

“PLUG AND DO BUSINESS” AND THE EUROPEAN R&D PROGRAMMES

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Interoperability is perhaps the most critical issue for organisations that have started or are looking to do business electronically. For organisations to do business over the Internet, they must communicate and effect electronic exchanges with a wide range of business partners. E-business is more than buying and selling transactions over the Internet. It involves new forms of collaboration in which business processes, resources, skills and knowledge are shared. Today, the poor level of interoperability of business applications impedes the adoption of this new form of collaboration in particular the forms based on loosely coupled associations of businesses over the Internet for many organisations.

The paper summarises the main outcomes of an expert discussion group which has been hosted by the European Commission's Information Society Technologies R&D Programme with a view to providing the framework for the development of a radically new basis for interoperability of Internet-enabled business (applications). The aim of this group is to build a wide consensus on the strategy and approaches which could be implemented through a research initiative supporting the vision of "Plug and Do Business" within the proposed new 6th Framework Programme for Research, for the years 2002-2006. Three technology-oriented themes have been identified so far: i) Modelling internet-worked organisations, ii) Open architectures supporting inter-enterprise collaboration and iii) Ontologies

1. EXECUTIVE SUMMARY

Europe has a history of success in co-operative projects such as Airbus, Concorde, ESA and others, however its economic future will be even more conditioned by its capability to cooperate, internally and externally, on a world wide basis.

It has become clear that, for successful co-operation, a higher level of advanced IT support is required. Interoperability, the main thrust of the proposed action "Plug and do Business" is the vital, and currently missing, element of such IT systems and the objective of this document is to define an R&D action, resulting in a state-of-the-art IT interoperability mechanism to enable Virtual Organisations (VOs) to operate in the most effective way.

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1.1 Scope and purpose of “Plug and do Business”

In March 2000, in Lisbon, the European Union set the ambitious target of becoming the world’s most dynamic knowledge-based economy within ten years and recognised that the achievement of this goal depended on making the best possible use of ICT. At the core of this ambition lies the needs for radically changing the operations of enterprises and the life of workers to take full advantages of the incoming network era, a world of fast changing opportunities where to be flexible is a must.

Today, the inter-enterprise collaboration is still hugely complex, expensive and time-consuming. For businesses to be able to work together as virtual or extended enterprises they have to introduce a new generation of software applications that allow for seamless reconfiguration and are able to support business processes across the companies borders. It is within this context that the European Commission has launched a working group on “Interoperability of Enterprise Software”ⁱⁱⁱ with the view of promoting new generations of enterprise applications, enabling European industry to take a leading role in this field; building industrial consensus to launch a large scale action capable of creating impact. This group is investigating new ideas on interoperability needs and requirements that provide the seamless operation of business applications both within and across enterprise. In its work the working group has identified three major themes:

- Architecture and framework for interoperability.
- Enterprise modelling – modelling the inter-networked organisation to establish interoperability needs and requirements.
- Ontologies development addressing the semantics necessary to assure interoperability.

The focus of the Framework Program 6 (FP6) will be on large mission-oriented projects, named Integrated Projects that can show clear benefit to the Member States and gain their support. The working group’s outputs are likely to provide the basis for Integrated Projects on interoperability in business applications supporting the vision of “plug-and-do-business” under the FP6. The following part of the paper expands on the main conclusion and results identified by the working group during four meetings held between October 2000 and November 2001.

2. CURRENT STATE OF PRACTICES

2.1 Architecture and Framework for Interoperability

2.1.1 The Virtual organisation

According to ^v the Virtual Organisation (VO) can be defined as an interoperable network of pre-existing enterprises that collaborate by means of specific IT components, towards the achievement of a common goal.

As described in ^{vi} the VO faces a new way of working that encompasses intra and inter-domain collaboration, business process and knowledge sharing and information integration.

The VO paradigm is nowadays an active research area, however there is a lack of common focus both of specific bottom up tools and of top down standardised reference framework so it is doubtful that the resulting software will be really able to

interoperate.

2.1.2 Interoperability Architecture

With reference to^{vii} the interoperability architecture deals with the development of approaches that would provide effective interoperability between software applications. The reference framework, or architecture, should comply with the particular feature of the VO's that act to:

- preserve its rights to local choices and solutions (e.g. local models and mechanisms),
- protect its proprietary information, especially that part of its information that it will not share,
- provide special access rights to parts of its information only to those other enterprises that either it can trust or to whom it is obliged to provide information by contract.

2.2 Enterprise Modelling

As defined in^{vi}, Enterprise Modelling (EM) is “the representation of a part of or the set of enterprise activities at a global and a detailed level, using activities, processes, in order to understand its running”.

Much work has been proposed at ISO and CEN level on generic Enterprise Reference Architecture and generic construct for EM, according to^{ix}; however, the second ICEIMT^{viii} has recognised the limited use and poor awareness of EM in industry (especially SME's) and emphasised the role of human and organisation aspects in enterprise organisation as opposed to technical aspects that have been overemphasised in the past.

If we look at the market, today, we find several types of product; focusing on business process representation of one business unit. They have not yet been applied to VO's and to functional interaction between organisations, as well as to socio and organisational aspects. It is believed that the technology is available, nevertheless, what is needed is focus on the VO's needs.

Another problem for existing business process modellers is the difficulty, or even impossibility of exchanging enterprise models between different software modellers, so, the question of interoperability in such a domain, is how to translate one model based on one proprietary modelling technique into the equivalent model represented with another (proprietary) modelling technique. To solve the problem, UMEL (Unified enterprise Modelling Language) is a new approach in its very early stage.

2.3 Ontologies

As defined by^{viii}, an ontology is a conceptual information model that describes things that exists in a domain and its main purpose is:

- (i) to support human understanding and organizational communication;
- (ii) be machine-processable and thus facilitate content-based access, communication and integration across different information systems.

A decade of international research has led to the creation of ontology languages, editors, reasoning techniques, libraries and development guidelines. Various languages for ontology specification and implementation are available. These languages have built-in reasoning techniques, and also allow developing special-

purpose reasoning services. Another promising approach is PSL, a process specification language that would facilitate communication among the various manufacturing applications. As it stands now, PSL is an ontology which defines the meaning of all the process related term. It will later incorporate a syntax and a grammar to make it a language. With reference to ^{ix}, one area of great impact is the semantic web. Nowadays, the Web has developed most rapidly as a medium of information/document for people rather than of information that can be manipulated automatically. By augmenting Web pages with data targeted at computers and by adding documents solely for computers, the web will be transformed into a Semantic Web. The DAML+OIL language ^x, developed by W3C and the EU OIL community, provides a rich set of constructs with which to create ontologies and to mark-up information so that it is machine readable and understandable.

2.4 Related European Funded projects

A large number of EU funded projects address architecture, modelling and emerging Knowledge technologies in the context of the Virtual Organisation and business collaboration. Projects related to architecture and modelling are: EXTERNAL ¹⁴ which aims at developing a methodology and infrastructure supporting the concept of extended enterprise, PATTERNS^{xi} which aims at creating an internet-worked architecture of knowledge centres that will support their transformation in knowledge driven and learning organisations, GLOBEMEN¹³ which aims at creating IT infrastructures to support globally distributed and dynamically networked operations in one-of-a-kind industries in manufacturing sector, BUSINESS ARCHITECT^{xii}, which make extensive use of modelling and knowledge sharing to support VE process integration, E-COLLEG^{xiii} which aims at investigating an advanced collaborative infrastructure to establish a backbone for pan-European collaborative research and engineering, CO-OPERATE^{xiv} which focuses on co-ordination of manufacturing planning and control activities in the supply chain management, WHALES^{xv} which provides a planning and management infrastructure for complex distributed organisations working as networks on large scale engineering projects. Nevertheless some projects seems to develop and implement their own solution to fulfil their specific needs. A reference architecture covering all the different aspects and levels from organisational, business processes to ICT platform, seems to be missing so far. Ontologies are a pillar of these technologies and related projects are ONTO-LOGGIN^{xvi} which aims at developing a set of tools for modelling and managing distributed knowledge management systems, ONTOWEB^{xvii} which is a thematic network on Ontologies based information exchange for knowledge management and e-Commerce and CoMMA²¹ which aims at implementing a corporate memory management framework based on Agent technology and OnToKnowledge^{xviii} which was the first European project on ontologies and semantic webs.

3. STRATEGIC DIRECTION AND POSSIBLE RESEARCH AREAS

3.1 Architectures

With reference to ^{xix}, a largely uncovered area in interoperability architectures is the

discussion of their applicability to different industry domains. The group identified a strong need to thoroughly present the implications of any architecture on the way organizations conduct business. Therefore, any research that is concerned with interoperability architectures needs to consider organizational and relational aspects. The relationships between the partners need to be analysed at a strategic, business and technical level. The results of such analyses influence the selection of the appropriate architecture from a set of available solutions for the particular case. From the group's perspective ³⁰, research should develop a number of different interoperability architectures and eventually arrive at a generic architecture that supports universal interaction of business processes and data whilst being possibly enterprise model-independent. This research should take into account technical requirements, but also business (e.g. domain-specific) and organizational and social-economic requirements. Technologies supporting e-business are evolving extremely fast today, therefore any work aiming at long term perspective, should ideally be implementation technology independent. The architecture components that the group has identified as the most relevant are the following: Coordination/Workflow Management System, Electronic Contracts, Electronic Services, Workflow Models/Enterprise Models, Infrastructure Technologies, Security, Legacy Systems.

3.2 VO Enterprise Modelling

The group has analysed three major research themes to support EM:

- i) the essential characteristics required from VO enterprise modelling;
- ii) the need to relate models developed in different languages and the means to inter-operate models;
- iii) the need to integrate enterprise modelling with architecture and ontology.

In terms of necessary developments, the group has indicated the following directions: An enterprise model should be a blueprint for the virtual organisation and should be supported by technology that provides flexible engineering of “smart” organisations; EM should be outward oriented and able to distinguish public and private interfaces of the enterprise, and to manage a continuously re-configuring VO.

Defining a common language that unified existing languages was seen as impractical, however the practical strategy was to define a set of common concepts that would enable transformations to be carried out between models in different languages, thus enabling communication between different models.

With reference to ⁹, another important research area is the Enterprise components or Patterns: previous work has defined the concept of Partial Enterprise Models that can be stored and later instantiated and assembled to form the Particular Model of an enterprise. This concept needs to be revisited in the light of component-based frameworks as proposed in computer science. The idea is to build generic models or patterns (by industry sectors or for some parts of the enterprise) that would represent modules of knowledge about components and characteristics of the enterprise (e.g. bills-of-materials, suppliers, customer order processing, sales strategies, ...) to be adapted and reused when building a particular model. An ontology should provide common concepts across these models, allowing semantic integration.

3.3 Ontologies

The expert group has indicated that there are many key areas to be addressed by future research such as:

- a standardized web-enabled ontology language
- well-documented industry experiences and case studies that enable learning from successful ontology development and application,
- research into a scientific but practical structured roll-out methodology,
- advances in commercial tool support (lightweight, heavyweight, development vs. use, interoperable with e.g. UML tools),
- availability of tested and documented, public and commercial, reusable ontology libraries (of varying semantic depths and different levels of generality and domain-specificity).

Although Europe has a strong position in this area, the US are also heavily investing here: a relevant point of discussion is how to shape and maintain a strong European dimension. Possible specific elements are multilingual and multicultural aspects (leading to an inherent information heterogeneity and clearly vital for the Union) and innovative applications and services tied to economic and social activities in Europe or European regions.

4. OTHER RELATED AREAS

4.1 Standardisation activities with CEN/ISSS

With the very rapid development technologies occurring in e-Business, standardisation is an important area. Application developments based on these technologies, require standards to allow for widely usable solutions and corresponding large markets. European Standardisation in e-Business is CEN/ISSS but many other “consortia standards” such as OMG, RosettaNet, eXML have also their role to play.

The CEN/ISSS Electronic Commerce (EC) Workshop ^{xx} is one of the longest established committees within the Information Society Standardisation System, the relevant department of the European standardisation body CEN. It was created in 1998 by the former Electronic Commerce Technical Steering Group of CEN/EBES (the European entry point for UN/CEFACT). A number of the EC Workshop’s projects relate directly to the three main themes identified by the working group. Related to architecture, these projects are Architectures and Models for Electronic Commerce (ARCHITECTURES) Project and Open Source Supply Chains Project. This project provides an analysis of major publicly available architectures and will provide recommendations for interoperable systems. In the enterprise modelling area, Ecommerce Integration Meta-Framework (ECIMF) project provides a common approach to inter-operate systems using incompatible standards and on Ontologies, the Multilingual Upper Level Electronic Commerce Ontology (MULECO) project will provide upper-level ontology for describing relationship between e-commerce applications.

4.2 Example of Industry consortia standards “OMG”

The Object Management Group (OMG)^{xxi} is an open membership, not-for-profit consortium that produces and maintains software industry specifications for interoperable enterprise applications. The membership includes a very extensive representation of large and small company both in the software industry and end user companies of different industrial sectors. OMG develops public domain specifications and made its success on CORBA and UML which have greatly contributed to solve integration and interoperability problems.

Middleware entered the IT lexicon ten years ago and was the standard to integrate a confusing mixture of platform inside the firewall and reach intra-enterprise application integration. Nowadays, in the new e-business scenario, middlewares have proliferated outside the firewall such as the Web services, WAP and others and the integration problem has now turned into integrating a confusing mixture of middlewares across the firewalls. To tackle such new challenge, to protect investments and maximise flexibility OMG has designed a Model-Driven Architecture (MDA)^{xxii} that addresses the complete cycle of designing, deploying, integrating, and managing applications as well as data using open standards. The MDA separates the fundamental logic behind a specification from the specifics of the particular middleware that implements it. According to OMG declaration MDA works at different level than Microsoft's .NET and Sun's ONE; these are individual platform aimed to broad application targets, while MDA works above the level of every middleware platform. Eventually, OMG expects MDA will be able to work above all the emerging platforms such as .NET, ONE, Java/EJB, SOAP or XP. The first generation of MDA tools are expected soon and some pilot installations are already implemented at some the aerospace and automotive industries.

5. INDUSTRIAL PERSPECTIVE

5.1 The Automotive Industry

The car industries are moving fast ahead and looking for common industry sector based solutions. The experience of the automotive, companies^{xxiii} was that the Public Internet was not meeting the requirements of the advanced B2B communications for security, performance and reliability. Extranets had problems through failing to solve the complexity of the many to many-to-many relationships of the industry sector. In fact, Extranets, connecting the OEM company to a multi-tiered supply chain did not solve the confusing situation of multiple processes and systems, and was even seen as obstacle to flexibility especially in the lower level tiers. The final choice was to move away from the complexity of the many-to-many relationship model to a “hub and spoke” design. ENX^{xxiv}, the newly launched global network for the European automotive industries, is the solution for easy and worldwide connection between all the industry players. The network, strongly based on Internet IP- Technology, will offer a platform for communication services, portal and market place services, integration services for mission critical applications such those of procurement, product development, supply chain

management and others. COVISINT^{xxv}, is the equivalent network launched by the American car industries and both promise to deliver opportunity for improvement through better communication, integration and basic interoperability. Today, another important issue is the architecture adaptation to assure quick reaction and innovation. The key solution is sharing methods, applications and data exchanges with the partners through “assets reuse”: a common software platform specifying the catalogue and the framework of technical solutions ready for external access to enable efficient integration between internal and external systems. The final vision is a “super platform”, also referred to as a “virtual mainframe”, that will support the seamless integration of an OEM’s internal applications to the external applications of dealers, logistic operators, suppliers and others through the various ENX like networks.

5.2 The Aerospace Industry

The recently restructured European aerospace industry is the paradigm for European industrial partnership involving both very large corporations and SMEs. The European partnership is deeply involved with interoperability issues between its industrial partners cooperating in AIRBUS, for example, and between the extended and virtual enterprises of the supply chain. The focus is on the product development context where interoperability involves engineering data exchange and sharing, workflow connection and portals.

Today the system support of the development environment is highly fragmented as different PDM systems are deployed, different methods, rules and processes are in place. Engineering data exchange make use of STEP AP214^{xxvi} and PDM enablers, however they are based on proprietary solutions. Where possible, common development processes and interfaces are defined, however the connection and monitoring of workflows is hampered by the usage of different tools provided by the PDM or ERP vendors.

The publication of technical information on engineering portals suffer from the heterogeneous organisation or software sources.. The interoperability problem is also a business integration problem that requires mapping between organisations at semantic level, definition of common way to work, common processes and, as a consequence, the development of new tools for higher level coordinating and monitoring needs to be developed. In parallel to the business integration effort, but with tight consistency to it, the technical integration can be pursued and should be done making use of the many existing standards and results that must be re-used.

The aerospace industry was deeply involved in advanced research projects such CIMOSA, AIT, AIT-IP, RISESTEP, MOKA, SAVE^{xxvii}, ENHANCE and it is in a position to provide expertise and re-use of results and standards. The industry can contribute to address interoperability at business level providing real cases for requirements and validation and is a major player in the exploitation of future interoperability work.

6. CONCLUSION

Looking towards the sixth European Framework Programme of Research, one of the key challenges for Europe is to build on its early success to support and promote

European industry. Europe is highly successful in areas such as mobile telecommunication, smart cards, enterprise systems and the creation of an environment and framework which enables innovative ideas to take shape. Partnerships are becoming increasingly important and must be supported by innovative ICT. The advent of the second generations of enterprise systems, relies heavily on the possibility of reaching an industry wide consensus on an interoperability framework. This paper has shown that several initiatives have been launched on trying to solve the interoperability issues. It is time now to initiate a strong collaboration between these initiatives, as well as other activities investigating future innovative type of business co-operations. Industry and researchers from a mix of disciplines, like technical, should be involved in this future work. Finally the business aspects of interoperability should be looked at in more concrete terms, in particular the making the business application inter-operable required changes of the organisation and the mind set of people which is recognised as a slow and difficult process.

It is clear that the purpose of an EC supported initiative is not to generate just another initiative on interoperability but this initiative should rather capitalise, liase and possibly co-ordinate the different existing initiatives. In 2002, Key Action II, will be soliciting proposals from this audience for exploring ideas for possible Integrated Projects in this area of Interoperability of Enterprise Software.

iii

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xiii E-COLLEG: <http://www.ecolleg.org>

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