

**INTRODUCTION**

Increasingly, organizations are cooperating with other organizations. For many enterprises, doing business globally has become a critical success factor. Others discover new opportunities by focusing their business in new ways. Not only do large enterprises set up cooperation agreements with other enterprises, but small and medium enterprises (SME) are also combining forces to compete jointly in the regional or global market.

In this process of change, Information and Communication Technology (ICT) plays a significant role both enabling and triggering the re-organization of activities. ICT is becoming ubiquitous, invading all aspects of the business and public domain, and having a profound impact as the major enabler of the move from an industrial society to a knowledge society. Nowadays, an enterprise’s competitiveness is largely determined by its ability to seamlessly interoperate with others. Yet, this transition will only take place reasonably smoothly if adequate measures, which take into account not only the technical aspects of interoperability, but also the characteristics of the specific organizational and social environment within which they will have to function, are in place.

The Internet has considerably accelerated the diffusion of inter-organizational networks and has intensified the collaboration between organizations. Regardless of company size and type of business, today virtually all organizations’ ICT systems are interconnected. In such an increasingly networked world, ICT and e-business standards aim to ensure interoperability between different IT systems both within and between organizations. As ICT enabled collaboration has become a decisive tool to achieve competitive advantage, interoperability within and between organizations has become a strategic necessity in all industries. To communicate and collaborate, interoperability is absolutely essential.

The interoperability in enterprise systems and applications can be defined as the ability of a system or product to work with other systems or products without special effort from the customer or user. The possibility to interact and exchange information with collaborators is a key issue in the enterprise sector. It is fundamental in order to produce goods and services quickly, at lower cost, while maintaining higher levels of quality and customization. Interoperability is considered achieved if the interaction can, at least take place at the three levels: data, applications and business enterprise through the architecture of the enterprise model, and taking into account the semantics. It is not only a problem of software and IT technologies. It implies support of communication and
transactions between different organizations that must be based on shared business references.

However, seamless communication and integration of data and information as well as synchronized inter-organizational business processes are not possible in the absence of common standards, proper applications, shared understandings, adequate business processes, and so forth. Legacy enterprise applications, for example, often hinder cooperation. These applications were often not designed to interoperate with other applications.

Enterprise interoperability has numerous direct and indirect positive effects on productivity through the two levels of efficiency (e.g. through the provision of affordable solutions for end-to-end application integration across firm boundaries and the reduction of application integration costs) and agility (e.g. through business process automation across business partners).

Currently, there are a number of research projects within this area. One is the ongoing European Network of Excellence, INTEROP (2003-2007). The primary goal of INTEROP is the sustainable structuring and shaping of the European Research Area (ERA) on Interoperability for Enterprises Applications and Software and the emergence of a lasting European Research Community that will solve recurrent problems, affect policy, and influence standards in this strategic field. By the end of the project a European virtual research laboratory on Interoperability for Enterprises Applications and Software will be established. INTEROP will impact education by creating a European Master program on Interoperability of Enterprise Applications and Software both focusing on academic and industrial points of view. It will also propose an e-learning service for both research and industrial audiences. The various tasks will be achieved by the end of the three-year project duration.

From a technological as well as a business process point of view, there are numerous gaps between the existing paradigms and the comprehensive systems required to enable true Interoperability for Enterprises Applications and Software. INTEROP is studying exactly these concepts. The originality of the project lies in the multidisciplinary approach by merging four research areas supporting the development of interoperability of enterprise applications and systems: to provide implementation frameworks, to define interoperability requirements, to support solution implementation, and to identify interoperability semantics in the enterprise.

INTEROP brings together leading academics, research centers, industrial stakeholders and standards communities from Europe, representing 47 organizations, 15 countries, and gathering 200 researchers and 140 doctoral students. The project is coordinated by the research center LAPS/GRAI of University Bordeaux 1. (See www.interop-noe.org for the list of partners and additional information).

**INSIDE THIS ISSUE**

This special issue is related to the INTEROP-ESA conference first held in 2005 which was aimed at bringing together researchers, users, and practitioners dealing with different issues of Interoperability of Enterprise Applications and Software. As with the conference and INTEROP in general this special issue will focus on interoperability related research areas like Enterprise Modeling to define interoperability requirements, Architecture and Platforms to provide implementation frameworks and Ontologies to define interoperability semantics across enterprises. The special issue contains four articles that look upon different aspects of this problem area.

In the article “Interoperability Middleware for Federated Business Services in Web-Pilarcos” by Lea Kutvonen, Toni Ruokolainen, and Janne Metso, the Web-Pilarcos architecture is introduced to address the needs of managing collaboration and interoperability of autonomous business services in an inter-organizational context. Participation in electronic business networks has become necessary for the success of enterprises. The strategic business needs for participating in multiple networks simultaneously and for managing changes in these networks are reflected as new requirements for the supporting computing facilities. The Web-Pilarcos B2B middleware is designed for lowering the cost of the collaboration establishment and to facilitate management and maintenance of electronic business networks. The approach is a federated one: All business services are developed independently and the B2B middleware services are used to ensure that technical, semantic, and pragmatic interoperability is maintained in the business network.
In the architecture and middleware functionality design, attention has been given to the dynamic aspects and evolution of the network. This article discusses the concepts provided for application and business network creators, and the supporting middleware-level knowledge repositories for interoperability support.

In the article “Integrating Semantic Web Technology, Web Services, and Workflow Modeling: Achieving System and Business Interoperability” by John Krogstie, Csaba Veres, and Guttorm Sindre, the focus is also on electronic business networks. Here the outset is the way Semantic Web services can be made applicable for this setting. Much of the early focus in the area of Semantic Web has been on the development of representation languages for static conceptual information while there has been less emphasis on how to make Semantic Web applications practically useful in the context of knowledge work. To achieve this, a better coupling is needed between ontology, service descriptions, and workflow modeling, including both traditional production workflow and interactive workflow techniques. This article reviews the basic technologies involved in the area to provide system and business interoperability, and outlines which can be achieved by merging them in the context of real world workflow descriptions.

In the first two articles, the focus has been on functional models. In the article “Quantitative Analysis of Service-Oriented Architectures”, Maria-Eugenia Iacob, and Henk Jonkers address the integration of functional models with non-functional models in the context of service-oriented enterprise architecture. Starting from the observation that current approaches to model-driven development have a strong focus on functionality, they argue the necessity of including non-functional aspects as early as possible in the service design process. They distinguish two modeling spaces, the design space and the analysis space, which can be integrated by means of model transformations. Quantitative results obtained in the analysis space, using special-purpose analysis techniques, can be related back to the design models by means of a reverse transformation. This provides a framework for incorporating non-functional analysis into methodological support for e-service development. While for detailed design models, performance analysis is more or less covered by existing techniques, there is still a gap at the architectural overview level. Therefore, the authors propose an approach for performance analysis of layered, service-oriented architecture models, which consists of two phases: a top-down propagation of workload parameters, and a bottom-up propagation of performance or cost measures. By means of an example they demonstrate the application of the approach and show that a seamless integration with detailed performance analysis methods (e.g., queuing analysis) can be achieved.

In “Measuring and Diffusing Data Quality in a Peer-to-Peer Architecture” by Diego Milano, Monica Scannapieco, and Tiziana Catarci, the focus is on data rather than functionality. Data quality is becoming an increasingly important issue in environments characterized by extensive data replication. Among such environments, they focus on Cooperative Information Systems (CIS) for which it is very important to declare and access quality of data. They describe a general methodology for evaluating quality of data and the design of an architectural component, named Quality Factory, which implements quality evaluation of XML data. The detailed design and implementation of a further service, named data quality broker is presented. The data quality broker accesses data and related quality distributed in the CIS and improves quality of data by comparing different copies present in the system. The data quality broker has been implemented as a peer-to-peer service and a set of experiments on real data show its effectiveness and performance behavior.
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