An Efficient Profit Maximization Scheme in Cloud for Customer Satisfaction

First Author: B. Murali Krishna,M.Tech, Assistant Professor in Deportment of CSE, PBR Visvodaya Institute of Technology and Science, Kavali, Nellore.

Second Author:

P.Madhuri, pursuing B.Tech (CSE) from PBR Visvodaya Institute of Technology and Science, Kavali, Nellore.

G. Kavya, pursuing B.Tech (CSE) from PBR Visvodaya Institute of Technology and Science, Kavali, Nellore.

K. Sowmya, pursuing B.Tech (CSE) from PBR Visvodaya Institute of Technology and Science, Kavali, Nellore.

S. Sravani, pursuing B.Tech (CSE) from PBR Visvodaya Institute of Technology and Science, Kavali, Nellore.

ABSTRACT

Alongside the advancement of distributed computing, an expanding number of endeavors begin to embrace cloud administration, which advances the development of many cloud specialist co-ops. For cloud specialist organizations, how to arrange their cloud administration stages to acquire the greatest benefit turns out to be progressively the center that they focus on. We think about consumer loyalty to address this issue. Consumer loyalty influences the benefit of cloud specialist organizations in two different ways. On one hand, the cloud arrangement influences the nature of administration which is an essential factor influencing consumer loyalty. Then again, the consumer loyalty influences the demand landing rate of a cloud specialist organization. In any case, few existing works think about consumer loyalty in tackling benefit augmentation issue, or the current works considering consumer loyalty don't give a legitimate formalized definition for it. Subsequently, we initially allude to the meaning of consumer loyalty in financial matters and build up a recipe for estimating consumer loyalty in distributed computing. And after that, an investigation is given in detail on how the consumer loyalty influences the benefit. Finally, mulling over consumer loyalty, administration level understanding, leasing value, vitality utilization, etc, a benefit augmentation issue is planned and illuminated to get the ideal design to such an extent that the benefit is amplified.-

1. INTRODUCTION

Cloud computing is the delivery of resources and computing as a service rather than a product over the Internet, such that accesses to shared hardware, software, databases, information, and all resources are provided to consumers on-demand. Customers use and pay for services on-demand without considering the upfront infrastructure costs and the subsequent maintenance cost. Due to such advantages, cloud computing is becoming more And more popular and has received considerable attention recently. Nowadays, there have been many cloud service providers, such as Amazon EC2, Microsoft Azure, Saleforce.com, and so forth. As a kind of new IT commercial model, profit is an important concern of cloud service providers. As shown in Fig1, the cloud service providers rent resources from infrastructure providers to configure the service platforms and provide paid services to customers to make profits. For cloud service providers, how to configure their cloud service platforms to obtain the maximal profit becomes increasingly the focus that they pay attention to the optimal configuration problem with profit maximization of cloud service providers has been researched in our previous researches which assumed that the cloud service demand is known in advance and not affected by external factors. However, the request arrival rate of a service provider is affected by many factors in actual, and customer satisfaction is the most important factor.

For example, customers could submit their tasks to a cloud computing platform or execute them on their local computing platforms

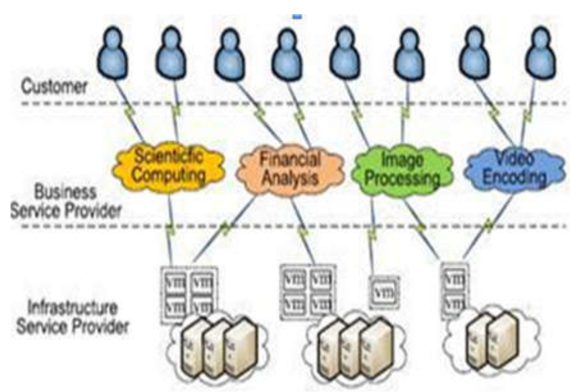

Fig.1. the three tier cloud structure.

The customer behavior depends on if the cloud service is attractive enough to them. To configure a cloud service platform properly, the cloud service provider should know how customer satisfaction affects the service demands. Hence, considering customer satisfaction in profit optimization problem is necessary. However, few existing works take customer satisfaction into consideration in solving profit maximization problem, or the existing works considering customer satisfaction do not give a proper formalized definition for it. To address the problem, this paper adopts the thought in Business Administration, and firstly defines the customer satisfaction level of cloud computing. Based on the definition of customer satisfaction, we build a profit maximization model in which the effect of customer satisfaction on quality of service (QoS) and price of service (PoS) is considered. From an economic standpoint, two factors affecting customer satisfaction are QoS and PoS. The PoS is determined by cloud service providers. The QoS is determined by the service capacity of a cloud service provider which largely depends on its platform configuration. Under the given pricing strategy, the only way to improve the customer satisfaction level is to promote the QoS, which can be achieved by configuring cloud platform with higher service capacity. Doing so can affect a cloud service provider from two asides.

On one hand, the higher customer satisfaction level leads to a higher market share, so the cloud service provider can gain more revenues. On the other hand, more resources are rented to improve the service capacity, which leads to the increase of costs. Hence, the ultimate solution of improving profit is to find an optimal cloud platform configuration scheme. In this paper, we build a customersatisfaction-aware profit optimization model and propose a discrete hill climbing algorithm to find the numeric optimal cloud configuration for cloud service providers. The contributions of this paper are listed as follows:

- Based on the definition of customer satisfaction level in economics, develop a calculation formula for measuring customer satisfaction in cloud;
- Analyze the interrelationship between customer satisfaction and profit, and build a profit optimization model considering customer satisfaction;
- Develop a discrete hill climbing algorithm to find the optimal cloud configuration such that the profit is maximized.

II. LITERATURE SURVEY

We firstly review the literatures concerning customer satisfaction, and then the profit maximization problem in cloud computing. To estimate the service demand of a service provider, it is critical to measure its customer satisfaction. In business management, there have been many specialists who focus on the researches of the definition of customer satisfaction. The concept of customer satisfaction is firstly proposed by Cardozo in 1965 and he believed that high customer satisfaction produces purchase behavior again. In recent years, cloud computing has become a booming service industry. How to increase profit is an important issue for cloud service providers. Many works have been done to research this issue. There are some researches focusing on the profit maximization problem of the service providers. Chaisiri took into consideration the uncertainty of the customers demand, and proposed a stochastic programming model with two-stage recourse to solve the profit maximization problem for the service providers. There are some works in cloud computing which consider customer satisfaction. Chen adopted utility theory leveraged from economics and developed an utility model for measuring customer satisfaction in cloud.

In the utility model, consumer satisfaction is relevant to two factors: service price and response time. They assumed that consumer satisfaction is decreased with higher service price and longer response time. However, the user satisfaction here is defined as how much the requirements specified in a request are satisfied. Morshedlou and Meybodi defined the users' satisfaction level based on expected value of user's utility that an user attaches to a certain monetary amount. However, the existing formulas measuring customer satisfaction of cloud computing cannot properly reflect the definition of customer satisfaction, and they did not take into account user's psychological differences. To address this problem, we use the definition of customer satisfaction leveraged from economics and develop a formula to measure customer satisfaction in cloud. And then, how cloud configuration affects customer satisfaction and how customer satisfaction affects the profit of cloud service providers are analyzed. Based on these works, a profit maximization problem considering customer satisfaction is formulated and solved such that the optimal configuration is obtained.

III. PRELIMINARY KNOWLEDGE

Before analyzing the customer satisfaction of a cloud service provider, we present the service model first. Besides, Service-Level Agreement (SLA) is also introduced, which is a negotiation about the charge and the QoS between cloud service providers and customers.

A. The Cloud Service Model

The cloud service system is a multiserver system shown in Fig2 which can be modeled as an M/M/m queuing model. Similar models are used in many researches on cloud computing. In the M/M/m model, m is the number of servers, and all servers run at an identical speed s (measured by the number of instructions that can be executed in one unit of time). Assume that the interarrival times of service requests are independent and identically distributed (i.i.d.) exponential random variables, in other words, the arrival requests follow a Poisson process with arrival rate λ. The execution requirements of the tasks (measured by the number of instructions to be executed) are i.i.d. exponential random variables r with mean r. Since the server execution speed is s, the service times of the requests are also i.i.d. exponential random variables x = r/s with mean x = r/s. Hence, the average service rate, i.e., the average number of service requests that can be completed by a server with

speed s in one unit of time, is μ = 1/x = s/r. Assume that the number of virtual machines in a server is fixed and cannot be changed during the runtime. Each arriving request enters the multiserver system and waits in a queue with infinite capacity when all the servers are busy. The first-come-first-served (FCFS) queuing strategy is adopted. Let πk denote the probability that there are k service requests (waiting or being processed) in the M/M/m queuing system.

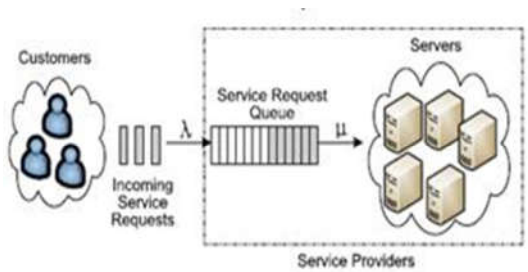

Fig.2. the M/M/m queuing model.

B. The Service-Level Agreement

In general, the QoS is affected by many factors such as the service time, the failure rate and so forth. However, in this paper, we measure the QoS of a request by its response time for two reasons. First, the service time is easily measured. Second, it gives customers an intuitive feeling of QoS. For customers, they do not care how failures are managed when failures occur. They only care whether the task can be completed successfully and how long it takes. The response times of requests are different from each other due to the changing system workload and limited service capacity, which leads to different QoS and QoS satisfaction. In general, each customer has a tolerable response time which is related to the execution requirement of its requests. We denote the tolerable response time of a request with execution requirement r by cr/s_0, where s_0 is be baseline speed of a server and c is a constant coefficient. If the response time of a request exceeds the tolerable value, the customer feels dissatisfaction about the service, which leads to the degrade of the overall customer satisfaction of the service provider.

IV. THE PROFIT OPTIMIZATION PROBLEM How the customer satisfaction of a service provider

affects its profit is first analyzed. And then the profit optimization model is build to find the optimal configuration of cloud service providers.

A. Customer Satisfaction Aware Arrival Rate

In a market economy, the customer satisfaction of a service provider affects its market share. Assume that the total market demand is λmax, the market share MS of a service provider is the ratio of the actual task arrival rate λ and λmax which can be formulated as MS = λ/λmax. In general, a higher customer satisfaction would lead to a larger market share, but the growth trends are different in different situations. In this paper, we assume that the market share MS of a service provider is linearly increasing with its customer satisfaction which is denoted as MS = S. Combining above two equations, we can get the relationship between the actual task arrival rate λ and the custom satisfaction MS as λ = Sλmax. Substituting tha above two equation, we can get the task arrival rate of a service provider in steady sate by solving is so complicated that we cannot find a closed-form solution of λ. However, we can obtain a numerical solution of λ for it. Hence, we can

Algorithm 1 Actual Arrival Rate $\lambda_{m,s}$

Input: multiserver configuration m and s;
Output: the actual task arrival rate, $\lambda_{m,s}$;
find the monotone interval $[\lambda_l, \lambda_u]$ of $D(\lambda)$ such that $D(\lambda_l) > 0$ and $D(\lambda_u) < 0$;
while $D(\lambda_l) - D(\lambda_u) > \varepsilon$ **do**
  $\lambda_{mid} \leftarrow (\lambda_l + \lambda_u)/2$;
  if $G(\lambda_{mid}) < 0$ **then**
    $\lambda_u \leftarrow \lambda_{mid}$;
  else
    $\lambda_l \leftarrow \lambda_{mid}$;
    break;
  end if
  calculate $D(\lambda_l)$ and $D(\lambda_u)$ using Eq. (17);
end while
$\lambda_{mid} \leftarrow (\lambda_l + \lambda_u)/2$;
$\lambda_{m,s} \leftarrow \lambda_{mid}$;

adopt the standard bisection method to find a numerical solution of λ and the process is given as Algorithm 1. In Algorithm 1, the input is arbitrary multiserver configuration (m, s), and the output is the actual arrival rate λm,s of the service provider with configuration (m, s).

B. The Profit Model

From the service providers' respective, the profit is mainly determined by the cost and the revenue.

The Cost Model: The cost of a service provider is mainly used to pay the rent and the electricity fee. A service provider rents servers from an infrastructure provider and pays the corresponding rent. The rent is determined by the number of rented servers and the rental price per server per unit of time. Assume that the rental price of one server per unit of time is β, and m servers are rented. The rent per unit of time is calculated as Erent = βm.

The Revenue Model: To calculate the revenue of a service provider, we should know the expected charge to a service request On one hand, the platform configuration directly affects the profit. On the other hand, the request requirement λm,s is affected by customer satisfaction which largely depends on the service capacity of a cloud service provider. Hence, the platform configuration affects the profit indirectly. Generally speaking, configuring a cloud platform with more resources and faster speed can lead to a higher service capacity and a higher customer satisfaction. A higher customer satisfaction can attract more customers, hence lead to the increasing of the revenue. Whereas, a higher platform configuration also has a negative effect which is the costs is increasing correspondingly.

V. CONCLUSION

We consider customer satisfaction in solving optimal configuration problem with profit maximization. Because the existing works do not give a proper definition and calculation formula for customer satisfaction, hence, we first give a definition of customer satisfaction leveraged from economics and develop a formula for measuring customer satisfaction in cloud. Based on the affection of customer satisfaction on workload, we analyze the interaction between the market demand and the customer satisfaction, and give the calculation of the actual task arrival rate under different configurations. In addition, we study an optimal configuration problem of profit maximization. The optimal solutions are solved by a discrete hill climbing algorithm. Lastly, a series of calculations are conducted to analyze the changing trend of profit. Moreover, a group of calculations are conducted to compare the profit and optimal configuration of two situations with and without considering the affection of customer satisfaction on customer demand. The results show that when considering customer satisfaction, our model performs better in overall.

VI. REFERENCES

[1] P. Mell and T. Grance, “The nist definition of cloud computing,” Communications of the Acm, vol. 53, no. 6, pp. 50–50, 2011.

[2] J. Cao, K. Hwang, K. Li, and A. Y. Zomaya, “Optimal multiserver configuration for profit maximization in cloud computing,” IEEE Trans. Parallel Distrib. Syst., vol. 24, no. 6, pp. 1087–1096, 2013.

[3] J. Mei, K. Li, A. Ouyang, and K. Li, “A profit maximization scheme with guaranteed quality of service in cloud computing,” IEEE Trans. Computers, vol. 64, no. 11, pp. 3064–3078, Nov 2015.

[4] R. N. Cardozo, “An experimental study of customer effort, expectation, and satisfaction,” Journal of marketing research, pp. 244–249, 1965.

[5] J. A. Howard and J. N. Sheth, The theory of buyer behavior. Wiley New York, 1969, vol. 14

[6] G. A. Churchill Jr and C. Surprenant, “An investigation into the determinants of customer satisfaction,” Journal of marketing research, pp. 491–504, 1982.

[7] D. K. Tse and P. C. Wilton, “Models of consumer satisfaction formation: An extension,” Journal of marketing research, pp. 204–212, 1988.

[8] A. Parasuraman, V. A. Zeithaml, and L. L. Berry,
“Reassessment of expectations as a comparison standard in measuring service quality: implications for further research,” the Journal of Marketing, pp. 111–124, 1994.

[9] K. Medigovich, D. Porock, L. Kristjanson, and M. Smith,
“Predictors of family satisfaction with an australian palliative home care service: a test of discrepancy theory,” Journal of palliative care, vol. 15, no. 4, p. 48ł56, 1999.

[10] J. J. Jiang, G. Klein, and C. Saunders, Discrepancy Theory Models of Satisfaction in IS Research. New York, NY: Springer New York, 2012, pp. 355–381.

[11] M. Mazzucco, D. Dyachuk, and R. Deters,
“Maximizing cloud providers’ revenues via energy aware allocation policies,” in 2010 IEEE 3rd International Conference on Cloud Computing (CLOUD). IEEE, 2010, pp. 131–138.

[12]A.Beloglazov, J. Abawajy, and R. Buyya, “Energyaware resource allocation heuristics for efficient management of data centers for cloud computing,” Future Generation Computer Systems, vol. 28, no. 5, pp. 755–768, 2012.

[13] J. Cao, K. Li, and I. Stojmenovic, "Optimal power allocation and load distribution for multiple heterogeneous multicore server processors across clouds and data centers,"
IEEE Trans. Computers, vol. 63, no. 1, pp. 45–58, 2014.

First Author: B. Murali Krishna,M.Tech, Assistant Professor in Deportment of CSE, PBR Visvodaya Institute of Technology and Science, Kavali, Nellore.

Second Author:

P.Madhuri, pursuing B.Tech (CSE) from PBR Visvodaya Institute of Technology and Science, Kavali, Nellore.

G. Kavya, pursuing B.Tech (CSE) from PBR Visvodaya Institute of Technology and Science, Kavali, Nellore.

K. Sowmya, pursuing B.Tech (CSE) from PBR Visvodaya Institute of Technology and Science, Kavali, Nellore.

S. Sravani, pursuing B.Tech (CSE) from PBR Visvodaya Institute of Technology and Science, Kavali, Nellore.