

## Chapter 12

# A Multi-Agent Approach to Allocate Orders to Distribution Centres in a Highly Dynamic Environment

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### ABSTRACT

*Nowadays, competition takes place in an environment characterized by high market shifting, rapid new technology development and introduction, global competition and customers who need focalization. Therefore, supply chain networks are becoming more dynamic and turbulent than ever before. The Distribution Centre (DC) is an important node in a supply chain network in maintaining the flow of goods and materials among manufacturers and customers. The capability of the DC to maintain the same level of performance in a highly dynamic scenario allows improvement of the competitiveness of the supply chain network. The focus of this chapter is on the allocation of customers to the DCs in very dynamic environments. A Multi-Agent System (MAS) is designed, in order to implement an architecture that is capable of rapid response to changing market conditions. A negotiation approach is proposed for coordinating the involved agents in the architecture: customers and distribution centres. The implementation of the MAS architecture was developed using the JAVA development kit; this platform was used to perform a discrete event simulation and test the proposed approach. Several scenarios are investigated, in scenarios ranging from static to highly dynamic market conditions. The simulation results highlight that the cooperation approach allows obtaining significant growth of performance in several different types of environment.*

### INTRODUCTION

In order to compete in a global market characterized by high competitiveness, firms need to improve product quality, customer service,

reduce costs, etc. The success of a supply chain depends on the entire business entity, including manufacturers, suppliers and Distribution Centres (DCs). In recent years, production capacity has been delocalized in different and geographically dispersed plants, in order to achieve higher flex-

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ibility, lower logistics costs and proximity to customers. In this environment, the allocation of customers to DCs is more complex than in traditional supply chain configurations. Moreover, their complexity is increased by short product life cycles, volatile customer demand and frequent new product introduction. The allocation of customers to DCs has to be realized, in order to balance the workload among the DCs and increase customer service. Workload balance leads to a better supply chain network product flow, in terms of efficiency and costs. Customer service can be measured by the following parameters: lead time to deliver the goods to the customers and unsatisfied customer's demand.

The purpose of a Distribution centre can be defined as follows: "Accumulate and consolidate products from various points of manufacture within a single firm, or from several firms, for combined shipment to common customers.... Product movement may be typified by full pallets or cases in and full cases or broken case quantities out" (Frazelle, 2002a). The Distribution Centre is the stage of the supply chain that operates directly upon the demand of the final customers. Distribution Centres are critical to the success or failure of many companies, and the evaluation of their performance is necessary and critical to long-term business success (Frazelle, 2002b; Kengpol, 2004). Despite the plethora of location-allocation literature, the balanced allocation problem has received little attention from academicians and practitioners.

The balanced allocation problem discussed in this chapter is concerned with the assignment of product flows between multiple Distribution Centres and a set of customers. The problem is identified as an *NP-hard* problem. Therefore, in a practical application, the problem has to be resolved with high flexibility and low computational time. The problem regards independent, geographically distributed Distribution Centres. The development and management of relationships with other firms can improve the performance of

the participants. Inter-firm relationships involve a mix of cooperative and competitive elements. Each DC competes on a geographical area, in order to acquire orders, and can cooperate with other DCs that are in different geographical areas to improve the performance of the network. The network can assure provision to the participants of a value added service by a cooperative mechanism that improves order allocation and profit for the DCs. Moreover, cooperation allows the companies work together to achieve a level of agility beyond the reach of individual companies. Small and Medium Enterprises (SMEs) can adopt business models consisting of a cooperative network, which allows gathering together the advantages coming from both a typical multinational holding business model and the advantages coming from a typical SME. The rapid development of Information and Communication Technology (ICT) and the growth of internet diffusion offers the possibility supporting enterprise networks. In particular, this objective can be achieved by the implementation of a distributed and integrated computer network that allows enterprises to coordinate and collaborate with each other.

Kocsis (2000) discussed the driving forces of networking (Gubik, 2005):

- *Profit maximization*; the main motivation to participate in a network for a SME is the possibility of increasing its profit; in particular, in the dynamic environment in which SMEs compete.
- *Saving of expenses*; the possibility of sharing resources among SMEs leads to reduction of expenses for all participants.
- *Searching for safety*; the network allows improvement of flexibility and, therefore, reacting more rapidly to market change.
- *Advantages gained from competition*; the strong competition of the external contractors works against potential opportunistic behavior of employees.

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