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Resource Allocation in Grid Computing

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Abstract

Grid computing is a form of distributed computing that involves coordinating and sharing computational power, data storage and network resources across dynamic and geographically dispersed organizations.Grid computing is a term referring to the combination of computer resources from multiple administrative domains to reach a common goal. 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.

Keywords: *Grid computing, Resource management and Economic models.*

I. Introduction

Grids are a form of distributed computing whereby a "super virtual computer" is composed of many networked loosely coupled computers acting together to perform very large tasks.

As defined by Ian Foster and Carl Kesselman [10]

"A computational grid is a hardware and software infrastructure that provides dependable, consistent, pervasive, and inexpensive access to high-end computational capabilities"

After two years, Ian Foster refined the definition: Grid computing is concerned with

"coordinated resource sharing and problem solving in dynamic, multi-institutional virtual organization."

A set of individuals and institutions defined by some sharing rules form what we call a virtual organization (VO) [11].

This kind of virtualization is only achievable through the use of open standards. Open standards help ensure that applications can transparently take advantage of whatever appropriate resources can be made available to them [17].

Grid Resource Management means identifying application requirements, resource specification, matching resources to applications, allocating/scheduling and monitoring those resources and applications over time in order to run as effectively as possible.

II. Resource Management

The Grid environment contains heterogeneous resources, local management systems (single system image OS, queuing systems, etc.) and policies, and applications (scientific, engineering, and commercial) with varied requirements (CPU, I/O, memory, and/or network intensive). The *producers* (also called resource owners) and *consumers* (who are the users) have different goals, objectives, strategies, and demand patterns

In managing the complexities present in large-scale Grid- like systems, traditional approaches are not suitable as they attempt to optimize system-wide measures of performance. Traditional approaches use centralized policies that need complete state information and a common resource management policy, or decentralized consensus based policy.

Challenges in Grid Resource Management are resources are heterogeneous in nature (processors, disks, data, networks, other services), application has to compete for resources and lack of available data about current systems, needs of users, resource owners and administrators.

III. Economic Models

Commodity market model:

In the commodity market model, resource owners specify their service price and charge users according to the amount of resource they consume. The pricing policy can be derived from various parameters, and can be flat or variable depending on the resource supply and demand. In the flat price model, once pricing is fixed for a certain period, it remains the same irrespective of service quality. It is not significantly influenced by the demand, whereas in a supply-and-demand model prices

change very often based on supply-and-demand changes. In principle, when the demand increases or supply decreases, prices are increased until there exists an equilibrium between supply and demand. Pricing schemes in a commodity market model can be based on: flat fee usage duration (time) subscription or demand and supply [5,14].
The resource broker (working for the user) can carry out the following steps for executing applications:
1. the broker identifies service providers;
2. it identifies suitable resources and establishes their prices (by interacting with the GMD and GTS);
3. it selects resources that meet its utility function and objectives (lower cost and deadline requirements met); it uses heuristics and/or historical knowledge while choosing resources and mapping jobs to them;
4. it uses resource services for job processing and issues payments as agreed;
Implementation specific details of our Nimrod/G resource broker [1,4,6] vary from other related systems.

Posted price model:

The posted price model is similar to the commodity market model, except that it advertises special offers in order to attract (new) consumers to establish market share or motivate users to consider using cheaper slots. The activities that are specifically related to the posted price model in addition to those related to commodity market model are:
1.GSPs post their special offers and associated conditions etc. in the GMD;
2.a broker looks at the GMD to identify if any of these posted services are available and fit its Requirements ;
3.a broker enquires (GSP) about the availability of posted services;
4.other steps are similar to those pointed out in the commodity market model.

Bargaining model:

In the bargaining model, resource brokers bargain with GSPs for lower access prices and higher usage durations. Both brokers and GSPs have their own objective functions and they negotiate with each other as long as their objectives are met.

Tender/contract-net model:

Tender/contract-net model is one of the most widely used models for service negotiation in a distributed problem-solving environment [16]. It is modeled on the contracting mechanism used by businesses to govern the exchange of goods and services. It helps in finding an appropriate service provider to work on a given task.

Auction model:

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. The steps involved in the auction process are:
1. a GSP announces their services and invites bids;
2. brokers offer their bids (and they can see what other consumers offer if they like—depending on how open/closed);
3. step 2 goes on until no one is willing to bid a higher price or the auctioneer stops if the minimum price line is not met;
4. the GSP offers the service to the one who wins;
5. the consumer uses the resource.
Auctions can be classified into five types:
• English auction (first-price open cry);
• first-price sealed-bid auction;
• Vickrey (second-price sealed-bid) auction [18];
• Dutch auction;
• double auction (continuous).

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. In this model, the key issue is how GRBs decide how much to bid. Those not interested in bidding anymore can openly declare so (open-exit) without the possibility of re-entry.

First-price sealed-bid auction:

Each bidder submits one bid without knowing the others' bids. The highest bidder wins the item at the price of his bid. 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 to bid less than the true valuation and one might still win the bid, but it all depends on what the others bid.

Vickrey (second-price sealed-bid) auction:

Each bidder submits one bid without knowing the others' bids. The highest bidder wins the item at the price of the second highest bidder [18].

Dutch auction:

It is similar to a 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. From the broker's bidding strategic point of view, a Dutch auction is similar to an English auction (first-price sealed-bid auction). The key difference between them is that in an English auction the bids start with a low opening and increase progressively until demand falls, whereas in a Dutch auction the bids start with a high opening price and decrease progressively until demand rises to match supply.

Double auction:

In fact, it is the primary economic model for trading of equities, commodities and derivatives in stock markets (e.g., NASDAQ)[15]. 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.

In this auction orders are ranked highest to lowest to generate demand and supply profiles. Researchers have developed software-based agent's mechanisms to automate the double auction for stock trading with or without human interaction [9].
The double auction model has high potential for Grid computing.

All the above auctions differ in terms of whether they are performed as open or closed auctions and the offer price for the highest bidder. In open auctions, bidding agents can know the bid value of other agents and will have an opportunity to offer competitive bids.

Bid-based proportional resource sharing model:

The users are allocated credits or tokens, which they can use to have access to resources. The value of each credit depends on the resource demand and the value that other users place on the resource at the time of usage. Market-based proportional resource sharing systems are quite popular in cooperative problem-solving environments such as clusters (in a single administrative domain). Example systems such as Rexec/Anemone, Xenoservers and D'Agents CPU market employ a proportional resource sharing model in managing resource allocations [3].

Community/coalition/bartering/shareholders model:

A community of individuals shares each other's resources to create a cooperative computing environment. Those who are contributing their resources to a common pool can get access to that pool. A sophisticated model can also be employed here for deciding how much resources share contributors can get. It can involve credits that one can earn by sharing a resource, which can then be used when needed. A system like Mojonation.net employs this model for storage sharing. This model works when those participating in the Grid have to be both service providers and consumers.

Monopoly/oligopoly:

In economic theory this model is known as a monopoly. Users cannot influence the prices of services and have to choose the service at the price given by the single GSP who monopolizes the Grid marketplace. As regards the technical realization of this model, the single site puts the prices into the GMD or information services and brokers consult it without any possibility of negotiating prices. The competitive markets are one extreme and monopolies are the other extreme.

In most of the cases, the market situation is an *oligopoly*, which is in between these two extreme cases: a small number of GSPs dominate the market and set the prices.
There are other influences on price setting strategies in competitive, international markets. Supply and demand is the most common one but one also has to take into account national borders and different pricing policies within different countries, such as taxation, consumer price index, inflation, etc. These factors are not dealt with in this paper; however implementations may need to consider them. There are also micro- and macro-economic factors that play an important role.

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 [8], Condor [13], AppLeS [2],Netsolve [7], Punch [12]).

IV. Conclusion and Future Work

In this paper grid computing and resource management have been studied. Also various economic models and their strategies have been studied. This paper tried to provide a comprehensive survey, analysis of various models and related issues. Various market-based economic models have been discussed.

These models are implemented and experimented for various grid environments.

Various efficient models can be proposed using different approaches for the future work.

References

[1] Abramson D, Giddy J, Kotler L. High performance parametric modeling with Nimrod/G: Killer application for the Global Grid? Proceedings International Parallel and Distributed Processing Symposium (IPDPS 2000), Cancun, Mexico, 1–5 May 2000. IEEE Computer Society Press: Los Alamitos, CA, 2000.

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

[3] Buyya R, Abramson D, Giddy J. A case for economy Grid architecture for service-oriented Grid computing. Proceedings of the International Parallel and Distributed Processing Symposium: 10th IEEE International Heterogeneous Computing Workshop (HCW 2001), 23 April 2001, San Francisco, CA. IEEE Computer Society Press: Los Alamitos, CA, 2001.

[4] Buyya R, Abramson D, Giddy J. Nimrod/G: An architecture for a resource management and scheduling system in a global computational Grid. Proceedings 4th International Conference and Exhibition on High Performance Computing in Asia-Pacific Region (HPC ASIA 2000), Beijing, China, 14–17 May 2000. IEEE Computer Society Press: Los Alamitos, CA,2000.

[5] Buyya R, Abramson D, Giddy J. An economy driven resource management architecture for global computational power Grids. Proceedings of the 2000 International Conference on Parallel and Distributed Processing Techniques and Applications (PDPTA 2000), 26–29 June 2000, Las Vegas. CSREA Press, 2000.

[6] Buyya R, Giddy J, Abramson D. An evaluation of economy-based resource trading and scheduling on computational power Grids for parameter sweep applications. Proceedings of the 2nd International Workshop on Active Middleware Services (AMS 2000), Pittsburgh, PA, 1 August 2000. Kluwer Academic Press, 2000.

[7] 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.

[8] 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.

[9] Das R, Hanson J, Kephart J, Tesauro G. Agent–human interactions in the continuous double auction. Proceedings of the International Joint Conferences on Artificial Intelligence (IJCAI), 4–10 August 2001, Seattle, WA.

[10] Foster, I. and Kesselman, C, “The Grid: Blueprint for a New Computing Infrastructure,” Morgan Kaufmann, 1999.

[11] Foster, I., Kesselman, C. and Tuecke, S, “The Anatomy of the Grid: Enabling Scalable Virtual Organizations,” International Journal of High Performance Computing Applications, 15(3). 200-222. 2001.

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

[13] 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.

[14] McKnight LW, Boroumand J. Pricing Internet services: Approaches and challenges. IEEE Computer 2000; 33(2):128–129

[15] Reynolds K. The Double Auction, Agorics, Inc., 1996. http://www.agorics.com/Library/Auctions/auction6.html .

[16] Smith R, Davis R. The contract Net protocol: High level communication and control in a distributed problem solver. IEEE Transactions on Computers 1980; 29(12):1104–1113.

[17] [Sullivan III WT, Werthimer D, Bowyer S, Cobb J, Gedye D, Anderson D. A new major SETI project based on Project Serendip data and 100,000 personal computers. Proceedings of the 5th International Conference on Bioastronomy, 1997.

[18] Vickrey W. Counter-speculation, auctions, and competitive sealed tenders. Journal of Finance 1961; 16(1):9–37.