

Virtual Enterprise as a Multi Agent System

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ABSTRACT

This article describes changing customer demands require that enterprises mobilize their resources to quickly develop a suitable product. This is achievable if competing enterprises collaborate to deliver the product. Each of them brings their expertise into the collaboration. This collaboration where each enterprise brings in its core competency is referred to as a virtual enterprise (VE). A construction project is implemented by a team of professionals and an alliance of companies that is formed by consultants who evaluate contractors for specific project tasks. Partners can be represented as multiple agents. Prior evidence of multi-agent system (MAS) model that facilitates formation of VEs is lacking. VE MAS ontology has been designed and used in agent interactions. The model can be used in evaluation and selection process of partners. Delegation of the process to the model, gives partners time to implement the tasks. Partner evaluation and selection problem for building construction projects is solvable if pragmatic scientific approaches are employed with appropriate mathematical models. This article proposed a VE model for evaluating and selecting right partners for building construction projects. The model was used to demonstrate the choice of the most preferred partner. Researchers have not evaluated this model but propose that once in place, it can be evaluated against manual selection of potential partners using similar parameters by examining the closeness of the output.

KEYWORDS

Java Agent Development Environment (JADE), Multi Agent Systems (MAS), Ontology, Partners Evaluation and Selection Problem (PESP), Virtual Enterprise (VE)

INTRODUCTION

Due to frequently changing demands from customers, global competition and technological advances, it has been stated that the next generation of advanced production technologies will rely on cooperation and collaboration of enterprise (business) partners to share expertise, costs and risks (Hsieh & Lin, 2014). The changing customer demands require that enterprises mobilize their resources to quickly develop a product to meet these demands. This can be achieved if enterprises in competition work together to deliver the product instead of each trying to deliver it. Each of them brings their expertise into the collaboration. This collaboration where each enterprise brings in its core competency as suggested in (Unver & Sadigh, 2013) is referred to as a virtual enterprise (VE).

A numbers of researchers have paid more attention to the formation phase of the VE life cycle, which perhaps explains the importance attached to it. The formation phase of a VE can be divided into four steps (Tolle, 2004; Afsarmanesh & Camarinha-Matos, 2005; Guerra, 2006). These steps are: (1) Identification of the problem, (2) Identification of the core competencies required to develop a solution to the problem, (3) The evaluation and selection of the partner companies capable of delivering the

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required core capabilities and (4) Integrating the core capabilities of the partners. Among these steps, the partner evaluation and selection step is the most crucial one and is the main focus of this study. The first two steps are problem specific. The integration phase identifies the functional requirements for VE after identifying the required partners' core competencies.

A typical application area for the VE paradigm is in industrial manufacturing. Nowadays, most manufacturing processes are not carried out on a single line. Companies tend to focus on their core competencies and join efforts with others, in order to fulfill the requirements of new products and associated services demanded by the market. In a VE, every enterprise is just a node that adds some value to the process. Although most classic examples of cooperative networked organizations can be found in some particular business domains such as the automotive industry, this tendency is spreading to many other areas including the food and agribusiness industry, electronics and civil engineering.

Similar to manufacturing industries, the need to remain competitive in the market also forces service provider companies to seek alliances outside their core competencies when additional skills / resources are needed to fulfill business opportunities. For instance, travel agencies typically offer aggregated or value-added-services composed of components supplied by a number of different organizations. To "book a complete journey plan", services may include several means of traveling, several hotel bookings, car rentals and leisure tour bookings. A networked cooperation must exist among the many different organizations (Afsarmanesh & Camarinha-Matos, 2000) to enable collaboration.

Classification of Virtual Enterprises

Attempts have been made to classify VEs based on a number of factors on their formation. Camarinha-Matos and Afsarmanesh (2001) classified VEs according to three dimensions: 1) time, 2) topology and 3) structure. The time dimension refers to the duration or lifespan of the organization. VEs are created for both short and long-term purposes. The formation of short-term enterprises is designed to take advantage of time-dependent client demands that appear for a short period or a single business cycle. In long-term VEs, the life of the enterprise extends for several business cycles. In this case, the VEs focus on establishing strategic bonds amongst its members. The relationship among member partners may survive, even if the initial customer problem has been solved. They can reassemble their core capabilities to satisfy new customer needs in different projects.

The topology dimension considers the membership of a VE. A VE can be either open or closed. Closed memberships are static since partner companies remain in the VE for several business cycles and therefore little or no change in membership is seen. Open memberships, on the other hand, are dynamic since there is a constant renewal of the membership. Partner companies join or, and leave the VE based on factors such as the need for the capabilities of a partner, the stage of the business cycle and scale of the project (Tolle, 2004). For example, it is possible to bring into the VE a member for its research and development competencies for a given product. Once the research and development phase is completed, the VE may not require these competencies anymore, but may require the capabilities of another member to manufacture a product on a large scale. In this dynamic process, each member shares both risks and benefits regardless of the stage of the product development process where its core competencies are needed.

The structural dimension deals with the different management structures of VE. The three most common forms are star-like, democratic alliances and federations. The distinguishing factor of these structures is the partners' level of independence with respect to the collaboration of the VE members. The star-like structure is characterized by the dominant role of one of the members. Usually, the dominant member establishes the protocols for information and communication exchange within

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