JOURNAL OF INFORMATION, KNOWLEDGE AND RESEARCH IN COMPUTER ENGINEERING

AN EXPERIMENTAL STUDY ON VALIDATION OF COMBINATORIAL ALLOCATION IN CLOUD COMPUTING ENVIRONMENT

[1] N.SRINIVAS, [2] M.VENKATESWARARAO, [3] L.VIJAY KUMAR

[1] AssocProf-CSEDEPT , Vignana Bharathi Institute of Technology, Aushapur, Ghatkesar, R.R Dist-501301, AP, India.
[2] AssocProf-CSIT DEPT , Vignana Bharathi Institute of Technology, Aushapur, Ghatkesar, R.R Dist-501301, AP, India.
[3] Assoc Prof&Head-CSE DEPT ,Vijaya Krishna Institute Of Technology And Sciences, palamakula (V), Shamshabad(M), R.R.Distict-509325

srinivas_sesha@yahoo.com, venkat2m2@gmail.com, ledallavijay@gmail.com

ABSTRACT: *This paper proposes a marketplace mechanism for resource allocation to develop an enterprise system in cloud computing environment. The proposed mechanism performs resource allocation between users and PaaS providers using combinatory al double-sided auction. In other words, both users and PaaS providers place buying/selling orders of resources, and the market mechanism decides resource allocations by means of auctions. The user's enterprise system often consists of multiple resources, thus, the user is able to order arbitrary combination of services for future use at desired time, price and QoS requirements. The proposed mechanism employs mixed integer programming (MIP) to obtain optimal resource allocation enforcing a Pareto optimum outcome as well as a fair trading.*

1. HISTORY

Auction Theory : Auction is a type of market mechanism where the price is neither preset nor arrived at by negotiation, but is discovered through the process of competitive bidding. More formally speaking, an auction is a “protocol that allows agents’ to indicate their interest in one or more resources and that uses these indications of interest to determine both an allocation of resources and a set of payments by the agents” . Auction allows multiple buyers to negotiate with a single seller by submitting bids through an auctioneer, or vice versa. The auctioneer sets the rules of the auction and acts as an arbitrator. Negotiation continues until a single clearing price is reached. Thus, auction regulates supply and demand based on the competition of bidding price among sellers and/or buyers. Auction is a powerful tool to resolve a competitive situation of resource acquirement. There is virtually infinite variety of auction mechanisms in the world

2.BACKGROUND WORK

2.1 Taxonomy of auction design

.This paper classifies them from two points of view: the number ofgoods and the number of participants (i.e. sellers and buyers). The former means that how many kinds of good (or merchandise, service, etc.) are traded in an auction at the same time. The latter implies that on which side of participants the competition occurs. Table 2.1 summarizes the classification and the sections below review typical types of auction from above two points of view.

		#Sellers : #Buyers	
		1 : N or M : 1	M : N
#Goods	One	Single-good single-sided (Section 2.2.1)	Single-good double-sided (Section 2.2.2)
	Many	Combinatorial (Section 2.2.3)	

Table 2.1 Taxonomy of auction design

2.1.1 Single-good Single-sided Auctions

A. English auction

Perhaps the readers imagine the English auction simply by the word "auction”, because the English auction is widely used in both traditional auction houses and today’s internet auctions. In English auctions, there is one seller and the competition occurs among multiple buyers. The procedure is (1) the auctioneer first declares the initial price of the good, (2) the buyers then monotonically raises the price by making their bids, and (3) the auctioneer finally stops the biddings when no more biddings are made or when a fixed time is reached. The final bidder with the highest price becomes the winner and he must purchase the good at that price.

B. Japanese auction

In Japanese auctions, not the buyer but the auctioneer raises the price. The procedure is (1) the auctioneer sets the initial price and starts raising it periodically,

(2) In each period a buyer must declare whether he remains in or drops out of the auction, and (3) the auction finishes when only one buyer remains in. The final remained buyer becomes the winner and he must purchase the good at the final price. A dropped buyer cannot come back to the same auction.

C. Dutch auction

In Dutch auctions, the price goes down from high to low.

The procedure is (1) the auctioneer declares a high initial price and starts a wall clock that indicates the descending price, (2) a buyer pushes a button at an arbitrary time to stop the wall clock, and (3) the auction finishes immediately. The first buyer pushing the button becomes the winner and he must buy purchase the good at that price. The Dutch auction is used in the Amsterdam flower market as it is particularly suitable to determine the winner as quick as possible.

D. Sealed-bid auctions

The biddings can be secret from other buyers. In sealed-bid auctions, unlike the three types of auctions discussed above, the biddings are not open to the public. The procedure is (1) the buyers submit their “sealed” biddings directly to the auctioneer,(2) the auctioneer then compares these biddings, and (3) the buyer with the highest bid becomes the winner and he must purchase the good. The price at which the winner purchase the good is determined separately in several ways: (a) in first-price auctions the winner's due is equal to his own bid, (b) in second-price auctions the winner’s due is equal to the second-highest bid (i.e. the highest rejected bid), and (c) in k^{th}-price auctions the winner's due is equal to the k^{th}-highest bid. The second-price auctions are also used in combination with the English auctions. For instance, in the internet auctions like Yahoo! Auctions, (1) the buyer tells his reservation price to a proxy agent, (2) the proxy agent then keeps bidding above the previous highest bid until the reservation price is reached, and (3) the auction finishes at a pre-defined time. The highest bidder becomes the winner and he pays the price just one unit above the second-highest bid. This type of auction can be seen as a combination of the English auction and the second-price sealed-bid auction.

E. Reverse Auctions

The above four sections have considered situations with one seller and multiple buyers. We can consider the opposite: auctions with multiple sellers and one buyer. Such a family of auctions is called reverse auctions. For instance, in a public procurement, there is one buyer (e.g. a local government office) and multiple sellers (e.g. construction companies) competing each other to provide the lowest price for a good (e.g. building). The discussion on the non-reverse auctions can also be applied to the reverse auctions by negating the prices (a negative payment means an earning) and swapping the word “seller” for “buyer”, “highest” for “lowest” and soon, without loss of generality. Therefore the sections below will not discuss reverse auctions any further.

2.1.2 Single-good Double-sided Auctions

There may be many buyers and many sellers at the same time for single kind of merchandise. This setting is called double-sided auctions or exchanges. A typical example is the stock market, in which many people are participating to buy or sell company’s stock. Note that the double-sided auction causes two kinds of competition at the same time: one is on the buyer’s side (a buyer competes against other buyers) and the other is on the seller’s side (a seller competes against other sellers). It is different from the internet auctions like Yahoo! Auctions where the sellers do not directly compete with each other. There are primarily two approaches to implement the single-good double-sided auctions: the continuous double auction (CDA) and the periodic double auction (PDA)also known as the clearing house auctions. In both the CDA and the PDA, a participant places orders at any time and as many times as he want. Each order includes a price (maximum for buying or minimum for selling) and a quantity(positive for buying or negative for selling). The auctioneer then registers the incoming orders on an order book.

The difference between the CDA and the PDA is the time when the trading occurs. In the CDA, as soon as the order comes, the auctioneer attempts to match it against the orders put on the order book. For example, an incoming buy order for 10units may be matched against an existing sell order for 4 units and another sell order for 6 units, as long as the buying price exceeds the selling price. In cases of partial matches, the remaining units (either of the incoming order or of the existing orders) are put back on the order book. For example, when a sell order for 13 units is coming and two buy orders – one for 4 units and another for 6 units – are existing on the order, 10 units of the sell order is matched against the buy orders and the remaining3 units are put on the order book as a sell order. In the PDA, in contrast, the auctioneer does not attempt to match the order at the time it comes; instead he simply put it on the order book. Then, at some pre-defined clock time, he attempts to match the orders as much as possible. The Itayose algorithm is often used for matchmaking, by which he ranks the orders according to their price and determines the point at which supply meets demand.

Figure 2.1.2 depicts a snapshot of an order book before and after the trading occurs. In this example 14 units are traded and the remaining ones are left on the order book.

Before			After		
#Sell	Price	#Buy	#Sell	Price	#Buy
4	$9	6	4	$9	
0	$8	0	0	$8	
0	$8	0	0	$8	
2	$6	0	2	$6	
0	$5	4	0	$5	
6	$4	6		$4	2
0	$3	3		$3	3
3	$2	5		$2	5
5	$1	2		$1	2

Figure 2.1.2 Example order book of periodical double-sided auction

2.1.3 Combinatorial Auctions

Combinatorial auction is the most generic form of auctions, which allows different kinds of good to be traded at once, unlike the single-good auctions discussed in the above sections. This is particularly meaningful for the agents (buyers and/or sellers) whose valuations depend on the set of goods they deal with, rather than the good itself. For example, to make use of a computer, you need to procure not only the computer itself but also its operating system and perhaps an internet connection. Real-world applications of the combinatorial auctions so far include the auctions for radio spectrum, energy, shipping paths, and corporate procurement. More formally, consider a set of agents' $N = \{1... n\}$ and a set of goods $G = \{1... m\}$. Let $v = (v1... vn)$ denote the valuation functions of the different agents, where valuation for each i belongs to N, $vi : 2^G \rightarrow$ R . There is an assumption that there are no externalities. Specifically, it is asserted that an agent's valuation depends only on the set of goods he wins; that is, we do not consider such an agent who also cares about the allocations and payments of the other agents. The agents in the combinatorial auctions have non additive valuation functions. There are two kinds of nonadditivity: substitutability and complementarity.

The substitutability means that the combined value of multiple goods is less than the sum of their individual values. For example, imagine you want to buy a car and your option is a Toyota and a Renault. Since you cannot drive both of them at the same time, your satisfaction of having both is less than twice as much as having one of them; in other words, these two cars are partial substitutes for each other. If two goods are strict substitutes their combined value is equals to the value for either one – in this case these items can also be seen as multiple units of a single kind of good. The complementarity means that the combined value of multiple goods is greater than the sum of their individual values. For example, imagine you are commanded to travel from Tokyo to Pyongyang via Beijing; you need the tickets for both flights – not only one of them – otherwise you cannot accomplish your mission. A business process is much like this; the value of corporation is created not by each job alone but by the combined outcome of whole company. The advantage of the combinatorial auctions is their ability to simplify the agent's strategy. If there is no combinatorial auction, for example in thecomplemental case, an agent needs to arrange a bundle of multiple goods in aOne-by-one manner at the risk of incompletion (so-called "exposure risk"). This is a risky and complex task for the agent. With combinatorial auctions, in contrast, an agent needs to simply express his requirement for a bundle to the auctioneer. There is no risk of incompletion since the allocation is guaranteed to be all-or-nothing. Essentially the combinatorial auction eliminates the complexity from the agent and instead transfers it to the auctioneer. "Indeed, these auctions have been the subject of considerable recent study in both economics and computer science".

3.EXPERIMENTAL STUDIES

To confirm the advantage of the proposed mechanism, an experiment has been carried out: (1) validation of combinatorial allocations, this paper presents these results and discusses the excellence and weakness of the proposedmechanism.All the simulations in this chapter are carried out using our W-Mart simulator

3.1. Validation of Combinatorial Allocation

The proposed mechanism enables combinational allocations for workflows and co-allocations. This section investigates two simple cases to see how combinational allocations are achieved in the forward market and in the spot market.

3.1.1 Settings

The forward market is assumed to have four timeslots (i.e. from zero o'clock to four o'clock). Two kinds of services are offered by three providers: the provider 1 offers service A; the provider 2 and the provider 3 offer service B with different prices. Two users require these services in different manners: the user 1 needs the services A and B simultaneously for co-allocation; the user 2 needs the services A and Sequentially for a workflow. The quantities, valuations and start/finish times of each service are shown in Figure 3.1.2.1 and Figure 3.1.2.3 The required runtime of the task equals (finish time -start time), which means that no interruption occurs. Table 3.1.1shows the formulations of the simulation parameters. Only one timeslot is available for the spot market. The providers and the services are the same as those of the forward market. The user1and the user2 require the same combination of the services A and B, but the valuation of the user 1is higher than that of the user 2.

		Forward	Spot
Market	Forward delivery hours	$T = 4$ slots	
Seller	Service types	$\{g_{m_1}, g_{m_2}, g_{m_3}\} = \{A, B, B\}$	
	Quantity of a service	$\{q_{m_1}, q_{m_2}, q_{m_3}\} = \{40, 30, 30\}$ units	
	Order price	Shown in Figure 6.1 thru Figure 6.4	
Buyer	Service types	$G \in \{A, B\}$	
	Number of task in a workflow	$H = 2$	
	Quantity of service required by a task	$q_j = [10, 30]$ units	
	Order price	Shown in the figures	
	Length of a workflow	$l_j = [3, 4]$ slots $l_j = d_j - b_j + 1$	$l_j = 1$ slot
	Length of a task	Shown in Figure 6.1 thru Figure 6.4	

Table 3.1.1 Simulation settings for validation of combinatorial allocation

3.1.2 Results

Figure 3.1.2.1 and Figure 3.1.2.2 respectively show orders and the allocation results in the forward market. These results show that orders from all the users are fulfilled. In particular, the order from the user 2 consists of two tasks in a workflow – a task of the service A and one of the service B – and the services are properly allocated to the tasks. These results indicate that the proposed mechanism using the combinational auction properly allocated the services to workflow tasks. Note that the provider 3won the competition to sell the service B for the user 1 in timeslot 2 because he priced it lower than the provider 2 did and therefore generated more total welfare. Figure3.1.2.3 and Figure 3.1.2.4 respectively show orders and the allocation results in the spot market. The supply of the service B is less than the demand. As a result, the user 2 lost the competition and bought nothing. Indeed the provider 1 still has enough capacity for the service A, but it is not allocated to the user 2 since it doesnot fulfill the combinational order of the user 2

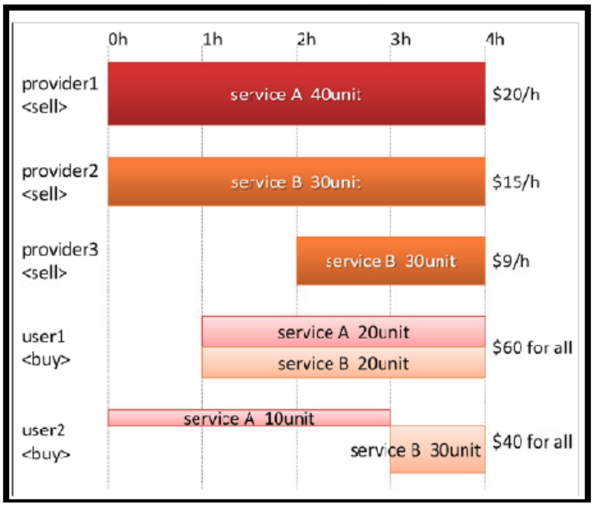

Figure 3.1.2.1 Forward orders

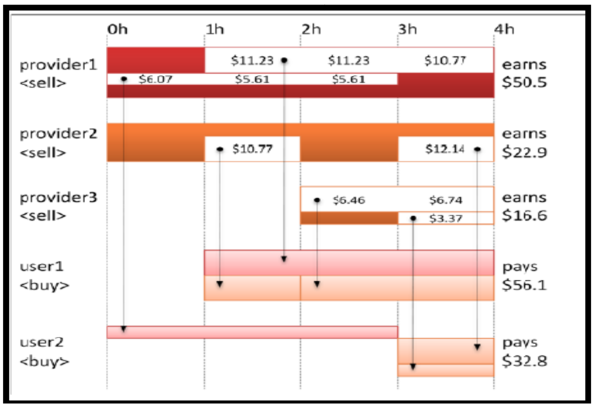

Figure 3.1.2.2 Forward allocation

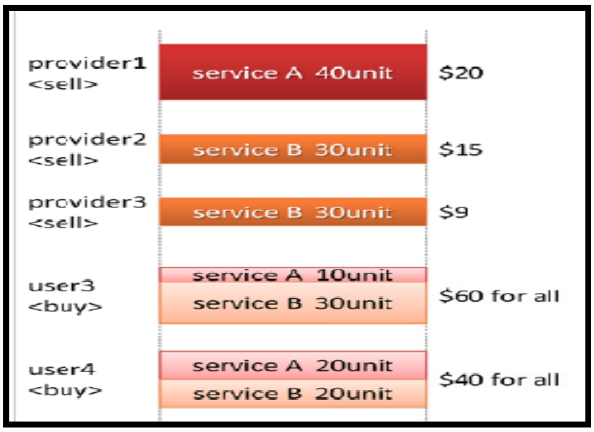

Figure 3.1.2.3 Spot orders

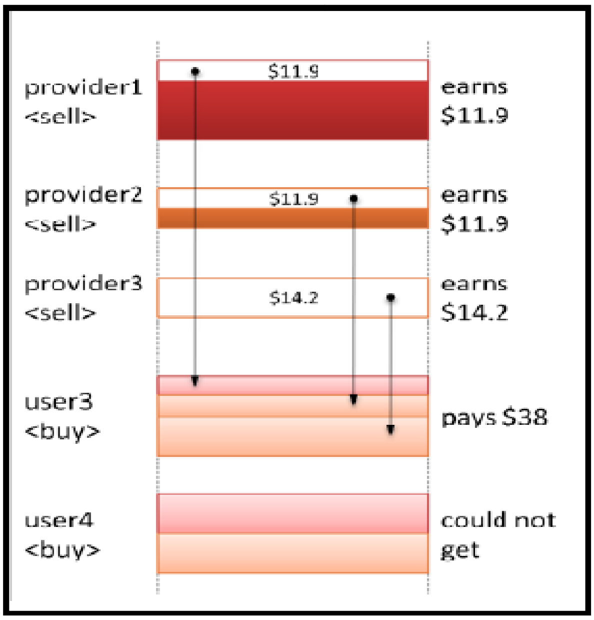

Figure 3.1.2.4 Spot allocation

4. SUMMARY

It is confirmed through this preliminary experiment that the proposed mechanism properly allocates the services amongst multiple providers, multiple users, multiple kinds of services and combinatorial requirements for them. The outcome of the mechanism is reliable.

5. CONCLUSION

An intelligent marketplace for optimal service allocation in the cloud computing environment is desired to be established. This paper presents proposed a combinatorial auction-based marketplace mechanism to support enterprise workflow-based applications built on the cloud services. It employs an exact optimization technique to achieve a Pareto-efficient allocation of services. The proposed marketplace consists of a forward market for an advance reservation and a spot market for immediate allocation of services so that the users reliably plan the use of cloud services within budget limitations.
an experiments have been carried out in this papers: (1) validation of combinatorial allocations

6.FUTURE WORKS

Sophisticated strategies of seller/buyer agents can significantly improve the performance of the market. For instance, a buyer agent can reduce wasted resources and can increase workflow completion rate by employing a smarter strategy to make his orders. Moreover, it is essential for seller/buyer agents to adjust their orderprice according to the market price in competition with each other6. The future work will therefore investigate the market behavior using more sophisticated strategies of seller/buyer agents. Interesting research objectives include the autonomous behavior of the market price, particularly the interaction between the forward market and the spot market, where the forward price is expected to be a forecast of the spot price. A high price in the forward market indicates a busy hour of the provider. By watching the forward price, a buyer can predict the demand-supply conditions and avoid purchasing an unnecessarily high-priced service. As a result, the demand-supply ratio (and thus the market price) is expected to be smooth and stable. This can be seen as an autonomous load-balancing functionality achieved by the dual-market design, which cannot be realized by the spot market alone. However, it is not clear that these selfish participants are able to sustain such a peaceful marketplace; therefore furtherstudy with various agents is needed in the future research.

7. REFERENCES

[1] O. Regev, “The POPCORN market. Online markets for computational resources,”Decision Support Systems, vol. 28, Mar. 2000, pp. 177-189.

[2] R. Wolski, J.S. Plank, T. Bryan, and J. Brevik, “G-commerce: market formulations controlling resource allocation on the computational grid,”Proceedings 15th International Parallel and Distributed Processing Symposium.IPDPS 2001, IEEE Comput. Soc, 2001, p. 8.

[3] R. Wolski, J. Brevik, J.S. Plank, and T. Bryan, “Grid Resource Allocation andControl Using Computational Economies,” GRID COMPUTING: MAKING THEGLOBAL INFRASTRUCTURE A REALITY, 2003, pp. 747 - 772.

[4] R. Buyya, D. Abramson, and J. Giddy, “Nimrod/G: an architecture for aresource management and scheduling system in a global computational grid,”Computer, vol. 1, 2000, pp. 283-289.

[5] D. Abramson, I. Foster, J. Giddy, A. Lewis, R. Sosic, R. Sutherst, and N. White,“The Nimrod Computational Workbench: A Case Study in Desktop Metacomputing,” Australian Computer Science Communications, vol. 19, 1997,pp. 17-26.

[6] I. Foster and C. Kesselman, “Globus: A Metacomputing Infrastructure Toolkit,”International Journal of Supercomputer Applications, vol. 11, 1997, pp. 115-128.

[7.] P. Padala, C. Harrison, N. Pelfort, E. Jansen, M.P. Frank, and C. Chokkareddy,“OCEAN: the open computation exchange and arbitration network, a marketapproach to meta computing,” Second International Symposium on Paralleland Distributed Computing, 2003. Proceedings., IEEE, 2003, pp. 185-192.

[8] A. AuYoung, B.N. Chun, A.C. Snoeren, and A. Vahdat, “Resource Allocation inFederated Distributed Computing Infrastructures,” Proceedings of the 1stWorkshop on Operating System and Architectural Support for the Ondemand IT Infrastructure, 2004, pp. 1-10.

[9] L. Peterson, T. Anderson, D. Culler, and T. Roscoe, “A blueprint forintroducing disruptive technology into the Internet,” ACM SIGCOMM Computer Communication Review, vol. 33, Jan. 2003, pp. 59-64.

[10] D. Oppenheimer, J. Albrecht, D. Patterson, and A. Vahdat, Scalable wide-arearesource discovery, 2004.

[11] B.N. Chun, P. Buonadonna, A. AuYoung, D.C. Parkes, J. Shneidman, A.C.Snoeren, and A. Vahdat, “Mirage: A Microeconomic Resource Allocation System for Sensornet Testbeds,” The Second IEEE Workshop on EmbeddedNetworked Sensors, 2005. EmNetS-II., IEEE, , pp. 19-28.

[12] K. Lai, L. Rasmusson, E. Adar, L. Zhang, and B.A. Huberman, “Tycoon: Animplementation of a distributed, market-based resource allocation system,”Multiagent Grid Syst., vol. 1, 2005, pp. 169-182.

[13] T. Eymann, M. Reinicke, W. Streitberger, O. Rana, L. Joita, D. Neumann, B.Schnizler, D. Veit, O. Ardaiz, P. Chacin, I. Chao, F. Freitag, L. Navarro, M. Catalano, M. Gallegati, G. Giulioni, R.C. Schiaffino, and F. Zini,“Catallaxy-based Grid markets,” Multiagent and Grid Systems, vol. 1, Dec.2005, pp. 297-307.

[14] B. Schnizler, D. Neumann, D. Veit, M. Reinicke, and W. Streitberger,Theoretical and Computational Basis for CATNETS - Annual Report Year 1,2005.

[15] D. Veit, G. Buss, B. Schnizler, and D. Neumann, Theoretical andComputational Basis for CATNETS - Annual Report Year 2, 2006.

[16] D. Veit, G. Buss, B. Schnizler, and D. Neumann, Theoretical andComputational Basis for CATNETS - Annual Report Year 3, 2007.
[17] Z. Tan and J.R. Gurd, “Market-based grid resource allocation using a stablecontinuous double auction,” Grid Computing, 2007 8th IEEE/ACM InternationalConference on, 2007, pp. 283-290.
[18] T. Zhu and J.R. Gurd, “Market-based grid resource allocation using a stablecontinuous double auction (Ph.D. thesis),” 2007.
[19] “Amazon EC2 Spot Instances” http://aws.amazon.com/ec2/spot-instances/.
[20] “Heroku | Add-ons” http://addons.heroku.com/.