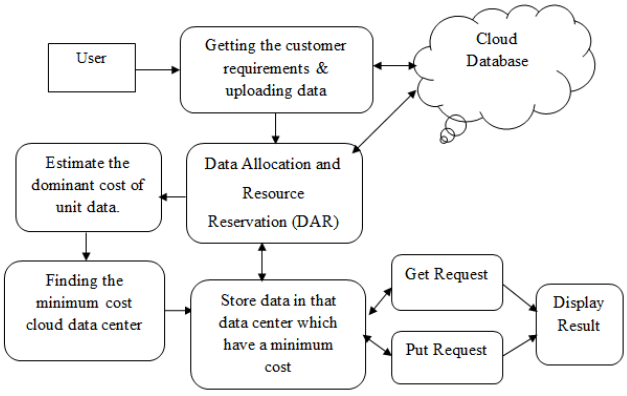

Figure 6: Flow of proposed work

For the major CSPs, the data centers are established at different locations, where the actual data is being stored. In genera;, the data files are stored in their nearest locations, the problem with this approach is that if the size of file is increased, to store the replicas, it require even more storage space.

To reduce this we have used DAR algorithm, where the company can place the data centers at different locations. The users can opt the number of data centers from 1 to n from these cloud service providers. If user wants to store a data file, he is able to save the file with less cost in an appropriate data center automatically. Our data set contains different data centers and we have stored the test files in all the data centers with different put/ get frequencies and compared the results**.** The sample data set is shown in Figure 7.

The details of the CSPs owned by the customer for a specific period is shown in Figure 7. The customer can purchase any number of other cloud services. We have taken four services from windows, amazon, and 2 data centers from iCloud. We can upload the data individually by opting the desired CSP and our main aim is to select the

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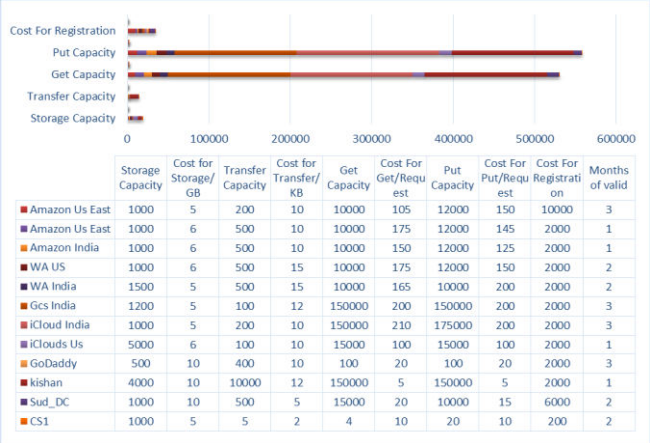
optimal cloud service provider i.e. the while uploading the data, after selecting the file our DAR algorithm will find the better place to store the data by considering all the parameters which we have discussed earlier.



	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	1000	5	200	10	10000	105	12000	150	10000	3
Amazon Us East	1000	6	500	10	10000	175	12000	145	2000	1
Amazon India	1000	6	500	10	10000	150	12000	125	2000	1
WA US	1000	6	500	15	10000	175	12000	150	2000	2
WA India	1500	5	500	15	10000	165	10000	200	2000	2
Gcs India	1200	5	100	12	150000	200	150000	200	2000	3
iCloud India	1000	5	200	10	150000	210	175000	200	2000	3
iClouds Us	5000	6	100	10	15000	100	15000	100	2000	1
GoDaddy	500	10	400	10	100	20	100	20	2000	3
kishan	4000	10	10000	12	150000	5	150000	5	2000	1
Sud_DC	1000	10	500	5	15000	20	10000	15	6000	2
CS1	1000	5	5	2	4	10	20	10	200	2

Figure 7: Input data with Certain Parameters.

We compared by taking a test file of size of 11 kilo bytes. We have taken a file which has small in size, but in real time the size of the file is huge i.e. typically in Giga Bytes. The cost is computed for the test file with different get/put frequencies as shown in Figure 8.

CSP	Gets	Puts	Total Cost
Azure	1	1	112170.0028
AWS	**1**	**1**	**56085.0229**
iCloud	1	1	224342.0
Azure	2	2	112830.0056
AWS	**2**	**2**	**56415.0460**
iCloud	2	2	112830.7999
Azure	3	3	112830.0085
AWS	**3**	**3**	**56415.0689**
iCloud	3	3	112831.2000
Azure	1	1	112170.0080
AWS	**6**	**6**	**56085.1380**
iCloud	1	1	224352.000
Azure	10	10	112830.0283
AWS	**10**	**10**	**56415.23**
iCloud	10	10	112834.0

Figure 8: Comparison result of Computational cost with different get/put latencies

The get/put frequency of the CSP is shown in Figure 9 and the cost to store the file and error percentage with each data center are shown in Figure 10 and Figure 11.

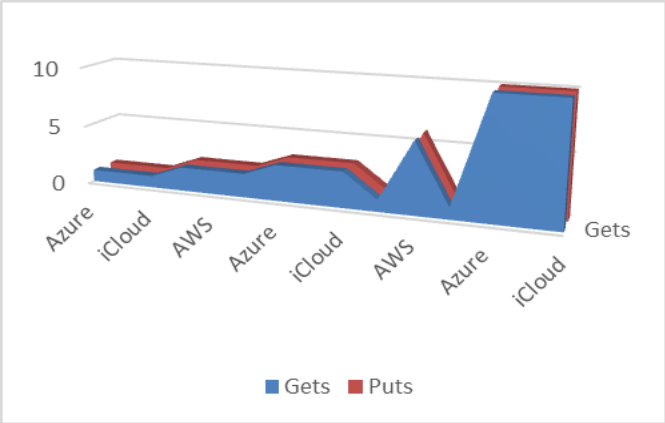


Figure 9: Get/Put requests of each CSP

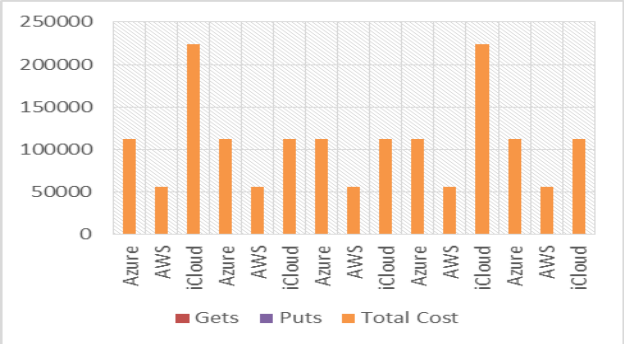


Figure 10: Comparison of Total cost of each CSP

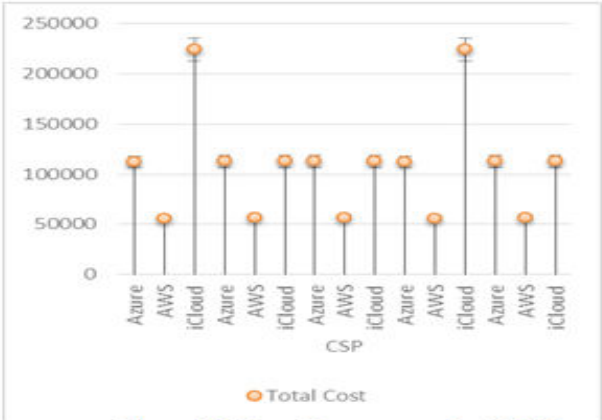


Figure 11: Error Percentage of each CSP

5. CONCLUSION

In cloud computing model, every user is able to access their information from remote server via internet instead from their PC storage. Cloud computing is specialized into three distinct models such as Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). Most of the CSP's (Cloud Service Providers) gives data garage services with datacenters disbursed worldwide. Those datacenters provides various get/placed latencies and costs per unit for resource

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utilization and reservation. In this paper we have implemented an algorithm with least cost requirement to choose the optimal datacenters. Additionally we also took latency into sight. These works are continued on the basis of derived methods from coefficient-based totally statistics reallocation, multicast-primarily based information moving and request redirection-based congestion manipulate.

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