Towards Interoperability of Enterprise Heterogeneous Enterprise Networks and their Applications - Requirements Handling and Validation activities

Maria Anastasiou¹, Maria José Nuñez ², Óscar García³

¹ INTRACOM S.A., Markopoulo Ave, 190 02 Peania Attika, Greece mana@intracom.gr
² AIDIMA, C/Benjamín Franklin, 13 Parque Tecnológico. Paterna. Valencia. Spain mjnunez@aidima.es
³ AIDIMA, C/Benjamín Franklin, 13 Parque Tecnológico. Paterna. Valencia. Spain osgarcia@aidima.es

Abstract. This paper presents the current results of ATHENA-IP programme. More specifically, the paper focuses on the programme’s activities related to interoperability requirements handling and validation activities. The first part of the paper describes the ATHENA Dynamic Requirements Process that was defined to deal with requirements management within the different sub-projects, presents the Industrial sectors represented in ATHENA and their areas of interest as these are reflected in the industrial scenarios they are focusing on. The second part of the paper summarizes the current piloting activities and presents the validations methodologies that have been defined to support the pilots.

1 Introduction

ATHENA (Advanced Technologies for Interoperability of Heterogeneous Enterprise Networks and their Applications) integrated project (IP) aims to be a comprehensive and systematic European research initiative in IT to remove barriers to interoperability, to transfer and apply the research result in industrial sectors, and to foster a new networked business culture.

This paper presents the current results of ATHENA-IP programme related to industry short-term needs and requirements regarding interoperability of enterprise software
and application. In particular, the way industrial interoperability requirements are handled within the programme is presented and the scenarios used for extracting specific interoperability requirements are briefly described. The requirements handling in ATHENA is carried out within the context of B4 sub-project named Dynamic Requirements Definition.

The scenarios and the specific requirements form the basis for developing test cases and validation scenarios through which the evaluation and testing of the solutions provided by the R&D technology providers will be performed. Validation activities are performed under ATHENA B5 sub-project named Piloting including Technology Testing Coordination and Pilot Infrastructure. The methodology and the first test cases to be used for the validation are also presented in section 3.

2 Interoperability Requirements Handling

Interoperability of enterprise applications and software in a networked organization is a complex topic for which gathering, elicitation, analysis and management of requirements are difficult activities. As it is illustrated in Figure 1, we have to deal with a complex system of independent subsystems, with different lifecycles, and with numerous stakeholders with conflicting interests. Classical requirements engineering approaches used in IT projects are not adopted to deal with these issues.

Fig. 1. Stakeholders, software and applications in an interoperability scenario

Another important factor that we had to take into consideration was that the requirements handling approach of ATHENA will be used actually by a programme of projects and that a community, the Enterprise Interoperability Center (EIC), will finally adopt it.
Therefore, we took into account classical requirement engineering methods, and moved one step forward to address the purposes of the programme.

Towards this direction, our approach was to define a method and an associated process for enhanced requirement engineering in order to provide a coherent and common way for the different projects to perform their activities concurrently and to integrate as soon as possible evolution in terms of solutions or needs coming from the market. This is the reason why we are talking about dynamic requirements definition process.

2.1 ATHENA Dynamic Requirements process

This section presents the requirements process that was formed and adapted by ATHENA. The process is called the ATHENA Dynamic Requirements process. Figure 2 provides an overview of the process.

![ATHENA Dynamic Requirements process diagram]

We determine two origins for the requirements. The first one is the set of scenarios proposed by the industrial users in the ATHENA Programme. From these scenarios, an initial set of requirements is determined: we call these requirements Specific Requirements.

On the other hand, a lot of requirements had already been proposed by the literature, other projects, in particular the Unified Enterprise Modelling Language (UEML) Project (IST – 2001 - 34229) and IDEAS Thematic Network (IST-2001-37368). We call these requirements Generic Requirements.

In both cases, the objective of the first activities (P1 and P2) is to determine which requirements belong to the ATHENA Programme domain. So from P1 and P2 we get the Specific and Generic Requirements for ATHENA. The third activity (P3) is to analyse and select this set of ATHENA Requirements in order to:

? Determine the requirements according to interoperability issues,
Collect the needed information about requirements including a classification according to industrial needs (inside and outside ATHENA), priority in terms of market, etc.

Provide consistent requirements definition.

The rest of the phases are outside the scope of B4 subproject, but they are very important in order to have the complete process. A brief description of is following provided.

In Phase 4, the list of Potential Generic solutions is determined, based on the selected Athena Requirements.

Phase 5 is related to the development of the adapted Generic Solutions, which follows after an agreement inside the project.

During Phase P6, generic Information Technologies (IT) Products will be proposed by the Information Technologies (IT) suppliers.

Finally, in Phase P7, Specific Information Technologies (IT) products will be proposed to the ATHENA Industrial Users, in order to answer to the initial requirements deduced from their scenarios. Some specifics validation scenarios, in accordance of realised Test plans, will be the outputs of P7.

If we consider ATHENA Dynamic Requirements process in the light of the classical requirements engineering approach, then we could illustrate how ATHENA Dynamic Requirements Process addresses the same issues that are addressed in classical requirements engineering. The classical requirements engineering process consists of the following sub-processes:

- Requirements determination and gathering.
- Requirements elicitation, analysis and modeling.
- Requirements negotiation.
- Requirements validation.

Requirements Determination and Gathering
Requirements are gathered from research activities and the industry. These requirements are considered in the context of the ATHENA project. Research activities provide a set of generic requirements while industrial users provide a set of specific requirements. These requirements can be modeled for the purpose of managing them and viewing information related to them in a structured manner.

Requirements Elicitation, Analysis and Modeling
The requirements elicitation sub-process provides an initial set of requirements for ATHENA, which can then be generalized and analyzed according to the objectives of the project and interoperability issues. The requirements can then be categorized according a specific classification and modeled for the purpose of managing the requirements and the information related to them.

---

1 In the context of ATHENA Dynamic Requirements Process, a product is considered as a concrete implementation of a given solution, in particular the tools that can be produced by solution providers.
Requirements Negotiation

Requirements negotiation takes place between the developers and stakeholders and among the stakeholders to select a set of requirements that is mutually acceptable for all parties. For example, to agree upon the requirements that will be fulfilled by a particular solution.

The requirements negotiation may occur at different places, within different subprocesses of the Dynamic Requirements Definition Process, e.g. P5 and P7. This is because in P5, the negotiation will be about developing a generic solution addressing given ATHENA requirements, and about giving priorities related to this development. In P7, the negotiation will be about developing a pilot or not, that will take into account some other constraints. The negotiating parties and stakeholders in P5 differ from the ones in P7.

Requirements validation

Requirements validation is conducted to examine the set of requirements to find out potential problems with these requirements.

2.2 Scenarios in ATHENA

As it has already been mentioned, specific interoperability requirements are extracted through the analysis of real life scenarios. The initial set of scenarios in ATHENA has been formed based on the needs and interests of the industrial users in the programme. The four industrial sectors and their representatives currently inside the programme are presented in table 1.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aeronautic and Aerospace</td>
<td>EADS CCR</td>
</tr>
<tr>
<td></td>
<td>European Aeronautic Defence and Space Company (EADS) is Europe's premier aerospace and defense company and No. 3 worldwide. EADS comprises the activities of the founding partners Aerospatiale Matra S.A. (France), Construcciones Aeronáuticas S.A. (Spain) and DaimlerChrysler Aerospace AG (Germany). EADS CCR is the French part of EADS Corporate Research Centers. EADS CCR has a permanent staff of 250 people, 60% of which are senior scientists.</td>
</tr>
<tr>
<td>Automotive</td>
<td>Fiat CR</td>
</tr>
<tr>
<td></td>
<td>Fiat Research Centre (CRF) is an industrial organization having the mission to promote, develop and transfer innovation providing competitiveness to its partners: Fiat Sectors, external SMEs, national research agencies and the European Commission. CRF fulfils its task by focusing on: development of innovative products, implementation of innovative processes</td>
</tr>
</tbody>
</table>
(manufacturing and organization), development of new methodologies, and training of human resources.

**Furniture**

**AIDIMA**

AIDIMA is a research and development association for the wood and furniture industries. It is a private, not-for-profit Spanish industrial association made up of more than 650 furniture manufacturers, many of which are small and medium size enterprises (SMEs). Founded in 1984, it has more than 70 employees and several offices across Spain.

**Telecommunication**

**INTRACOM S.A.**

RACOM was established in 1977. Nowadays, it constitutes the largest Greek new technologies company with domestic and international activity. It engineers products, provides services and undertakes complex and integrated large-scale technology projects across the four basic economy sectors of: Telecommunications, Government, Banking and Finance, Defense systems.

The industrial scenarios initially defined cover the following four areas.

**Product Data Management in a Virtual Networked Enterprise**

The concrete case concerns sharing and exchange of technical information in the aeronautic sector for the change management process and for different types of supply chain relationship. Important factors that are specific to the Aeronautic and Defense sector:

- The long lifecycle of an aircraft (around 50 years long). This means that information about it should be useable during the whole lifecycle, which is longer than the lifecycle of an application, software product or even an organisation.
- The complexity of the product, due to high level of reliability required, and the number of disciplines involved.
- Change management is very important; a product is defined as a set of ordered modifications.

This scenario highlights a family of cases mainly to deal with the first factor.

**Collaborative Product Development**

This scenario focuses on the Automotive sector and on the Product Development Process portion that prescribes the suppliers involvement on the objectives definition and on the product planning: Collaborative Product Development (CPD). CPD can be depicted as a three phases process that starts with the **Target Setting** and the nearly contemporary suppliers choice process or **Sourcing**. A third phase, once defined the suppliers’ panel, consists in the real **Product Design**. Along the whole PDP process, the interaction between OEM and suppliers consists in a heavy exchange of information, sometimes conveyed through the net, and sometimes directly transferred face to face during meetings. Also if in most cases data are managed by suitable Enterprise
Information System, human action is needed in order to carry out these data from a system to another.

**e-Procurement**

The objective of the e-Procurement scenario is to facilitate e-Business services interoperability and implementation of integration mechanisms by analysing the current e-Business implementation level in furniture sector and promoting multi-sector international agreements.

Product suppliers sell goods over the Internet through sell-side e-Commerce applications. Buying companies purchase goods over the Internet through buy-side e-Procurement applications. The scenario focuses on an eProcurement application, through which members of a buying company purchase goods from multiple suppliers.

**Product Portfolio Management**

The focus of this scenario is on the management of the portfolio of new product development projects (NPD Projects), including also projects related to the development of new versions of already released products. The Product Portfolio Management is of significant importance especially to large enterprise with many business units and complex products.

The efficient performance of the product portfolio process requires federated information coming from marketing, project execution, as well as from the product life cycle management. It is also a knowledge intensive process, as it presupposes a very good and holistic view of the enterprise: strategy and objectives, skills and competences, as well as experience coming from previous projects. It requires therefore, many different aspects of interoperability to be covered: Business aspects, Knowledge Aspect and ICT aspects. The Product Portfolio Management scenario studied in ATHENA focuses on intra-enterprise level.

Although the above mentioned scenarios are identified and developed by the industrial users, their analysis, extraction of requirements and identification of interoperability solutions is performed through the collaborative work of multi skilled teams including industrial users, methodologists and solution providers. This collaborative work aims to close the gap between research and industry by facilitating users’ deeper understanding of research trends, as well as researchers’ deeper understanding of industrial needs. It will lead to the development of “realistic” ATHENA global to-be scenarios from which interoperability requirements will be derived and that will form the basis for the evaluation and piloting activities.

**3 Pilot Activities and Validation Methodology**

The validation tasks inside the ATHENA-IP Programme are carried out under the B5 sub-project named *Piloting including Technology Testing Coordination and Pilot*
3.1 ATHENA Pilot Cases

The pilots will cover the Aerospace, Automotive, Telecom and Furniture Industries. The piloting activities include the identification and implementation of test cases, test scenarios and test procedures in a real context of industrial users. The test cases and test scenarios are defined taking into consideration the to-be scenarios developed during phase P1 of the ATHENA Dynamic Requirements process. Currently, the following use cases have been defined.

Product Data Management in a Virtual Networked Enterprise

The case is based on establishment of collaboration between two organizations, that use different specific change and configuration management processes, and nevertheless need to have to interconnect their process, in a way that allow interoperability between the heterogeneous Product Data Management Applications and software products. The federation of the processes, applications and software is based on the usage of consensual business (CMII, Manufacturing STEP application protocols) and technical standards at the level of the considered network. Integration of Product models is based on usage of neutral information model related to several disciplines : AP233 for System Engineering, AP239-PLCS for customer support, AP214 for geometry, AP209 for calculation…

Collaborative Product Development Case

The essential test case is centered around the lifecycle of a Request for Quotation (RFQ) document and focuses on the management of process-critical events during the processing of the RFQ and allocated discussion and – if necessary – modification of the technical specification attached to the RFQ.

The core process regarding this case is the parallel process (respect to Target Setting, Sourcing and Design) of “Testing” (Virtual and physical Testing), involving FIAT (OEM) and Suppliers (1st and 2nd Tier). The problem can be represented in this way:

- Inside the CPD there are different applications that manage vehicle testing information in different ways
- The data are stored in different databases using different formats
- Application integration is accomplished through the definition/management of point to point translations that are computationally difficult and expensive

The test case is an integral part of collaborative product development and it is located in the early phase of the CPD, during which an OEM and its 1st and 2nd tier sup-
pliers collaborate in order to verify (and where necessary to amend) a request for quotation (RfQ).

In the automotive sector, major portions of RfQ related input specifications are driven/owned by the OEM. A major problem and obstacle to interoperability between an OEM and its 1st and 2nd tier suppliers are modifications made to the specifications after publishing them together with the RfQ.

There are different reasons for these modifications:

- Availability of new business-level information that change business parameters and may affect the technical specifications
- Inconsistencies and technical problems observed as the RfQ is discussed between the OEM and its suppliers may force changes in the specification
- In some cases, the availability of new technology may lead to changes being made
- Sometimes, business relationships change during the process, and the specification needs to be adopted to the capabilities of new suppliers

**e-Procurement Case.**

The Test Case for the e-Procurement Scenario is based on a major Spanish office furniture manufacturer. Currently they are looking at implementing new technologies to assist its interactions with both customers and suppliers. The scenario is divided in two parts. In each case, apart from the manufacturer there is another company implied: either a Supplier either a Retailer.

The Supplier side of the e-Proc scenario deals with the raw material procurement and the Client side deals with Quotations, Orders and Products delivery.

The points to be solved due to the case are the following:

- Repetitive manual process for regular bulk orders
- Confusion resulting from poor product descriptions
- Missing information
- Lag. Time from product order to delivery could be shorter
- Time spent rating supplier

**Product Portfolio Management Case.**

The PPM case investigates into the use of Model Generated Workplaces to support simultaneous project, resource and results management, performance measurement through work management views, and the provision of shared project and work monitoring views.

The overall objective is to support collaborative work by providing the actors in the enterprise with the tools, information and communication support they need to efficiently perform their work. This could be spitted down into the following expectations:

- Support faster initiation and assessment of collaboration
- Support integration of the various associated enterprise processes, information and roles / people through a single point of entry
- Provide the different actors with an integrated view of the project, products or development initiatives depending on their roles
Provide the actors with up to date information related to sales, products, project plans and progress status, available and consumed resources

Improve the communication between the different participants and the coordination work

Facilitate more justified decisions.

The above scenarios have in common the Business Process Interoperability that plays a crucial role in achieving business integration. In this sense, the interoperability will force the enterprises to slightly vary their Business Process to achieve a better performance of their processes that are directly “in touch” with the different stakeholders involved in their processes. Although these stakeholders usually are external to the enterprise that intends to improve its processes, some of them could be integrated in the discipline of the enterprise itself.

In this way, the e-Proc and the SCM scenarios include other business like Providers and Clients of the main Industrial Enterprises to cover the maximum issues. On the other hand, the CPD and the PPM scenarios work over the intradepartmental structure of the selected enterprise.

3.2 Validation Methodology

A set of different methodologies combining methods, procedures and evaluation criteria is proposed for evaluation preliminary, intermediate and final solutions. With these methodologies we intend to satisfy the basic characteristics of a method (clearness, completeness, coherence, impartiality, replicability) and to look at two complementary aspects: the Technical and Business aspects. Both aspects are relevant from an industrial perspective and will constitute the basis for a complete validation activity supported by two distinct methodologies.

3.2.1. Technical Validation
The methodology used for technical validation will draw from the ISO/IEC 9126 methodology “Information technology - Software Product Evaluation - Quality characteristics and guidelines for their use”.

The objective of this standard is to provide a framework for the evaluation of software quality. ISO/IEC 9126 does not provide requirements for software, but it defines a quality model that is applicable to every kind of software. It defines six product quality characteristics and provides a suggestion of quality sub-characteristics (Figure 3).
In ATHENA such sub-characteristics should be interpreted with respect to the identified reference architecture and Athena Interoperability Framework (multi-cultural, multi-lingual, multi-standard) and not just in the specific pilot, in particular, we’d like to take into account the assessment of solutions in terms of architecture, knowledge, business modeling, and ontology.

The criterion used to evaluate the solution is based on the use of qualitative metrics, in order to facilitate the validation. The characteristics will constitute the base on which the testing scenario for the technical validation will be executed and are related to five different levels: Business, Knowledge, Application, Data and Quality.

3.1.2 Business Validation
The business validation methodology will be based on a business perspective and its main goal is to attempt to prove that interoperability has been reached and to identify and evaluate the real benefits deriving from the introduction of a solution in the enterprise.

Whereas it is relatively easy to identify the costs and evaluate the investment on IT, this is not the case with the identification and evaluation of benefits achieved by an organization deriving from the introduction of a new solution able to cover and solve interoperability issues.

For this reason a Business methodology should be tailored to the specific situation in order to verify and assess the impact of an interoperability solution on the involved processes as described by industrial users and if necessary to extend the analysis to related processes.
The suggested methods to evaluate the interoperability from a business perspective and covering several aspects at different levels are:

1. Method 1: Solution oriented (identification of real applicability areas)

4 Future Work

Future work of ATHENA requirements handling and validation activities include the analysis of the already defined scenarios to extract specific requirements, as well as to identify commonalities and specific issues related to them. Actual validation will commence with simple interoperability test scenarios to test and evaluate preliminary solutions. Finally, as ATHENA enters its second year, additional scenarios will be identified and developed to enter a second iteration of the various activities. It is expected that the defined methodologies for requirement handling and validation will be adapted to reflect the experience gained through their practical application during this first iteration.

5 Acknowledgement

This paper is partly funded by the E.C. through the Athena IP. It does not represent the view of E.C., and authors are responsible for the paper’s content.

The authors thank and acknowledge the members of the Athena consortium: SAP (D), AIDIMA (E), COMPUTAS (NO), CR FIAT (I), DFKI (D), EADS (F), ESI (E), FORMULA (I), FHG IPK (D), GRAISOFT (F), IC FOCUS (UK), INTRACOM (EL), LEKS (I), SINTESF (N), TXT (I), UNIV. Bordeaux I (F), UNINOVA (POR), IBM (UK), SIMENS AG (D).

References

1. ATHENA Deliverable D.B4.1 Dynamic Requirements Definition Principles. (September 2004).
4. ATHENA Working Document WD.B5.2.1 Use Case for test piloting (January 2005)