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Auction Oriented Approach for Resource Management in Grid Computing

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Abstract

Grid computing, emerging as a new paradigm for next-generation computing, enables the sharing, selection, and aggregation of geographically distributed heterogeneous resources for solving large-scale problems in science, engineering, and commerce. The resources in the Grid are heterogeneous and geographically distributed. The paper demonstrates the capability of economic-based systems for wide-area parallel and distributed computing by using auction-oriented approach. In this paper implementation of the various auction models-English Auction, Dutch Auction, First-Price Sealed Auction, Continuous Double Auction is done. Also these models are compared.

Keywords: *Grid computing, Resource management, Economic models, Auction Models*

I. Introduction

The auction model supports one-to-many negotiation, between a service provider (seller) and many consumers (buyers), and reduces negotiation to a single value (i.e., price). The auctioneer sets the rules of auction, acceptable for the consumers and the providers. Auctions basically use market forces to negotiate a clearing price for the service. In the real world, auctions are used extensively, particularly for selling goods/items within a set duration. The three key players involved in auctions are: resource owners, auctioneers (mediators) and buyers. Many e-commerce portals such as Amazon.com and eBay.com are serving as mediators (auctioneers). The steps involved in the auction process are [9]:

a) GSPs announce their services and invite bids.
b) Brokers offer their bids (and they can see what other consumers offer if they like - depending on open/closed).
c) Step (b) goes on until no one is willing to bid higher price or auctioneer stops if the minimum price line is not met.
d) GSP offers service to the one who wins.
e) Consumer uses the resource.

Depending on various parameters, auctions can be classified into four types:

1. English Auction (first-price open cry)
2. First-price sealed-bid auction
3. Dutch Auction
4. Continuous Double Auction

Most of the related work in Grid computing dedicated to resource management and scheduling problems adopt a *conventional style* where a scheduling component decides which jobs are to be executed at which site based on certain cost functions (Legion [3], Condor [7], AppLeS [1], Netsolve [2], Punch [6]).

II. Auction Protocols

This section presents a brief overview of the auction protocols examined in this work. FIPA standards were followed for the implementation of English and Dutch auctions policies [4] [5].

English Auction (EA): The English auction [8] is an ascending auction in which the auctioneer tries to find the price of a good by proposing a price below the supposed market value and slowly raising the price. Initially, the auctioneer issues a call for proposals, then waits to see whether a bidder is interested in taking the good for that price. As soon as a bidder makes a proposal, the auctioneer will issue a new call for proposals with an increase in the price. The auction stops when no bidder is interested in paying the current price for the good. Thus, the auctioneer allocates the good to the bidder who has made the past highest bid. *In English Auction (first-price open cry),* all bidders are free to increase their bids exceeding other offers. When none of the bidders are willing to raise the price anymore, the auction ends, and the highest bidder wins the item at the price of his bid.

Dutch auction (DA): The Dutch auction [8] is a descending auction and differs from the English auction in the sense that the auctioneer starts by issuing a call for proposals with a price much higher than the expected

market value. The auctioneer then gradually decreases the price until some bidder shows interest in taking the good for the price announced. The auctioneer starts with a high bid/price and continuously lowers the price until one of the bidders takes the item at the current price. It is similar to first-price sealed-bid auction because in both cases the bid matters only if it is the highest and no relevant information is revealed during the auction process.
The interaction protocols for Dutch auction are as follows: the auction attempts to find market price for a good/service by starting at a price much higher than the expected market value, then progressively reducing the price until one of the buyers accepts the price. The rate of reduction in price is up to the auctioneer and they have a reserve price below which not to go. If the auction reduces the price to reserve price with no buyers, the auction terminates. In terms of real time, Dutch auction is much more efficient as the auctioneer can decrease the price at a strategic rate and first higher bidder wins.

First-Price Sealed Auction (FPSA): In our implementation of the First-Price sealed auction, bidders are not aware of each other's offers. In addition, it is a single round auction, which makes it very similar to an e-procurement. In our policy, the minimum price is the reserve price of the good. When bidders receive a call for proposals, they can verify the minimum price and either decide to bid or not to bid for the good. The auctioneer waits a given time for the bids and then allocates the good to the bidder who has valued the good the most. The auctioneer then informs bidders about the final price a price and is the winner when it clears the auction. In this case a broker bid strategy is a function of the private value and the prior beliefs of other bidders' valuations. The best strategy is bid less than its true valuation and it might still win the bid, but it all depends on what the others bid.

Continuous Double Auction (CDA): The Continuous double auction [8] works with a system of bids and asks. The price is found by matching asks and bids. After the auction is started, the auctioneer accepts asks and bids and tries to match asks and bids. The auctioneer informs the bidder and the seller about the price when it matches a match is done. It is the primary economic model for trading of equities, commodities, and derivatives in stock markets (e.g. NASDAQ). In the double auction model, buy orders (*bids*) and sell orders (*asks*) may be submitted at anytime during the trading period. If at any time there are open bids and asks that match or are compatible in terms of price and requirements (e.g., quantity of goods or shares), a trade is executed immediately. The double auction model has high potential for Grid computing. The brokers can easily be enabled to issue *bids* depending on budget, deadline, job complexity, scheduling strategy, and resource characteristics requirements and GSPs can issue *asks* depending on current load and perceived demand, and price constraints. Both orders can be submitted to GMD agents that provide continuous clearance or matching services. Since bids are cleared continuously, both GRBs and GSPs can make instant decisions with less computational overhead and complexity.

III. Experimental Setup and Implementation Details

In order to evaluate the suitability of the auction protocols for resource allocation in Grids, we performed several experiments. We have implemented policies for English, Dutch, First-Price sealed and Continuous auctions. We used three resources. The first experiment considers an English model. In this there are three different selling prices-100, 200 and 300. The three buyers are buyer 1, buyer 2 and buyer 3.

Implementation of English Auction

Algorithm used:

- All bidders are initially *active.*
- Start price and increment are fixed.
- At each stage of the bidding:

1. Auctioneer calls out last price + increment
2. Zero or more bidders may become inactive
3. If at least 2 bidders are still active, auction proceeds to the next stage.
4. If only one auctioneer is active, then he wins at the current price.

Selling Price	Buyer 1	Buyer 2	Buyer 3
100	110	**130**	120
200	210	230	**240**
300	310	320	**330**

Table 1: Table for English Auction

Implementation of Dutch auction

Algorithm used:

- All bidders are initially *inactive*.

- Start price and decrement are fixed.

1. At each stage of the bidding:
2. Auctioneer calls out last price – decrement
3. If at least one bidder says yes, then the first bidder to respond wins at the current price.
4. Else auctioneer proceeds to the next round.

Table: Decremented Level-20

Selling Price	Buyer 1	Buyer 2	Buyer 3
100	90	**Buyer 2=80**	_
200	**Buyer 1=200**	_	_
300	260	270	**Buyer 3=260**

Table 2: Table for Dutch auction

Implementation of FPS Auction

Algorithm used:

- The price inserted into the bid is the price initially estimated by the bidder announced.
- Steps followed in First-Price sealed are:

  1. Ask bids.

  2. Display the winner having the highest bid.

Selling Price	Buyer 1	Buyer 2	Buyer 3
X	100	**300**	200
Y	100	200	**300**
Z	**300**	100	200

Table 3: Table for FPS Auction

Implementation of Continuous Double Auction

Algorithm used:

- The price inserted into the bid is the price initially estimated by the bidder announced.
- In **Continuous double auctions**, the auctioneers match asks and bids. The auctioneer maintains a list of asks ordered in a decreasing order and a list of bids ordered in an increasing order. When the auctioneer receives and ask she proceeds as follows:

1. She compares it with the first bid of the list. If the price in the ask is greater than or equal to the bid's value, it informs that seller and bidder can trade at the price (price ask + price bid) / 2)

2. Otherwise, the auctioneer adds the asks in the list.

If the auctioneer receives a bid, she does the following:

1. She compares it with the first asks of the list. If the price in the ask is greater than or equal to the bid's value, it informs that seller and bidder can trade at the price (price ask + price bid) / 2).

2. Otherwise, the auctioneer adds the bid in the list.

Selling Price	Buyer 1	Buyer 2	Buyer 3
300	40	50	60
200	70	80	90
100	**100**	_	_

Table 4: Continuous double auction in which buyer 1 is winner

Selling Price	Buyer 1	Buyer 2	Buyer 3
300	110	120	130
200	150	**200**	_
100	_	_	_

Table 5: Continuous double auction in which buyer 2 is winner

Selling Price	Buyer 1	Buyer 2	Buyer 3
300	260	270	**300**
200	_	_	_
100	_	_	_

Table 6: Continuous double auction in which buyer 3 is winner

Selling Price	Buyer 1	Buyer 2	Buyer 3
300	_	_	**300**
200	_	**200**	_
100	**100**	_	_

Table 7: Winner's table in CDA

IV. Experimental Results and Analysis

Evaluations Results of English Model

The first experiment considers an English model. In this there are three different selling prices-100, 200 and 300. The three buyers are buyer 1, buyer 2 and buyer 3. All bidders are initially active. Starting price is 100 and is incremented in each level. At first stage of the bidding auctioneer calls out last price and increment 100. In round 1st buyer 2 is winner. In round second and third buyer 3 is winner.

English Auction: According to the various prices, graph has been plotted for buyer 1, buyer 2 and buyer 3 and winner's graph has been plotted for only winners of each selling price.

Selling Price	Buyer 1	Buyer 2	Buyer 3
100	110	**130**	120
200	210	230	**240**
300	310	320	**330**

Table 8: Table for English Auction

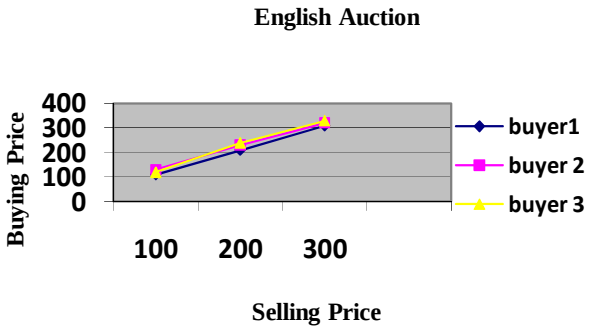

Figure 1: Price interactions of different buyers in English Auction

Winner's Graph:

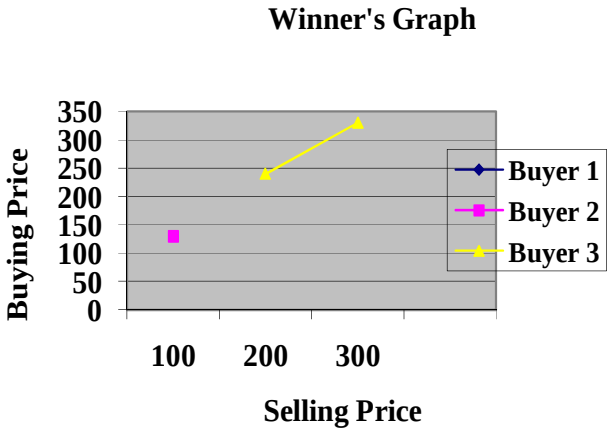

Figure 2: Winner's Graph for English Auction

Evaluations Results of Dutch Model

The second experiment considers a **Dutch model**. In this there are three different selling prices - 100, 200 and 300.The three buyers are buyer 1, buyer 2 and buyer 3. All bidders are initially in*active.* Starting price is 100 and is decremented in each level. At first stage of the bidding auctioneer calls out last price and decrement it. Decremented level is set 20.In round 1st buyer 2 is winner, in round second buyer 1 is winner and in third buyer 3 is winner.

Table: Decremental Level-20

Selling Price	Buyer 1	Buyer 2	Buyer 3
100	90	**Buyer 2=80**	_
200	**Buyer 1=200**	_	_
300	260	270	**Buyer 3=260**

Table 9: Table for Dutch Auction

According to the various prices, graph has been plotted for buyer 1, buyer 2and buyer 3 and winner's graph has been plotted for only winners of each selling price.

Graph:

Dutch Auction:Decremental Level=20

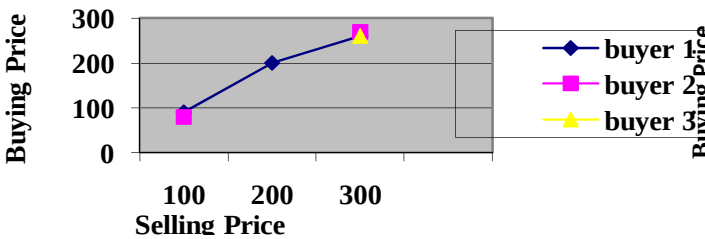

Figure 3: Price interactions of different buyers in Dutch Auction

Winner's graph:

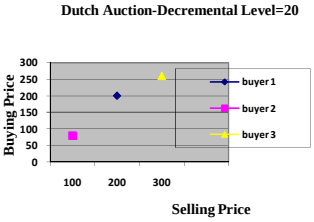

Figure 4: Winner's graph for Dutch Auction

Evaluations Results of First Price Sealed Model

The third experiment considers a First Price Sealed. The three buyers are buyer 1, buyer 2 and buyer 3.It simply asks the bids and display the winner having the highest bid. In round 1st buyer 2 is winner, in round second buyer 3 is winner and in third buyer 1 is winner.

Selling Price	Buyer 1	Buyer 2	Buyer 3
X	100	**300**	200
Y	100	200	**300**
Z	**300**	100	200

Table 10: Table for First Price Sealed Auction

According to the various prices, graph has been plotted for buyer 1, buyer 2and buyer 3 and winner's graph

First-Price Sealed Auction

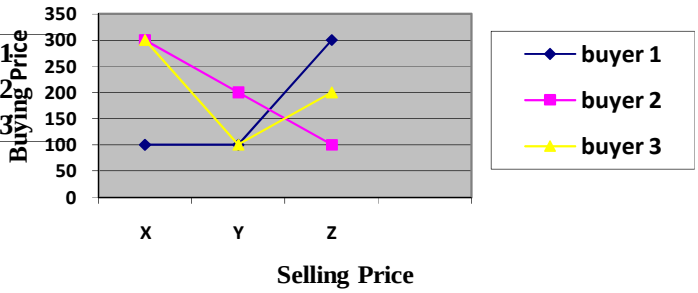

Figure 5: Price interactions of different buyers in First-Price Sealed Auction

Winner's Graph:

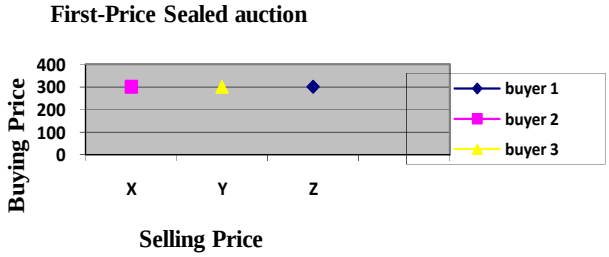

Figure 6: Winner's graph for First-Price Sealed Auction

Evaluations Results of Continuous Double Auction

The 4th experiment considers a Continuous Double Auction. The three buyers are buyer 1, buyer 2 and buyer 3.It simply asks the bids and display the winner having the highest bid. , the auctioneers match asks and bids. The auctioneer maintains a list of asks ordered in a decreasing order and a list of bids ordered in an increasing order. In table 1 asks and bids are matched at 100. In table 1st buyer 1 is winner; in round second buyer 2 is winner and in third buyer 3 is winner.

Selling Price	Buyer 1	Buyer 2	Buyer 3
300	40	50	60
200	70	80	90
100	**100**	_	_

Table 11: Continuous double auction in which buyer 1 is winner

Selling Price	Buyer 1	Buyer 2	Buyer 3
300	110	120	130
200	150	**200**	_
100	_	_	_

Table 12: Continuous double auction in which buyer 2 is winner

Selling Price	Buyer 1	Buyer 2	Buyer 3
300	260	270	**300**
200	_	_	_
100	_	_	_

Table 13: Continuous double auction in which buyer 3 is winner

Selling Price	Buyer 1	Buyer 2	Buyer 3
300	_	_	**300**
200	_	**200**	_
100	**100**	_	_

Table 14: Winner's table in CDA

According to the various prices winner's graph has been plotted for only winners of each selling price on Algorithms 4 / 15.

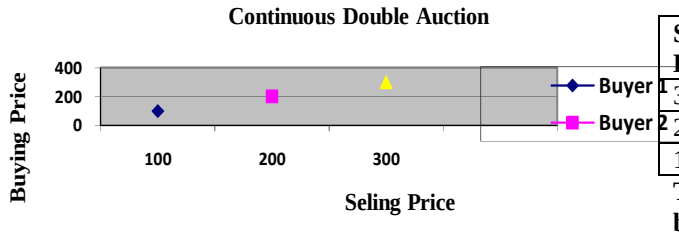

Figure 7: Winner's graph for continuous double Auction

V. COMPARISION OF VARIOUS MODELS AND EVALUATION OF RESULTS

In fifth experiment four auction models i.e. English Auction, Dutch auction, First Price sealed auction are compared and graph has been plotted.

English Auction:

Selling Price	Buyer 1	Buyer 2	Buyer 3
100	100	80	**300**
200	200	250	**300**
300	**350**	300	260

Dutch Auction-Decremental level=20

Table 15: Table for English Auction having buying value same to other models

Selling Price	Buyer 1	Buyer 2	Buyer 3
100	**100**	80	300
200	**200**	250	300
300	**350**	300	260

Table 16: Table for Dutch Auction having buying value same to other models

First Price Sealed Auction:

Selling Price	Buyer 1	Buyer 2	Buyer 3
	100	80	**300**
	200	250	**300**
	350	300	260

Table 17: Table for First Price Sealed Auction having buying value same to other models

Continuous Double Auction:

Selling Price	Buyer 1	Buyer 2	Buyer 3
300	**100**	80	300
200	**200**	250	300
100	350	**300**	260

Table 18: Table for Continuous Double Auction having buying value same to other models

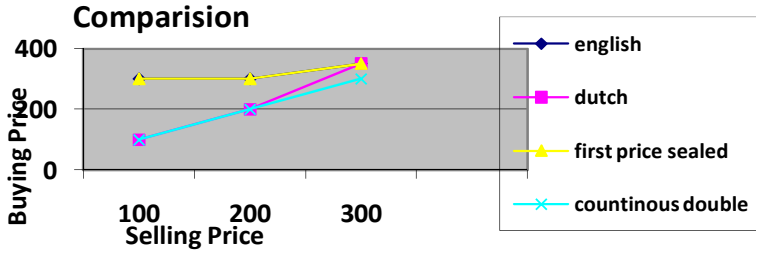

Figure 8: Comparision graph for four Auction Protocols

VI. Conclusion and Future Work

We performed several experiments in order to evaluate the suitability of the auction protocols for resource allocation in Grids. We have implemented policies for English, Dutch, First-Price sealed and Continuous auctions. We used three resources. The first experiment considers an English model. In this there are three different selling prices- 100, 200 and 300.The three buyers are buyer 1, buyer 2 and buyer 3.

We have carried out experiments that demonstrate that English auctions present higher price demand while Continuous double auctions presents least. In addition, we demonstrated that English and Dutch auctions lead to the same final prices, It can also been noted from the graph that English and first price sealed lines coincides and hence winners are same in these two models. The experiment also shows buyer 1 is winner in case of Dutch auction and continuous Double Auction.

It provides good bases for further work on auction oriented approach.Efforts are underway to propose a model which allows bidders to bid on various attributes beyond the price.

References

[1] Berman F, Wolski R. The AppLeS Project: A status report. Proceedings of the 8th NEC Research Symposium, Berlin,Germany, May 1997.

[2] Casanova H, Dongarra J. NetSolve: A network server for solving computational science problems. International Journal of Supercomputing Applications and High Performance Computing 1997; 11(3):212–223.

[3] Chapin S, Karpovich J, Grimshaw A. The Legion resource management system Proceedings of the 5th Workshop on Job Scheduling Strategies for Parallel Processing, San Juan, Puerto Rico, 16 April 1999 Springer: Berlin, 1999.

[4] Fipa dutch auction interaction protocol specification. FIPA-Foundation for Intelligent Physical Agents (http://www.fipa.org/), August (2001)

[5] Fipa english auction interaction protocol specification. FIPA-Foundation for Intelligent Physical Agents (http://www.fipa.org/), August (2001)

[6] Kapadia N, Fortes J. PUNCH: architecture for Web-enabled wide-area network-computing. Cluster Computing: The Journal of Networks, Software Tools and Applications 1999; 2(2):153–164.

[7] Litzkow M, Livny M, Mutka M. Condor—a hunter of idle workstations. Proceedings 8th International Conference of Distributed Computing Systems (ICDCS 1988), San Jose, CA, January 1988. IEEE Computer Society Press: Los Alamitos,CA, 1988.

[8] R. JR. Cassady. Auctions and Auctioneering, University of California Press, Berkley and Los Angeles, California, (1967)

[9] Rajesh Bauya Economic-based Distributed Resource Management and Scheduling for Grid Computing,April(2002)