



Market-based Resource Allocation in Grids

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Introduction

Grid is a way to share a wide variety of distributed resources.





Resources in Grids

- geographically distributed
- Heterogeneous in nature
- Owned by different individuals or organizations with their own policies
- Have different access and cost models
- Have dynamically varying loads and availability

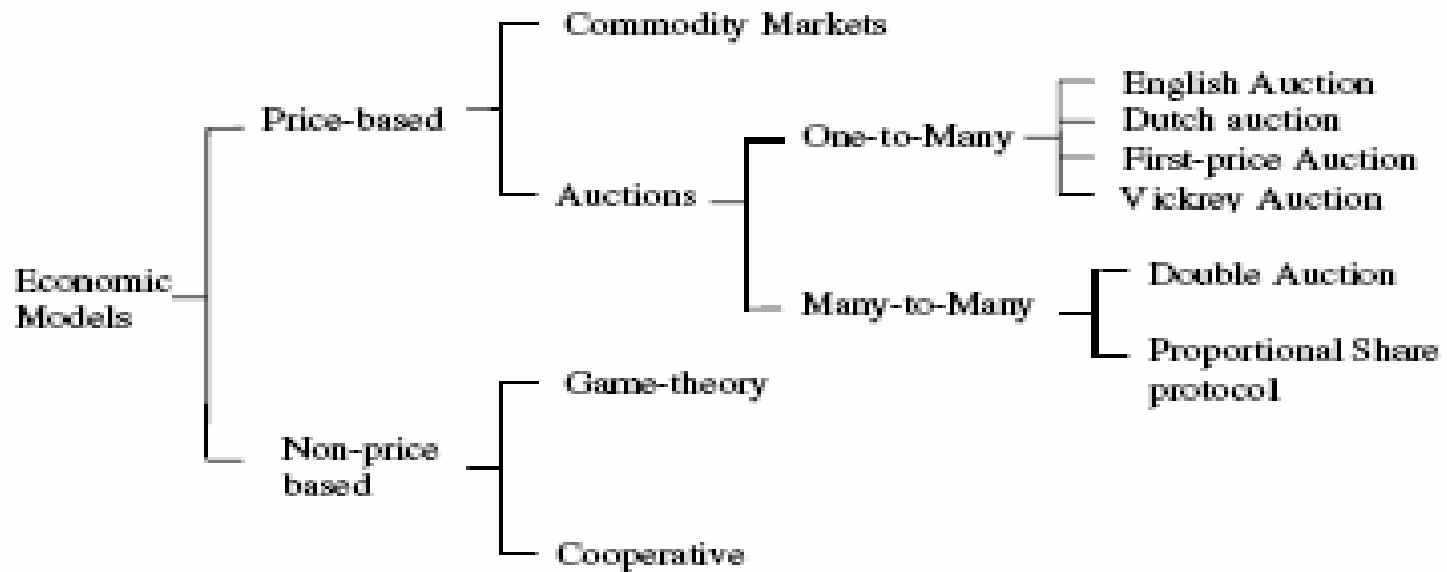


Grid Economy; managing resources in a Grid computing environment based on economy approaches

- Motivation for resource owners to contribute their idle resources for others
- Providing a fair basis for access to grid resources for everyone.
- Regulating the demand and supply.
- Providing both user-centric and system-centric mechanisms.
- Helping to build a highly scalable system as decision making process is distributed across all users and resource owners.
- Decentralization is provided by the fact that economic models consist of agents which selfishly attempt to achieve their goals

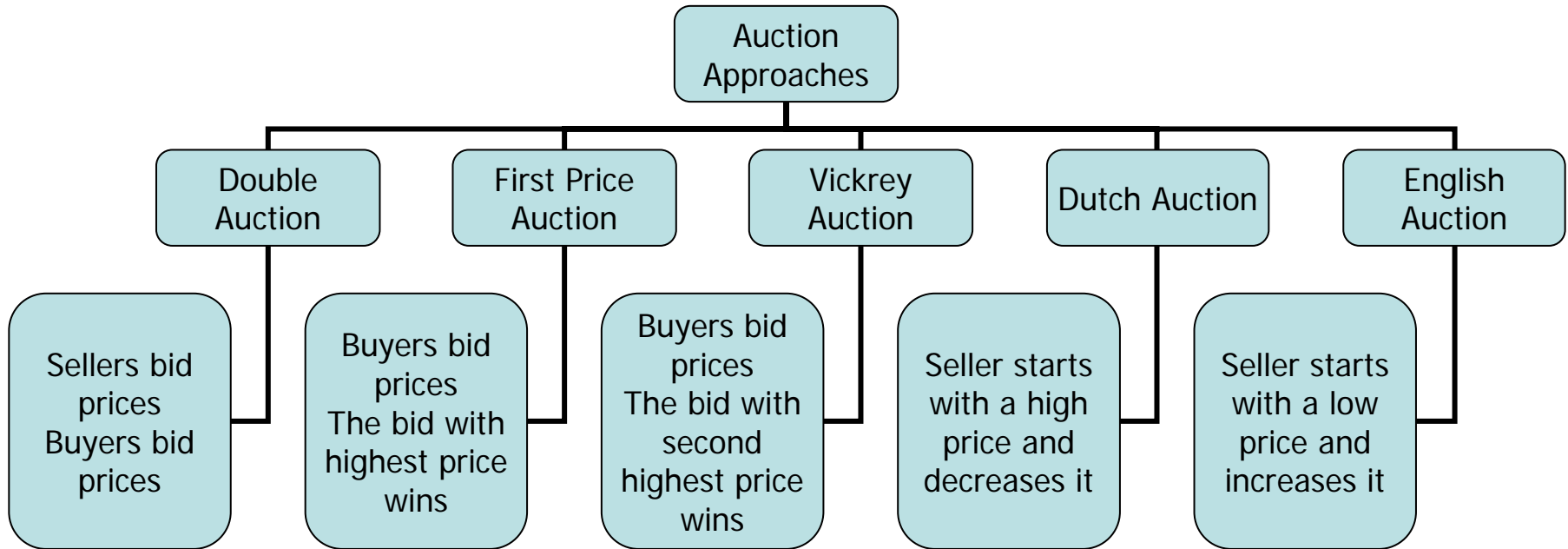


Economic Models





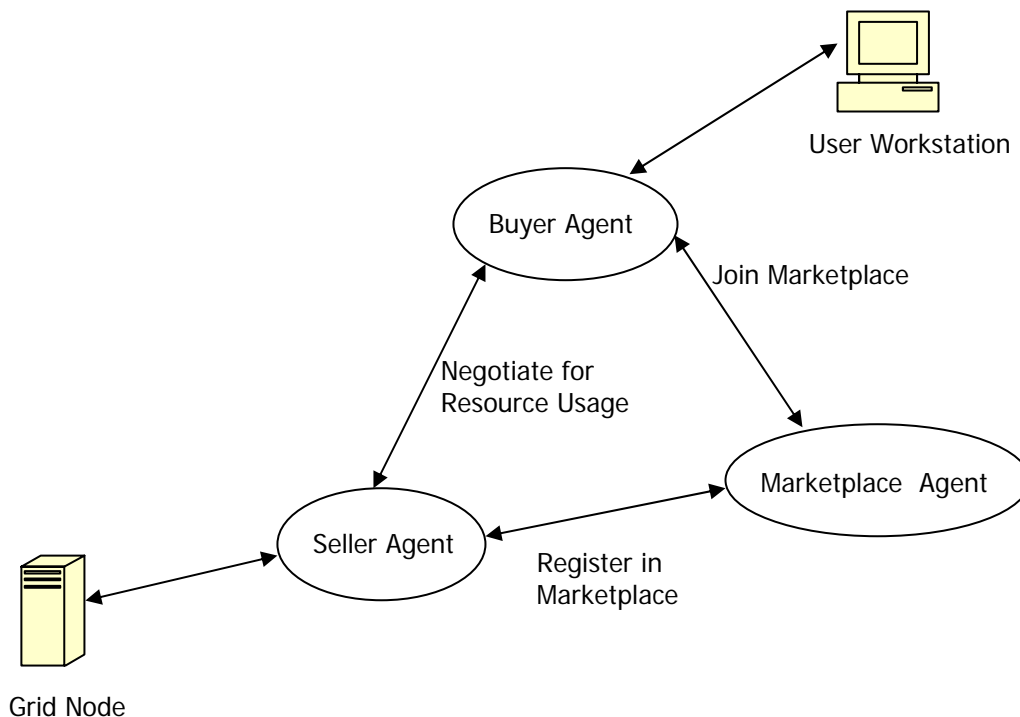
Auctions





Agent-based Grid Economy

Economic models introduce money and price to coordinate the selfish behavior of the agents.

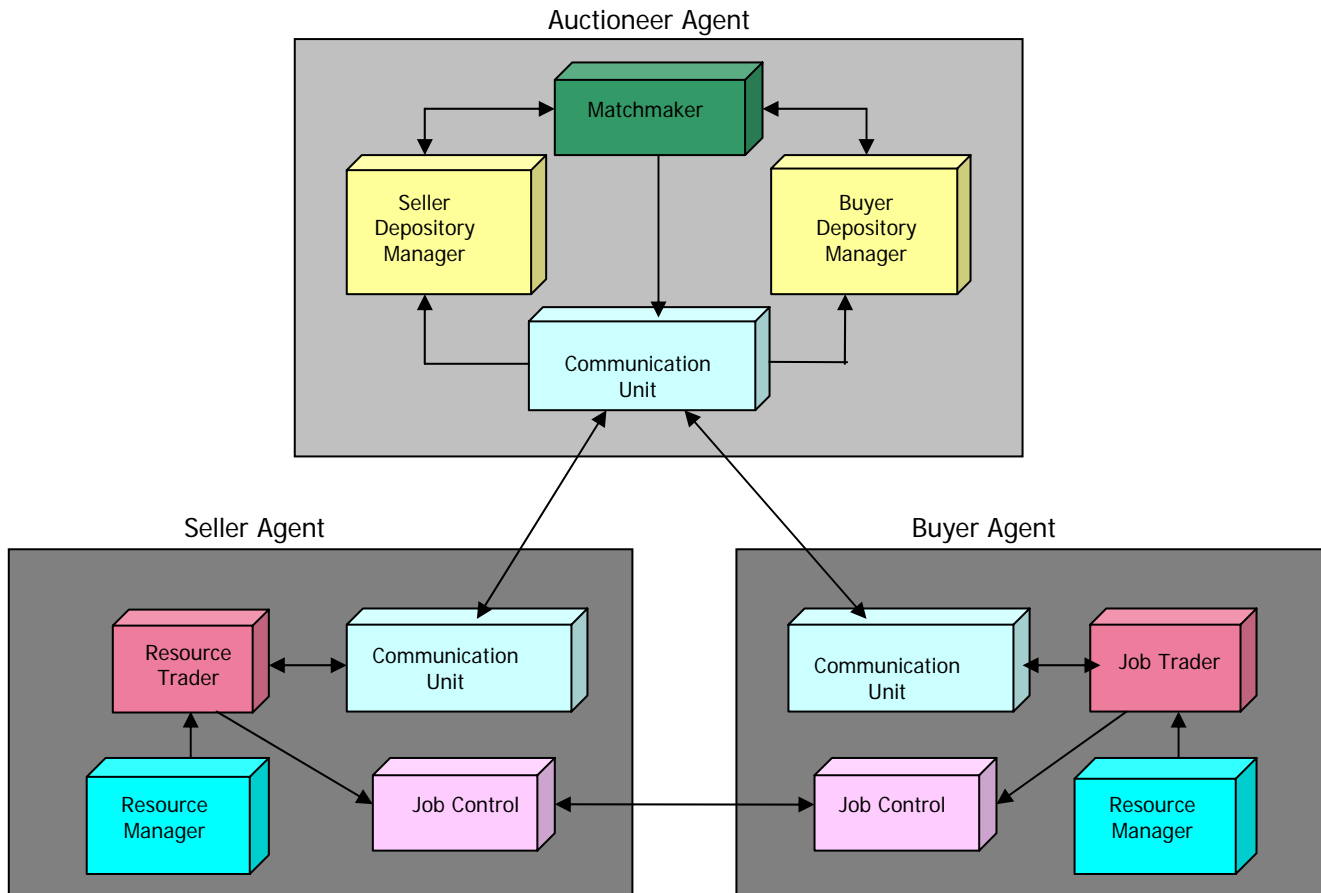




Research Challenges

- How do the agents demand and offer resources?
- What rational pricing mechanisms do the agents adopt?
- How are the prices adjusted to clear the markets?
- What are the principal conditions for a matching between consumer and producer of resources?

Proposed Market-based Model





Continuous Double Auction

- Auctioneer acts as a mediator between sellers and buyers
- Buy orders (requests) and sell orders (offers) may be submitted at anytime during the trading period
- Price is attached to the requests or offers
- At any time when there are open requests and offers that match in term of requirements and price, a trade is executed immediately
- Transaction price is the average of consumer's and producer's price



Pricing Strategy

- **Consumer's (buyer's) strategy:** solving their problems at low cost within a required timeframe. Lowering the price when supply is high and raising the price when supply is low
- **Producer's (seller's) strategy:** obtaining best possible return on their investment. Raising the price when demand is high and lowering the price when demand is low



Pricing Algorithm

$$p(t) = p(t-1) + \Delta p$$

For Seller :

$$\Delta p = \alpha(u(t) - u_{th}) p(t-1)$$

For Buyer :

$$\Delta p = \beta(u_{th} - u(t)) p(t-1)$$

Rate of price changing : $0 \leq \beta \leq 1$ $0 \leq \alpha \leq 1$

Utilization threshold : $0 \leq u_{th} \leq 1$

Resource/task utilization by the time t : $u(t) = \sum_{i=t_0}^t x(i) / \sum_{i=t_0}^t N(i)$ $0 \leq u(t) \leq 1$

Sold/purchased resources: $\sum_{i=t_0}^t x(i)$ Offered/requested resources: $\sum_{i=t_0}^t N(i)$



Experimental Model; A Java-based Platform

- J2EE: Java 2 Platform, Enterprise Edition (J2EE) - a version of Java for developing and deploying enterprise applications.
- EJB: The Enterprise JavaBeans specification is a Java APIs in the Java 2 Platform, Enterprise Edition. It is a component architecture for the development and deployment of object-oriented, distributed, enterprise-level applications.
- JBOSS application server: is an Open Source J2EE based application server implemented in pure Java.
- JMS: Java messaging service is the standard API for sending and receiving messages.



Experimental Conditions

- **Balanced Network:** Resource and tasks are almost equal
- **Resource Intensive Network:** Resources are more than tasks (Buyer Market)
- **Task Intensive Network:** Tasks are more than resources (Seller Market)

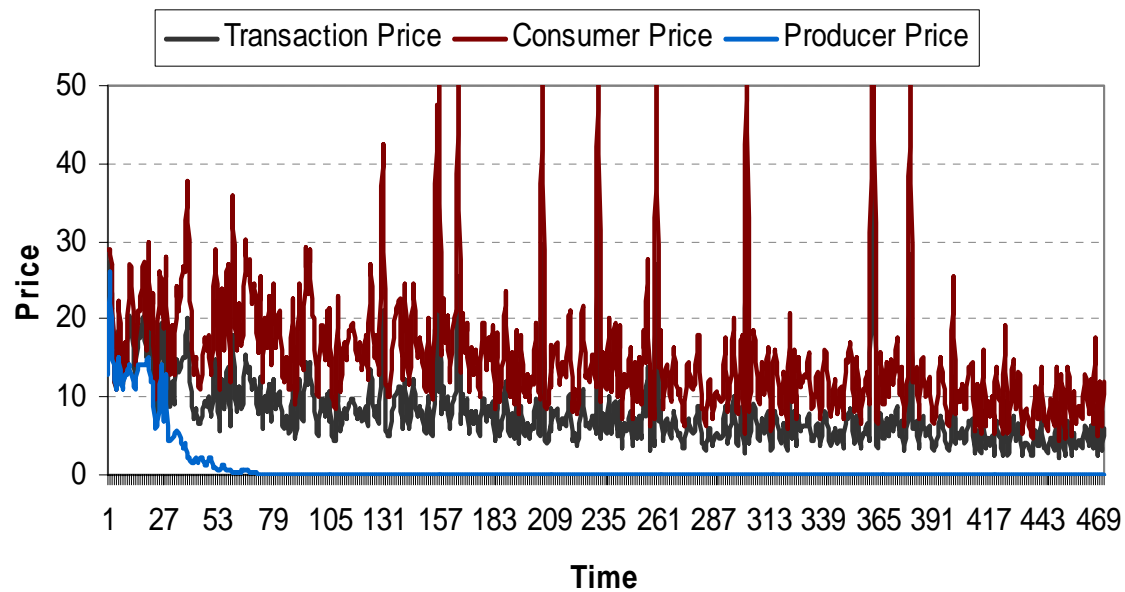


Experimental Criteria

- **Price Evolution:** how the price is evolving in each network condition
- **Task Utilization:** the ratio of allocated tasks to all sent resource requests
- **Resource Utilization:** the ratio of allocated resources to all sent resource offers
- **Time of Match:** the average time for finding a match

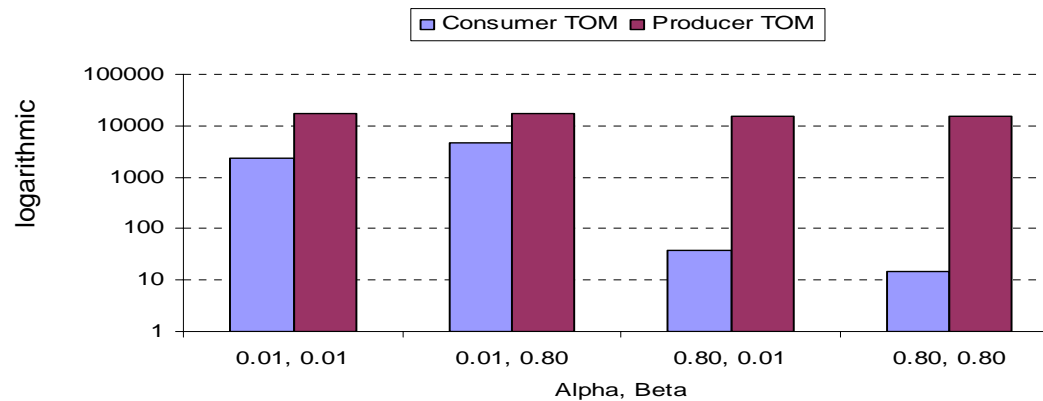
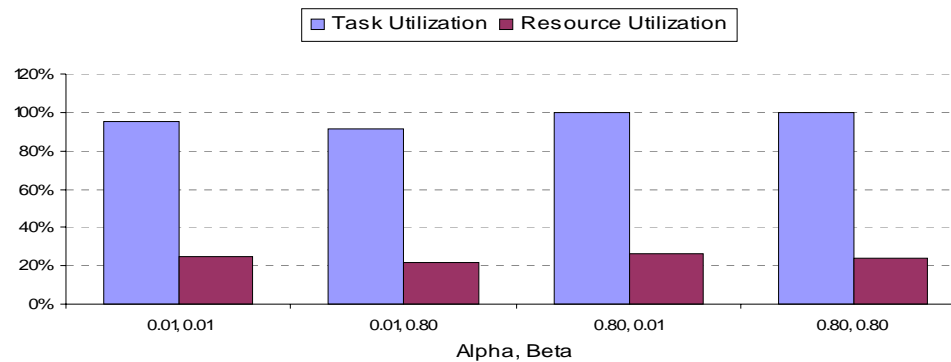


Price Evolution in a Resource Intensive Network



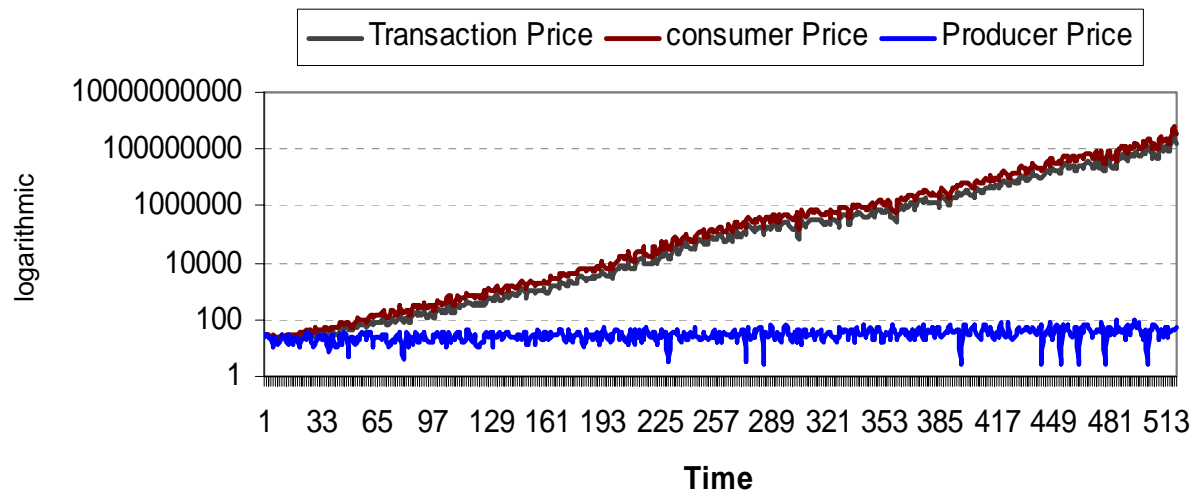


Task/Resource Utilization and Average Time of finding Match in a Resource Intensive Network



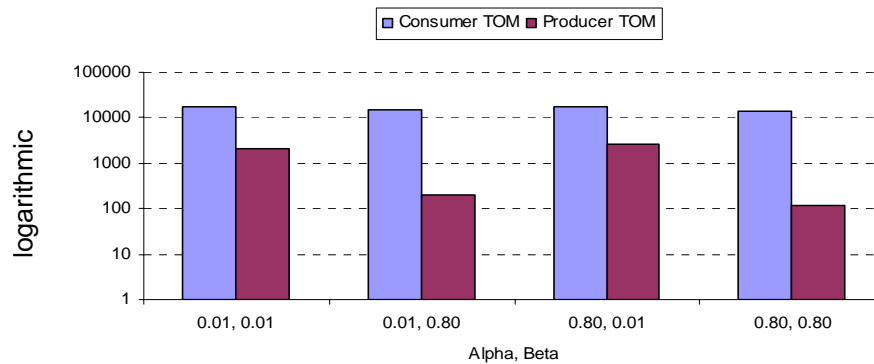
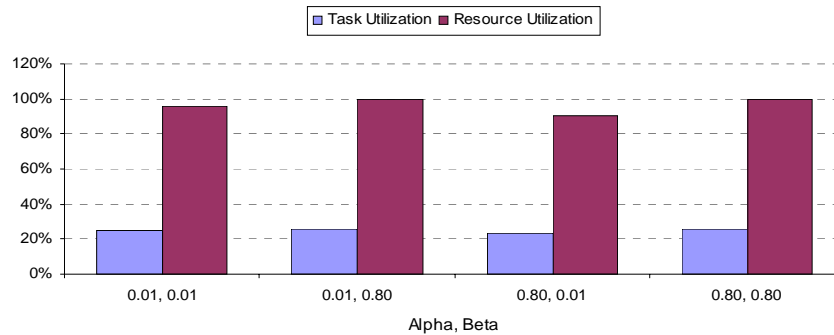


Price Evolution in a Task Intensive Network



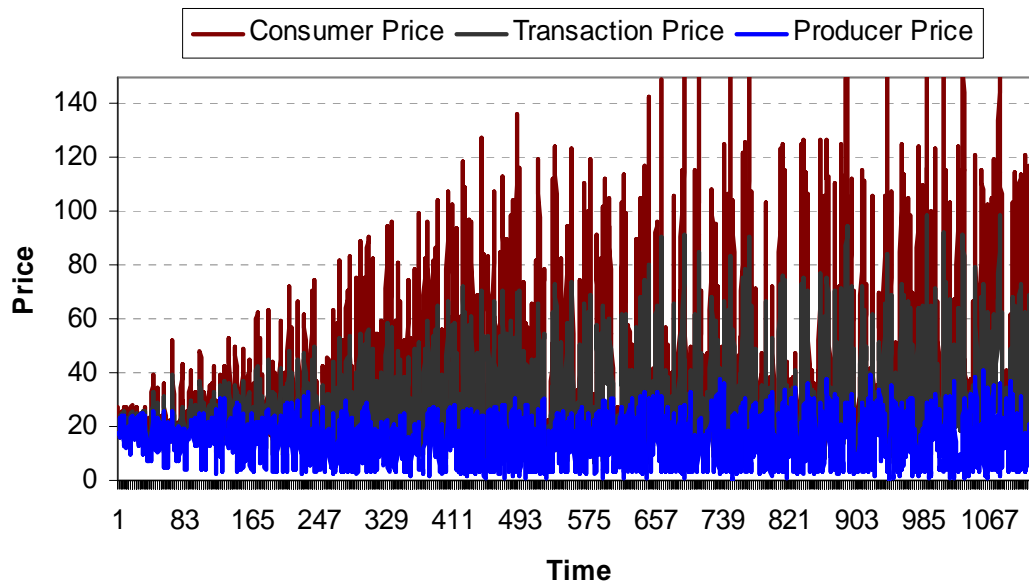


Task/Resource Utilization and Average Time of finding Match in a Task Intensive Network



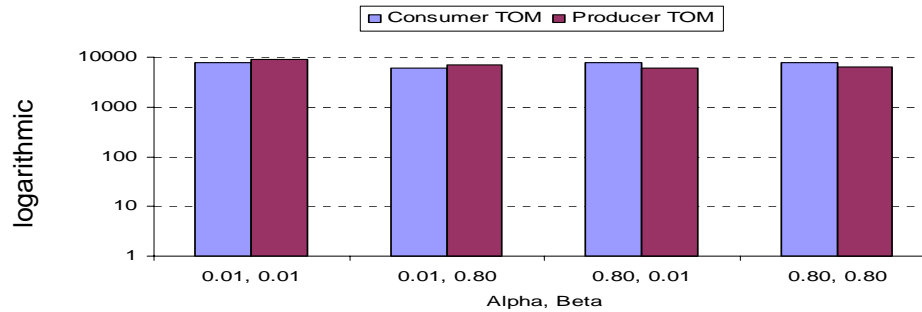
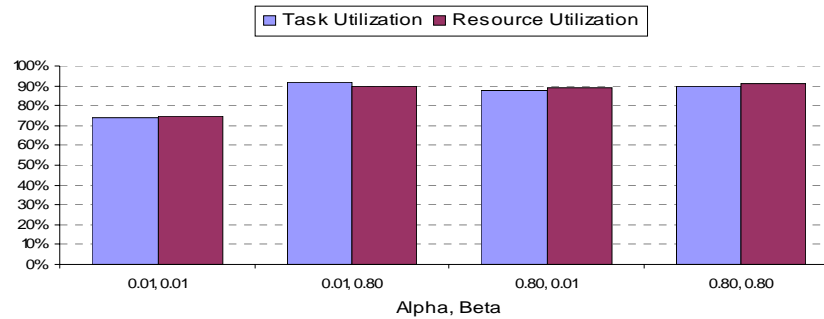


Price Evolution in a Balanced Network





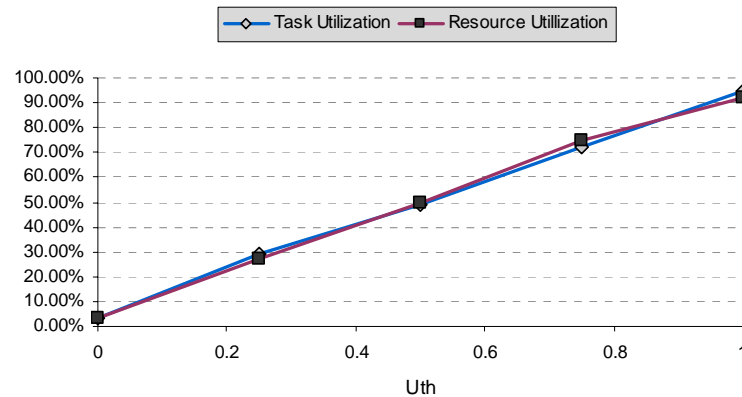
Task/Resource Utilization and Average Time of finding Match in a Balanced Network





Agent Activity in the Grid

u_{th} can be interpreted as the degree of activeness of the consumer and producer agents in the Grid



$$\text{Consumer Price : } \Delta p = \beta(u_{th} - u(t))p(t-1)$$

$$\text{Producer Price : } \Delta p = \alpha(u(t) - u_{th})p(t-1)$$



Conclusion

- Implementing a market-based resource allocation model in which the consumer and producer agents are able to set their own prices.
- Introducing a dynamic pricing strategy which is adaptive to the environment conditions.
 - Producer of the resource raise the price when the demand is high and lower the price when demand is low.
 - Consumer of the resource raise the price when supply is low and lower the price when supply is high.
 - Producer and consumers can change the degree of their activity in the Grid.



Future Work

- Investigating heterogeneity among agents in terms of Alpha, Beta and Utilization Threshold
- Applying Budget restriction
- Exploring different kinds of Auction mechanisms
- Better understanding of different structural design choices, enables us to provide a framework in which self –management and self-organization becomes possible.



Thank You

