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Enhanced Real-Time Group Auction System for Efficient Allocation of Cloud Internet Applications

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Abstract- **Cloud internet applications have recently attracted a large number of users in the Internet. With the invention of these cloud internet applications, it is inefficient to allocate maximum number of participants in real time group auction system. So an efficient approximation algorithm is proposed with the improved combinatorial double auction protocol. It is developed to enable different kinds of resource distribution among multiple users and providers. At the same time it includes more number of participants in an auction. Due to the NP-hardness of binary integer programming for resource distribution in a real time group auction system, the improved approximation algorithm is proposed to deal with np-hardness and to obtain the optimal solution. Participant honesty is necessary to ensure auction trustfulness.**

Keywords – **Cloud computing; Approximation Algorithm; Resource allocation;**

I. INTRODUCTION

Cloud computing provides literally boundless computing power in the form of utility service to consumers. It enables various provisioning models for on-demand access to applications (Saas or software as a service), platforms (PaaS or platform as a service), and infrastructures for computing (IaaS). It has created a competitive market where consumers pay providers in order to use the resources. To provide the facility of trading, a market mechanism should be exploited to utilize and allocate resources within their capacities making sure that it does not over-provision or under-provision.

Resources in cloud are geographically distributed, which may be heterogeneous and owned by various organizations with different cost and usage policies. A huge number of self-interested providers and consumers exist together. Resource allocation usually occurs at any time with demand and supply relation varying often, and resource usage cannot be completely anticipated. Several issues, such as multi-objective multi-task scheduling, automatic resource provisioning, and workflow scheduling, has to be solved [2], [3]. Specifically, resource allocation must provision the nature of heterogeneity, decentralization and dynamics of cloud. Since the allocation of resources among different individuals with different objectives in human societies is concerned with economics, many economic models are usually applied to resource allocation in cloud [4].

Even though there are a number of fixed-price based approaches are used in cloud, they are inefficient economically [5]. Conversely, auction-based approaches belong to dynamic pricing and are economically efficient [5]. The Components of a cloud market can be classified buyers (consumers), sellers (providers), and auctioneers. Buyers are charged for the resources which are consumed by them based on their valuations, which encourages the competitions among buyers and also among sellers. Auction offers incentive not only for the sellers in order to provide their resources and to get profits, but also for buyers to back off whenever it is necessary, regulating the demand and supply which arrives at market equilibrium. It can cope with the various and conflicting interests of the participants, match dynamic demand and supply which enables the participants to make decisions independently. Due to the above mentioned highly appealing advantages of the auction, there has been any proposals for auction based resource allocation approaches, and there are some cloud service providers who have already used auction to sell their resources, for example, spot instances in Amazon's EC2 [6]. Since cloud computing has become more and more popular and since it is widely available, especially Inter-Cloud, distributed cloud, and OCX are emerging, the cloud market has now become really complex and increasingly competitive [7], [8], [9].

In such an environment, a consumer may apply for various kinds of services and a provider may also provide various kinds of services. The services are provided as a combination of resources, which makes the problem more difficult than focusing on a single resource and calling for combinatorial auction [10]; at the same time, appropriate resources may be available from a large number of providers, and a number of consumers may be competing for the same resources. Thus, the providers and consumers are treated symmetrically. The providers submit the asks and consumers submit the bids, calling for double auction [11]; hence, combinatorial double auction should be provided [11]. In addition, the resources demanded by a consumer may be offered by one provider alone, or by multiple providers jointly in order to, for example, optimize market profits, balance system load, or partition an extra-large task among several providers, which cannot be accommodated by any single provider, especially in Inter-Cloud or distributed cloud. This cannot be supported by [10], [11] and other related solutions. Therefore, we improve the combinatorial double auction further to enable task partitioning among multiple providers.

At the end of the auction, which provider offers the demanded service to which consumer based on the eligible transaction relationship at the same time whether and how a demanded service should be carried out by multiple providers jointly are decided.

In fact, a comprehensive cloud resource allocation approach is really fundamental in such a challenging cloud market. Oriented to IaaS, we propose an approximation algorithm to allocate the following basic resources: processing, memory, storage, network bandwidth. In particular, we consider the following basic services: virtual machine service (VMS), computation service (CPS), database service (DBS), and storage service (STS). The major contributions of this paper are as follows. (1) With integration and necessary improvement of existing techniques, the approximation algorithm is proposed to comprehensively deal with the aforementioned resource allocation challenges. (2) An improved combinatorial double auction protocol is devised to enable various kinds of resources traded among multiple consumers and multiple providers, and at the same time enable task partitioning among multiple providers. (3) A price formation mechanism is devised.

II. RELATED WORK

A lot of auction based cloud resource allocation researches have been done. Several resource allocation strategies based on a reverse auction model for allocating one type of cloud resource from different providers are investigated. A reverse batch matching auction is proposed for allocating various kinds of cloud resources from different providers. In [14], a truthful online auction mechanism is proposed for a provider to allocate one type of cloud resource among consumers with heterogeneous demands. A continuous double auction mechanism is designed to enable consumers and providers to bid and offer one type of cloud resource. A knowledge based continuous double auction model is proposed to trade one type of cloud resource. A non-additive negotiation model is proposed with multiple objectives considered, by which a provider can efficiently allocate various kinds of resources to a consumer. In [13], cloud resource allocation is done through the auction of different types of VM instances, and a randomized combinatorial auction is proposed, which is computationally efficient and truthful in expectation with guaranteed social welfare approximation factor. In [10], an online combinatorial auction framework is proposed, which can optimize system efficiency across temporal domain and model dynamic provisioning of heterogeneous VM types. In [12], a suite of truthful and computationally efficient auction mechanisms for cloud resource pricing are proposed with the multi-unit combinatorial auction problem solved. In [11], a combinatorial double auction cloud resource allocation model is proposed, allowing double-sided competition and bidding on bundles of items.

However, the aforementioned researches cannot deal with transactions of various kinds of resources among multiple consumers and multiple providers with task partitioning among multiple providers enabled, which is solved by our work. In addition, we consider VMS, CPS, DBS, and STS, which usually provided in IaaS cloud; in contrast, [10], [11], [12], [13] only consider VMS. A lot of price formation mechanisms have been proposed. In [5], [14], bidding and asking prices are given directly, not reflecting supply and demand relation. The asking price is determined by a dynamic pricing scheme based on instant supply and demand information. The asking price is calculated based on instant capacity information or historical win/loss ratio information. Bidding and asking prices are determined by a two-stage game strategy based on historical price information. Bidding and asking prices are determined by a learning algorithm based on historical price information. A genetic model based on both price and non-price historical information is proposed to offer suitable price, however, it does not adapt to rapid market changes.

III. THE SYSTEM MODEL

In the system model there are mainly two participants

A. Cloud Users:

A cloud user submits a bid defined by b(d,l,v) where d is a demand, and l is a demand period. vi is user i's valuation for the demand as a bidding price, which indicates the maximum price that is acceptable for sthe user to buy the requesting instances.

B. Cloud Providers:

A cloud provider submits an offer defined by O = (s,w,j) s is a supply, w denotes a length of time that a provider is able to provide the instances between start time t_s and end time t_e . Q_j is provider j's valuation for the supply as an offering price curve, which indicates the minimum of a unit price of the offered instances that the provider wishes to sell.

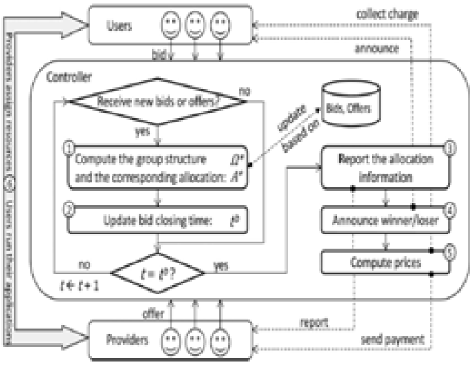

Figure 1. SYSTEM MODEL

Figure 1 is the central controller will collect bids from users and offers from cloud providers. All the bids and offers are received by the system administrator. Comparing the needs of both users and providers the resource allocation will occur. All the bids after bid closing time will be rejected. Based on time the resources will be allocated between users and providers. After the auction the winners and losers of auction are announced. After that price is determined to the auction winners.

IV. PROPOSED ALGORITHM

Approximation algorithms are often associated with NP-hard problems; since it is unlikely that there can ever be efficient polynomial-time exact algorithms solving NP-hard problems, one settles for polynomial-time sub-optimal solutions. Unlike heuristics, which usually only find reasonably good solutions reasonably fast, one wants provable solution quality and provable run-time bounds. Ideally, the approximation is optimal up to a small constant factor (for instance within 5% of the optimal solution). Approximation algorithms are increasingly being used for problems where exact polynomial-time algorithms are known but are too expensive due to the input size. A typical example for an approximation algorithm is the one for vertex cover in graphs: find an uncovered edge and add both endpoints to the vertex cover, until none remain. It is clear that the resulting cover is at most twice as large as the optimal one. This is a constant factor approximation algorithm with a factor of 2.

NP-hard problems vary greatly in their approximability; some, such as the bin packing problem, can be approximated within any factor greater than 1 (such a family of approximation algorithms is often called a polynomial time approximation scheme or PTAS). Others are impossible to approximate within any constant, or even polynomial factor unless P = NP, such as the maximum clique problem.

NP-hard problems can often be expressed as integer programs (IP) and solved exactly in exponential time. Many approximation algorithms emerge from the linear programming relaxation of the integer program.

For some approximation algorithms it is possible to prove certain properties about the approximation of the optimum result. For example, a ρ-approximation algorithm A is defined to be an algorithm for which it has been proven that the value/cost, f(x), of the approximate solution A(x) to an instance x will not be more (or less, depending on the situation) than a factor ρ times the value, OPT, of an optimum solution.

$$\begin{cases} \mathrm{OPT} \leq f(x) \leq \rho\mathrm{OPT}, & \text{if } \rho > 1 \\ \rho\mathrm{OPT} \leq f(x) \leq \mathrm{OPT}, & \text{if } \rho < 1 \end{cases}$$

The factor ρ is called the relative performance guarantee. An approximation algorithm has an absolute performance guarantee or bounded error c, if it has been proven for every instance x that

$$(\mathrm{OPT} - c) \leq f(x) \leq (\mathrm{OPT} + c)$$

Similarly, the performance guarantee, R(x,y), of a solution y to an instance x is defined as

$$R(x, y) = \max\left(\frac{\mathrm{OPT}}{f(y)}, \frac{f(y)}{\mathrm{OPT}}\right)$$

where f(y) is the value/cost of the solution y for the instance x. Clearly, the performance guarantee is greater than or equal to 1 and equal to 1 if and only if y is an optimal solution. If an algorithm A guarantees to return solutions with a performance guarantee of at most r(n), then A is said to be an r(n)-approximation algorithm and has an approximation ratio of r(n). Likewise, a problem with an r(n)-approximation algorithm is said to be r(n)-approximable or have an approximation ratio of r(n).

V. SIMULATION AND PERFORMANCE EVALUATION

The Group auction system with approximation algorithm for resource allocation is simulated in "cloudsim". The market scale is classified into six categories according to the number of users and providers in cloud market, as shown in Table 1.

Table1:

1	Tiny
2	Small
3	Medium
4	Large
5	Huge
6	Oversized

In order to evaluate economic efficiency and trustfulness of Group Auction System, we use simulation to verify its effectiveness and compare its performance with its counterpart SCDA [16] in resource allocation. In SCDA, a compulsory bidding is added to Continuous Double Auction to promote continuous matching and immediate allocation with low runtime overhead. In particular, it deals with resource allocation among self-interested participants in a dynamic and distributed market. Due to the treatment situation similarity and the auction nature, we choose the counterpart which applies SCDA as the comparison benchmark to Group Auction System.

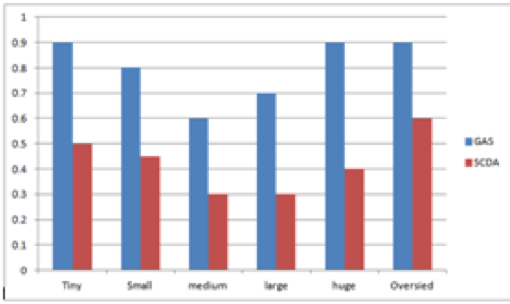

Figure 2 RESULTS COMPARISION

Figure 2 shows the comparison graph of resource allocation for cloud internet applications in SCDA and GAS.

VI. CONCLUSION AND FUTURE WORK

In this paper, we have proposed an approximation algorithm for efficient allocation of cloud internet applications and to accommodate more number of participants in the real time group auction system. In the current system, formulated binary integer programming is known to be NP-hard that the number of different allocations to be evaluated exponentially increases as the numbers of users and providers increases. So, binary integer programming is not efficient when there is more number of participants. To overcome this problem approximation algorithm is proposed which solves np-hard problems. As our future work, we have two areas to improve. First, finding the best bid closing time. Second, we can include many bidding strategies in auction.

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