DISTRIBUTED DECISION ALGORITHMS FOR FAIR RESOURCE ALLOCATIONS IN COLLABORATIVE NETWORKS

DISSERTATION DEFENSE

Ibrahim Yilmaz

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ABSTRACT

This research addresses distributed decisions for to enhance fairness and total profit among collaborative networked enterprises (CNEs). The arbitrary nature of demand and capacity patterns in manufacturing/service enterprises require to form a CNE with other enterprises to overcome such uncertainties. In any CNE, the collaboration process often leads to a dilemma: the need to choose between fairness and total profit. The aim of this research is to investigate a new sharing protocol (SP) to control CNEs and to propose an algorithm that attempts to increase optimal weights of fairness while maintaining total profit. Most CNE research studies have been designed under a centralized SP. However, centralized SPs appear to be unfeasible or inadequate because of enterprises' operating environments and local objectives; therefore, each CNE requires a distributed decision-making mechanism. Furthermore, market globalization and competition necessitate rapid responses to market changes and give rise to two major concerns about CNEs: 1) how can collaborations be rendered re-configurable to dynamically capture and adapt to market patterns; and 2) how can the resources of all CNEs be utilized fairly among enterprises, ensuring mutual benefits? Therefore, Dynamic-Distributed Sharing Protocol ($D^2SP$), which is inspired by the principles of Collaborative Control Theory and the Contract Net Protocol, is proposed to address these concerns. Under the assumptions used in this research, experimental results and analyses indicate that $D^2SP$ reduces the number of messages and inventory cost of shared amounts by up to 30\%, and 9\%, respectively and total profit and fairness index are increased by up to 15\% and 10\%, respectively. The proposed algorithm in which Jain’s fairness index and the generalized $\alpha$-fair concept are utilized, is tested with conceptual heterogeneous and homogeneous CNs (HeCNs and HoCNs, respectively) based on the enterprise capacity. Experimental results indicate that fairness increases up to 28\% in HeCN and 32\% in HoCN while maintaining the current total profit of a CN. The gap between two CNEs, which are the most benefited and least benefited enterprises in terms of total profit, lost sale cost, and inventory cost, can reduce up to 57\%, 54\%, and 78\%, respectively. Therefore, the proposed algorithm can minimize the deviation between most and least beneficial CNEs in terms of total profit, lost sale cost, and inventory cost.