# Resource Provisioning Cost of Cloud Computing by Adaptive Reservation Techniques

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***Abstract* – In this paper presents the Cloud providers to provide cloud consumers for two provisioning plans are On-Demand plan and Reservation plans. Because it provides users an efficient way to allocate computing resources are dynamically to meet demands. Normally, cost of utilizing computing resources provisioned by on-demand plan is higher than reservation plan. Because reservation plan can provide offer of consumer can reduce the total resource provisioning cost. It can be achieved in Uncertainty of consumer's future demand and provider's resource prices. To control the cloud resources adaptively based on the reservation technique for under over provisioning (RTUOP) algorithm. The RTUOP algorithm is used to multi provisioning stages of long-term plan. The OCRP mainly considered in the demand and price uncertainty. The solutions of the RTUOP algorithm are considered including benders decomposition deterministic equivalent formulation and stochastic integer programming. To overcome this problem to applied by the scenario reduction techniques (SRT) to reduce the number of scenarios and successfully minimize total cost of resource provisioning in cloud environments.**

***Key Words* – Cloud computing, resource provisioning, virtual machine, stochastic programming, scenario reduction technique**

## 1. INTRODUCTION

Cloud computing is a large-scale distributed computing paradigm in which a pool of computing resources is available to users via the internet. Several trends are opening up the era of Cloud Computing, which is an Internet-based development and use of computer technology. The ever cheaper and more powerful processors, together with the software as a service (SaaS) computing architecture, are transforming data center into pool of computing service on a huge scale. The Internet as a service (IaaS) is increasing network bandwidth and reliable yet flexible network connections. In this model considered, virtualization technologies can be used to provide resources to cloud consumers. The consumers can specify the required software stack, e.g., operating systems and applications. The hardware requirement of VMs can also be adjusted by the consumers. Finally, those VMs will be outsourced to host in computing environments.

In this paper, minimizing both under provisioning and over provisioning problems under the demand and price uncertainty in cloud computing environments is our motivation to explore a resource provisioning strategy for cloud consumers. In particular, an optimal cloud resource provisioning (OCRP) algorithm is proposed to minimize the total cost for provisioning resources in a certain time period. To make an optimal decision, the demand uncertainty from cloud consumer side and price uncertainty from cloud providers are taken into account to adjust the tradeoff between on-demand and oversubscribed costs.

This optimal decision is obtained by formulating and solving a stochastic integer programming problem with multistage recourse. Benders decomposition and sample-average approximation are also discussed as the possible techniques to solve the RTUOP algorithm. Extensive numerical studies and simulations are performed, and the results show that RTUOP can minimize the total cost under uncertainty. A cloud provider is responsible for guaranteeing the Quality of Services (QoS) for running the VMs. The pioneer of Cloud Computing vendors, Amazon Simple Storage Service (S3) and Amazon Elastic Compute Cloud (EC2) are both well-known examples. It can be acted by another operating system environment to increase in our source that produced in high bandwidth.

## 2. RELATED WORK

In [1], Available resource provisioning options was proposed. A profile-based approach to capture expert's knowledge of scaling applications was proposed in [9] which extra demanded resources can be more efficiently provisioned. The concept of resource slot was proposed in [3]. In [4] the arrival pattern of workloads is estimated by using online forecasting techniques. In [10], heuristic method for service reservation was proposed. Prediction of demand was performed to define reservation prices. In [2], K-nearest-neighbors algorithm was applied to predict the demand of resources. In [11], a dynamic VM placement was proposed. However, the placement is heuristic-based which cannot guarantee the optimal solution. The optimal virtual machine placement (OVMP) algorithm was proposed in [7]. This OVMP algorithm can yield the optimal solution for both resources provisioning and VM placement in two provisioning stages. In [8] introduce the OCRP algorithm in this paper which achieves many improvements. The problem is generalized into the multiple stage formulation first. Second the different approaches to obtain the solution of computing resource provisioning are considered. To analyze the [6] Sample Average Approximation (SAA) to be calculated in the under and over provisioning level to be calculated. Motivated by this previous work, we introduce Scenario Reduction Techniques (SRT) are achieves more availability than RTUOP algorithm can avoid the under provision and overprovision problems.

## 3. SYSTEM MODELS AND ASSUMPTIONS

It considered by the cloud provider, cloud broker, user and Virtual machines are used to design the system model and analyzed the resource provisioning concept.

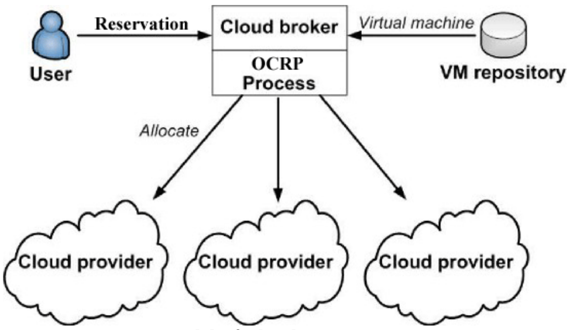


Fig.1. System Model of Cloud Computing Environment.

### *3.1 Cloud Computing Environment*

As shown in Fig. 1, the system model of cloud computing environment consists of four main components, namely cloud consumer, virtual machine (VM) repository, cloud providers, and cloud broker. The cloud consumer has demand to execute jobs. Before the jobs are executed, computing resources has to be provisioned from cloud providers. To obtain such resources, the consumer firstly creates VMs integrated with software required by the jobs. The created VMs are stored in the VM repository. Then, the VMs can be hosted on cloud provider's infrastructures whose resources can be utilized by the VMs. In Fig. 1, the cloud broker is located in the cloud consumer's site and is responsible on behalf of the cloud consumer for provision resources for hosting the VMs. In addition, the broker can allocate the VMs originally stored in the VM repository to appropriate cloud providers. The broker implements the OCRP algorithm to make an optimal decision of resource provisioning.

### *3.2 Provisioning Plans*

A cloud provider can offer the consumer two provisioning plans, i.e., reservation and/or on-demand plans. For planning, the cloud broker considers the *reservation* plan as medium to *long-term planning*, In contrast, the broker considers the *on-demand* plan as *short- term planning*, since the on-demand plan can be purchased anytime for short period of time.

### *3.3 Provisioning Phases*

The cloud broker considers both reservation and on-demand plans for provisioning resources. These resources are used in different time intervals, also called provisioning phases. There are three provisioning phases: *Reservation*, *Expending*, and *On-Demand* phases. First in the reservation phase, without knowing the consumer's actual demand, the cloud broker provisions resources with reservation plan in advance. Second the demand exceeds the amount of reserved resources, the broker can pay for additional resources with on-demand plan. As a result, the reserved resources could be observed to be either *over-provisioned* or *under provisioned.*

### *3.4 Uncertainty of Parameters*

The optimal solution used by the cloud broker is obtained from the OCRP algorithm based on stochastic integer programming .Stochastic programming takes a set of uncertainty parameters described by a probability distribution into account.

### *3.5 Provisioning Costs*

With three aforementioned provisioning phases, there are three corresponding provisioning costs incurred in these phases, namely reservation, expending, and on-demand costs. The main objective of the RTUOP algorithm is to minimize all of these costs while the consumer's demand is met, given the uncertainty of demand and price. The reservation cost is defined as follows:

$$c_{ijk}^{(R)} = \sum_{r€R} b_{ir}\, c_{jkr}^{(R)}.$$

4. STOCHASTIC PROGRAMMING MODEL

In this section, the queue will follows the first in first out technique to apply the scheduling. For our reservation technique we implement the scheduling algorithm of priority scheduling. Priority scheduling will take the starting date which is specified in the reservation plan. Virtual machines are individually scheduled during the time of when the reservation plan submitted. Next we use the scenario technique to reduce the scenarios present in the individual services.

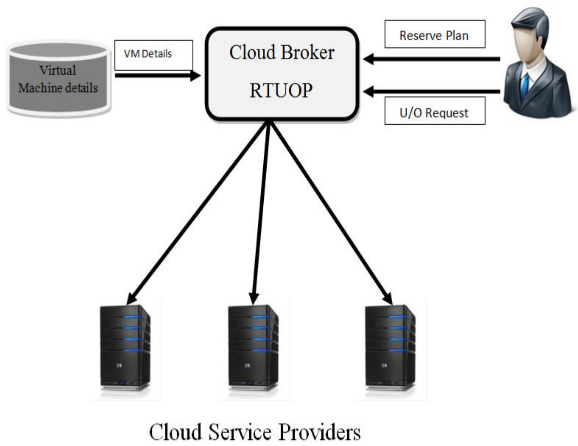


Fig. 2. System Diagram of RTUOP Concept.

*4.1 Stochastic Integer Programming for RTUOP*

Stochastic programming problems appear as mathematical models for optimization problems under stochastic uncertainty. Most computational values are solving underlying probability distribution by a probability measure with finite support.

It formulated by,

$$z = \sum_{i€I} \sum_{j€J} \sum_{k€K} c_{ijk}^{(R)}\, x_{ijk}^{(R)} + IE_{\Omega}\,[\prod(x_{ijk}^{(R)}, w)]$$

Subject to,

$$X_{ijk}^{(R)} € IN_0, \qquad ¥i € I,\ ¥j € J,\ ¥k € K.$$

*4.2 DETERMINISTIC EQUIVALENT FORMULATION*

A probability distribution of all scenarios in sets is transformed into the deterministic integer programming called deterministic equivalent formulation. To solve this DEF, probability distributions of both price and demand must be available.

It Expressed by,

$$\hat{z}_{\Omega} = \sum_{i€I} \sum_{j€J} \sum_{k€K} cijk^{(R)}\, x_{ijk}^{(R)} + \sum_{w€\Omega} \sum_{i€I} \sum_{j€J} \sum_{k€K} \sum_{t€T_k} p\,(w)\, c_{ijkt}^{(r)}(w)\, x_{ijkt}^{(r)}(w) + \sum_{w€\Omega} \sum_{i€I} \sum_{j€J} \sum_{t€T} p(w)\, (\sum_{k€K} c_{ijkt}^{(e)}(w)\, x_{ijkt}^{(e)}(w) + c_{ijt}^{(o)}(w)\, x_{ijt}^{(o)}(w)\,)$$

*4.3 BENDER'S DECOMPOSITION*

The Benders decomposition algorithm is applied to solve the stochastic programming problem. The goal of this algorithm is to break down the optimization problem into multiple smaller problems which can be solved independently and parallelly.

It derived by,

$$z_v^{(r)} = \sum_{i€I} \sum_{j€J} \sum_{k€K} \sum c_{ijk}^{(R)}\, x_{ijk}^{(R)} + \sum_{w€\Omega} \sum_{i€I} \sum_{j€J} \sum_{k€K} \sum_{t€T_k} \sum p(w) c_{ijkt}^{(r)}(w)\, x_{ijkt}^{(r)}(w)$$

*4.4 SAMPLE AVERAGE APPROXIMATION*

The SAA approach is applied to approximate the expected cost in every considered provisioning Stage. Because the number of scenarios is numerous, it may not be efficient to obtain the solution of the OCRP algorithms are solved. It performed in two boundaries form. They are,

4.4.1 SAA Lower Bound Estimates:

The SAA lower bound can be obtained from

$$L_{N,\,M} = (1/M) \sum_{m=1}^{M} \hat{z}^{*}_{N,m.}$$

Where $L_{N,\,M}$ is an unbiased estimator of the mean which forms a statistical lower bound for z*.

4.4.2 SAA Upper Bound Estimates:

The SAA upper bound can be estimated from

$$L_{\dot{N},\,\dot{M}}\, (\ddot{\mathbf{x}}^{*}_{N}) = (1/\dot{M}) \sum_{m=1}^{\dot{M}} \hat{z}^{*}_{\dot{N},m}\, (\ddot{\mathbf{x}}^{*}_{N}).$$

Where the distribution of SAA upper bound estimate converges to a normal distribution.

4.4.3 Scenario Reduction Techniques:

Assume that the original probability distribution $P$ is discrete and carried by finitely many scenarios $w_i \in \Omega$ with weights $p_i > 0$, I = 1,.., N and $\sum^{N}_{i=1} pi = 1$. i.e . . . . , $P = \sum^{N}_{i=1} p_i \partial w_i$. Let J < {1….N} and consider the probability measure $Q$ having scenarios $\omega j$ with probabilities $qj$ , $j \in \{1, . . . , N\} \setminus J$ , i.e., compared to $P$ the measure $Q = \sum_{j\epsilon J}$ is reduced by deleting all scenarios $\omega j$, The optimal reduction concept described in Section 2 advices to consider the functional

$$D (J ; q) := \mu_c \left(\sum_{i=1}^{N} p_i \partial w_i, \sum_{j\epsilon J} q_j \partial w_j \right),$$

Where the function $c$ is chosen such that the underlying stochastic program behaves stable with respect to the Fortet-Mourier metric $\zeta c$ and, hence, with respect to the Kantorovich functional $\hat{}\mu c$.We assume throughout this section that $c$ satisfies (C1)–(C4). The reduction concept (9) says that the index set $J$ is selected such that the distance $D (J ; q)$ of the original and the reduced measure is optimal subject to all index sets with given cardinality. We distinguish two cases: *optimal* or *prescribed* weights $qj$ , $j \_\in J$. Our first result provides an explicit representation of $D (J ; q)$ in case of optimal weights $q$.

*4.6. RESERVATIONT TECHNIQUE for UNDER OVER PROVISIONING (RTUOP) ALGORITHM*

**RTUOP**

**Global** Reservation_Plan R, Cost C, Time t;

**Stochastical_Computation (**Reservation_Plan p, Cost c**)**

Check no. of reserved vm in p;

Scost=no. of vm * c;

**Return** scost;

**Provisioning_Computation (**Reservation_plan p, Cost_plan cp)

Check the reserved services in p;

Cost c1 = Get the cost for each service for 1 day in cp

Cost c2 = Get the size for each service for 1 day in p

Cost = sum of (c1* c2)

**Return** cost;

**Benders_Computation (Data**_in_cloud dc, time t**)**

Size s1= check the size of the data in cloud

Cost c1=check the cost of the data

Date d1 =Get the last computed date in dc;

Cost = s1* c1*(t-d1);

**Return** Cost;

**Main ()**

Cost_paln cp;

Rservation_plan P = Get reservation plan;

Cost cc = Provisioning Computation (p, cp);

User login and file uploading;

Stocastical_computation**(** p, cc**);**

Data_in_Cloud d;

Cost c=Benders_decomposition (d, t);

**End**

## 5. COST BENEFIT ANALYSIS

First set the cloud environment, the environment consist of only one consumer. Initially the resource reserved by advance reservation of reservation plan in first phase of both OCRP & RTUOP algorithm. In OCRP algorithm, any under provisioning or overprovisioning problem will arise or not is checking. In second phase SRT algorithm predict future need. In third phase both algorithms used on demand phase to solve this problem.

Assumption are expending cost for both algorithms is zero, number of VMS reserved is 1 and small load variation is not consider.

Table 1 shows the details of customer total paying cost using OCRP algorithm

. Table 2 shows the same consumer utilize the same resources by using Scenario Reduction RTUOP algorithm the under or over provisioning problem occur in four time in five stages. But using the SRT algorithm the total paying cost for resource in cloud is low when predicted future prediction is relatively correct. Assume the prediction always true here Using Scenario Reduction Tech only allowed the user.

*Table 1: Consumer sample provisioning cost detail using OCRP algorithm*

| **Existing OCRP algorithm** | | | | | |
|---|---|---|---|---|---|
| Si No | Reservation Plan | | On Demand Plan | | Problem |
| | Resources | Cost | Resources | Cost | |
| 1 | 2gb | 10$ | Nil | 0 | No |
| 2 | 2gb | 10$ | 1024 Mb | 5$ | Yes |
| 3 | 2gb | 10$ | 256 Mb | 1$ | Yes |
| 4 | 2gb | 10$ | 800 Mb | 6$ | Yes |
| 5 | 2gb | 10$ | 600 Mb | 3$ | Yes |
| Total cost | | | | 65$ | |

*Table 2: Consumer sample provisioning detail Using RTUOP algorithm*

| **Proposed RTUOP algorithm** | | | | | |
|---|---|---|---|---|---|
| Si no | Reservation Plan | | On Demand Plan | | Prob Lem |
| | Resources | Cost | Resources | Cost | |
| 1 | 2gb | 10$ | Nil | 0 | No |
| 2 | 1.25gb | 08$ | 200 Mb | 2$ | Yes |
| 3 | 2.50gb | 14$ | Nil | 0 | No |
| 4 | 1.50gb | 10$ | Nil | 0 | No |
| 5 | 2.50 gb | 14$ | Nil | 0 | No |
| Total Cost | | | | 58$ | |

Normally the prediction value not exactly true so small deviation will occur here. After some few stages the prediction value should be optimal and provision problem will solved early.

Table 3 shows the comparison result in cost parameter for both OCRP and RTUOP algorithm. First Table 3 shows the comparison result in cost parameter for both OCRP and RTUOP algorithm. First and third stage both algorithm produce nearly same cost. Other three stages RTUOP algorithm produce low cost for reserved cloud resources. The total paying cost for resources in cloud is low in proposed system when the prediction value is correct. In initial stage, prediction value will differ from actual value but in later stages, prediction value will produce more approximate equal value to actual value. In later stages, RTUOP algorithm should be produce optimal cost.

Fig 1 shows the difference between the on-demand plan and reservation plan cost of data storage service method. Because there are used to Scenario Reduction technique allocated by lowest cost and minimum processing time in reservation method. They can be only allocated in the user and cost of columns is used in the diagram.

Fig 2 shows the difference between the on-demand plan and reservation plan cost of data storage service method. In initial stage, prediction value will differ from actual value but in later stages, prediction value will produce more approximate equal value to actual value. So in later stages RTUOP algorithm should be produce optimal cost. The virtual machines are created by the cloud and allocate in the memory for storing database, file system and software's. Because the cloud provider is responsible for guaranteeing the Quality of Service (QoS) for running the VMs. It achieve the optimal computing resource management is the critical stage problem in very shortly.

*Table 3: Consumer Resource Utilization Details for Both Algorithms*

| SI. NO | OCRP | | | RTUOP(with true prediction) | | | RTUOP (with wrong prediction) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Resource | Utilization | Problem | Resource | Utilization | Problem | Resource | Utilization | Problem |
| 1 | 2gb | 2gb | No | 2gb | 2gb | No | 2gb | 2gb | no |
| 2 | 2gb | 2.5gb | up 0.5 gb | 2.6gb | 2.5gb | No | 2.3 gb | 2.5gb | up 0.2 gb |
| 3 | 2gb | 2.5gb | up 0.5 gb | 2.7gb | 2.5gb | No | 2.25 gb | 2.5gb | up0.25gb |
| 4 | 2gb | 2.7gb | up0.7 gb | 2.8gb | 2.7gb | No | 2.3 gb | 2.7gb | op 0.4gb |

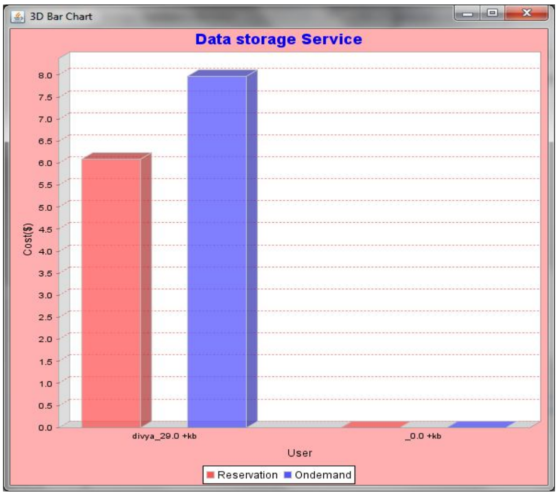


*Fig 1: Consumer resource utilization of Data storage service details in rtuop (with true prediction) algm*

## 6. UTILIZATION BENEFIT ANALYSIS

In this utilization analysis we analysis how much resources are available and how much resources are utilized by consumer. Table 3 shows the performance details of the customer using both algorithms. Using OCRP algorithm we need 0.5GB, 0.5GB& 0.7GB more additional resources in second, third stage and final stage respectively. Totally 1.7GB over provisioning occurs. In SRT Concept are correct prediction of future need the additional resources are reserved previously, so the under provisioning and over provisioning problem not occur when the prediction value is always true. In second case of PCRP is with wrong prediction, 0.2 GB and 0.25 GB, 0.4 GB under provision will occur. Totally 0.85 GB under provision will occur. This provisioning problem rate is low compare to OCRP algorithm.

Fig 4 shows the resource allocation of data storage service that compared in on-demand and reservation plans. The OCRP algorithm we reserved 2 GB advance for all stages, false prediction value lies in between true prediction value calculate the correct cost of price by using RTUOP algorithm. Fig 5 shows the software service resource can be allocated in the both the provisioning plans. The ideal state of all true prediction is reducing the total cost of cost rate compare to OCRP. Even the prediction value is not correct the cost rate is high compare to OCRP. The cost rate of RTUOP false prediction value lies between both methods similarly in resource allocation.

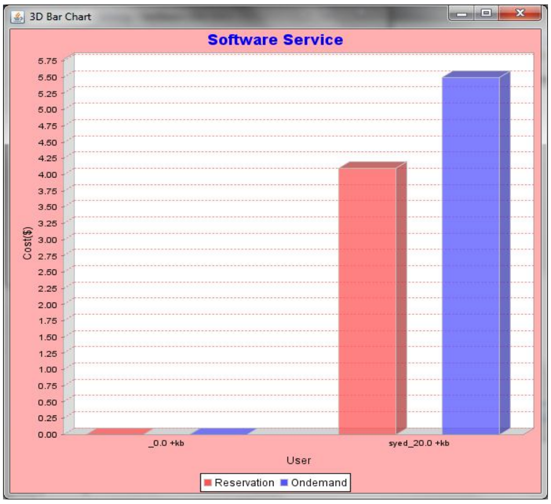


*Fig 2: Consumer resource utilization of Software service details in rtuop (with false Prediction) algm*

## 7. EXPERIMENTAL DISCUSSION

### *7.1 Results*

1. Limitation of Stochastic Programming*:* It obtained appropriate probability distribution describing Uncertainty.

2. Balance of costs: The cloud provider with SRT will minimize on-demand cost rather the oversubscribed cost and the reservation plan is more attractive by the cloud broker

3. Benefit of SAA: Sample-average approximation method can overcome the provisioning problems with a large set of scenarios.

4. Order of Scheduling*:* Priority Scheduling can be used to maintain the database in random order.

5. Lowest Processing Time: Scenario Reduction Techniques are maintaining the low processing time.

### *7.2 Future work*

For the future work, Probability based Cloud Resource Provisioning (PCRP) algorithm will be applied to huge sudden work load variation and Improve the security in the cloud environment by using the Cipher Techniques (CT). Reservation technique may cause some unauthenticated user access. It may be reduced by using the cipher techniques. In addition, the optimal pricing scheme for cloud provider's competition market will be investigated.

## 8. CONCLUSION

This paper, we have proposed the Reservation Technique for Under over Provisioning (RTUOP) algorithm to provision resources offered by multiple cloud providers. As the results, the algorithm can adjust the tradeoff between reservations of resources and allocation of on-demand resources. The SRT can be used as a resource provisioning tool for the emerging cloud computing market in which the tool can effectively save the total cost and better utilizing resources. The DET can be Equivalent to the whole value of workload variations using this model. The SAA approach can effectively achieve an estimated optimal solution even the problem size is greatly large and can eliminate under provisioning and over provisioning problems because the prediction value will accurate. In SRT concept can be used as a resource provisioning tool for the emerging cloud computing market in which the tool can effectively save the total cost.

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