Profit maximization with customer satisfaction using optimal multiserver configuration in cloud computing

[1]Md Toufiq Farooqi, [2]K Arjun
[1]M.Tech II year, [2]Assistant Professor
[1]Computer Science & Engineering
[1]Bheema Institute of Technology & Science, Adoni, Dist: Kurnool, India

Abstract: Cloud computing is the widely used technology and it provides computing resources management in very cost effective and energy efficient way. Configuration of cloud service platforms for obtaining maximum profit is the main focus to pay attention for cloud service providers. This problem can be address by taking customer satisfaction into consideration. In this paper first customer satisfaction is defined in economics and formula is developed for satisfaction of customer measurement in cloud computing system. The analysis is carried out to know how the profit is affected by customer satisfaction. Also formulation of profit maximization problem is done by considering customer satisfaction, service-level agreement, renting price, energy consumption and optimal configuration is obtained in such a way to get maximum profit. This proposed work is implemented using Java and HTML.

IndexTerms **– customer satisfaction, cloud computing; multiserver system; profit maximization; PoS; QoS; service-level agreement**

I. INTRODUCTION

The services such as delivery of resources and computing in cloud computing, instead a product over the Internet/web, are provided with accesses to shared hardware, software, databases, information, and all resources on-demand [1]. Without using costs of upfront infrastructure and subsequent maintenance customer's use and pay for services on-demand [2]. With this advantages cloud computing is widely useful. Today there are many cloud service providers: Amazon EC2 [3], Microsoft Azure [4], Saleforce.com [5]. For cloud service providers profit is more important concern. The cloud service providers will have resources on rent from infrastructure providers for configuring the service platforms and provide services with payment from customer to have profit. Configuration of cloud service platforms to have profit maximization for cloud service providers is the biggest attention to be taken [6]. There are many factors that affects the request arrival rate of service provider and most important factor is customer satisfaction. The customers can submit their tasks to a cloud computing platform and also can execute them on local platforms. First the cloud service provider has to know the service demands are affected by customer satisfaction. So for problem of profit optimization consideration of customer satisfaction is needed. There are some existing research works that takes consideration of customer in solving profit maximization problem. This paper uses the thought in Business Administration, and firstly defines the customer satisfaction level of cloud computing for addressing the issues of profit maximization. We develop a model called profit maximization based on customer satisfaction definition in this the effect of customer satisfaction on quality of service (QoS) and price of service (PoS) is taken into consideration. The factors affecting customer satisfaction in economic standpoint of view are QoS and PoS. The PoS and QoS is determined by cloud service providers and by the service capacity of a cloud service provider which depends on its configuration of platform. By providing the configuration of cloud platform with service capacity higher the customer satisfaction level is improved by promoting the QoS. With this the clould service provider is affected from two sides.
The cloud service provider can have gain revenues more with higher customer satisfaction level and a higher market share. The service capacity is improved by utilizing more resources on rent. Hence, finding the scheme called optimal cloud platform configuration is the better solution for profit improvement. The profit models are cost model and revenue model. In this paper, we develop a model called customer satisfaction aware profit optimization and a discrete hill climbing algorithm is proposed to have a numeric optimal cloud configuration for cloud service providers.

The contributions of this work are as follows:

- Development of calculation formula to measure customer satisfaction in cloud system based on the definition of customer satisfaction level in economics.
- Analysis of customer satisfaction and profit interrelationship, and develop a profit optimization model with customer satisfaction
- Design and implementation of discrete hill climbing algorithm to obtain optimal cloud configuration to have maximum profit.

The rest of the paper is organized as follows. In Section 2, we describe related work, in section 3 we present the proposed work, queuing model, multi-server model and software requirements. In section 4 results and discussion and we conclude the paper in Section 5

II. RELATED WORK

The literatures review related to customer satisfaction and profit maximization problem in cloud system computing work is done [7, 8, 9, 10, 11].

In 1965, Cardozo [7] was first to propose concept of customer satisfaction and he thought that high satisfaction of customer produces purchase behavior again.

Howard *et al.* [8] proposed the psychological states of a customer as customer satisfaction at the time of evaluating the reasonability of pay and gain.

Churchill *et al.* [9] proposed comparison results between the payment to buy a product (service) and the benefit using this product or service of customer satisfaction

Tes *et al.* [10] proposed assessment of the distinction between prior expectation and performance of cognitive for customer satisfaction as

Parasuraman *et al.* [11] proposed the customer satisfaction is a function of PoS and QoS[12, 13].

The important issue of cloud service providers is how to increase profit and lot of works r research has carried out to this issue [2, 14, 15, 16, 17, 18, 19]. There are a few research works focusing on service providers for profit maximization.

Chaisiri *et al.* [18] have proposed a model called stochastic programming based on two-stage recourse to work out the service providers profit maximization problem with the customers demand uncertainty.

Cao *et al.* [2] have proposed a configuration of optimal multi-server approach. The server size and speed can be determined in such a way that profit of multi-server system is maximized.

Liu *et al.* [19] have proposed the concept of geographically distributed data centers of cloud service provider in multi electricity market environment, and a algorithm is proposed for net profit maximization of service providers by having energy efficient, profit and cost aware request dispatching and resource allocation. But they have not considered customer satisfaction [20, 21, 22, 23, 24, 25, 26, 27, 28].

Chen *et al.* [20] have proposed the utility model for measuring customer satisfaction in cloud system using utility theory leveraged from economics In [21], calculation of user satisfaction is carried out as the ratio of the actual QoS level and the expected QoS level.

Wu *et al.* [22] have proposed concept for profit maximization using algorithm called admission control and scheduling for SaaS providers. In this work cost is minimized and customer satisfaction level is improved.

Chao *et al.* [24] have proposed a ant colony optimization based algorithm for customer satisfaction aware for geo distributed datacenters. [26], the authors proposed the users' satisfaction, as the extent to which the user's resource requirements, have been met, and calculated as the ratio of the actual consumption and the expectation resources.

Unuvar *et al.* [27] have proposed the concept of predictive approach for selecting an optimum cloud availability zone for maximization of user satisfaction.

Morshedlou *et al.* [28] have proposed the users satisfaction level based on user utility expected value of certain monetary amount.

But the existing work of measuring customer satisfaction cannot properly reveal the definition of customer satisfaction, and did not considered user's psychological differences. This problem is solved by using customer satisfaction leveraged from economics. The analysis of cloud configuration affects on customer satisfaction and how the profit of customer satisfaction is affected. Based on literature works, we formulate the profit maximization problem, based on customer satisfaction to have optimal configuration.

III. PROPOSED WORK

A multi server configuration of cloud computing system is proposed for profit maximization and customer satisfaction. In this work, for solving of problem of optimal configuration we consider the customer satisfaction. The proposed system consists of three levels customer, business service provider and infrastructure service provider. We first provided a description for satisfaction of customer leveraged from economics and derive a formula for measuring customer satisfaction in cloud system.We analyze the market demand and satisfaction of customer interaction based on workload, affection of satisfaction of customer and determines the actual task arrival rate for various configurations. Also we analyze the problem of optimal configuration for profit maximization. The discrete hill climbing algorithm is used to solve the optimal solutions/ Figure 1 shows the Proposed System Architecture

The following work is proposed

- The multi server configuration of cloud system
- The heuristic algorithm is proposed to find the configuration of optimal cloud.
- Cloud service system model and the service-level agreement is proposed
- The analysis of changing trend of the customer satisfaction and the profit with varying cloud configuration is carried out

The Figure 2 shows the Queuing Model used for proposed system for customer and service provider.

The method of entering to the cloud system is in queue form; consequently each user has to wait until serving the current user. The user of cloud computing will request the cloud computing service provider for using resources and if the server is busy user has to wait until the completion of job by current user and waiting time is increased with more queue length. The queue length and waiting time can be reduced by using multiple servers' configuration. The multi-server system can be treated as an M/M/m queuing model. In cloud computing the pricing model of service provider is based on income and cost. The revenue or income for service provider is the user service charge and the renting plus utility cost paid to vendors of infrastructure. A pricing mode includes the amount of service, the application environment workload, the multi server configuration, agreement of service level, customer satisfaction, the QoS, low quality service penalty, renting cost, energy consumption cost and margin and profit of service providers

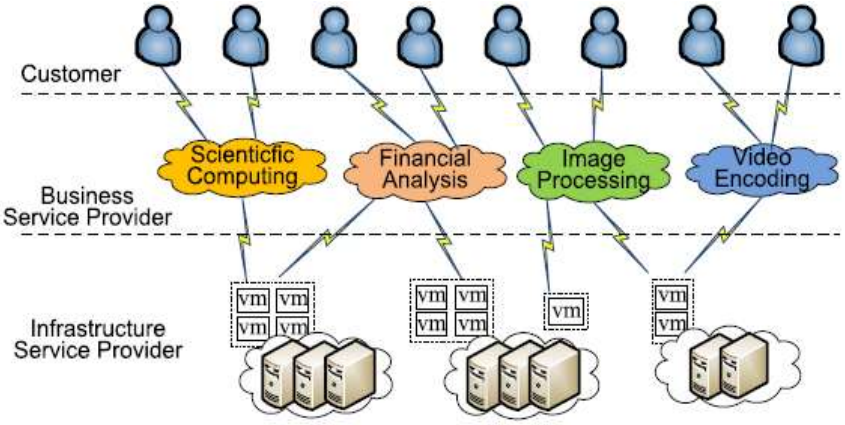

Figure 1 shows the proposed system architecture

i. Queuing Model

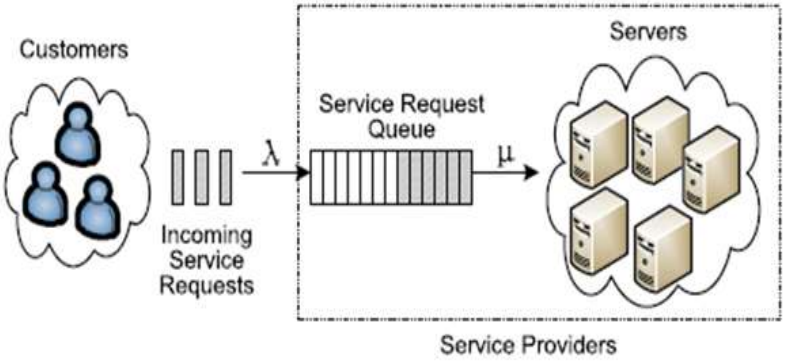

Figure 2 shows the queuing model

There are two situations that cause negative gain of business. In the first case, there is no enough business so a service provider should reduce the number of servers m or server speed s, so as to reduce infrastructure renting cost and the energy consumption cost. Also there is too much business so a service provider should increase the number of servers and or server speed, so as to reduce waiting time and the revenue has to be increased. However, increasing the number of servers and/or server speed also increases the infrastructure renting cost and the cost of energy, 'consumption. The selection of optimal server size and/or server speed problem so as to get maximum profit.

ii. Multi server model

The multi server system configuration is used by cloud service provider to serve users and this is constructed and maintained by vendor of infrastructure. This is rented by service provider. The multi-server architecture is quite flexible. Multi server such as blade servers clusters of traditional servers [7], [18], [19], and multicore single core server processors [15]. The users submit service requests to service provider and the request is served by service provider on the multi-server system.

iii. Software Requirements

Front End	HTML, Java, Jsp
Scripts	JavaScript
Application server	Tomcat5.0/6.X
Server side Script	Java Server Pages
Database Connectivity	Mysql.

IV. RESULTS AND DISCUSSIONS

Data Owner:

Click on Data Owner option, it will display the login and registration page. If you have already registered then login directly, or else register yourself. If you click on Register then it will display the page like this: then click on *register*, it shows the message (msg) as: for login to data owner enter your name and password then submit: after login to data owner login is shown in figure 3.

Figure 3 data owner login

Figure 4 detail of data upload

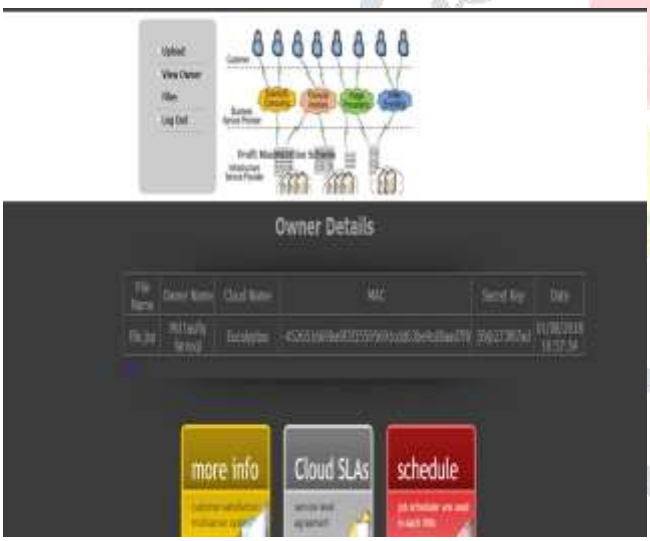

Figure 5 details of data owner

Figure 6 business service provider cloud scheduler

in data owner we have the options like: Upload, View Owner Files, Feed Your Satisfaction and Log Out. For uploading the file click on upload then it shows the page:

choose the text file and give the name of file then click on Encrypt button, then the text in the file will be encrypted, and it takes MAC address automatically for the file, given below: click on Upload button for uploading the file, then it shows the msg: for viewing the file, click on View Owner File then it shows all files which are uploaded by the owner. Then for giving a satisfied feedback click on Feed Your Satisfaction, select cloud server, enter your feedback and submit. Then your feedback submission msg will be displayed. data owner work has been finished then click on log out button. Details of these steps are shown in figure 3 through figure 6.

Business Service Provider:
The next option is business service provider (BSP). Click on it then it shows the web page. For login to BSP you have to put bsp as username and password respectively and submit

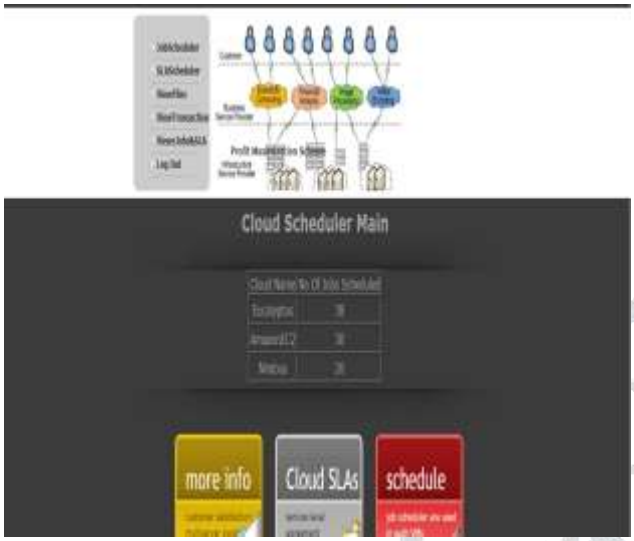

Figure 7 details of cloud scheduler main

Figure 8 details of SLA period of Nimbus

Figure 9 details of SLA period and No of jobs in clouds

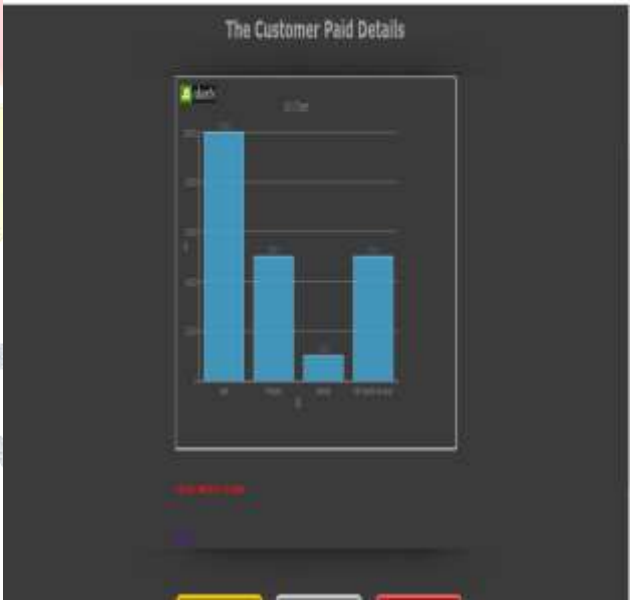

Figure 10 details of customer paid

After submitting the name and password this page will be shown.
BSP have the options like:Job scheduler, SLA scheduler, View Files, View Transaction , Views Jobs and SLA, View Satisfaction and Total Profit
Job Scheduler:
SLA Scheduler: View Files: View Transaction: View Jobs and SLA:
View Satisfaction: Negative Satisfaction:, Positive satisfaction , Total profit
Bsp work has been finished then log out. Details of this is shown in figure 7 through 10.

Cloud Server (ISP):

Figure 11 cloud files details

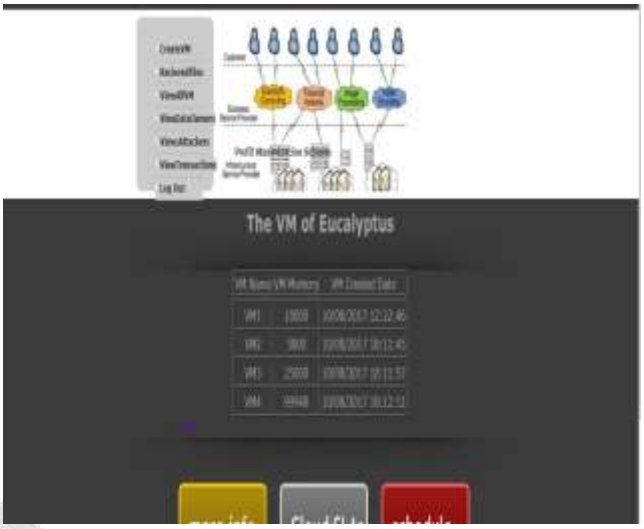

Figure 12 VM of Eucalyptus details

End User:

Figure 13 Eucalyptus customer

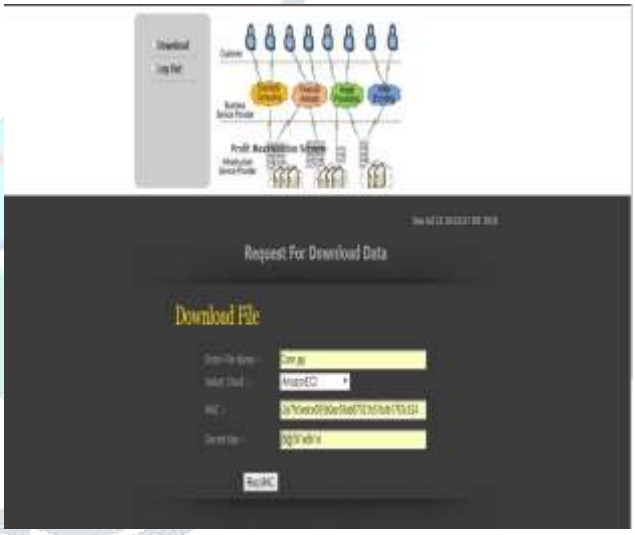

Figure 14 request to download data

Figure 15 content of downloaded file

Cloud Server (ISP):
Username: cloud1, Password: server1, Cloud: Eucalyptus.
Create VM: Receive files View All VM: View Data Owners: End user
View Attackers: View Transaction:

End user
click on end user then it displayed the web page like this:
For registration to end user, click on register and fill all the required fields and click on register button
After registration it shows the msg like:
For login to end user submit the name and password and click on submit
After submitting it will display the page:
End user has the options like: Download, View Files and Log Out
For downloading the file click on download button and enter file name, select cloud. MAC address and Secret key appears automatically then click on Reg MAC.
Click on RegMAC Download option will appear. After click on download button then it shows the content of file.
Once again click on download then file will be downloaded.
If you click on ViewFile then all files will be appear in the list which you have downloaded.
Then click on log out. This is the work of end user. Details of this are shown in figure 11 through figure 15

V. CONCLUSION AND FUTURE ENHANCEMENT

Conclusion

In this paper, we solved problem of optimal configuration with profit maximization using customer satisfaction. This is carried out using formula for measuring customer satisfaction in cloud and analysis of market demand and the customer satisfaction interaction. The actual task arrival rate is calculated for various configurations. Also we have analyzed an optimal configuration problem of profit maximization and discrete hill climbing algorithm is used to solve optimal solutions. The changing trend of profit are analyzed by conducting a series of calculations

Future Enhancement

In future, we can have dynamically configured multi-server system as a virtual cluster from a physical cluster in cloud computing system. Also problem of profit maximization can be extended to multiple heterogeneous multi-server systems of different sizes and speeds and speeds and application environments with total power consumption constraint.

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