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A Novel Economic Based Resource Allocation Model for Grid

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Abstract: This paper presents a novel economic based resource allocation model for grid. We proposed model which contains three components the client, monetary grid and local grid. The proposed model supports basic requirements for grid market. This model address issues like reduce scarcity of resource, shakeout of grid and ruinous competition. We presented future trading in proposed model and benefits of future of proposed model are discussed.

Keywords: Grid Market, Local grid, Future Trading, Issues in Grid, Grid Market Model.

I. INTRODUCTION

The proliferation of bandwidth and computational cycles is driving rapid change in high performance parallel and distributed computing, making possible a shared large scale wide-area computational infrastructure, a concept which has been named the Grid. Foster et al. (2001) defined grid as "coordinated resource sharing and problem solving in dynamic, multi-institutional virtual organizations". Today, most of computers are idle after business hours. In a grid world, the idle time of hundreds or thousands of nodes could be harnessed and rented out to anyone who needed a massive infusion of processing power. Entrepreneurs are imagining what it would be like to ip a switch, access what computation power they need, and pay only for what they use [1,2].

Since opening of grid market to competitive market in last decade, scarcity of resources to serve consumers is always an issue. Decision related to supply of resources, pricing strategy is a big problem, so financial instrument is necessary for efficient operation for this market. Economic theory mostly deals with allocating scare resources [5]. Resources are considered scared when because of tendency to demand more resources than available resources. It is presence of scarcity that motivates study in grid to allocate resources. [4] proposed several economical models for resource allocation in grid. A market based resource allocation techniques are discussed in POPCORN [6], TYCOON [7], G-commerce [14], GARA [8]. In this paper, we proposed a novel economic based resource allocation model which is three actor models contains consumer, monetary grid and local grid. Monetary grid acts as mediator between consumer and provider. It makes arrangement of resources for task execution. Consumer and provider both trust on monetary grid for financial transaction. It establishes monetary policy to coordinate between them.

The rest of the paper is organized as follows. Section 2 gives overview of related work of resource allocation through economic model. Issues in grid market are discussed in Section 3. Section 4 explains monetary grid based resource allocation grid market model. Future trading in proposed model is introduced in Section 5. Finally, some conclusions are drawn in Section 6.

II. RELATED WORK

A grid market consist of resource consumer and resource provider (resource provider consist of computing node for providing services.) with the potential to trade with each other. It works through interaction of service providers and consumers with the help of some mediator. Provider decides what to supply in market and decides where to employ their resources. Consumer decides resource usage. Provider must decide how much current consumption to forego in order to save and invest resources for future consumption.

Nature of grid business

A. Dealing in resources: - The first characteristic of grid business is that it deals in providing services. There is set of resource provider and consumer can demand resources anytime at certain cost.
B. Regularity and continuity in dealings: - One transaction cannot constitute business. Continuous dealing can run the business.
C. Risk factor: - Risk factor involves the possibility of loss or there is uncertainty of return on investment.

D. Profit motive: - Resource providers are engaged in grid business primarily to earn profit.

Various economic models has been proposed for resource allocation as shown in Fig. 1 but question is which most appropriate model for resource allocation. Ample of research has been done on auction for resource allocation. In Grosu and Das (2004), three types of auction allocation protocols are investigated; First-Price Auction, Vickrey Auction and Double Auction. These protocols are compared from producer and consumer perspectives in terms of resource utilization, resource profit and user payment. It concludes that first price auction is better from producer perspective while vickrey auction is better from producer perspective and double auction favors both consumer and producer. Kant and Grosu (2005) conclude that continuous double auction performs best from both perspectives in terms of resource utilization, resource profit. Our work is distinguished from others in terms of future trading, expansion of business and our model reduces ruinous competition. In our model, we are providing future trading option to both consumer and producer and resource provider can expand their business by joining monetary grid to get customers from all around world.

III. ISSUES IN GRID MARKET

There are several issues in grid market like coordination among grids, shakeout of grid and hidden cost between transactions.

A. Shakeout of grid: - If there is no proper coordination between resource providers or if providers not getting incentive on regular basis or if resource providers did not get consumers then shakeout may occur which can disturb environment of grid application and resource provider may quit from grid application.

B. Hidden cost: - Before taking service, consumer must take following hidden costs into consideration:-
   a) Brokering fee
   b) Transaction fee
   c) Task submission fee

C. Utilization of resources: - Resource utilization is biggest concern in grid application. Factors which make it difficult to eliminate is dependence on trade. If demand for resources fall then resource utilization decreases suddenly.

D. Scarcity of resources: - Scarcity of resources causes prices to rise, provider receive abnormal amount of money and make abnormal profit.

E. Ruinous competition: - In grid market each grid has its own goals and they try capture as much as consumers for fulfillment of purpose. In this scenario, competition for capturing consumers can be ruinous to some grid since their revenue may fall below general level and revenue of other grid may increase abnormally.

In this paper, we address issues like reduce scarcity of resources, shakeout of grid and ruinous competition.

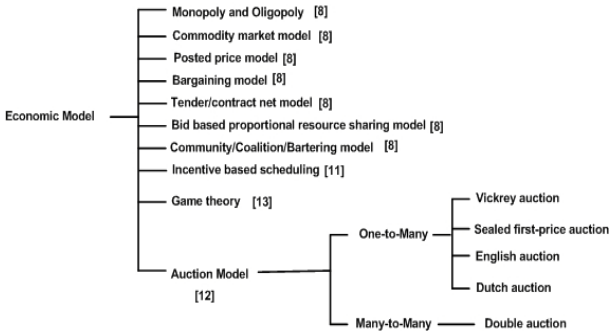

Figure 1. Types of Economical Model

IV. PROPOSED GRID MARKET MODEL

A. *Model Description:*

Overview of grid market structure is shown in Fig. 2 while task execution in proposed model is shown in Fig. 3. There are three main components in the model which are geographically distributed: the client, monetary grid and local grid as shown in Fig. 4. Client submit task for execution through grid user interface. Monetary grid accepts the task, process task query and execute task on local grid and provide various services like transaction, naming, trading, messaging and licensing.

We use following concept for constructing for grid market model.

a. Identify system structure.
b. After identifying structure, study component of system and relationship between them. Thereby it clarifies circuit structure of system.
c. Identify benefits of proposed system.

B. *Components of Market Model:*

Client: Client is an entity that generate task which requires computational resources. Client should pay to execute task. There are two attributes associated with it each task viz. size W, deadline D. Client submit task to monetary for execution. Client deposit electronic cash in monetary grid task execution whatever asks by local grid. Task execution from client point of view is shown in Fig. 4.

Local grid: Features of local grid:-

a. Single ownership.
b. Instability of business.
c. Limited business.
d. Inefficient management.

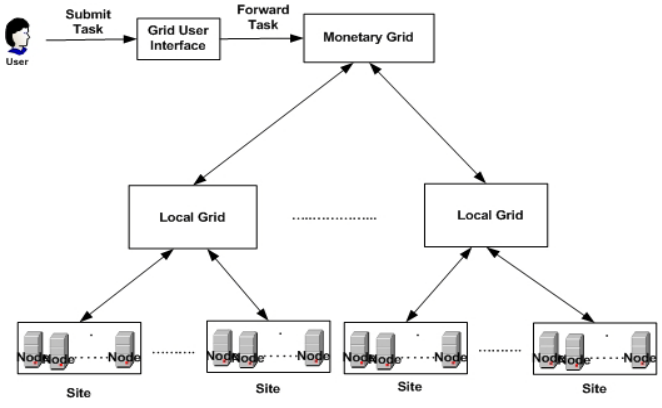

Figure 2. Overview of Grid Market

Local grid operates locally and their business is restricted to only up to certain region. To expand their business globally they join to monetary grid to get customers beyond their regional boundaries. Local grid consists of site and each site contains number of processing nodes for servicing task. DTD representation for local grid is shown in Fig. 5. We assume that task preemption is not possible i.e. once task is assigned to site; it must reside in that site until completion. After submitting task query by monetary grid, it checks resource availability and after checking task requirement local grid sends task execution price to monetary grid.

Monetary grid: - Monetary grid is a 'super grid' which coordinate economic activity between consumer and provider. Components and services provided by monetary grid is shown in Fig. 6. Monetary grid has no control over resources. At its core, the role of the monetary grid is to execute the demands of their client.

Need of Monetary Grid:-

a. To reduce ruinous competition for profit maximization.
b. To increase resource utilization.
c. Expose local grid globally.
d. Maximize return on investment.

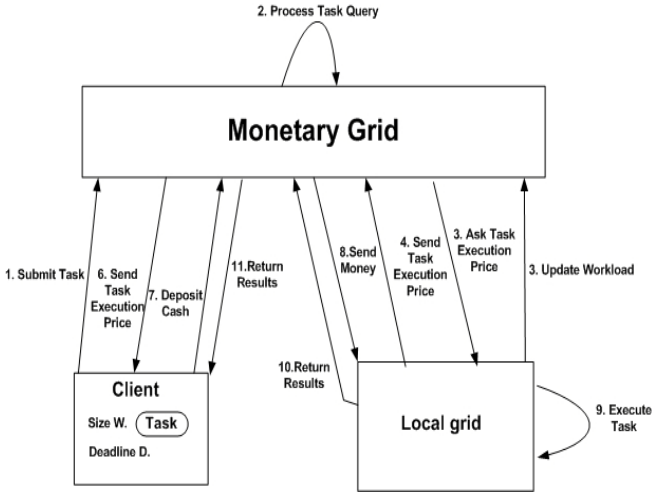

Figure 3. Task Execution in Proposed Model

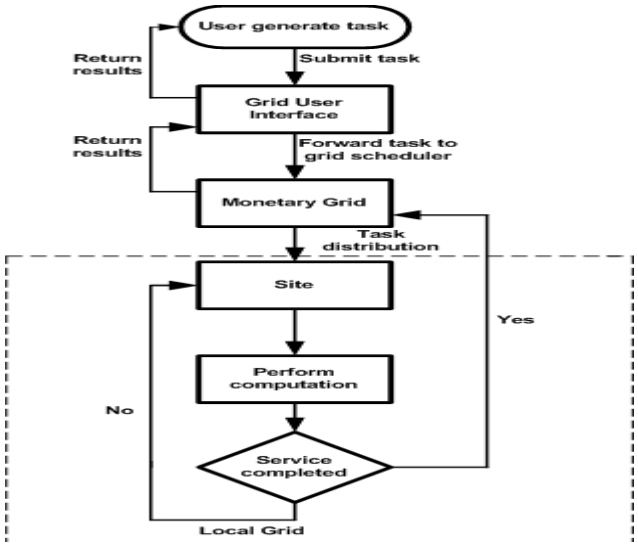

Figure 4. Task Execution (Client View)

Monetary grid oversees financial system of grid application. Monetary grid not only mediates between consumer and provider and but also provides a consistent and homogeneous access to resources. Monetary grid hides the heterogeneous and distributed nature of the available resources and represents to users as a single computing resource. Based on market signal, monetary grid will try to connect to as much as local grid to serve consumers. Until monetary grid become skilled in dealing with risk associated in competitive market there is always imbalance between supply and demand of resources. When local grid comes into grid market it needs to register at monetary grid. These include following parameters.

a. Number of resources available.
b. Computational capability C_p.
c. Status of each node.

When task is submitted by user then monetary grid ask task execution price to local grids and task is given to that local grid which is demanding less execution price. Whenever any task finished or started execution it updates its workload at monetary grid. It also maintains task information such as

a. Arrival time of task.
b. Execution time require by task.
c. ID of grid to which task is allocated.

```
<?xml encoding ="US-ASCII"?>

<!ELEMENT GRID (SITE+,TASK+)>

<!ELEMENT SITE (RESOURCE,SITEID,STATUS,LOAD,NEIGHBOURING SITES)>
<!ELEMENT SITEID ID #REQUIRED>
<!ELEMENT STATUS (#PCDATA)>
<!ELEMENT LOAD (#PCDATA)>
<!ELEMENT NEIGHBOURING SITES (#PCDATA)>

<!ELEMENT RESOURCE (DATA+,IO+,COMPUTATIONAL+)>

<!ELEMENT DATA (SPACE,DISKBANDWIDTH)>
<!ELEMENT SPACE (#PCDATA)>
<!ELEMENT DISKBANDWIDTH (#PCDATA)>

<!ELEMENT IO (LOAD,SPEED)>
<!ELEMENT COMPUTATIONAL (SPEED,LOAD)>
<!ELEMENT LOAD (#PCDATA)>
<!ELEMENT SPEED (#PCDATA)>

<!ELEMENT TASK (STATE+,STARTTIME,ARRIVALTIME,DEADLINE,PRIORITY)>
<!ELEMENT STARTTIME ID #REQUIRED>
<!ELEMENT ARRIVALTIME ID #REQUIRED>
<!ELEMENT DEADLINE ID #REQUIRED>
<!ELEMENT PRIORITY ID #REQUIRED>

<!ELEMENT STATE (READY,RUNNING,BLOCKED)>
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<!ELEMENT RUNNING (#PCDATA)>
<!ELEMENT BLOCKED (#PCDATA)>
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Figure 5. DTD Representation of Local Grid

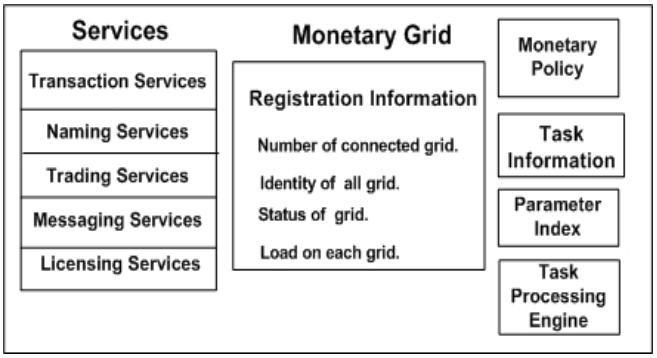

Figure 6. Components of Monetary Grid

C. Expressing Task Eexecution Price:

The Table 1 shows task execution price on local grid. Monetary grid keeps track of total number of request and revenue generated from each request.

Following parameters measured by monetary grid:-

a. Gross grid product (GGP):- GGP is a measure of grid overall economic output. GGP= C+I
where, C- Consumption of resources by user, I- Investment from user to get services.

Table I. Task Execution Price at Monetary Grid

User	*Number of Task*	*Local Grid ID*	*Price per Task ($)*	*Revenue in ($)*
U1	3	179326	3	9
U2	4	280308	2	8
Sum	7			17

b. Grid price index (GPI):- A grid price index (GPI) measures changes through time in the price level of services from provider get by consumers.

c. Efficiency of system = No. of served task/No. of task in system.

D. Advantages of Proposed Model:

Figure 7 shows comparison between various economic models. Following are some advantages of our economic model.

Economical Model	Required global price information	Reliability of service quality	Required mediator	Future Trading	Expansion of business	Ruinous competition among grid service provider to get consumers
Commodity Market Model [8]	✓	✗	✓	✗	✗	✓
Posted Price Model [8]	✗	✗	✓	✗	✗	✓
Bargaining Model [8]	✗	✗	✓	✗	✗	✓
Tender/Contract Net Model [8]	✗	✓	✓	✗	✗	✓
Auction Model [8]	✗	✗	✓	✗	✗	✓
Bid Based Proportional Resource Sharing Model [8]	✗	✓	✗	✗	✗	✗
Bartering Model [8]	✗	✗	✗	✗	✗	✓
Our Model	✗	✓	✓	✓	✓	✗

Figure 7. Comparison of Economic Model

Following parameters measured by monetary grid:-

a. Reduction in marketing time: - Our grid market model allows consumers to get services quickly and efficiently. Any consumer willing to get service can participate in grid market any time. This model reduces expensive marketing campaigns and risks associated with the marketplace.

b. Targeting qualified consumers: - Through grid market the resource provider find best means to reach a targeted consumer. Providing services to those incapable consumers who are lacking the ability to pay, is a genuine waste of time.

c. Selling according provider convenience: - In most traditional listing agreement there is no flexibility for service providing. But in our grid model, resource provider can join and leave grid market according to his convenience.

d. Reduces ruinous competition and scarcity of resource*:* - Local grid join monetary grid to expand their business thus, it reduces ruinous competition among two local grids to some extent since they are getting customer beyond regional boundaries. Now user task is executed to any of available local grid node thus, thus it reduces scarcity of resource for task execution.

V. FUTURE TRADING IN PROPOSED MODEL

Future trading in proposed model is done through forward. Forward is an agreement between provider and consumer to get service at specified price on a specified time in the future. The forward is an agreement between two parties to provide service with agrees upon quantity, price and time. Once forward contract is established trading occurs at an agreed price regardless of market price. In our model, forward is established through monetary grid between consumer and producer.

A. Pricing a Forward Contract:

In above model, pricing in forward contract is done through bonds. Thus, bonds act as gateway to consumer to invest in grid market.

Important feature of bonds in grid:-

a. Issue price: - The price at which consumer buy the bonds.

b. Maturity period: - It indicate validity period of bond. The length of time until maturity time is often referred to as the term or maturity of a bond. The maturity can be any length of time.

To describe service provided by grid in futures, we assume that events or actions takes place at different time interval. We are assuming that events may take place at time t=0 and also later at time t=T>0. Generally, there are three actions involved in a service providing

a. Fixing or agreeing on the price.

b. Making payment.

c. Getting service.

Logically the price is fixed before payment is made so it is assumed that the price of service is fixed at time t=0. However, remaining two actions may occur at either t=0 or t=T depending on the arrangement made between consumer and provider.

B. Advantages of Future Trading:

A future trading is considered as a measure of hedging the price volatility. In addition to hedging price changes, a future trading offers much more advantages over other forms of trading. Following are the advantages of future trading.

a. Fraction payment: - In order for a consumer to own a futures contract, he only needs to invest a small fraction of the value of the contract and rest of payment consumer can be paid after getting service.

b. Versatile contract: - Orders can be placed quickly and they can be bought or sold in a similar fashion. Consumer buys or sell contract to others at anytime.

c. Minimize risk: - Since service prices are already fixed it has no impact of fluctuating service prices which depend on market condition.
d. Price stability: - The shortage of resource causes prices to rise, supplier receive an abnormal amount of money and make abnormal profits. This can be reduced by future trading. In future trading each consumer has given a quota for resource usage.

VI. CONCLUSIONS

We proposed a novel economic based resource allocation model in order to deal with resource management in grid and discuss the benefits of proposed model. Our model reduces scarcity of resources, reduces ruinous competition among resources and shakeout of grid. Compared to other economical model, our model gives option of future trading and better service quality. Finally, we conclude that i) Supply and demand together determine the prices of resources. ii) Prices in turn are the signals that guide the allocation of resources.

VII. REFERENCES

[1] Foster Ian , "The Anatomy of the Grid: Enabling Scalable Virtual Organizations", Euro-Par 2001 Parallel Processing, Vol. 2150, 2001,pp.1-4.

[2] J Robert Buchanan, "An Undergraduate Introduction to Financial Mathematics", World Scientific, 2008.

[3] I. S. Jacobs and C. P. Bean, "Fine particles, thin films and exchange an Ian Foster, Carl Kesselman 2008, 'The Grid: Blueprint for a Future Computing Infrastructure', *Elsevier*,2008,

[4] Rajkumar Buyya and David Abramson and Jonathan Giddy, "A Case for Economy Grid Architecture for Service Oriented Grid Computing",2001.

[5] John Duffy , "Economics", Wiley Publishing Inc,1993.

[6] Regev, Ori and Nisan, Noam 1998, 'The POPCORN market an online market for computational resources', Proceedings of the first international conference on Information and computation economies, pp.148-157.

[7] Lai, Kevin and Rasmusson, Lars and Adar, Eytan and Zhang, Li and Huberman, Bernardo A., "Tycoon: An implementation of a distributed, market-based resource allocation system", Multiagent Grid Syst., vol. 1, pp.169-182, 2005.

[8] Rajkumar Buyya and David Abramson and Jonathan Giddy and Heinz Stockinger, "Economic models for resource management and scheduling in Grid computing", Wiley Press, pp.1507-1542, 2002.

[9] D. Grosu and A. Das 2004. "Auction-based resource allocation protocols in grids". In Proceedings of the 16th IASTED International Conference on Parallel and Distributed Computing and Systems, pp.20-27.

[10] U. Kant and D. Grosu. "Double auction protocols for resource allocation in grids". In Proceedings of the International Conference on Information Technology: Coding and Computing (ITCC05), pp.366-371.

[11] Ni L.M. Zhiwei, Xu Lijuan Xiao, Yanmin Zhu. "Incentive-based scheduling for market-like computational grids.", IEEE Transactions on Parallel and Distributed Systems, vol. 19, pp.903-913.

[12] B. Pourebrahimi, K. Bertels, G.M. Kandru, and S. Vassiliadis, "Market-based resource allocation in grids". International Conference on e-Science and Grid Computing, pp.80-87, 2006.

[13] Preetam Ghosh, Nirmalya Roy, Sajal K. Das, and Kalyan Basu. 'A pricing strategy for job allocation in mobile grids using a non-cooperative bargaining theory framework'. Journal of Parallel and Distributed Computing, vol. 65, pp.1366 -1383.

[14] Rich Wolski and James S. Plank and John Brevik and Todd Bryan 2001,"Analyzing Market-Based Resource Allocation Strategies for the Computational Grid", International Journal of High Performance Computing Applications, Vol. 15, pp.258-281.