

DESIGN AND DEVELOPMENT OF AN EXTENDED ENTERPRISE MODEL

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Dorina Kabakchieva¹, Kamelia Stefanova²

¹Centre of Information Society Technologies, Sofia University "St. Kliment Ohridski", Bulgaria

²University of National and World Economics, Sofia, Bulgaria

Abstract. *Companies in Europe, especially small and medium-sized enterprises, are confronted with a number of changes that require innovative answers. While, globally, virtual collaboration among enterprises is growing, the clear lack of collaborative networks among SMEs in EC region and Eastern Europe is an issue that comes with the need to create efficient innovative solutions to communicate and plan business activities. This paper provides the main aspects of an extended enterprise model and an overview of a service-oriented architecture that could support the collaborative paradigm, specifically designed to support the participation of SMEs in assembled-product development and manufacturing processes in Enlarged Europe.*

Key Words: *Extended Enterprise, Collaborative Environment, Service Oriented Architecture*

1. INTRODUCTION

The globalisation process of markets and the great technological revolution have generated a rapidly changing and highly competitive business environment. The increased competition compels organisations to search for new ways to improve their competitiveness. Through connectivity via the Internet, an enterprise is now able to conduct business anywhere, anytime - overcoming the traditional constraints of time, distance, and location. The Web- based solutions, on the other hand, require a transformation of business processes and procedures within the counter partners (suppliers and customers) relationships.

Companies in Europe, especially small and medium-sized enterprises (SMEs), are confronted with a number of changes, such as the emergence of a competitive global economy, the trend towards an information-based economy, and the shift from mass production to a customer-driven economy, that require innovative answers. While, globally, virtual collaboration among enterprises is growing, the clear lack of collaborative networks among SMEs in EC region and Eastern Europe is an issue that comes with the *need*

to create efficient innovative solutions to communicate and plan business activities. In domains concerning the manufacturing of assembled products, different involved companies rely upon a great variety of software applications, which are not integrated, difficult to use and often ineffective. High costs are sustained to train employees and acquire tools as required by the Original Equipment Manufacturers (OEM). Besides, some challenges evolving from the OEM and SMEs requirements for team productivity should also be considered. A technology, specifically designed to support product development and manufacturing processes, is needed.

In response to the existing need, a consortium of several universities, manufacturers, software developers and consulting companies from Western and Eastern Europe has been created with the main goal to develop an innovative integrated collaborative environment specifically tailored to answer the needs of the suppliers operating in a business network which involves companies from all over Europe. The research and development work is funded by the European Commission within the international project titled "Extended Enterprise management in Enlarged Europe" (E4 project) [1,2].

This paper briefly presents the main theoretical concepts on which the research work performed within the E4 European project is based. An overview of the developed collaborative platform for extended enterprise management is also provided.

2. NEEDS FOR INTRODUCING AN INNOVATIVE APPROACH TO COLLABORATIVE BUSINESS ACTIVITIES

The most important factors that have driven the shift from the traditional enterprise model to the extended enterprise approach of doing business are *customer empowerment*, *globalization of markets*, *dramatic cost reduction*, *reduced time-to-market*, *improved logistics and delivery*, and *e-business applications* [3,4,5].

Recent technological developments have drastically changed the position of clients who are becoming the most critical aspect to a company's success. Global environment provides *interconnectivity* through the use of the Internet, which is driving competition, lowering costs, and reinforcing globalization. Partnering with other organisations is often the only successful strategy for the survival and prosperity of small companies. Contemporary business trends enable cost reductions and highly contribute to the growth of the *global economy*. In the emerging business model, businesses are seeking to maintain virtual inventories by directly linking to suppliers. In turn, this leads to a reduction in required inventory levels, as the supplier can ship directly to the customer. Manufacturers are also seeking to lower inventories by having suppliers maintain component inventories at nearby locations, or they are involved in collaborative product design and coordinated production scheduling with other enterprises. *Minimal time-to-market* has long been considered a competitive advantage, but now it is a competitive necessity for survival. Through collaborative product development and knowledge sharing with business partners, that parameter can be successfully reduced.

The above-mentioned drivers provide an indication of some of the emerging trends in the extended enterprise environment. They also represent a broad framework for enabling new forms of business, for requiring new strategies for business, and for encouraging the

evolution of *e-business* in the *extended enterprise*. To effectively support e-business, organisations must turn inwardly focused processes around to face outward toward customers, trading partners, suppliers, and distributors.

3. THE EXTENDED ENTERPRISE

Two of the leading authors in the field of Strategic Management, Michael Hammer [6] and Kevin Kelly [7], emphasize the clear tendency for organisations to become more and more "virtual" – keeping only core business activities within the enterprise and outsourcing all the rest through creation of an extended network.

The phenomenon where an organisation extends outside its traditional boundaries is commonly described as an extended enterprise, a virtual enterprise, or even as a virtually integrated enterprise. In the diversity of the e-business environment, the greatest benefits for an organisation have been attained by those entities that endorsed and embraced this extended enterprise concept, and then adapted it to best fit the environment in which they operate.

Traditional organisations were structured as vertical silos, in which all typical activities (R&D, manufacturing, distribution, sales, logistics, and customer relationship management) were performed and managed, and the business processes were pointed inward. Although this approach may have been successful in the past, it had several drawbacks. *First*, it was extremely capital-intensive, because organisations had to invest significantly in purchasing, building, and operating various pieces of the supply chain. *Second*, and perhaps more important, this model forced organisations to focus efforts on business functions that were not their core competencies.

With increasing competition, organisations began to disperse some of the key business activities to various geographic locations, but still within the same enterprise. Gradually, cost constraints and global competition have forced these organisations to look beyond their internal boundaries - at outsourcing all non-core activities. The rapid proliferation of the Internet and the development of web-enabled technologies enable customers today to select the best quality of products/services offered around the world, on one hand, and provide great opportunities for enterprises to deliver world-class products/services without taking into account geographic boundaries, making significant improvements in productivity, customer service, and quality, on the other hand. Many organisations are now focusing on their core competencies, or what they can do best, and extending their business processes by teaming with networks of similarly focused partners and sharing services.

The shift from the traditional vertical integration model to the extended enterprise model is presented on Fig.1. The ability to adapt to market changes is inversely proportional to investment in fixed assets.

Many enterprises today become "core competency centric", directing their resources only to the activities and efforts that directly affect the quality of the products or services they provide. The non-core activities are outsourced by creating strategic partnerships and alliances. This extended network of business partners, also known as a value chain, includes suppliers, partners, customers, and other entities that have a stake in satisfying the value chain's customers.

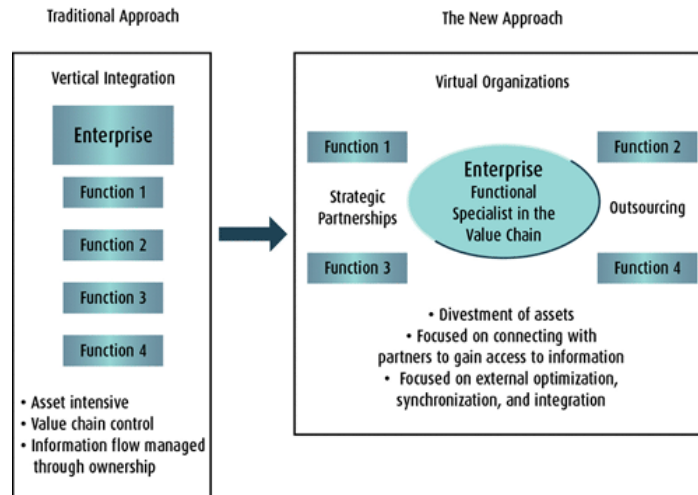


Fig. 1 Shift from traditional to virtual organisation (Source [8])

The **extended enterprise structure** can be described as *a combination of extended value chains, where enterprises are members of value networks that pull together capacities in an unprecedented manner*. One enterprise can participate in multiple extended enterprises and provide services across many value chains.

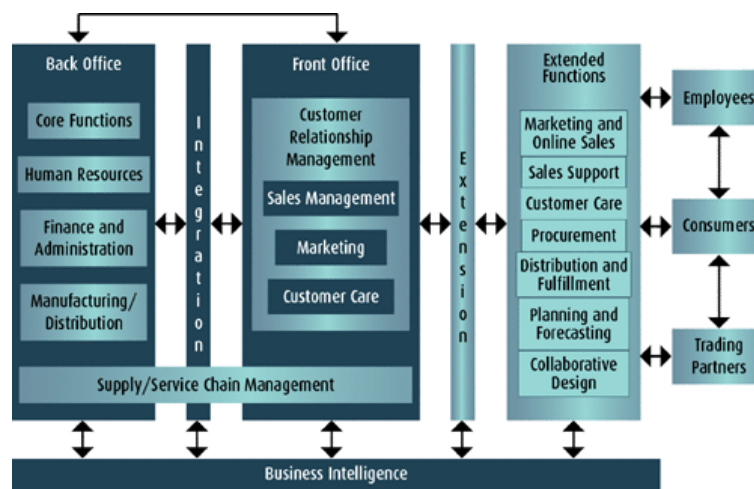


Fig. 2 The Extended Enterprise Model (Source [8])

This vision is captured in the extended enterprise business model [8], which integrates an organisation's internal information systems and business processes with those of customers, employees, and business partners (Fig.2). The ultimate outcome are truly integrated value chains, enabled by shared applications and business processes, that form the foundation of extended enterprises.

This model depicts the entire environment in which organisations may now conduct business. In this complex business environment, organisations must look at the "big picture" of their operations - both internally and externally - in order to remain competitive and achieve success. The model focuses on extending out the business functions from the back- and front office to include customers and trading partners. This inclusion creates a more efficient and effective set of business processes.

The complexity of an extended enterprise is much higher than that of a classical one. Each partner of the extended enterprise needs to share objectives, goals and expectations of the group in order to cope with the increased dynamics and complicated network communications. Although members of a common value chain, the enterprises are still separate entities that have their own interests. Intellectual property rules are a very important aspect of collaborative work. They must be strictly followed to ensure that each enterprise, participating in a virtual enterprise, cannot use the common results without compliance to these rules.

4. SERVICE-ORIENTED ARCHITECTURE

The Extended Enterprise Management (EEM) software industry is currently highly fragmented, with prevailing industry-specific narrow applications, in most cases based on existing Enterprise Resource Planning (ERP) systems. Some vendors are trying to make systems more neutral by using industry standards or providing Internet integration and connectivity services. However, speaking generally, there is a lack of satisfactory solutions, especially appropriate for SMEs specific needs and resources available.

One of the possible effective ways to drive EEM is to implement a Service Oriented Architecture (SOA). Its main objective is to allow businesses to establish a common, integrated data model that further enable communication, decision making and information sharing between the existing tools.

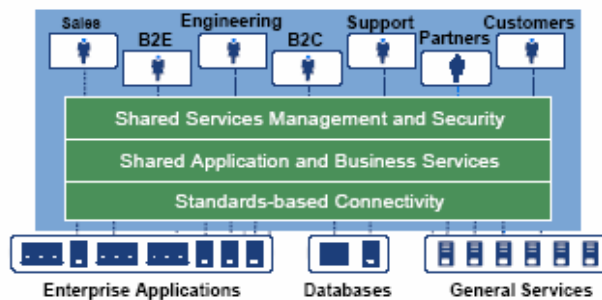


Fig. 3 Service-Oriented Architecture (SOA), Source [9]

A service-oriented architecture (SOA) is a higher level of application development that enables IT to focus on business processes, rather than the underlying IT infrastructure, to achieve competitive advantage. According to BEA Systems Inc. [9], "Service-Oriented Architecture (Fig.3) is an IT strategy that organizes the discrete functions con-

tained in enterprise applications into interoperable, standards-based services that can be combined and reused quickly to meet business needs."

By organizing enterprise IT around services instead of around applications, SOA provides key benefits, including: allowing IT to deliver services faster and align closer with business; leveraging existing assets; improving productivity, agility and speed for Business & IT; reducing development times and costs through re-use; decreasing integration costs and risks; lowering maintenance costs and higher data integrity; allowing business to respond quicker and deliver enhanced user experience; enabling new ways to relate to employees, partners and customers.

5. MAIN DESIGN ASPECTS OF THE E4 COLLABORATIVE PLATFORM DEVELOPMENT

The main goal of the project "Extended Enterprise management in Enlarged Europe" is to implement an effective, integrated, easy to understand, user friendly and low cost platform, to specifically support Eastern Europe enterprises to take active part and jointly develop collaboration initiatives with long-tradition Western EU R&D and Innovation Centers for intelligent and extended products development in several sectors of the EU manufacturing industry. The developed platform logical architecture [1,2], based on SOA principles, is presented on Fig. 4.

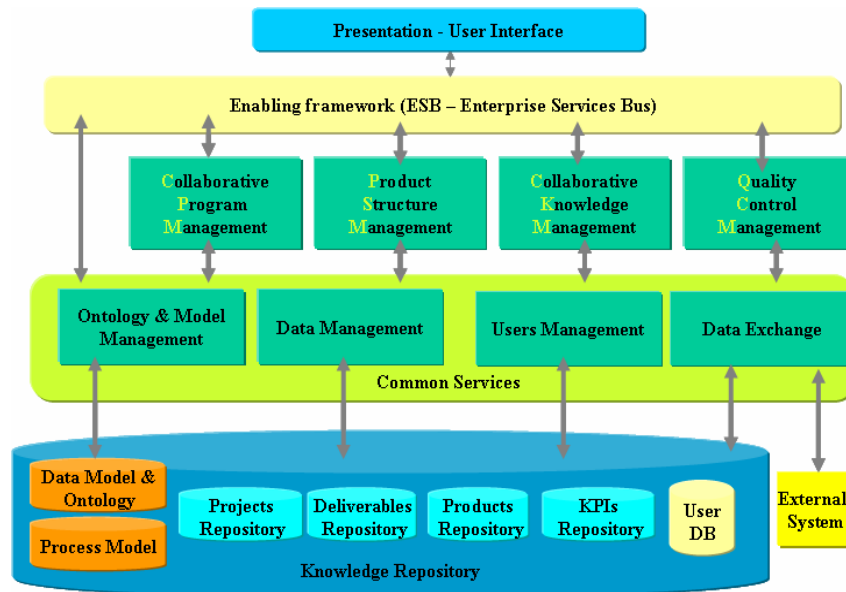


Fig. 4 E4 Collaborative Platform Architecture, Source [2]

The architecture is split into 5 layers – Data layer, Common Services layer, Vertical Modules layer, Process Choreography layer and Presentation layer, which are briefly described below.

The lowermost layer is the *Data layer*. Data may reside in the platform itself or be part of *External System*. E4 Platform can exchange information with External Repositories or Systems through standard formats such as XML. The *Knowledge Repository* is the whole common repository of the platform; it contains all the information needed by all the composing E4 modules and all the knowledge shared among the virtual organisation. This information may come from *Projects, Deliverables, Products, KPIs* and any other source of knowledge such as documents, ideas, emails, media, exchanged by the platform users. The *User Database* resides here; it contains all the profiles of the E4 users: enterprise employees, customers, suppliers and administrators of the platform. The *Process Model*, the *Data Model* and *Ontology Database* will contain the description of the E4 VO value chain model.

The *Common Services* layer is the lower layer of services: the layer of technical fine-grained services. It consists of *Ontology* and *Model Management, Data Management, User Management, Data Exchange* and all that services that can provide reusable functions.

Above is the *Vertical Modules* layer where the coarse-grained services reside. The vertical modules to be developed are logical clusters of the main functions of the development process from a supplier perspective:

- Collaborative Program Management (CPM) Module - will manage the planning and monitoring of development activities;
- Product Structure Management (PSM) Module - will manage the structure of the product under development and all related information;
- Collaborative Knowledge Management (CKM) Module - will provide knowledge re-use and learning from past experiences;
- Quality Control Management (QCM) Module - will keep a record and provide a report of all planning and execution activities traced by the platform.

The *Enabling Framework* represents the *Enterprise Service Bus* and the *Process Choreography* layer of the E4 SOA. This module provides a set of infrastructure capabilities, implemented by middleware technology, that enable the integration and the choreography of services in the E4 SOA.

The top level is the *Presentation* layer, which consists of the *User Interface* module that will be the access point to all the functionalities provided by the platform.

CONCLUSIONS

The challenges that the manufacturing industry faces today are also opportunities. Beyond the manufacturing facility, profitability depends on collaboration, communication and other means of making the supply chain more visible and responsive to customer demands. The competitive pressures are forcing major organisations to co-operate ever more closely in designing, manufacturing and supporting new products and major assets, forming Extended Enterprises.

This paper presents the research work performed within a European project, devoted to the development and implementation of a platform for assembled-product development and manufacturing, to specifically encourage the participation of Eastern European SMEs in extended enterprises around Europe. The developed platform will support project man-

agement, monitoring and control, traceability and quality control, product structure, knowledge management, the use of CAE tools on a pay-per-use basis, and connectivity to local Original Equipment Manufacturer (OEM) systems at a low cost. The research efforts will also contribute to the general improvement of the network enterprise cooperation structure, involving also partners coming from enlarged Europe, to more flexible and less expensive way of working on common projects and to increased efficiency.

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DIZAJNIRANJE I RAZVOJ MODELA PROŠIRENJA PREDUZEĆA

Dorina Kabakchieva, Kamelia Stefanova

Preduzeća u Evropi, posebno mala i srednja preduzeća, suočena su sa brojnim promenama koje zahtevaju inovativne odgovore. Dok, globalno, virtuelna saradnja između preduzeća raste, jasan nedostatak mreža saradnje između MSP u istočnoj Evropi je pitanje koje dolazi sa potrebom da se kreiraju efikasna inovativna rešenja za komunikaciju i planiranje poslovnih aktivnosti. Ovaj rad obrađuje osnovne aspekte modela proširenja i pregled uslužno orijentisane arhitekture koja može podržati paradigmu saradnje, posebno dizajniranu da podrži uključjenje MSP u proizvodne procese u proširenoj Evropi.

Ključne reči: prošireno preduzeće, okruženje saradnje, uslužno orijentisana arhitektura.