Service–Oriented Architectures and ESB in VE Integration

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INTRODUCTION

Service-oriented architectures (SOA), mostly based on Web services (W3C), provide an industrial standard for deploying, publishing, discovering, and invoking enterprise's services. From its emergence, many specialists have predicted that SOA will revolutionize the distributed computing paradigm and it will make various kinds of e-business (e.g., virtual enterprises, inter-enterprise collaboration, and ASP paradigms) a reality.

This article examines the service-oriented architectures (SOA) applied to innovative organization schemes such as virtual enterprises (VE) to resolve the enterprise organizational structure integration problem. The evolution of software architectures from traditional to SOA is presented, along with the characteristics, advantages and disadvantages, and problems and difficulties in applying the SOA, while also focusing on the compatibility between SOA and modern organizational structures. The new standard in the service orchestration level BPEL is considered as a language for business process modelling and its impact to the integration problem is examined. New messaging protocols and frameworks such as the enterprise service bus (ESB) or messaging service bus are also examined. The main focus is on the SOA technology trends of modern organizational structures with regards their formation and integration. The comparison between SOA and traditional architectures provides a clear path to their adoption in various cases.

BACKGROUND

Since 1996, where service-oriented architecture was first introduced by Gartner (1996, p. 1-2), a lot of effort has been put worldwide in this area. Gartner defined SOA as "a software architecture that starts with an interface definition and builds the entire application topology as a topology of interfaces, interface implementations, and interface calls." SOA would be better named *interface-oriented architecture*. SOA is a relationship of services and service consumers, both software modules large enough to represent a complete business function. Services are software modules that are accessed by name via an interface typically in a request-reply mode. Service consumers are software that embeds a service interface proxy (the client representation of the interface)."

SOA has excited many software architects and developers but only recently with the advent of Web services, SOA has found its route to real applications. Other technologies have been tried in the mean time but undoubtedly, Web services is the most prominent technology that forms a solid base to develop robust SOA applications. Web services are defined by Gartner (Plummer, Blosch, & Woolfe, 2002) as "modular business services with each module fully implemented in software and delivered over the Internet. The modules can be combined, can come from any source, and can eventually be acquired dynamically and without human intervention when needed."

SOA and Web services are complimentary technologies that represent the most recent step in the evolution scale, which started with distributed programming and object distribution technologies like CORBA, COM/DCOM, DCE and more recently J2EE. Web services represent a technology specification meaning that an application must use its standards like Web services description language (WSDL), simple object access protocol (SOAP), or universal description, discovery, and integration (UDDI) to be considered as Web services. SOA on the other hand is more considered as a design principle (Natis, 2005) meaning that Web services interfaces like WSDL (WSDL) and SOAP are suitable interface definition standards (Atkinson et al., 2002; IBM, 2001; SOAP, 2001; UDDI, 2001; WSDL, 2001).

A virtual enterprise is defined as a temporary alliance where different economic organizations are combining their strengths to provide a specific service

traditionally provided by a single enterprise. They come together to share skills and resources in order to better respond to business opportunities, whose cooperation is supported by computer networks and adequate IT tools and protocols (Camarinha-Matos & Afsarmanesh, 1999). The life cycle of a virtual enterprise is generally considered to be a four-stage process: creation, operation, evolution, and dissolution. Among them, the first step (virtual enterprise creation) involves dynamically generated partnerships and dynamically composed service workflow in order for the successful operation of a virtual enterprise.

We consider a virtual enterprise is dynamically created following a process of order generation, partner search and selection, bid negotiation and contract awarding. Workflow is used to define the business process logics that are shared by the participants of a formed virtual enterprise. If we consider the workflow definition as a "class" in programming, a virtual enterprise can be considered as a running instance of such a class, which is triggered by customer requirements, created by its lifecycle, controlled by workflow management, executed by workflow engine and dismantled once its goal is fulfilled (Wang, Shen, & Hao, 2006).

SOA has an inherent ability to apply itself efficiently across enterprises, being the most promising technology to form and operate virtual enterprises. Such a development will offer, in the long term, immense influence on the economy and enterprise development strategies. The availability through SOA on the Internet of standardized SME information, relevant for participating in virtual enterprises, will dramatically multiply the number of business opportunities transformed into successful business ventures. The most important requirements for virtuality in virtual enterprises are (Protogeros, 2005):

- **Global visibility across the virtual enterprise.** There is a need to have an overall visibility on the entire life cycle of the products and/or services produced, starting from its development to its launch into the market. Such a visibility must be permitted to all the companies' personnel involved in the virtual enterprise operation and in particular to the project managers that often, in the traditional supply chain, cannot adequately follow the development of important sub-systems, which are supplied by a sub contractor.

- **Uniform and consistent business model.** Gou et al. (2003) define a business process of a virtual enterprise as a set of linked activities that are distributed at member enterprises of the virtual enterprise and collectively realize its common business goal. A uniform business model is very important for the viability of the virtual enterprise. It should support the evolution of the product, process, and organization according to the increasing detail of the attributes representing the same concept (such as the status of an order, the categorization of the order, the customer contact information, the customer account representation, etc.) in a consistent manner.

- **Uniform organizational model.** The organizational view of enterprises captures information about departments, roles, employees, partners, and entire organizations. The organizational model of the virtual enterprise should encompass ownership, privileges, and responsibility of messages, documents, and activities that are involved in the processes of the virtual enterprise. It also has to involve extensive security as well as personalization requirements. Virtual enterprises can be thought of as an aggregation of processes. Thus, processes use information, operations, roles, and sequencing of tasks to carry out specific objectives in the virtual enterprise.

- **Consistent process and data model.** The data model of the companies can capture various behavioural semantics of the business entities. Thus, it is not sufficient to have just a consistent conceptual business model of the business entities for smooth operation (Setrag, 2002). Data semantics and operational behavior must also be represented and applied consistently.

The large diversity in business practices reflected in the plethora of monolithic and legacy applications, along with the huge gaps in business scope and differences in working standards between the large enterprises and the SMEs make the integration process for virtual enterprises a real headache for analysts and developers. SMEs significantly contribute to the value chain by supplying to large enterprises the equipment and subsystems required. In Europe, for example, where a large number of SMEs exist, the need for harmonizing the large and small/medium enterprises business approach and practices has been pointed out several times

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