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Optimizing The Cloud Service Provider And Its User In Cloud Computing

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Abstract : *In this paper, we try to design a service mechanism for profit optimizations of both a cloud provider and its multiple users. We consider the problem from a game theoretic perspective and characterize the relationship between the cloud provider and its multiple users as a Stackelberg game, in which the strategies of all users are subject to that of the cloud provider. The cloud provider triesto select and provision appropriate servers and configure a proper request allocation strategy to reduce energy cost while satisfying its cloud users at the same time. We approximate its servers selection space by adding a controlling parameter and configure an optimal request allocation strategy. For each user, we design a utility function which combines the net profit with time efficiency and try to maximize its value under the strategy of the cloud provider. We formulate the competitions among all users as a generalized Nash equilibrium problem (GNEP). We solve the problem by employing variation inequality (VI) theory and prove that there exists a generalized Nash equilibrium solution set for the formulated GNEP. Finally, we propose an iterative algorithm (IA), which characterizes the whole process of our proposed service mechanism. We conduct some numerical calculations to verify our theoretical analyses. The experimental results show that our IA algorithm can benefit both of a cloud provider and its multiple users by configuring proper strategies.*

I. Introduction

Cloud computing is an increasingly popular paradigm of offering subscription-oriented services to enterprises and consumers [1]. Usually, the provided services refer to Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS), which are all made available to the general public in a pay-as-you-go manner [2], [3]. To support various services, more and more cloud centers are equipped

with thousands of computing nodes, which results in tremendous energy cost [4]. It is reported that about 50% management budget of Amazon′s data center is used for powering and colling the physical servers [5]. There are also researchers who have studied the cost of data centers and concluded that around 40% of the amortized cost of a data center falls into power related categories [6]. Hence, it is important to reduce energy cost for improving the profit of a cloud provider. However, it can often be seen that there are many under-utilized servers in cloud centers, or on the contrary, cloud providers provide less processing capacity and thus dissatisfy their users for poor service quality. Therefore, it is important for a cloud provider to select appropriate servers to provide services, such that it reduces cost as much as possible while satisfying its users at the same time. For a cloud provider, the income (i.e., the revenue)

is the service charge to the aggregated requests from all cloud users [7]. When the per request charge is determined, servers selection and request allocation strategy are two significant factors that should be taken into account. The reason behind lies in that both of them are not just for the profit of a cloud provider, but for the appeals to more cloud users in the market to use cloud service and thus also impact the profit. Specifically, if the provided computing capacity is large enough (i.e., many servers are under-utilized), this will result in tremendous amount of energy waste with huge cost and thus reduces the profit of the cloud provider. On the other hand, if the cloud provider provides less computing capacity or improperly configures the request\ allocation strategy, this will the cloud service minus the payment [8]. In addition, the utility of a user is not only determined by the net profit of his/her requests (i.e., how much benefit the user lead to low service quality (e.g, long task response time) and thus dissatisfies its cloud users or potential cloud users in the market. A rational user will choose a strategy to use the service that maximizes his/her own net reward, i.e., the utility obtained by choosing can receive by finishing the configured tasks), but also closely related to the urgency of the tasks (i.e., how quickly they can be finished). The same amount of tasks are able to generate more utility for a cloud user if they can be completed within a shorter period of time in the cloud center [8]. However, considering from energy saving and economic reasons, it is irrational for a cloud provider to provide enough computing resources to complete all requests in a short period of time. Therefore, multiple cloud users have to configure the amount of requests in different time slots.

Since the requests from users are submitted randomly, in our paper, we approximately characterize the request arrivals as a Poisson process [9]. Since the payment and time efficiency of each of the cloud users are affected by the decisions of others, it is natural to analyze the behaviors of these users as strategic games [10]. In this paper, we try to design a new service mechanism for profit optimizations of both a cloud provider and its multiple users. We consider the problem from a game theoretic perspective and characterize the relationship between the cloud provider and its users as a Stackelberg game, in which the strategies of all users are subject to that of the cloud provider. In our mechanism, the cloud provider tries to select appropriate servers and configure a proper request allocation strategy to reduce energy cost while satisfying its users at the same time. The main contributions of this paper are listed as follows.

- We characterize the relationship between the cloud provider and its users as a Stackelberg game, and try to optimize the profits of both a cloud provider and its users at the same time.
- We formulate the competitions among all users as a generalized Nash equilibrium problem (GNEP), and prove that there exists a generalized Nash equilibrium solution set for the formulated GNEP.
- We solve the GNEP by employing varational inequality (VI) theory and propose an iterative algorithm (IA) to characterize the whole process of our proposed service mechanism.

Experimental results show that our IA algorithm can benefit both of the cloud provider and its multiple users by configuring proper strategies.

The rest of the paper is organized as follows. Section 2 presents the related works. Section 3 describes the models of the system and presents the problem to be solved. Section 4 formulates the problem into a Stackelberg game, which consists of a leader and a set of followers. We analyze the strategies for both of the leader and the followers. Many analyses and several subalgorithms are presented in this section. Section 5 is developed to verify our theoretical analysis and show the effectiveness of our proposed algorithm. We conclude the paper with future work in Section 6.

II. Existing System

To our knowledge, hardly any previous works investigate multiple users′ profit optimizations, let alone optimizing the profits of a cloud provider and its users at the same time.

Mei et al. proposed an energy-aware scheduling algorithm for sporadic tasks. The authors try to reduce energy consumption by using dynamic voltage frequency scaling (DVFS) technique.

In existing system, based on DVFS technique and the concept of slack sharing among processors, the authors also proposed two novel energy-aware scheduling algorithms.

III. Proposed System

In this paper, we try to design a new service mechanism for profit optimizations of both a cloud provider and its multiple users. We consider the problem from a game theoretic perspective and characterize the relationship between the cloud provider and its users as a Stackelberg game, in which the strategies of all users are subject to that of the cloud provider.

In our mechanism, the cloud provider tries to select appropriate servers and configure a proper request allocation strategy to reduce energy cost while satisfying its users at the same time.

Advantages Of Proposed System:

Cost effectiveness will be provided.

Application performance will be improved.

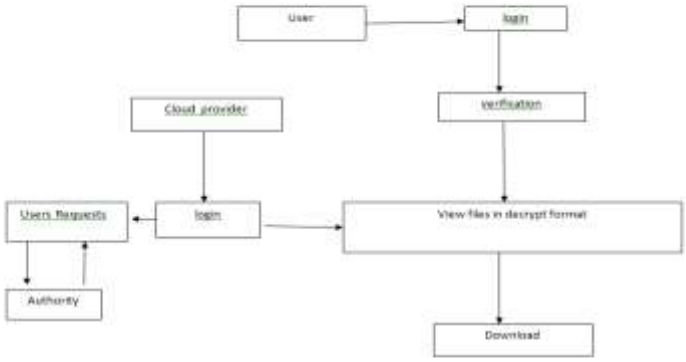
In this work, we first try to optimize multiple users′ profits. Since multiple cloud users compete for using the resources of a cloud provider, and the utility of each user is affected by the decisions (service request strategies) of other users, it is natural to analyze the behaviors of such systems as strategic games.

We characterize the relationship between the cloud provider and its users as a Stackelberg game, and try to optimize the profits of both a cloud provider and its users at the same time.

We formulate the competitions among all users as a generalized Nash equilibrium problem (GNEP), and prove that there exists a generalized Nash equilibrium solution set for the formulated GNEP.

We solve the GNEP by employing varational inequality (VI) theory and propose an iterative algorithm (IA) to characterize the whole process of our proposed service mechanism.

IV. Architecture Diagram



V. Conclusion

A With the popularization of cloud computing and its many advantages such as cost-effectiveness, elasticity, and scalability, more and more applications are moved from local computing environment to cloud center. In this work, we try to design a new service mechanism for profit optimizations of both a cloud provider and its multiple users. We consider the problem from a game theoretic perspective and characterize the relationship between the cloud provider and its multiple users as a Stackelberg game, in which the strategies of all users are subject to that of the cloud provider. The cloud provider tries to select appropriate servers and configure a proper request allocation strategy to reduce energy cost while satisfying its cloud users at the same time. We approximate its server selection space by adding a controlling parameter and configure an optimal request allocation strategy. For each user, we design a utility function which combines the net profit with time efficiency and try to maximize its value under the strategy of the cloud provider. We formulate the competitions among all users as a generalized Nash equilibrium problem (GNEP). We solve the problem by employing varational inequality (VI) theory and prove that there exists a generalized Nash equilibrium solution set for the formulated GNEP. Finally, we propose an iterative algorithm (IA), which characterizes the whole process of our proposed service mechanism. We conduct some numerical calculations to verify our theoretical analyses. The experimental results show that our IA algorithm can reduce energy cost and improve users utilities to certain extent by configuring proper strategies. As part of future work, we will study the cloud

center choice among multiple different cloud providers or determine a proper mixed choice strategy. Another direction is the opposite, we consider problem from cloud providers and study the competitions among multiple cloud providers, which may incorporate charge price, service quality, and so on.

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