Modeling Agent Auctions in a Supply Chain Environment

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ABSTRACT

Agent-based auction technology has revolutionized auction trading in the Supply Chain environment by reducing the cost of transactions, and by increasing the satisfaction factor in matching requirements of seller and buyer agents. In this article, we have considered methods of matching quantities of buyer and seller agents by cooperation, with a priority on the buyer's requirements. The article discusses the architecture of the agent and the agent community when there is cooperative matching of volume. We present a Dynamic Programming algorithm to describe the agent's decision process, and heuristic algorithms as the practical solution methodology. The results of a simple experiment show the improvement achieved by cooperation.

Keywords: auction trading; dynamic programming; heuristic methods; multi-agent systems; supply chain management

INTRODUCTION

Aspects and applications of information technology can have significant effects on costs and efficiencies in areas of implementation in Supply Chain management. An example of these effects is shown in this work in the area of procurement. E-procurement is a widely used method of using the Internet to make easy, fast, and less expensive purchases of materials of all kinds, including both direct and indirect materials. The process has gained popularity in recent years. Companies, such as GE (Meehan, 2002), already have processes in place to purchase a large part of their
material online. There are many other corporations in this category. Well-managed e-procurement can help firms reduce their inventory levels. Further, e-procurement enables firms to centralize strategic procurement processes while decentralizing operational procurement processes (Puschmann & Alt, 2005). The benefits of e-procurement in material procurement and inventory management are great, especially for indirect materials, that is, materials for maintenance, repair and operations, also known as MRO. According to the survey report (Arminas, 2005), the world market for e-procurement in 2004 was $300 million in license revenues alone, and it also included $79 million in subscription revenues from hosted e-procurement systems.

E-procurement often involves online auctions with Web-based buyers and Web-based sellers. There are four types of online auction systems, based on the number of buyers and sellers. These are, respectively, bilateral negotiations, Web-based sales auctions, Web-based procurements, and Web-based exchange (Pinker, Seidmann, & Vakrat, 2003). The common online auction type used in e-procurement is reverse procurement auction, in which suppliers bid on a bid placed by a buyer to win the contract (Neef, 2001). The potential benefits of reverse auctions include reduced market prices, shortened cycle times, and expanded outreach (Johnson & Klasssen, 2005). The first reports of companies adopting e-procurement mention software firms, such as Ariba and Commerce One, both of which focused on indirect goods and services (Swaminathan & Tayur, 2003).

In this article, we propose a two-tier e-procurement auction agent structure made up of multiple suppliers and multiple buyers. Trading begins with a buyer proposing a trading amount. A seller may match the trading amount, or may propose a different trading amount. The buyer then seeks to match the trading amount with cooperation from other buyers. Alternately, the seller seeks to split the order, if possible, to suit the buyer, or hold the order for a future offer that matches. The purpose of this approach is to provide better matches with offers, while reducing wait periods by use of split offers by means of cooperative trading. Thus, the efficiency of trading is increased.

This is an agent-based application of group purchasing, and conversely group selling, as a part of e-procurement, that is, material transactions in the supply chain performed via the Internet (Turban, Leidner, McLean, & Wetherbe, 2006). The use of agents (1) reduces the transaction time, (2) reduces information overload on human operators and managers, and (3) saves time on the part of the human supervisors. The disadvantage that agents have is a limited capacity for intelligent collaboration. This is the issue that we address in this article with a model that enables agents to collaborate and form consortiums. This first collaboration model is best suited for transactions in
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