A Market-Oriented Model for Grid Service Management*

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Abstract. Grid service management and trading is a complex undertaking as services are geographically distributed, heterogeneous and large-scale, owned by different organizations with their local policies. Each service provider needs flexible relationships between them, and each consumer joins Grid with the intention of getting its purchase requirements satisfied. To allow Grid to reduce the cost of e-business trading, to deal faster and to open up more new opportunities, a market-oriented architecture called GTM (Grid Trading Model) is proposed in order to establish a real-life Grid which provides a business mechanism for organizing users and services efficiently based on market economic rationale. GTM derives from an inherent similarity between typical networks and classical economic market structures based on Virtual Organization (VO) concept and the small-world theory. An emulated environment is presented to illustrate the model’s economic feature, performance and cheap service trading cost.

1 Introduction

Grid provides an opportunity to integrate large numbers and various types of dynamic services owned by different individuals or organizations with their own policies in distributed environment [1]. Service management and trading in large-scale Grid is challenged due to Grid needs to organize users and services efficiently and let users find more trading opportunities, which is similar with the business problem in the real-life market. A market-oriented Grid environment can combine the advantages of traditional service providing systems, and integrate present network applications across distributed, heterogeneous, dynamic environments and communities, in order to organize services in various industries, facilitate service providers finding credible cooperation partners, establish efficient service trading platform between enterprises and consumers. How to operate business process in Grid based on service characteristic and the market economic rationale is the challenging problem which this paper tries to deal with.

The specific problem that underlies the market-oriented Grid is coordinated resource sharing and problem solving in dynamic, multi-institutional Virtual Organizations

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* This paper is partly supported by National Natural Sciences Foundation of China (No.60503039), Beijing Natural Sciences Foundation (No.4042018) and China’s National Fundamental Research 973 Program (No. 2004CB217903).

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In real-life market economy, enterprises producing homologous products in the same industry form a “Product Group” [3]. In our market-oriented Grid model, Product Groups of different industries come to form corresponding industrial Virtual Organizations. Each VO in the model provides some distinct kinds of services in order to classify service provider and consumer groups by different service requirements and purchase interests.

To support service trading, The VO-based Grid model is focuses on market driven service management architecture, in which an essential base is the inherent symmetric relationship between typical networks architectures (including Client/Server, small-world and P2P) and classical economic market structures (including monopoly, oligopoly, monopolistic competition, perfect competition). By detailed description of network/market relationship, we expound that monopoly market fits in with Client/Server network; monopolistic competition market fits in with small-world network; and perfect competition market fits in with P2P network. Based on the most popular market type in e-business environment (monopolistic competition structure) and its corresponding network (small-world), we propose an architecture which can be employed in Grid market situation, and establish the Grid Trading Model (GTM).

2 Principles of Economics and the Small-World Phenomenon

2.1 Principles of Economics in GTM

Market structures are influenced by the number of sellers in the marketplace. With the number of enterprises increasing, the roles of product sellers, originally as price makers, are converted into price takers, and the product price is closer to its marginal cost [4]. A classification of markets is defined as the following four major types:

Monopoly: A single seller with complete control and the price maker over an industry in which each product has no close substitute, such as industries of water and CATV. Oligopoly: A market condition in which sellers are so few that the actions of any one of them will materially affect price and have a measurable impact on competitors, such as industries of tennis ball and base oil. Monopolistic competition: There are many sellers producing products that are close substitutes for one another. Sellers produce slightly differentiated products. It is popular in real-life economy; such as movies, books, PC games and music industries which are most popular contents of network market today. Perfect Competition: It is only an ideal market with many sellers and buyers in the market where sellers are price takers and price competition forces the price to marginal cost, such as industries of wheat and milk.

2.2 The Small-World Phenomenon

A social network exhibits the small-world phenomenon if, roughly speaking, any two individuals in the network are likely to be connected through a short sequence of intermediate acquaintances [5]. Recent work has suggested that the phenomenon is pervasive in a range of networks arising in nature and technology [6]. The GTM can be also demonstrated as a self-organized system based on small-world network.