International Journal of Information and Computation Technology.
ISSN 0974-2239 Volume 4, Number 3 (2014), pp. 299-308

http://www. irphouse.com /ijict.htm

# Study on Cost Estimation of Service Delivery in Cloud Computing Environment

**Rajesh Pal[1], Samaresh Mishra and PrasantKu.Patnaik**

*School of Computer Engineering, KIIT University, Bhubaneswar.*

## Abstract

The term cloud computing is sometimes used to refer to a new paradigm; some authors even cited a new technology that offers IT resources and services over the Internet. Cloud computing is becoming a powerful network architecture to perform large-scale and complex computing. Economic crisis can bring with enterprise as unpredicted business challenges now a days and more competition in the same market. To address different challenges, enterprise has to optimize and update their business operation. Moreover Cloud business is growing now days with respect to rapid application development with the existing large variety of options. So rapid advancements in cloud computing allowed multiple providers to offer basic computational resources to consumers as a digital service with the benefits of 'on-demand' and 'pay-per-use' characteristics of cloud. Basically Cloud Computing is an internet based distributed computing where user only concentrate on more on their business process rather than spending time the managing process. Here estimating cost is very important for cloud application when it needs remaining a certain services level at the same time interval. In this paper, we have studied some existing works on cost estimation of service delivery while application is being developed under Cloud computing environment.

**Keywords**: Cloud Computing, Cost Estimation, Networks,Rapid Application Development.

## 1. Introduction

Cloud Computing is an internet based computing which is based on utility, that provides different types of services by utilizing pool of resources mainly hardware, software, database, network, in terms of pay-for-use basis as per specific Service label agreement [1]. Cloud Computing is becoming more and more popular at present information technology setup of many large organizations. Now a day's organizations are more serious about quality product and rapid application development. Apart from business customers, cloud computing environment is also attractive to many scientists and engineering field. Cloud computing is a concept where IT resources and services are provided via internet i.e. highly scalable, on demand, web accessed IT resources, Cost and flexibility benefits due to Standardization, Modularization, and Virtualization[1][2].

## 2. Software Cost Estimation in Cloud Computing Environment

Accurately estimating software size, cost, effort and schedule is probably the biggest challenge for software developer now days. Software cost Estimation is a complex activity that requires knowledge of a number of key attributes about the project which is being constructed. On the other handCloud computing is all about cutting costs and we can say Cloud Computing is Cost-driven manifestation by which customers pay only for what they use. Whether you are a developer, small business or a global multi-national corporation, you will enjoy with your standard services [3].In Cloud Computing Environment (CCE) the estimation can be predicted through services that are provided by service provider. Servicesare generally pool of resources which is based on specific SLA [1]. Eventually, market-oriented resource management is necessary to regulate the supply anddemand of Cloud resources to achieve market equilibrium (where supply = demand) in betweencloud consumers and providers.In contrast to that many organizations are facing challenges to find out the exact total costs caused by offering own services in the cloud as well as to compare them with the costs caused by its own datacenter.On the other hand to derive appropriate market-based resource managementstrategies that encompass both customerdriven service managementand computational risk management to sustain SLA oriented resource allocation.

This paper has been organized as follows.

The section-3, we have shown the review of literature and the section-4 discussed the comparison among various models and matrix. In section-5 we have summarized the discussion and atlast we have given our conclusion and future work.

## 3. Literature Review

*Hong-Linh Truong and SchahramDustdar*suggested a Composable cost estimation model that is based on a service for estimating, analyzing and monitoring costs that associated with scientific applications in the cloud [4]. In this paper authors also have presented techniques to estimate costs for service dependency and to monitor costs associated with typical scientific applications.

*Composable Cost Model:*Whenever developers are going to develop software at that time estimation, monitoring, and analysis is needed on the basis of requirements.

Before utilizing the cloud resource developer must have vast knowledge about the application. Therefore the main intention of developa cost model that, before deciding to move to the cloud environment, scientists utilize their known performance characteristics like data transfer, execution time and other applications specific parameters are also needed to estimate the cost. But *Hong-Linh Truong and SchahramDustdar*developed acost model which is for different application models like OpenMP, MPI and workflows [4]. This can be achievedby also analyzing previous knowledge about performance estimation, monitoring and analysis. Based on basic cost models, cost estimation, monitoring and analysis tools and services can be developed.Table-1 describes basic cost models [4]. The first four models, $M_{ds}$; $M_{cm}$; $M_{d\,f\,i}$ and $M_{d\,f\,o}$ are basic models that are provided by cloud providers in their pricing specifications [5]. By using these models and the well-established execution models of sequential, parallel and workflow applications, corresponding cost models are introduced. The execution of sequential, multithreaded, or OpenMP programs uses a single machine and these programs may involve data transfers from/to the cloud [4] [5].

**Table 1**: (Techniques of Cost Estimation) [4]

| Model | Activities | Cost |
|---|---|---|
| $M_{ds}$ | Data storage | size(total)$t_{sub}$cost(storage) where $t_{sub}$ is the subscription time [5] |
| $M_{cm}$ | Machine Cost | (Cost ) Computational Machine Cost [5] |
| $M_{dfi/dfo}$ | Data Transfer Cost | (Cost)Into the cloud and out to the cloud |
| $M_{sd}$ | Single Data Transfer | size(in) $M_{d\,f\,i}$ + size(out) $M_{d\,f\,o}$ |
| $M_{we}$ | Workflows (cost Estimation) | $\sum_{i=1 \text{ to } nwr}$(Cost(Wri)) |
| $M_{wm}$ | Workflows (cost monitoring) | $\sum k_{i=1}$ (size($in_i$) $M_{d\,f\,i}$) +$\sum l_{i=1}$ (size($out_i$) $M_{d\,f\,o}$) + $\sum n_{i=1}$ ($M_{cm}$ $t_e$(machine$_i$)) |
| $M_{pe}$ | Parallel Programs on multiple machines(Cost Estimation) | n $M_{cm}$ $f_{pi}$ + size(out) $M_{d\,f\,o}$ + size(in) $M_{d\,f\,I}$ where $F_{pi}$ is Estimated performance improvement when "n process has used [5] |
| $M_{pm}$ | Parallel Programs on multiple machines(Cost Monitoring) | n $M_{cm}$ $t_e$ + size(out) $M_{d\,f\,o}$ + size(in) $M_{d\,f\,I}$ |

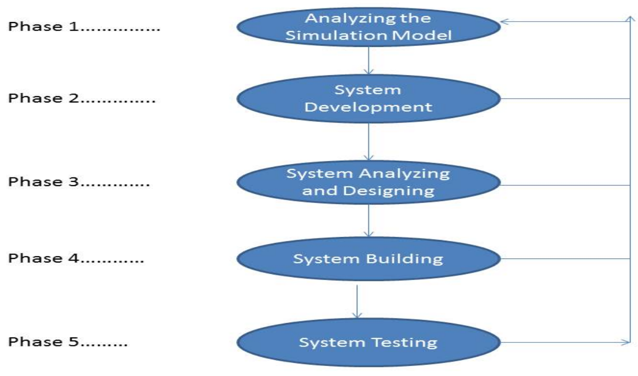
*b. Cloud Cost Estimation and Monitoring Service:*In this model of service authors have considered regarding the Service Dependency Toolfor specifying services and the Online Cost Analysis Tool for predicting cost of the application .To estimate and monitor costs associated with applications, need to capture information about execution time,data transfer, machines and storages [4].Depending on times and budgets, the scientists can use tools to decide which cloud systems and which parts of their application should be executed in the cloud [4].

Hong-Linh Truong and SchahramDustdar have done experiment by taking few scientific applications and they are only talking about the cost of different components associated with computing environment and most important challenges are to discuss only costs associated with application executions. While cloud service providers give some basic tools for determining computation and data transfer costs, they are trivial. On their work they do not perform the performance prediction butprovided a tool for scientists to define the dependency and estimated metrics for their applications based on that the cost is being estimated. Thus, the accuracy of the cost estimation is dependent on scientist knowledge, and this accuracy quality can be improved if our service can also be well integrated with existing performance prediction tools.

ZuzanaKristekova at.al [7] suggested to design and develop a simulation model which covers the system dynamic aspect and supports decision makers to analyze cost-benefits over cloud computing versus own datacenter [7]. Basically one important thing is for service providers whether it is more economical to move the existing datacenter-hosted services to the cloud or to keep them in the datacenter [7]. This means, that one of the service provider´s primarycriterion for such a decision is costs.In practice, some models exists that support organizations in analyzing and comparing costs, such as "*Amazon Simple Monthly Calculator*".Amazon Simply Monthly calculatoris a static and do not consider the dynamics of cost development by using cloud computing [8]. To overcome this problem they develop one simulation model, which covers the dynamics of cost development and assists decision makers by analyzing cost benefits associated with cloud computing and own data center. On the other hand the model is based on '*System Dynamic*' approach [7] [8]. System dynamics is useful for identifying key decision factors and relationship between them and helps to perform decision making in a more efficient way. System Dynamics is a simulation methodology for modeling dynamic and complex system [7].

The purpose of them is to design and develop a *simulation model* that supports decision makers in analyzing cost associated with cloud computing and own data center.

It is a theoretical framework which consists of 5 phases [7].




Prototype Model for Cost Analysis and Estimation

In figure, *Building the prototype system*[7], in this phase the system architecture is transferred to a prototype model. Implementation of a prototype system is used to demonstrate the feasibility of the design and the usability of the functionalities of a system. We can build the simulation model with the base of the interrelationship between the model components.

1. Final Cost per Server Instances = Number of Server Instances* hour per year * Cost per Server *Cost of data transfer.
2. The total Cost of Cloud Computing Instances = Cost per server instances+ {(Cost per Incoming) (Cost per Outgoing) Data Transfer.}.
3. Cost Per Server = Initial Cost + Operating System license + Additional Network Equipment.
4. Operating System Cost = Number of Required Server *Cost per Operating System

Expenditure of Network equipment usually consists of 10%-30% of the cost of server.

Decision makers can change the values in the user interface, where we list the key influencing values for cloud computing and its own data center.

This model is intended to fill gap where a cost model that covers dynamic issues for cloud computing is lacking. Researchers can use the proposed model for testing different types of hypothesis and deriving recommendation for further actions.In their research, they onlyproposed simulation model that considers costs for cloud computing and own datacenter. Thus, in the future, the simulation model might be more detailed to also be used for analyzing not only the economic impact but also organizational, as well as how is IT provisioned and used [7]. In future work the authors will concentrate on extending the proposed simulation model to also account for other domains.

Saravanan K, and Sri BighnaHema,[9] proposes a Dynamic Pricing Modelwhich is based on the cloud cache environment.A dynamic pricing scheme exploits a new-fangled method that estimates the cost of a cache structure and enhances the cloud revenue assure for customer satisfaction using price-demand model premeditated for cloud cache [9].Currently, Cache as a Service (CaaS)model is proposed as an elective services to offer infrastructure which assist to control the cloud economy by affording cloud profit. Customer can pose their queries to the cloud via the cloud coordinator and charged per usage. Then, the cloud looks for a query either in cloud cache or in backend database at a low cost to provide efficient querying. Cloud data administration needs a financial system to manage services of multiple users and its motive is to make a pricing model more effective by providing customer satisfaction and maximizethe revenue for cloud. With the intention of maximizing the cloud profit, Cache as a Service (CaaS) model is introduced using Amazon's Elastic Cloud Cache (EC2) system which forms relational database service [10].A dynamic pricing model for a cloud cache environment consists of three main components which consist of: *Application Service, Query Service, and Pricing Service*. Application Service is the service which incorporates the services such as authentication, verification, guarantee, justification, and optimization. Query Service further consists of the query engine, query tool, query reformation, cache database and backend database [10]. Where the Query engine is responsible for creating the column oriented back-end database with the comparison queries which is available in the cache memory. And the Cache Database is the history which stores all the information temporarily in browser. Which helps to the customer for searching point of view also helps to reduce the server workload. The pricing service is a component of price. It acts as a core for every pricing calculation, even if pricing data is passed to a third party. It provides the ability to store and maintain all the pricing data at the pricing organization.

*Compute cost of a cache structure,* which computes an operating cost i.e., Building cost (Bs) which is a one-time static cost and Maintenance cost (Ms) yields a storage cost that is linear with time t. Cache services are offered through query execution that uses cache structures. The Cost of a cache structure S,

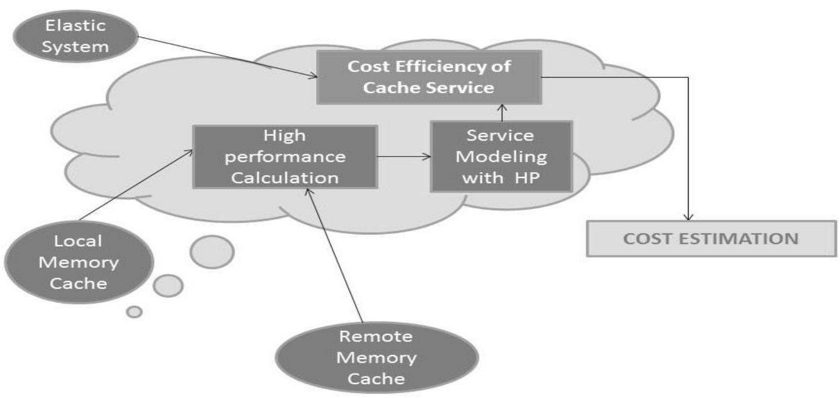
$$C_s(t) = B_s + M_s(t - t_{built}) \qquad \text{(i)}$$

*Evaluate the cloud profit;*Depends upon demand for a cache structure, the profit of the cloud is estimated. The demand for a cache structure S, denoted as $\lambda_S$ (t), is the number of times that cache structure (S) is employed in query plans selected for execution at time t.

$$\begin{cases} \lambda_S(t) >= 0 \text{ (if in cache)} \ldots\ldots\ldots\ldots \\ \lambda_S(t) = 0 \text{ (Otherwise)} \end{cases} \qquad \ldots\text{(ii)}$$

*Calculate a dynamic pricing,*to achieve an optimal price that guarantees the user satisfaction and maximizing the cloud profit, a dynamic pricing is calculated. Dynamic pricing, also known as time-based pricing, occurs when customers are divided into two or more groups with different prices charged to each group. When done successfully, price discriminationcan increase the profit of a cloud [10]

*Cache as a Service Model:* The CaaS model consists of two main components: An elastic cache system as the architectural foundation and a service model with a pricing scheme as the economic foundation as shown in Fig. 2[10].




Cache as a Service Model

**Fig. 2:** Cache as a service Model [9].

Elastic cache system is designed and is the key component in realizing CaaS. Important factors to design this elastic cache system are cache medium, communication between a cache server and a Virtual Machine (VM) and the implementation level of cache system. Cache medium consists of three options toimplement cache devices are Local Memory (LM), Remote Memory (RM), and Solid State Drive (SSD) [10].

Dynamic pricing optimization problem is implemented and run in *CloudSim 3.0 toolkit*. And which enables platform for dynamic and flexible applications. So, users can access and deploy applications from anywhere in the internet driven by demand and QoS requirements .This work proposes a dynamic pricing scheme that maximizes the cloud profit and also guarantees user satisfaction that adapts to demand changes. It also provides an efficient querying on the back-end data at a low cost, while being economically viable, and furthermore, profitable.

## 4. Discussion

After study of few papers about Cost estimation in Cloud Computing Environment, The goal of authors is to maximize the total profit by choosing which structures to build or discard and which price to assign to each built structure at any time.However to get the service from cloud environment, cloud users would require rapid deployment process which demands a Total Cost of Use (TCU) prior to deployment of software product in the cloud virtual environment i.e. called Pre-deployment Cost estimation. In table-2 there are mentioned different parameters used by different authors while estimation is obtained in Cloud Computing environment. In our review work we have studied cost estimation units and those are highly responsible to develop software in cloud computing environment.

**Table 2**: (A survey of cost estimation of service delivery in Cloud Computing Environment)

| Sl No. | Models/Technique have been proposed | Input parameter | Estimated Parameter | Papers have been covered | Validated or Not |
|---|---|---|---|---|---|
| 01 | 1.CCEMS (Cloud Cost Estimation Monitoring Services)<br>2. Composable Cost Model. | Data Transfer Cos, Computational Machine Cost (Cost of the Machine),Cost of Service Dependency tool, Scientific Application Development Cost, Work Flow of Cost Monitoring and Estimation., Storage cost. | Generalized Cost based on Scientific Applications | Composable cost estimation and monitoring for computational applications in cloud computing environments. (2009) | Validated |

| | | | | | |
|---|---|---|---|---|---|
| 02 | Simulation Model | Cost of Cloud Computing Environment., Data Center Cost, Cost per server Instances, Cost for incoming and outgoing data transfer, Operating System Cost, Network Expenditure Cost, Evaluation of the system Cost. | Total Service Cost with comparison of Data Centre and Cloud Computing Environment. | Simulation Model for Cost-Benefit Analysis of Cloud Computing versus In-House Datacenters (2012) | Validated by Simulation Model |
| 03 | Dynamic Pricing model | Cost of a cache structure, Maintenance Cost, Building Cost, Storage Cost, Data Transfer Cost. | Total Cost of the Cache Structure and enhance the cloud revenue assure for customer satisfaction. | Dynamic pricing Model For a cloud Cache Environment. (2013). | Validated by CAAS model. |

## 5. Conclusion

After survey of few papers related to Cost Estimation of cloud computing environment we got that Cloud Computing is a Cost-driven platform. As we know that cloud computing technology is increasingly used in enterprises and business markets. Some models and techniques are used there to estimate the actual cost of service that may be IAAS, SAAS or PAAS. Moreover estimating cost of business applications or scientific applications in cloud computing environment, recently a biggest challenge for software developers, when the application has quality of service requirements. Cloud services offer a range of economic benefits to their users and to the economy as a whole.This paper summarizes how the cost estimation occurs in the cloud computing environment and how it will be more efficient to calculate the actual cost of different services with the help of proposed models and techniques.

## References

[1] RajkumarBuyya,"Cloud Computing and Emerging IT Platforms:Vision, Hype, and Reality for Delivering Computing as the 5th Utility",2008, pp.5-13.

[2] R. Buyya, C. S. Yeo, S. Venugopal, Market-oriented cloud computing: Vision, hype, and reality for delivering it services as computing utilities, High Performance Computing and Communications, 10th IEEE International Conference on 0 (2008) ,pp.51–73.

[3] R.Buyya, D.Abramson, and S.Venugopal. The Grid Economy*Proceedings of the IEEE*, 93(3): March 2005, pp. 698-714.

[4] Hong-Linh Truong, SchahramDustdar,"Composable cost estimation and monitoring for computational applications in cloud computing environments", International Conference on Computational Science, ICCS 2010.

[5] H. L. Truong, P. Brunner, V. Nae, T.Fahringer, Dipas: A distributed performance analysis service for grid service-based workflows, Future Generation Comp. Syst. 25 (4) (2009) , pp.385–398.

[6] M.Geimer, S.Shende, A.D.Malony, F.Wolf, A generic and configurable source-code instrumentation component, in: G. Allen, J. Nabrzyski, E. Seidel, G. D. van Albada, J. Dongarra, P. M. A. Sloot (Eds.), ICCS (2), Vol. 5545 of Lecture Notes in Computer Science, Springer, 2009,pp. 696–705.

[7] ZuzanaKristekova, JesicaBrion, Michael Schermann, Helmut Krcmar , "Simulation Model for Cost-Benefit Analysis of Cloud Computing versus In-House Datacenters",Multikonferenz Wirtschaftsinformatik 2012 Tagungsband der MKWI 2012.

[8] Amazon Simple Storage Service (S3). http://www.amazon.com/s3/ [18 July 2008]

[9] Saravanan K, and Sri BighnaHema, "Dynamic Pricing Model for a Cloud Cache Environment" International Journal of Engineering Trends and Technology (IJETT) - Volume4Issue4- April 2013.

[10] L.Wang, J. Zhan, and W. Shi, In Cloud, Can Scientific Communities Benefit from the Economies of Scale. IEEE Trans. Parallel and Distributed Systems,Feb. 2012.vol.23, no. 2, pp. 296-303.