

Service-Oriented Architectures and Virtual Enterprises

Nicolaos Protogeros

University of Macedonia, Greece

INTRODUCTION

This article presents some trends in e-commerce technology and more specifically the service-oriented architectures (SOA) and its interoperability promise applied to innovative organization schemes such as virtual enterprises (VE). The evolution of software architectures from traditional to SOA is presented through comparison of 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 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

Service-oriented architecture was first introduced by Gartner, Inc. (1996) 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 since 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.”

Web services and SOA 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 (UDDI, 2001; WSDL, 2001; SOAP, 2001; Atkinson, 2002; IBM, 2001).

SOA has an inherent ability to apply itself efficiently across enterprises, being the most promising technology to form and operate virtual enterprises where different economic organizations are combining their strengths (and thus minimizing their weaknesses) to provide a specific service traditionally provided by a single enterprise. 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):

1. **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 im-

- portant sub-systems, which are supplied by a sub contractor.
2. **Consistent and Uniform Business Model:** Gou, Huang, Liu, and Xiu (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 (e.g., the status of an order, the categorization of the order, the customer contact information, the customer account representation, etc.) in a consistent manner.
 3. **Consistent Co-Operative Process and Data Model:** The data model of the companies can capture various behavioral 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.
 4. **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.
 5. 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 at European Community level. Technology should support the four main phases of a virtual enterprise life cycle [200], which are: creation/configuration, operation,

evolution and dissolution. By now a large number of projects are addressing various aspects of infrastructures for virtual enterprises including NIIP (NIIP), PRODNET II (Camarinha-Matos & Cardoso, 1999), VIRTEC (Bremer, 1999), Co-OPERATE (Azevedo, Torscano, & Sousa, 2002), and BIDSAVER (Protogeros, 2005). Some of them are developing Service based reference architectures for example the NIIP.

SOA TECHNOLOGY AND STANDARDS

In recent years a new trend has appeared related to the reuse of old applications in new type user-transactions. This style, being an alternative to the development of purely new applications, is known as composite development. In 2003 the majority of new business applications developed were composite applications (Natis, 2005). In taking that approach, wrappers are developed around legacy or other functionality that assemble those components into heterogeneous composite transactions. SOA is the natural place where these types of composite components fit together. From an industry and standards perspective, SOA technologies are quite advanced. All major software vendors have at least some level of support for Web services in their products, providing Web service technologies broad industry support. On the other hand, the baseline standards underlying Web services—XML, SOAP, and WSDL—are stable and mature since they have been used for many years now (since 1998, 2000, and 2001 respectively). According to Gartner Group, these standards have reached the “plateau of productivity,” a term Gartner applies to technologies whose value is demonstrated and accepted.

An important step towards interoperability in SOA is the formation of the WS-I—the Web Services Interoperability Organization—an organization driven by vendors. This organization’s role is to assure that the “common language” of Web services (and the entire supporting infrastructure around it) is interoperable among implementations.

The WS-I has published a “basic profile” which describes how to build and use the base Web services standards to ensure interoperability. In addition, a version of the “security profile” has also been published.

Can SOA Be the Key Driver of Virtual Enterprise Integration?

Ashkenas, Ulrich, Jick, and Kerr (2002) described the emergence of the “Boundaryless Organization” that in-

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