Business Network Modelling:
SOA-Based Approach and Dynamic Logistics Case Study

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ABSTRACT

Business networks have appeared as a reaction to changes taking place in the world economy and logistic networks can be considered as examples of such networks. The approach proposed in the paper is based on the idea to represent the business network members with services provided by them, and to achieve interoperability via application of the SOA standards. The approach is based on usage of such technologies as Web services, ontology, and context management. Web services enable interoperability at the technological level. Ontologies are used for description of knowledge domains and enable interoperability at the level of semantics. The purpose of the context is to represent only relevant information from the large amount of the information and the application of the approach is demonstrated on the case study from the area of dynamic logistics. The considered problem takes into account a continuously changing problem environment and requires nearly real-time solving.

Keywords: *Business Network Modelling, Context, Dynamic Logistics, Ontology, Service Networks*

INTRODUCTION

Today companies have to build new supply network strategies to maintain the high level of flexibility and to efficiently respond to changes in their environment (Gunasekaran, Lai, & Cheng, 2008; Gunasekaran & Ngai, 2005; Christopher & Towill, 2001). The appearance of business networks is one of the consequences of these changes. For example, one of the key competitive advantages for car makers is their ability to manufacture customised cars with a reduced lead time. At the same time, it is necessary to avoid significant inventory levels in order to keep costs lower. Such a strategy is called Build-to-Order (BTO) and stands for the capability to quickly build customized products upon receipt of customer orders without precise forecasts, inventory, or purchasing delays. In the BTO networks, customer orders are introduced in advance of, or at the start of the production process. An opposing strategy is build-to-stock (BTS), whereby the product is built prior to demand (Sen et al., 2000). Another example of business networks is logistic networks. Logistic networks often consist of several providers that can be interrelated in various ways (not only sequentially). Besides, such networks have

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to be very flexible in order to respond to the changes in their environment (including traffic, weather, etc.). A logistic network is considered in the paper as a case study.

In such business networks the decision making processes face problems of sharing and processing huge amounts of information and knowledge from distributed and heterogeneous sources (experts, electronic documents, real-time sensors, etc.) belonging to business network members, personalization, availability of up-to-date and accurate information provided by the dynamic environment. The problems include search of the right sources, extraction of content, and presentation of results in a personalized way, and others. As a rule, the content of several sources has to be extracted and processed (e.g., fused, converted, checked) to produce the required information. Since the sources often have different data formats and interaction protocols, this leads to a problem of semantic interoperability.

Hence, the knowledge sharing in a business network is highly important and should be achieved at both technical and semantic levels. The interoperability at the technical level is addressed in a number of research efforts. It is usually represented by such approaches as, e.g., Service-Oriented Architecture or SOA (SOA, 2007) and on the appropriate standards like WSDL and SOAP (Web Services, 2007). The semantic level of interoperability in the flexible supply network is also paid significant attention. As an example (probably the most widely known), the Semantic Web initiative is worth mentioning (Semantic Web, 2006). Its main idea is to use ontologies for knowledge and terminology description.

The approach presented in this paper also relies on the ontological knowledge representation to provide interoperability for its sharing. Ontologies are widely used for problem domain description in modern information systems to support semantic interoperability. An ontology is an explicit specification of a structure of a certain domain. It includes a vocabulary for referring to notions of the subject area, and a set of logical statements expressing the constraints existing in the domain and restricting the interpretation of the vocabulary (FIPA, 2007). Ontologies support integration of resources that were developed using different vocabularies and different perspectives of the data. To achieve semantic interoperability, systems must be able to exchange data so that the precise meaning of the data is readily accessible and the data itself can be translated by any system into the form that it understands (Heflin & Hendler, 2000).

Ontologies facilitate information retrieval over collections of distributed and heterogeneous information sources; they help to provide means for semantic integration of information and facilitate interoperability between heterogeneous knowledge sources at a high level of abstraction (Boury-Brisset, 2003). The conceptual model of the proposed ontology-driven knowledge sharing is based on the earlier developed idea of knowledge logistics (Smirnov et al., 2004) and correlates with the conceptual integration developed within the Athena project (Ruggaber, 2005). The model assumes existence of an ontology describing common entities of the enterprise systems and relationships between them. As a result, it is possible to treat all available knowledge and competencies as one distributed knowledge base.

Centralized control in complex distributed systems is not always possible: for example, business networks consist of independent companies and do not have a central decision making unit. Thus, decentralized organisation of distributed independent components is a promising architecture for such kind of systems (Viana et al., 2005; Hammer et al., 2004; Nakano & Suda, 2005). However, in order for the self-organisation to operate it is necessary to solve a number of problems including: (i) registration and cancelling of registration of network elements, (ii) preparation of initial state, (iii) self-configuration: finding appropriate network elements (Chandran & Hexmoor, 2007), negotiation of conditions and assignment of links, and preparation of alternative configurations. Different research projects are devoted to self-management of such networks: self -contextualization, -optimization, -organi-

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