Chapter 6.3
A Game Theoretic Approach for Sensitive Information Sharing in Supply Chain

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ABSTRACT

With the adoption of radio frequency identification (RFID) technology, information sharing among participants in a supply chain is greatly facilitated, raising privacy concerns on sharing sensitive information. Balancing the conflicts between the improvement of visibility and the decrease of sensitive information shared is paramount. In this paper, the authors propose a leader-follower game model called LFM to model the strategic game between buyer and supplier. A Stackelberg equilibrium state is then computed as the solution to this game model. The proposed approach exhibits better performance when compared with conventional optimization approaches via derivation in terms of the total information sharing level and the total gain acquired verified by the experiments. In the future, the authors will extend this approach to a more complex situation with more participants in a dynamic environment.

INTRODUCTION

Recently, information sharing becomes one of the key research issues in logistics and supply chain management (Li, Sikora, Shaw, & Tan, 2006; Lin, Huang, & Lin, 2002; Yan & Woo, 2004; Cachon & Fisher, 2000; Chen, 2003). By sharing information among participants, the visibility of logistics and supply chain is improved and thus the performance of the supply chain. With the adoption of radio frequency identification (RFID) technology, information sharing among participants in a supply chain is greatly facilitated. Simultaneously, RFID enabled supply chain arises the concerns on inap-

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propriate sharing of sensitive information such as transaction records (Juels, 2006; Weis, Sarma, Rivest, & Engels, 2003; Fokoue, Srivatsa, Rohatgi, Wrobel, & Yesberg, 2009). How to balance the conflicts between the performance improvement of supply chain and the reduction of information shared especially sensitive information becomes one of the hottest research topics now.

To protect sensitive information being shared, there are several existing approaches in the literatures. Role-based access control is proposed in (Ferraiolo, Sandhu, Gavrila, Kuhn, & Chandramouli, 2001) in which participants of a supply chain are entitled with different access right to the data shared according to their roles. Those roles are pre-defined in enterprise's database but a person might own more than one role in the same database decided by his/here actual role in organization structure. Alternatively, (Chu, Cheung, & Du, 2008) proposed a relation-based access control to handle the situation that a person has multiple roles. In their work, a partner relationship is formed to share sensitive information among participants with close inter-connection which were generally grouped by contracts in supply chain management. And the sharing scheme consists of exchanging their preference and privacy models. How to define the privacy scheme including the preference models is not mentioned in this work which is the core part in protecting sensitive information. Intuitively, how to share sensitive information and how much information will be shared depend on individual's diverse preference. It is hard to set a universal sharing standard for each participant to follow. Usually, one decides one's sharing scheme based on the negotiation result with his/her partners. Game theoretic approach then becomes the natural solution to this scenario due to its ability to model dynamic and complex situation. Related game theoretic works can be found in (Hennet & Arda, 2008; Krajewska, Kopfer, Laporte, Ropke, & Zaccour, 2008; Li, 2002). Authors in (Hennet & Arda, 2008) proposed a coordination game which coordinates participants in the supply chain with the purpose to enhance the efficiency. Authors in (Krajewska, Kopfer, Laporte, Ropke, & Zaccour, 2008) defined a cooperative game to encourage the autonomous cooperation among all participants in the supply chain. While these game theoretic approaches does not model the willingness of the participants to share sensitive information and how to share information when there exist other concerns such as privacy concern.

In this paper, we proposed a game theoretic approach a mechanism to allow negotiation among partners to make optimal trade-off with the ultimate purpose of improving the value of the entire supply chain. Inspired by (Camuffo, Furlan, & Rettore, 2007) in which the willingness to absorb risk by buyer is modeled, we proposed the willingness to share sensitive information also can be modeled in a similar way. Therefore, this study analyzes the information sharing strategies of buyer and supplier as one of the basic elements of a supply chain: the direct relationship between upstream and downstream partners. In this scenario, buyer has more power than supplier during negotiation. Both of buyer and supplier have privacy concern but at the same time try to share as much information as it can to reduce the impact of information asymmetry. Buyer actively compensates supplier for its extra information provided to buyer through increasing its contract price. The uncertainties that can be reduced through information exchange are associated with a certain sharing willingness. Then a game model is built up to model their sharing strategies. The equilibrium states are acquired through the game model as the best strategies for buyer and supplier as a whole. The general optimization approach is selected to be compared with our approach. The proposed game model can be further extended to model supply chain with more complex participants in the future research.

The rest of the paper is organized as follows. The background of game theoretic approach is presented, and the problems with our proposed Stackelberg equilibrium solution are formulated. Performance evaluation and discussions demon-