ASPIRE FP7 215417

Collaborative Project

ASPIRE

Advanced Sensors and lightweight Programmable middleware for Innovative RFID Enterprise applications

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Content

Section 1 Executive Summary

The EU-funded under FP7 ICT project ASPIRE develops an innovative, programmable, royalty-free, lightweight and privacy friendly middleware that is beneficial to European SMEs experiencing cost-related difficulties to deploying use of RFID to their portfolio activities and where such RFID use can significantly improve the SMEs operation and turnover.

This Deliverable 1.9 identifies the related risks to this main project objective. In particular, the risks lie in the successful integration of various SMEs into the deployment of the middleware for their purposes, into providing sufficient for the purposes of each SME security and privacy levels, and ensuring sufficient testing of the middleware in a realistic environment. D1.9 describes the proposed contingency plans for handling the identified risks and the success of achieving the project objectives. Finally, D1.9 describes the planned testing and evaluation scenarios.

Section 2 Introduction

RFID is a key technology for Europe [1]. Since the initial emergence of the technology, there has been a noticeable shift away from RFID pilot projects of the early days, towards a broad deployment of RFID in order to increase the efficiency and innovation of processes. Even though Europe is a leading player in the world of RFID technology, several challenges need to be addressed in order for RFID to reach its full potential [1]. The funded under FP7 ICT project ASPIRE is one of the coordinated European efforts to further the advancement of this technology, in the areas of enabling technology development for RFID. In particular, the focus of ASPIRE is on design, development and adoption of an innovative, programmable, royalty-free, lightweight and privacy friendly RFID middleware.

The widespread adoption of RFID and related challenges is the main objective of ASPIRE and the targeted end users are the Small Medium Enterprises (SMEs). More than 98 percent of all European companies are SMEs [2]. Even though their structural characteristics are well known, neither academia nor politics have paid much attention to the experiences of SMEs in using the RFID technology. Consequently, SMEs that deal with an implementation have so far only few guidelines regarding specific opportunities and risks.

One of the project outcomes is to provide recommendations for the RFID stakeholders who wish to support the technology. European networked enterprises in general and SMEs, in particular, are still reluctant to adopt RFID, since they perceive RFID as unprofitable or too risky.

Applications of RFID, however, can be found in many private sectors, like automotive, retail, and logistics, as well as in the public sector. From a short-term perspective, the technology offers its users new means to increase productivity by having a better and timelier control of the flow of goods and by providing real time information about economic processes. In the long term, it can create new products and services such as self-steering packages that move autonomously through an intermodal transport chain [3].

It is a difficult and complex task to calculate the economic effects of RFID; therefore currently there are only a few estimations regarding the economic impacts of RFID from a user's perspective. The progress and effectiveness of RFID, however, should not only be measured simply by the number of tags or amount spent on RFID, but also by judging how far the technology penetrates into daily life, and if new application fields are established through innovation. An RFID market analysis study [4] concluded that consistent growth in the RFID market will lead to heightened competition as more global players try to enter the market; therefore, it is important that smaller players try to claim as much market share as possible.

Besides its positive economic effects, radio frequency identification may also bring along societal advantages. Examples are the detection of a broken cool-chain in the food sector, the improved identification of patients, medicines and surgical instruments in hospitals, which prevents mistreatments, and faster services at border control based on electronic identity cards and passports [5]-[6].

One of the reasons for limited penetration of the RFID technology among the SMEs is largely due to the fact that the adoption of RFID technology incurs a significant Total Cost of Ownership (TCO). The EU-funded under FP7 project ASPIRE will significantly lower SME entry costs for RFID technology, through developing and providing a lightweight, royalty-free, innovative, programmable, privacy friendly, middleware platform that will facilitate low-cost development and deployment of innovative RFID solutions. This platform will act as a main vehicle for realizing the proposed swift in the current RFID deployment paradigm. Portions (i.e. specific libraries) of the ASPIRE middleware will be hosted and run on low-cost RFID-enabled microelectronic systems, in order to further lower the TCO in mobility scenarios (i.e. mobile warehouses, trucks). Hence, the ASPIRE middleware platform will be combined with innovative European developments in the area of ubiquitous RFID-based sensing (e.g., physical quantities sensing (temperature, humidity, pressure, acceleration), mobile re, low-cost); towards enabling novel business cases that ensure improved business results.

The core of the RFID's solution intelligence is the ASPIRE middleware, which is freely offered to end users (e.g., SMEs). The ASPIRE RFID middleware can be integrated with low-cost hardware, as well as with legacy IT and networking infrastructures of the networked enterprise.

As RFID leads to a more networked world, sometimes dubbed the Internet of Things (IoT), there are potential risks that stem from the envisaged ubiquity of radio frequency tags. This comprises for instance, the endangered privacy of personal data, the loss of security for information in open systems, and environmental pollution by hazardous tag components in mass applications.

The ASPIRE concept and solution, if properly adopted and deployed will bring in many benefits to the end users and will also advance the state of the art in the area of RFID and IoT. However, the openness of the middleware component, the fast changing market and technological requirements among some other factors bring in a number of risks that when not properly addressed can impede the successful deployment of the ASPIRE solution. A number of secondary risks were also identified at the project start related to the technical course of the project.

In general the following main barriers can be identified for the successful adoption of RFID technology by SMEs:

- Integration: In order to experience the full benefits of the technology, RFID has to be integrated into the company's existing IT infrastructure, in-house business processes and, in the case of an intercorporate use, into the corresponding cross-company processes as well. These activities can prove too costly for companies, especially when there is a shortage of adequately skilled employees. Additionally, the lack of commonly accepted standards can inhibit firms from using RFID as well as strong opposition among suppliers and customers (both of them mainly in the case of cross-company applications).
- Costs / Benefits: In current assessments of RFID technology, the fact that benefits of an RFID solution should exceed costs is frequently neglected, concentrating solely on the cost side of an RFID project. If this is the case and the fact is ignored that costs of a specific RFID solution exceed benefits, RFID projects will probably fail or be aborted. More specifically, especially the SMEs can perceive the costs of testing the technology at their sites as too high [2]. Moreover, while there are approaches for the approximate measurement of the costs of an IT solution in place (e.g., TCO, a lack of methods for forecast/measurement of RFID-related benefits is seen, making an application of cost/benefit approaches such as net present value method problematic.

- Functionality: Regarding the technical functionality of RFID systems, insufficient quality in terms of low read rates or inadequate tag features is an important potential barrier. Furthermore, the management of large data amounts can impose too high a burden for existing information systems [7].
- Security / Privacy: Regarding security, unresolved questions like the prevention of unauthorised executions of tag commands (e.g., read, write or kill) or the abuse of sensitive information in the case of a cross-company exchange of RFID data have to be addressed. Besides, unresolved legal aspects have to be addressed (e.g. liability in case of unauthorised tag reading). One of the most fundamental hurdles for RFID adoption are privacy concerns which may occur on the side of customers or employees and reported in [8].

2.1 Attributes of the ASPIRE Middleware

ASPIRE addressed the above challenges already in the concept conceiving phase by proposing a middleware solution with the following attributes:

- Royalty-free: ASPIRE will offer a licensing scheme enabling free use of its RFID developments. Royalty-free middleware will essentially contribute to a wider adoption of RFID in SMEs.
- Lightweight: Part (i.e. specific libraries) of the ASPIRE middleware; will be able to run over low-cost specialized Microsystems, which possess RFID sensing, filtering and communication capabilities. These microelectronic systems are developed within the project. In this way ASPIRE will implement lightweight middleware libraries for mobility scenarios where computing resources tend to be constrained. Implementation of fully fledged filtering functionality will take place in the core middleware platform (running in an application server), to enable the middleware to be used in conjunction with the low-cost readers that provide limited or no filtering functionality at all. Contrary to state-of-the-art middleware platforms which subsume and rely on the functionality of a host of middleware and database services, the ASPIRE middleware will not be resource intensive. Thus, it will be possible to run it in low-end servers, such as those possessed by the majority of European SMEs.
- Programmable: The ASPIRE RFID middleware platform will provide solution developers and integrators with the opportunity of configuring simple solutions using solution templates and tools. The configuration process will involve minimal coding, or even no coding at all for simple solutions-applications. Programmability will also allow visual development (i.e. based on an appropriate development environment) for a class of simple applications. Overall, programmability will significantly lower costs and efforts associated with application development and integration.
- Intelligent: On top of RFID programmability, the ASPIRE RFID middleware platform will incorporate intelligence enabling context-analysis and reasoning over numerous sensors observations. Reasoning will enable the ASPIRE middleware to alleviate problems associated with the physical layer of the RFID network (e.g., incorrect readings). Furthermore, the ASPIRE middleware intelligence will also support automated adaptation to the capabilities of the underlying readers network. Having the intelligence within the middleware platform will push functionality at the edge of the reader network and will allow the use of low-cost hardware (e.g., interrogators, gateways, tags) for the RFID solutions.
- Standards-Compliant: The ASPIRE RFID middleware developments will comply with existing RFID standards, starting from EPC standards (i.e. mainly on filtering and eventing) for both intra-enterprise and inter-enterprise applications development.

Support for non-EPC tags will also be pursued since EPC costs might be important for some SMEs.

- Scalable: The ASPIRE platform will be capable of supporting numerous massively distributed tags, as most likely required in realistic applications for the networked enterprise.
- Privacy-Friendly: The ASPIRE middleware will cater for minimalist data generation, which incorporates the principles of data quality, limitation and conservation into the logic itself. The ASPIRE tag data will not be created in the first place, kept for longer than required, or distributed to non-incumbents. Privacy is closely related to the royalty-free licensing, since privacy friendly middleware should by definition be open to public scrutiny.
- Integrated: The ASPIRE platform will offer a complete integrated environment for specifications, development, integrations and experimentations of the RFID components and concepts through a concurrent innovation engineering framework.

The ASPIRE middleware platform will also implement and provide end-to-end management functionality for all the heterogeneous elements (e.g., readers, antennas, terminal devices) comprising an RFID infrastructure. End-to-end management of this infrastructure will minimize the effort required to configure, monitor and administer the contemporary distributed, heterogeneous, multi-vendor RFID infrastructures.

In addition to the above unique properties and characteristics, the ASPIRE middleware platform will provide full support for conventional RFID middleware functionality, notably by the following:

- Collection of data from the underlying network of RFID interrogators, readers, antennas and tags.
- Transportations and presentation of RFID data to higher level (applications) software.
- Filtering of RFID detection and optimization of the use of network bandwidth while RFID data are carried over networks.
- Filtering of sensor streams and according detection and delivery of higher-level application events to the applications.
- Management of each connected reader, as well as other aspects of the reader network.
- Implementation of routing i.e. choosing on which network level/layer an RFID data should be transported (local server, warehouse server, company main server, etc...).

ASPIRE has defined innovative RFID scenarios and showcases, beyond conventional warehouse management that will be used to evaluate and test the ASPIRE middleware. To this end, ASPIRE will leverage innovative microelectronic systems technologies to enhance the functionality of conventional RFID devices, by integrating to the latter (third-party) physical quantity sensors (e.g., temperature, humidity, pressure, acceleration), as well as position sensors. Support for mobility is key for the success of the ASPIRE middleware. In particular ASPIRE will provide support for distributed RFID Systems, in which multiple geographically distributed warehouses, as well as Mobile Warehouses (e.g., vehicles delivering shipments to consignees), need to be monitored simultaneously. Such distributed RFID systems require expensive telecommunication infrastructure (e.g., PDA's and/or mobile RFID readers), which can further increase the TCO to unacceptable levels, especially for SME owning a considerable amount of warehouses and/or trucks. ASPIRE will address this issue by providing lightweight middleware that is able to run on legacy hardware platforms, including innovative low-cost hardware platforms that support RFID device mobility. The innovative low-cost hardware to be developed and used in ASPIRE refers to combinations of legacy technologies and Microsystems, or reference designs (forming new RFID-enabled SoBs (System-on-Board), or SoCs (System-on-Chip)), which implement the required reading and communication capabilities for RFID networks in mobility related scenarios. Note that no development of any new integrated sensing device (e.g., RFID-enabled sensors IC) will take place in the project.

The hardware developed within ASPIRE will be used to demonstrate the lightweight nature of the ASPIRE middleware and the support of several innovative business cases for SME's. In summary the key features of the ASPIRE solution are as follows:

- Running ASPIRE on low-cost, legacy systems (standard sensors, general-purpose microcontrollers, and GSM modems);
- Employing legacy telecom infrastructures and low-cost services (GSM/SMS) for the system's networking needs;
- Providing sensing capabilities required to enable added-value RFID scenarios (Cold Chain Management, Food Traceability).

Hence, the ASPIRE middleware can be a key enabler for simple, low-cost deployments based on legacy Microsystems.

2.2 Testing and Demonstration Scenarios

RFID middleware is a cornerstone of non-trivial RFID deployments in complex heterogeneous environments. In such environments many distributed readers and antennas (e.g., in factories, warehouses, and distribution centres) capture RFID data, which must accordingly be conveyed to a variety of applications (e.g., enterprise resource planning (ERP) systems, warehouse management systems (WMS), corporate databases, process management systems). Deployment and integration complexity are directly associated with the flexibility and versatility of the RFID middleware towards configuring and managing multiple heterogeneous devices, filtering and disseminating RFID data, translating low-level RFID data to high-level business semantics, as well as towards integrating RFID systems with legacy ICT systems and applications [9]-[10].

The typical information flow within an RFID middleware system involves the following [10]:

- Collecting RFID data from the physical readers, through reading the tagged items. At this level middleware implementations insulate higher layers from knowing what reader /models have been chosen. Moreover, they achieve virtualization of tags, which allows RFID applications to support different tag formats.
- Filtering the RFID sensor streams according to application needs, and accordingly emitting application level events. At this level middleware implementations insulate the higher layers from the physical design choices on how tags are sensed and accumulated, and how the time boundaries of events are triggered.
- Mapping the filtered readings to business semantics as required by the target applications and business processes. At this level middleware implementations insulate enterprise applications from understanding the details of how individual steps in a business process are carried out.

Software that implements any combination of these information flows can be conceived as an RFID middleware.

The ASPIRE middleware architecture has been designed to cover not only large scale open loop fully fledged RFID applications in the scope of inter-enterprise scenarios but also to suit less complex closed loop applications, which can be implemented based on cut down versions of the proposed main architectures. These applications require subsets of the presented middleware blocks. The ASPIRE middleware architecture can be decomposed to the middleware building blocks dealing with readers and tags virtualization, filtering and collection blocks and the middleware blocks for addition of business context to RFID sensor streams. This process was explained in details in [10].

RFID applications can be classified into various categories and the various middleware building blocks would be relevant for each category. This classification is shown below in Table 1.

Application Type/Middleware Block	**HAL**	**EPC-RP, EPC-LLRP**	**F&C**	**Business Context**
Simple	YES	Recommended	Recommended	NO
Simple Closed Loop	Yes	Yes	Recommended	NO
Complex Closed Loop	YES	YES	YES	Recommended
Open Loop	YES	YES	YES	YES

Table 1 RFID application Classification and Middleware Building Blocks.

The full range of middleware layers and building blocks are necessary only in the scope of large scale open loop middleware implementations. Simpler applications can leverage cut down versions of these architectures, towards economizing on performance overhead as well as implementation complexity and cost. Specifically, trivial applications can be implemented via customized filtering mechanisms on top of HAL layers or event the EPC-LLRP and EPC-RP protocols. Also, a wide range of closed loop intra-enterprise scenarios could be implemented without a need for sophisticated information sharing layer. Overall, ASPIRE claims that lightweight low-overhead implementations are essential for the smooth transition to fully fledged RFID deployments.

From numerous case studies from different sectors [11]-[13], it can be argued from an economic perspective that most of the current RFID solutions show considerable similarities regarding underlying technology (protocols, frequencies, tag standards etc.) and supported business processes (tracking & tracing, production scheduling etc.). However, even though enterprises from different sectors face similar challenges when it comes to RFID, a fundamental difference regarding costs and benefits of the solution (and therefore, business opportunities and risks) is linked to the question of whether one or several enterprises participate in RFID-supported processes (in-house vs. cross-company use). With respect to in-house applications, higher degrees of freedom regarding the choice of the most suited standard can be expected as well as lower complexity of distribution of RFID data among partners and less complex allocation of costs and benefits. On the other hand, cross-company applications promise further benefits (e.g. reduction of out-of-stocks etc.) and raise the expandability of the system (by lowering the possibility of “betting on the wrong horse”). Another strong impact on costs and benefits of a solution can be expected from the decision between non-returnable and reusable transponders (e.g. non-returnable bottle vs. reusable transport items). While closed-loop applications are characterised by the repeated use of circulating tags which can therefore be interpreted as a part of the initial investment, open loop applications require a constant new acquisition of transponders, therefore increasing unit costs.

The ease of development and cost-effectiveness enabled by the ASPIRE platform will be manifested across the following different application domains:

- Cold Chain Management for food and dairy products;
- Asset Management for Pharmaceuticals;
- Product Packaging, Tracking and Traceability.

The developments of the ASPIRE project will be validated in the scope of realistic pilot trials involving European SME. Some of the trials will be organized by the ASPIRE consortium; liaison with pilots of existing projects where partners participate will be also pursued. Innovative RFID scenarios showcase and pilots will be built around the following axes:

- Fully automated reading and processing functionality. Applications will run without human intervention.
- Mobility scenarios involving several mobile warehouses in the scope of the supply chain.
- Measurement of added-value parameters such as temperature, humidity or pressure.

In implementing these scenarios the ASPIRE middleware will interface with legacy IT systems that are already available in SMEs and supporting their corporate services (such as ERP (Enterprise Resource Planning) and (SCM) Supply Chain Management) systems and corporate databases).While this interfacing take into account the integration capabilities of these systems, the ASPIRE middleware will provide connectors supporting main state-of-the-art integration technologies such as Web Services, Messaging Oriented Middleware (e.g., via Java Messaging Service (JMS)), as well as legacy data centric integration technologies (e.g., stored procedures and database triggers).

2.3 Key Indicators for the Project Success

The following are the key indicators identified to measure the success of the ASPIRE technical solutions:

1. **The minimization of the Total Cost of Ownership (TCO) associated with RFID solutions for a range of scenarios with particular emphasis on mobility scenarios, full RFID automation and main target SMEs**. Through this indicator, the TCO of the ASPIRE based solutions (using ASPIRE developments in programmability, sensing, mobility and management) can be compared to TCO based on conventional RFID middleware/deployment approaches.
2. ASPIRE develops an Open Source middleware solution. Therefore, another indicator is **the degree of the acceptance of the project by the Open Source community**. OSS forges (such as the OW2) give reports on the activity of the project. Reports include bug reports, suggestions, mailing list activities (number of posts per month, number of writers,

etc.). These metrics as well as the activity of an OSS project is often correlated to the project's success. ASPIRE keeps a track and reports these metrics.

3. **The evaluation of the ASPIRE solutions from the SMEs, in terms of flexibility and ease of use**. This evaluation will be performed directly by the SME communities that will engage with the ASPIRE developments.

4. **The acceptance of the ASPIRE results from the academic community**. This indicator is realised through the respective research output (e.g., publications, presentations etc.).

5. The final indicator is **the number of SMEs** that show an interest, run pilot, or even deploy the ASPIRE-based solutions.

Specific figures (sound estimations) associated with the above indicators are provided in the periodic management reports of the project. These figures are appropriately amended to address realistic targets in the scope of an adaptive (rather predictive) planning of the target indicators.

2.4 Identified Risks

The Technical Annex identified three groups of risks, namely the following:

1. Overall project risks;
2. Technical project risks jeopardizing the achievement of the specific project objectives
3. Technical risks related to the successful adoption of the final project results.

The initially identified risks were described in the Technical Annex together with the proposed mitigation strategies. For completeness of this document Section 3 lists the different risks and strategies as tables. Section 4 describes the adopted testing and evaluation scenarios.

Section 5 concludes the document.

Section 3 Risk Management and Contingency Plans

3.1 Overall Risks and Contingency Plans

In a project aiming at forward-looking research several potential risks have to be considered. These subdivide into general project and technical specific risks. The tables in this section present the types of risks that may occur in the different categories, the chances of occurrence and the envisioned contingency plans.

The level of the foreseen risks is leveraged to the dimensions and objectives of a size Integrated Project (IP). The composition of the consortium and the management structure that already described in the Technical Annex provides the required handle the reported risks.

Table 2 lists the General Project Risks related to overall project management. Table 3 lists few strategies that ensure the smooth project running and on time delivery of documents to the EC.

Type of Risk	Risk Description	Consequence	Contingency plan	Chance
Competing technical solutions	In the phase of technology and the developments of the basic system concept competing and incompatible technical solutions may be proposed and developed by different partners.	Consensus may not be achieved, leading to delays or deadlocks an eventually jeopardizing the focus of the project	In the case the different visions persist, the appropriate bodies have to take a final decision by majority, re-plan the work if serious delays have been incurred by this decision, including re-planning of the work of the partners in disagreement with the decision of the majority	**Low**. Due to the initial assessment phase of concepts and definition of scenarios and main requirements in an early stage, an implicit consensus building process between the partners is initiated which will reduce the risk of serious disagreements between partners. The involvement of all partners from the very beginning in the system concept definition will mitigate this risk.

Operational Risks	Specific task or work package delays or issues	Unforeseen delays or other negative impact in the overall project due to the dependencies between tasks	The project manager has the responsibility to monitor continuously the status of the project by means of reports and meetings. In the case of impacts on other parts of the project in terms of time delays, alternative solutions and a re-planning of the affected parts have to be initiated immediately.	**Low**. All responsible persons in the project have to identify in their area of responsibility, deviations from the project plan and communicate it to the relevant bodies in the project. The close cooperation of the responsible persons is required in order to ensure a good synchronization of the different activities of the project.
Consensus related risks	During the decision making process, disagreements may occur due to different visions or interests among the partners.	Consensus may not be achieved, leading to delays or deadlocks eventually compromising he project objectives	Consensus should be sought but eventually to avoid deadlocks majority decisions by the general assembly or the board can be taken. Disagreements on strategic issues where partner's interests are involved will be handled by the board or general assembly, which will define the required actions.	**Low**. The decision process in section 2 and the close cooperation between all the partners from the very beginning should reduce the risk for major disagreements. The involvement of the partners from the very beginning in the definition activities should reduce this risk.
Partner problems	The amount or quality of work provided by a partner does not comply with the expectations. A partner may not respect his commitments.	According to the specific contribution expected from the partner may have implications on other tasks, leading to delays and eventually putting at risk the achievement of specific milestones or objectives	The partner will be informed by the coordinator about the problem and its impact on the overall project and required to improve his performance. If the partners fails to respond positively measures will be taken by the consortium on the initiative of the coordinator. In the worst case the partner can be removed from the project.	**Low** Due to the wide expertise and complementarities of the partners and some degree of overlap expertise no major risks are foreseen concerning this point.

Changed market and requirements	The requirements and deployment scenarios may change during the lifetime of the project	The scenarios defined at the beginning of the project may not be the most realistic ones at the end, and the overall concept may be in misalignment with the economic and deployment trends	Key aspect in the design is Cost efficient, OSS, Scalability and Privacy-friendly and therefore if changes from the initial requirements are smooth no major risks in adaptation are foreseen. In the unlikely case of dramatic changes relatively to the initial vision, the technical steering committee should evaluate the implications on the technical work and perform a re-planning to be submitted to the commission	**Low**. The initial definition of scenarios will be based on realistic traffic and penetration models, and this process will be continuously updated to track the emergence of new issues or paradigms worldwide. This will be continuously fed back to the development and implementation work packages

Table 2: General Project Risks

Risk	Contingency Plans
• Delays in accomplishing tasks, deliverable and with the quality needed to reach the objective of the project; • Problems in communication between the consortium and outside it. • Missing of important data. • Misunderstanding on what data should be collected and the importance related to. • Web page not delivered on time. • Dissemination and communication activities are scarce, not sound and efficient. • No involvement into dissemination events is done.	• The coordination with the aim of the consortium will focus his effort firstly to prevent, and if it occurs, to solve the problem and repair the provoked damage (delay, the quality of the work, deliverable, etc). • The coordination will solve the communication problem assuring the web page construction on time. If it would not be enough it will be tracked, managed and controlled each communication mean (conference call, direct call, etc.) and the conclusion of them. • If necessary surveys to be fulfilled by the industrial sector will be created , • A check list of important and crucial data will be collected to reach the project objective and prevent misunderstanding, • Monthly updates of Website by Webmaster. • Creation of a working plan to prevent any delay and problem, • Informal testing of the dissemination activity by contacting the appropriate target of these actions to check how they have received and understood the information. • Any problem detected will be discussed and

	quickly solved. • A list of annual dissemination event will be done to control and assure the minimal target

Table 3: Project Management Risks and strategies

3.2 Technical Risks Related to the Achievement of the Specific Project Objectives and Contingency Plans

ASPIRE is a project of significant size with respect to funding, involved partners and duration and pledges a large amount of research and innovation work. Projects of such scale should take provisions in order to be able to tackle with potential technical problems. This is important given the diverse problem that may arise, due to technological and organizational issues, or even due to unexpected/unforeseen circumstances. The management plan of the ASPIRE project, takes precautions for confronting potential problems, at least in the most common areas where such problem arise. The risk management Table 4 summarizes the main RTD risks and associated contingency plans. The detailed technical risks per work package are discussed in Table 5.

Type of Risk	Risk Description	Contingency Plan	Chance
Problems with licensed Technologies	Some licensed technologies (based on the ASPIRE license and reuse model) do not function properly.	Thoroughly test each licensed component prior to using within the ASPIRE middleware. Identify multiple providers of particular solutions and/or components. For example there are several EPC-ALE implementations available (e.g., http://www.logicalloy.com/, http://www.accade.com, IBM's, Singularity).	**Low**: This has been looked into at a early stage of the project and has been agreed upon by all partners and legal advisors in deliverable D2.1 due in Month 6
Technology and Standards evolution	Technology evolution obsoletes ASPIRE developments, while new standards subsume the ASPIRE standardization efforts.	The ASPIRE management team will thoroughly monitor related developments with a view to being aligned. The Advisory Board will play a role in maintaining the project in-line with recent developments and evolution.	**LOW**: ASPIRE will be on the forefront of the standardization efforts in this field by using our advisors.
Hardware Implementation Problems or Malfunctions	There are instability problems with respect to the interfacing of low-cost readers in the trials, which might delay or hinder deployment and trials.	Higher cost solutions (e.g., PDAs + readers) will be used (as a temporary solution) to integrate the middleware and deploy it for the trial. The lower cost readers, microelectronic systems will come into the trial at a later stage. Note that the ASPIRE middleware is independent of the reader vendor; hence trials will be also setup and supported by other commercial readers.	**LOW/MEDIUM**: These are always technical risks associated with the development of advanced ICs. These risks will be mitigated with the development of a prototype breadboard, to gain applicative experience. These boards will be made available in Q3 '08, prior to the delivery of the final chip. As part of WP2 and WP5

			ASPIRE is devising a technical architecture that allows multiple interfaces (in terms of underlying bearer networks) of the low-cost reader (based on MELEXIS chip) to the ASPIRE middleware;
Poor engagement of SMEs in the trials	Some SME(s) does not show the required commitment to the ASPIRE trial.	For each trial the ASPIRE consortium would came with a list of 2-3 SMEs (as back-up) that could benefit from the ASPIRE developments in the context of similar scenarios and business cases. The ASPIRE team will be ready to engage another SMEs, in case a trial is jeopardize due to some SME's poor commitment.	**LOW**: The initial steps have been taken by partners UEAPME and PV to ensure the participation of the SMEs. The ASPIRE partners have already organized several RFID Information Days (e.g., in France, Greece, Denmark, Belgium) in which the consortium has got in touch with several SMEs. More RFID information days are scheduled for the coming months, which increases the number of candidate SMEs for the ASPIRE trials.
Integration Problems	Integration effort explodes as part of the trials.	Integration work will be performed from the early stages of the project. A plan for gradual incremental deployment of each trial will be included in D6.1	**LOW**: the integration will be done step by step as the solutions are progressing which will ensure the low chance of problem occurring.

Table 4: RTD risks and associated contingency plans

Risk #	WP	Description	Probability	Impact	Contingency Plans
1	3	Problems with third party LGPL licensed components (Fosstrak) of the AspireRfid project – May require to permanently cease distribution of Fosstrak modules (binary and source code) of EPC-ALE, EPCIS, TDT and Reader Core.	Medium	High	ASPIRE has licensed Fosstrak software modules under LGPL and has based its developments on these modules (i.e. there is reliance in these modules). Following the Fosstrak letter, ASPIRE is investigating the following options as contingency plans: • Plan #1: Contributing its existing modifications and bug fixes over Fosstrak, directly in the Fosstrak project. This is the solution suggested

					by Fosstrak founders and asked for in the ASPIRE response letter. • Plan #2: In the case that Fosstrak does not want to host the ASPIRE modifications and extensions, ASPIRE could invest effort in developing baseline ALE and IS modules from scratch. While this solution is not the optimal in terms of resources, it guarantees the project's long term independence. • Plan #3: Another solution could be to license other open source projects that have implemented the ALE/IS modules e.g., Singularity or Mobitec. • Plan #4: ASPIRE will create a Vendor Brunch of Fosstrak source code inside the AspireRFID SVN repository for the "questioned" modules and implement the enhancements/bug fixes over the now compatible with Fosstrak source code. Furthermore all the ASPIRE's enhancements/ bug fixes over the Fosstrak's source code will be provided to Fosstrak for integration of it to their modules. The acceptance or not of the enhancements will be based on Fosstrak's judgment.
2	3	Fosstrak project does not allow ASPIRE to contribute all the enhancements to their project Plan #1 or create a Vendor Brunch Plan #4	Low	High	This is unlikely but can have a serious impact on the project. Plan #2 and Plan #3 outlined above should then be implemented to ensure absolute independence from the Fosstrak project.

3	3,4	High Complexity of AIT/UJF Branches Integration	Medium	Low	The reviewers and the consortium have identified the need for merging the AIT and UJF development branches. While a plan has been devised and is implemented, it is possible that the complexity for integrating all the functionalities of the two branches is high. In such as case the project will choose to provide some quite independent functionalities (e.g., reader managements) as stand-alone modules. This contingency plan will ensure a graceful integration, without any essential loss in middleware functionality.
4	3	Difficulty in coming up with a proper implementation of a middleware anti-collision protocol in multi-vendor environment	Medium	Low	The project pursues this implementation from multiple perspectives: (a) At the MAC layer (partners AAU, INRIA and IT), (b) At the filtering and collection middleware layer (partner AIT). This diversifies any associated risks.
5	7	ASPIRE publications are delayed as a result of Fosstrak not providing a proper disclaimer for referencing their work – This is already the case with 3-4 manuscript that have been completed	Medium	Medium	Specification results are published, without any reference to implementation platforms and the AspireRfid open source project. This will ensure the publicity of the ASPIRE EC project, while however inhibiting the publicity of AspireRfid.
6	3,4	Low-number of users for the AspireRfid software	Medium	Medium	Currently AspireRfid has 41 users and 26 developers registered in the AspireRfid mailing lists. It is the project's objective to help significantly increase these numbers. In addition to the dissemination plans of the project, the project will increase the number of seminars and dissemination events to SME RFID integrators (as potential users of the AspireRfid project), while also carrying out more training seminars for OW2 users.

7	7	Poor engagement of SMEs in the ASPIRE results	Medium	Medium	Increased number of dissemination actions by UEAPME, as well as training courses on RFID and the ASPIRE results. The e-learning platform to be setup will facilitate the implementation of the above contingency plan.
8	6	Poor Engagement of one of the liaison end-users in the ASPIRE trials	Medium	Medium	The consortium has already contacted and organized one additional trial in Greece (as described in Deliverable D6.1), thus increasing the number of trials to three (3). This gives the consortium the opportunity to evaluate its developments more thoroughly and across more use cases.
9	4	In terms of the programmable specification language, ASPIRE might face difficulties bridging existing process concepts (e.g., as specified in XPDL) with RFID business process descriptions (e.g., in terms of EPCIS events)	Medium	Medium	As an alternative the project may implement a custom programmable specification (i.e. based on plain XML Schemas rather than XPDL constructs). This can alleviate the complexity, however with a loss in potential extensibility. The project is investigating associated trade-offs.

Table 5: ASPIRE Technical Risks

3.3 Other Risks and Contingency Plans

Additional problems for which the ASPIRE consortium has worked out potential fallback solutions and related back plans relate to:

- Background technologies contributed by consortium partners
- Negative impact of emerging technological developments to the proposed plan
- Partners leaving the consortium

Problems with background technologies: The ultimate deliverables of the project depend on components and technologies contributed/developed by project partners, as well as components licensed in the scope of ASPIRE's license and reuse strategy. There is a possibility that some of these technologies are not reliable/mature or even not performing as expected for the particular tasks at hand (e.g., a licensed EPC-ALE implementation). ASPIRE has prepared to tackle such problems based on the synergy of remedial actions featuring diverse nature, in particular:

- At the consortium composition level through a necessary level of overlapping expertise with regard to both middleware component technologies and modules. For example programmable RFID middleware technology will be provided by AIT, UJF and INRIA, whereas network adaptation middleware can be provided/developed by

AAU and MELEXIS. Thus, the project does not rely on a single development solution, which can prove important in the case of poorly performing components. As a result, the project will have a readily available solution to background technology problems, which allows dealing with the project without essentially jeopardizing the project's success. Note also that as part of the project's license and reuse model, alternative modules, technologies and solutions will be identified to deal with poorly performing technologies. As an example royalty-free EPC-ALE implementations are currently provided by both Accada and IBM Singularity.

- At the technical level through a general and modular RFID architecture that operates with the minimal possible dependencies on the various underlying technology components. This is also in line with a major objective the project, which is to boost architectures and infrastructures for the development and deployment of open vendor independent RFID solutions.

In the rare case where the above contingency plans fail to provide a smooth and immediate solution, missing pieces (due to malfunctioning or poorly performing technology) could be simulated to allow continuation of development for a short interval.

Negative Impact of technology evolution: Technologies relating to RFID middleware components are evolving in a rapid pace. Therefore, there is always a slight probability that new technology emerges that obsoletes certain background components of the project. ASPIRE commits to monitor such developments (through the technical management team), being also ready to adapt the initial plan with a view to incorporating new developments that could beneficial to the project's success. It is also noteworthy that the middleware architecture and evolution plan of the project do not depend on particular technology. Also, they do not rule out the incorporation of new components (e.g., readers, tags, middleware components).

Partners Leaving: Unforeseen circumstances have at several projects pushed partners to abandon even successful projects. This could result in missing expertise at levels that could compromise the project's results. As emphasized earlier in this paragraph, overlapping technology providers, as well as technology independence will make sure that the project's success is not the jeopardized for the duration of processes relating to attracting new competent partners.

Section 4 Testing and Evaluation Scenarios

The testing and evaluation scenarios are key mitigation strategy to avoid the risk of unsuccessful adoption of the ASPIRE solution. The evaluation results will provide guidance on the ASPIRE technology implementation to those SMEs who wish to use RFID in their business processes. At the same time, the scenarios have been defined in such a way that they promote the ease of use and the benefits of the use of RFID.
The proposed demonstrations have the following purpose:

A Testing Scenario that is using the whole AspireRFID architecture is described in the deliverable D4.3b Section 9 where a receiving process is described. Specifically, for the Programmable Engine (PE) the same scenario and the interaction with the rest of the architecture that is expected from the PE are described in the Deliverable 4.2a Section 8-9. Deliverable D6.1 describes the pilots that are also example testing scenarios. Section 3 of the same Deliverable 6.1 proposes the evaluation methods for the complete ASPIRE middleware.

The following subsections describe in short a testing scenario for the ease of use of the ASPIRE PE.

4.1 Encoding Scenario

This scenario is intended to test the programmable engine of the ASPIRE middleware, which is a key factor related to indicators 1 and 3 as described in Section 1.3 of this Deliverable.

A Company Named “ACME” which is a Personal Computer Assembler collaborates with a Microchip Manufacturer that provides it with the required CPUs. ACME at regular basis places orders to the Microchip Manufacturer for specific CPUs. ACME owns a Central building with three Warehouses. The first warehouse named Warehouse1 has 2 Sections named Section1 and Section2. Section1 has an entrance point where the delivered goods arrive.

ACME needs a way to automatically receive goods at Warehouse1 Section1 and inform its WMS for the new product availability and the correct completeness of each transaction.

4.1.1 Solution Requirements

An RFID Portal should be placed to ACME’s Warehouse1 Section1 entrance point which will be called ReadPoint1. The RFID portal will be equipped with one Reader WarehouseRfidReader1. The received goods should get equipped with pre-programmed RFID tags from their “Manufacturer”. The received goods should be accompanied with a pre-programmed RFID enabled delivery document. And finally the APDL XML file (see Deliverable D4.4a: Section 8.4), should be used to configure the AspireRFID middleware instance (for complete details see Deliverable 4.2a, Appendix II). Figure 1 shows the ASPIRE middleware architecture with programmable engine.

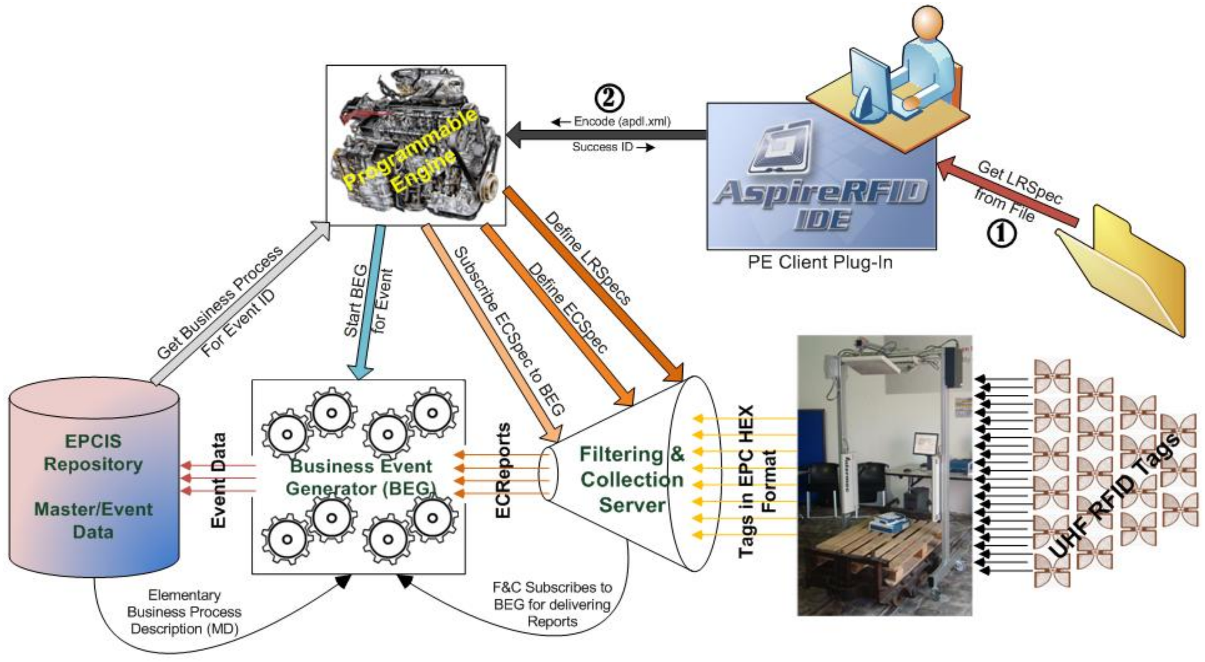

Figure 1: ASPIRE Middleware architecture with programmable engine.

At the PE's side as shown in Figure 1 after getting the command (Step 1, 2) from the user to encode this specific APDL file the next step is to analyze the received file and distinct the different CLCBProc's and their EBProc's, which in this case we have only one from each. For each EBProc and by taking in consideration their parent Objects (Attributes and IDs) the required specification files are built to configure the AspireRFID middleware running instance. So the PE extracts one by one all the required specification files from the EBProc to fill an Object, which is named as "ProcessedEBProc" and which ultimately, can be used to configure the AspireRFID running instance.

The ASPIRE Architecture introduces a tool, called Business Process Workflow Management Editor (BPWME) plug-in, which is part of the AspireRFID IDE capable of producing the APDL files and configuring the AspireRFID middleware with the help of the PEs Client.

The BPWME will be based on the Eclipse Rich Client Platform (RCP) design, which is what it is used for the AspireRFID IDE design. Someone can distinguish the main Design tab, the Diagrams outline, the Properties and the Toolbox. At the Design tab a pallet is provided, with APDL's main components, which a User can drag and drop inside the design area. As soon as the User clicks on a component inside the design area its properties appears at the Property tab where they can be changed. If the design gets too big the user can be navigated from the Outline tab where he can choose the area that appears in at the Design tab.

The PE's client can be embedded in this tool to achieve the direct Encoding of the AspireRFID middleware as soon as an APDL xml file is created. The ability of real time interaction of the BPWME plug-in through the PE's "encode" and "decode" Interface will be investigated. Moreover, ASPIRE is currently investigating the possibility of basing the End-to-End management interface on the BPWME.

The task of Designing and Implementing the BPWME plug-in, is/will be described in full details in Deliverables D4.4b, D3.5, D4.2b and D4.5.

In a similar way, the rest of the testing and evaluation scenarios have been developed to reflect to what degree the rest of the key indicators (Section 1,3) have reached the success value. In the Final Publishable Report, the full outcome of the testing and evaluation with relation to expected successful adoption of the ASPIRE solution will be reported.

Section 5 Conclusions

ASPIRE is a European project consortium brought together to assess the challenges to RFID middleware development from an SME point of view. This deliverable provided information about the current state of development of the ASPIRE solution, the identified until now technological challenges as well as the mitigation approaches to overcome those.

ASPIRE aims to contribute to the debate of the benefits of use of RFID for boosting up the economy from the specific perspective of European SMEs that use, develop and deploy RFID technologies in their daily business. Thus, the focus the project has identified some visionary application scenarios and the current challenges for the RFID technology providers and users. At the same time ASPIRE has a focus on the pragmatic approaches to meet these challenges. The latter were identified and described in this deliverable. It can be concluded that the risks and the challenges to the adoption of RFID, and in particular, the ASPIRE solution are not just technological issues, but regulatory and societal issues as well issues regarding privacy, health and environment.

The project is currently working towards solutions that take the above into account and the end results are being aligned with current policies and regulations to facilitate the final adoption and deployment of the ASPIRE solution. Further, across all sectors and different application areas, SMEs differ significantly from large enterprises in performance objectives and assessment of barriers. Therefore, the ASPIRE solution is developed in a way that makes it possible to address these particular specifics related to the RFID adoption by any SME. Such an approach mitigates the risk on developing a solution with limited capacities addressing only some needs and limited use that will make it obsolete with the emergence of new technologies.

Although the ASPIRE solution is aimed primarily at SMEs, it can benefit the adoption of RFID also by risk averse companies and other less technologically advanced companies because it proposes the use of low-cost equipment and an universal middleware approach that can be seen as a ‘plug-and-play’ approach. At the end of the project, in the Final Publishable Report, ASPIRE will provide recommendations for the use of the solution by other than SMEs companies.

Section 6 List of Figures

Section 7 List of Tables

Section 8 References and Bibliography

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Section 9 List of Acronyms

ALE	Application Level Event
ASPIRE	Advanced Sensors and lightweight Programmable middleware for Innovative Rfid Enterprise applications
DoW	Description of Work
EPC	Electronic Product Code
EPCIS	Electronic Product Code Information Services
ERP	Enterprise Resource Planning
F&C	Filtering and Collection
FML	Filter Markup Language
HAL	Hardware Abstraction Layer
IT	Information Technology
JMS	Java Messaging Service
LGPL	Lesser General Public License
LLRP	Low Level Reader Protocol
OSS	Open Source Software
RFID	Radio Frequency Identification
RP	Reader Protocol
SCM	Supply Chain Management
SME	Small and Medium Enterprise
SoB	System-on-Board
SoC	System-on-Chip
TCO	Total Cost of Ownership
WMS	Warehouse Management System
WP	Work Package
XML	Extensible Markup Language
APDL	AspireRFID Process Description Language
YAWL	Yet Another Workflow Language
XPDL	XML Process Definition Language