Collaborative Project

ASPIRE

Advanced Sensors and lightweight Programmable middleware for Innovative Rfid Enterprise applications

FP7 Contract: ICT-*215417*-CP

WP6 – Application Integration, Trials and Evaluation

Public report - Deliverable

Integration, Application Development and Technical Support of the ASPIRE Middleware

Due date of deliverable:	M39
Actual Submission date:	03.05.2011

Deliverable ID:	**WP6/D6.4**
Deliverable Title:	Integration, Application Development and Technical Support of the ASPIRE Middleware
Responsible partner:	Lei Zhang - INRIA
Contributors:	John Soldatos – AIT Nikos Kefalakis - AIT Nikolaos Konstantinou - AIT Panos Dimitropoulos – SENSAP Nikos Zarokostas – SENSAP Lei Zhang – INRIA
Estimated Indicative Person Months:	25

Start Date of the Project: 1 January 2008 Duration: 42 Months

Revision: 1.4
Dissemination Level: PU

ASPIRE FP7 215417

Document Information

Document Name: **Integration, Application Development and Technical Support of the ASPIRE Middleware**
Document ID: **WP6/D6.4**
Revision: **1.4**
Revision Date: **3 May 2011**
Author: **INRIA, AIT, SENSAP, PV**
Security: **PU**

Approvals

	Name	Organization	Date	Visa
Coordinator	Neeli Rashmi Prasad	CTIF-AAU	03.05.2011	Approved
Technical Coordinator	John Soldatos	AIT	18.04.2011	Approved
Quality Manager	Anne Bisgaard Pors	CTIF-AAU	18,04.2011	Approved

Document history

Revision	Date	Modification	Authors
0.1	26 Aug 10	First draft	Nikolaos Konstantinou, John Soldatos
0.2	29 Sep 10	Animal Hospital Demo	Lei Zhang
0.3	30 Sep 10	Integration and Technical Support of the ASPIRE middleware	Panos Dimitropoulos, Nikos Zarokostas
0.4	5 Oct 10	Executive Summary, Introduction and Conclusion	Lei Zhang
0.5	25 Jan 11	More details about the demos	Lei Zhang
0.6	21 Feb 11	Enhancements to the SENSAP Trial	Panos Dimitropoulos, Nikos Zarokostas
0.7	02 Mar 11	Enhanced Section 1, Section 2,	John Soldatos
0.8	04 Mar 11	Added Section 7	John Soldatos, Nikos Kefalakis
0.9	09 Mar 11	Added Section 6	Nikos Kefalakis
1.0	11 Mar 11	Enhancements to the Executive Summary, Conclusion and the Animal hospital Trial	Lei Zhang
1.1	18 Mar 11	Enhanced Sections 7.3, 7.4 and 7.5	Nikos Kefalakis
1.2	19 Mar 11	Finalization	Lei Zhang
1.3	14 Avr 11	Submission version	Lei Zhang
1.4	03.05.11	Review	Neeli Prasad

Content

Section 1 Executive Summary

This deliverable is a specialized activity and report, extended from deliverable D6.2, aiming at the smooth operation and completion of the pilots/demos.

ASPIRE has developed an open-source, lightweight, standards-compliant, integrated middleware along with several tools to ease the development, the deployment and the management of RFID-based applications and sensor-based applications. ASPIRE provides a set of tools enabling RFID consultants to deploy RFID solutions without a need for tedious low-level programming. ASPIRE allows the specification of RFID enabled processes. Accordingly, the tools generate all the RFID artifacts required to deploy these solutions over the ASPIRE middleware.
Developments and releases of such a platform, along with its detailed documentation, are available at the project's Wiki (http://wiki.aspire.ow2.org) and forge (http://forge.ow2.org/projects/aspire).

This deliverable describes the improvements on the application deployments and the business process for several pilot trials and demos (originally discussed in D6.2) across different industrial sectors, which have been carried out for demonstrating the benefits of the ASPIRE middleware platform and tools to SMEs (Small and Medium Enterprises).

- Improvements for the pilot for STAFF S.A. (leading Greek apparel manufacturer), which focuses in the scope of logistics and supply chain management.

- Improvements for the pilot set up by SENSAP S.A., which focuses on the business needs (i.e., asset management and tracking) of companies specialized in the sector of printing and packaging consumables.

- Improvements of the PV Lab pilot, which is a demonstration pilot aiming at showcasing the ASPIRE middleware.

- Improvements of the pilot deployed during the Niki Award Ceremony, where the registration system was based on a novel RFID application developed from the know-how gained within the project.

- Improvements of the pilot for Oncovet (animal hospital located in Lille, France), where INRIA-Lille developed a management system that integrates innovative RFID technology, so as to efficiently manage the medical resources in terms of user application requirements.

In addition to describing improvements and enhancements over existing pilot deployments of the ASPIRE middleware and tools, the present deliverable reports also on an additional set of third-party RFID projects (i.e. outside of the ASPIRE project consortium partners), which make use of the AspireRFID Open Source software. These projects provide early evidence for the potential of using ASPIRE beyond trials and demonstrations described by ASPIRE consortium members. In

a sense, these project can be thought as being more important than the above-mentioned projects, for ASPIRE's sustainability and wider use.

Section 2 Introduction

2.1 Background

Nowadays, one of the main challenging for the SMEs to apply RFID technology is the problem of significant implementation costs [4,5,6,7]. Specially, the expensive hardware and the costly RFID middleware are the two main barriers which prevent SMEs from large RFID deployments.

Otherwise, SMEs are reluctant to take risks to invest significant funds to largely deploy RFID technology due to the lack of an attractive business model that ensures their return of investment.

Our developed ASPIRE middleware satisfies such requirements by offering a lightweight, royalty-free, programmable, privacy friendly, standards-compliant, scalable, integrated and intelligent middleware platform that will facilitate low-cost development and deployment of innovative fully automatic RFID solutions. The open-source and lightweight natures allow it to be installed in low complexity hardware components and significantly reduce the costs for SMEs.

This deliverable presents several ASPIRE-associated pilots and demonstrators, to show how the ASPIRE middleware platform brings benefits to practical RFID implementations for SMEs.

2.2 Main Objectives of Pilots, Demonstrations

The main objective of these practical pilots and demonstrations is to test and validate the ASPIRE middleware and tools, as well as the ASPIRE deployment paradigm. In terms of the validation of the ASPIRE middleware and tools, the pilots makes use of almost all the developed middleware modules and configuration tools of the ASPIRE project. In terms of middleware modules, ASPIRE implements the following modules, which have been used and validated in the scope of one or more of the pilots:

- A Hardware Abstraction Layer (HAL) and its implementations for various reader devices (such as Impinj, Feig and other LLRP compliant devices). The deployment of ASPIRE in several pilots and demonstrations (as illustrated later in this document) has validated the HAL concept, while also manifesting that ASPIRE can be used with multiple readers and devices.
- A Filtering and Collection module (implemented over the respective module of the Fosstrak project [1] which conform the EPC ALE [2], have been used in the scope of the pilots requiring sophisticating filtering functionality.
- A Business Event Generation (BEG) Module, which enables automated mapping between application level events and business events. The BEG module has been used in the scope of pilots that comprise complex (yet well defined) business semantics. Note that the BEG has been used in several

pilots, which has validated ASPIRE's ability to support various business semantics (corresponding to different master data sets).

- Several tools enabling management and configuration of the above-mentioned RFID middleware modules, as well as of the overall RFID network. Almost all pilots and demonstrations have used one or more of the tools. Thus, all the tools have been validated in terms of their functionality and ease of use.
- The ASPIRE Programmability Infrastructure comprising the ASPIRE Programmable Engine (APE) and the ASPIRE Business Process Description Language (APDL). Note that only ASPIRE consortium pilots have so far leveraged the ASPIRE Programmability infrastructure, since it was only recently made available (i.e. as of the end of 2010), while it has a considerable learning curve. Nevertheless, the APE and APDL have also been validated in various logistics contexts (i.e. in the scope of the pilots where they have been used).

  Overall the use of the above modules in the scope of the ASPIRE pilots and demonstrations; have validated the fact that they can be integrated in realistic applications with fair effort. At the same time, the use of the above modules in a variety of applications, has validated the three programming and deployment models that are supported by the ASPIRE middleware and tools. In particular the three programming models are:
  - Employing programming in order to integrate the ASPIRE middleware libraries in an RFID solution.
  - Deploying an RFID solution based on the ASPIRE tools, i.e. using the ASPIRE tools in order to configure and deploy an RFID solution. This deployment model does not rule out the employment of programming (e.g., Java programming) in order to integrate the solution, yet the configuration of the solution is primarily based on the ASPIRE tools.
  - Deploying RFID solutions on the basis of the ASPIRE programmability infrastructure i.e. using the APE and APDL.

  The projects presented in the sequel make use and validate all three programming models. Note however that a comparative evaluation of the different programming models and deployment paradigms is out of the scope of this document. This is part of deliverable D6.3, which focuses on the evaluation of the ASPIRE middleware, tools and pilot applications.

2.3 Pilots and Demos within the ASPIRE consortium

Later sections of this deliverable describe improvements and additional application integration of several pilot trials and demos across different domains such as logistics, registration management, hospital applications, etc. These pilots have been carried out for demonstrating the benefits of the ASPIRE middleware platform. The pilots that were carried out by ASPIRE partners have already been described in Deliverable D6.2 and include:

- Two trials (STAFF Pilot and SENSAP Pilot) deployed by SENSAP in Greece, namely one in the SENSAP warehouse and another in the warehouse of the company STAFF. Both trials fall in the scope of logistics and supply chain management. The trials have been described in ASPIRE deliverable D6.2. Hence, rather than repeating the description of these pilots, the present deliverable emphasizes on the integration of the ASPIRE middleware libraries, as well as on the several improvements that were carried out during the provision of support to the end-users of the pilots.
- The trial embedded into PV Lab focuses on ASPIRE's deployment on the legacy demonstration applications of the Lab. The purpose of such deployment is to evaluate the easiness of deployment and configuration of ASPIRE's tools, and to illustrate the management of a full internal business process the RFID and ASPIRE's middleware. Improvements and additional application developments are included in the present deliverable.
- Oncovet RFID management system is developed by INRIA-Lille for an animal hospital, and is used for the identification of animals, delivered medicines; tracking the current status of treated animals and the medical records; as well as the traceability of medical procedures. This deliverable includes recent improvements and several new intelligent modules.
- Pilot System, based on ASPIRE middleware, was developed for the registration management of the Niki Award Ceremony. The use of RFID technology greatly assisted the registration procedure. Such system was characterized by increased speed and efficiency.

The primary feedbacks from end-users of the pilots and demos are quite positive, and argues those deployed systems allows significantly improve the operation efficiency in the different application fields.
Later paragraphs elaborate on additional developments that were carried out following the early deployments of the pilots described in D6.2. The emphasis is on the description of additional processes that were implemented, new tools that were implemented, problems/issues that were fixed, as well as processes that were improved and/or fine-tuned. In this sense, the present deliverable complements D6.2 in terms of ASPIRE trial descriptions.

2.4 Third-Party Pilots and Projects (AIT)

In addition to describing improvements and enhancements over existing pilot deployments of the ASPIRE middleware and tools, ASPIRE middleware and tools have been largely adopted as third-party applications in different RFID related research and engineering projects across the world (Europe, Asia, South America, etc.). The present deliverable will give a presentation of these related third party projects which push forward the Aspire middleware to a fruitful platform for RFID applications.

2.5 Scope of the document

The scope of this document is to present improvements and additional application development and integration for pilot /demos compared to deliverable D6.2.

2.6 Deliverable structure

The structure of this deliverable is as follows: Sections 3-6 describe the improvements of the pilot trials and demos; Section 7 focuses on the Third party projects related to Aspire. Section 8 gives the general conclusions of the deliverable.

Section 3 STAFF Pilot

A thorough description of the STAFF pilot in terms of business objectives and processes, as well as its supporting hardware and software has been provided as part of Deliverables D6.1 and D6.2. Following paragraphs concentrate on technical details associated with the integration of the AspireRFID middleware, additional development carried out as part of the pilot, as well as actions taken towards improving the system during the course of its actual operation.

3.1 Application Development and Integration

The STAFF pilot solution has been deployed based on the AspireRFID middleware, which has been appropriately extended and enhanced according to requirements of the end-user. The solution adopts the ASPIRE middleware architecture, through implementing the filtering and collection layer, the business event generation layer, as well as information sharing capabilities. To this end, the following functionalities were integrated based on the AspireRFID middleware and associated enhancements to this middleware realized by SENSAP:

- Filtering of tag streams during the container tagging, receiving, shipping, inventory and pick & pack processes. The filtering implementation was based on the mechanisms specified in EPCGlobal Application Level Events (ALE) specification.
- Generation of business events associated with the receiving, shipping, inventory and pick & pack processes. The generated business events are accordingly stored in the RFID database of the STAFF's central warehouse.
- Integration with the Warehouse Management System of the STAFF Company (namely the Logistics View system) via the connector library of the AspireRFID middleware.

As far as the filtering implementation is concerned, the deliverable includes (in the Appendix at the end of the document), a set of indicative EC Specs for the configured functionalities in the STAFF pilot.

In terms of the business generation and information sharing processes, these are based on the master data of the STAFF Company, which set a framework for defining business events stemming from the RFID system. These master data have been defined in accordance to the EPC-IS specification. Hence, they are s classified in categories (i.e., vocabularies) that impose certain attributes to the instances of entities that adhere to it. Therefore the vocabulary reveals information about the type of on abject. Moreover each vocabulary is linked with a specific barcode schema, which in turn specifies the actual GS1 barcode encoding to be used for these instances (if any). More specifically the following master data have been used:

- `BizLocationClass`: Indicates the various types of business locations utilized for the trial. For the purposes of the STAFF trial the following business location types have been utilized:
    - Warehouse
    - Shelf

- `BizLocation`: Indicates the actual business locations. For the purposes of the STAFF trial the following business locations have been utilized:
    - Warehouse:00
    - Shelf:00-Shelf:100
- `DispositionClass`: Indicates the various types of dispositions. For the purposes of the STAFF trial the following disposition types have been utilized:
    - Production.
- `Disposition`: Indicates the actual Production dispositions. For the purposes of the STAFF trial the following dispositions have been utilized:
    - Printed
    - Ordered
    - Received
    - Stored
    - Reserved
    - Packed
- `TransactionClass`: Indicates the various types of transactions. For the purposes of the STAFF trial the following transaction types have been utilized:
    - Commands
    - Receives
    - Orders
    - Shipments
- `Transaction`: Indicates the actual transactions that have been verified by the system, which in the case of STAFF correspond to the receiving, shipping and pick&pack processes.
- `ContainerClass`: Indicates the various types of containers that can be tagged by the system. For the purposes of the STAFF trial the following container types have been utilized:
    - CartonBox
- `Container`: Indicates the actual containers that have been tagged by the system.
- `ItemClass`: Indicates the various types of items that the system is aware of.
- `Item`: Indicates the actual items that the system is aware of.
- `ItemProperties`: Indicates the various types of properties that an item class can possess. For the purposes of the STAFF trial the following item property types have been utilized:
    - Gender
    - Pricelist
    - Season
    - Item Type
    - Size Type
    - Trading Item
    - Color
    - Size

Every item of STAFF (instance of the Item Class vocabulary) has three dimensions, namely its type, color and size. Items with the same value for all three dimensions are allocated the same barcode. Items with the same barcode are allocated a different serial number, resulting into a different EPC. The EPC encoding scheme used for the company's trading items is the SGTIN. Every item

can have sizes coming from a different size type (ex. M, L, XL or 48, 49, 50) and is associated with one price from each distinct price catalogue.

The labelling of each object depends on the barcode schema that is associated with its corresponding vocabulary. Every barcode schema is associated with one or more GS1 Application Identifiers (AI), from which the barcode and the Electronic Product Code of a particular object arise. The Application Identifiers (AI) of each vocabulary are provided in the table below:

BizLocationClass	AI	{GLN[1]}
BizLocation	AI	{GLN,GLNExt}
DispositionClass	AI	{91}
Dispostition	AI	{91, SERIAL}
TransactionClass	AI	{90}
Transaction	AI	{90, SERIAL}
Container	AI	{SSCC[2]}
ItemClass	AI	{GTIN}
Item	AI	{GTIN,SERIAL}

Table 1: Application Identifiers for the Vocalularies used in the scope of the STAFF trial master data

A schema for the database that holds the STAFF master data is illustrated in the Appendix of this document.

Given the above-mentioned meta-data the application implemented for STAFF, kept track of the states of the various items/objects as they internally transcend the company's value chain. To this end, SENSAP implemented middleware for keeping track of the states of the various objects, while also regulating the transitions between different states based on tag streams read at the various read points (i.e. dock-door portals). The implemented middleware is configurable, since it uses configuration files in order to define and regulate the possible transitions of the items to the various defined states. Sample configurations files for these processes are given in the Appendix of this deliverable. Note that these configurations files and uniquely combined with the EC Specs listed for the same processes in the Appendix of the document.

3.2 Improvements over the initial Deployment

The STAFF pilot was the first pilot to be deployed in the scope of the ASPIRE project. It has been operational since the first semester of 2009. During the course of the pilot deployment and operation, the continuous improvement of the pilot is pursued, in terms of robustness, functionality, but also overall business value delivered to STAFF. Since the first deployment, SENSAP has carried out a number of essential improvements in the following directions:

3.2.1 Reading Accuracy

One of the main objectives of the pilot RFID system at STAFF was to improving inventory accuracy, through automation and improvement of the receiving,

[1] Global Location Numbers
[2] Serial Shipping Container Code

shipping and inventory processes. To this end, reading accuracy become of uttermost importance. In ideal lab environments RFID reading accuracy can easily reach very high levels, exceeding 99%. This is not however the case from practical applications given that reading accuracy depends on characteristics of the tags and the surrounding environment, for example:

- Passive tags are affected by materials such as liquid and metal.
- Tag placement could impact the correct identification of tagged items.

It is perceived that RFID could improve the inventory control process of the small-to-medium retailer, but read rates would have to be improved for the technology to compete with the claimed 99.9% accuracy of barcodes in order to justify its implementation. Indeed, the lack of reading reliability can compromise the pledged RFID benefits concerning accurate inventory.

Acknowledging the need for improving reading accuracy the ASPIRE team invested effort towards fine-tuning the pilot deployment at the STAFF central warehouse. Based on the work undertaken, the deployment overcomes initial problems and achieves over 99% of reading accuracy, while also specifying processes for dealing with error reads and/or not read tags. The reading accuracy was improved on the basis of the following actions:

- The replacement of the initial NXP (Next Experience) semiconductor labels, which were initially used with Monza labels. While NXP labels offer a high read range and improved read rates, the Monza labels provide also 64 bits of user-programmable data in addition to memory for a 96-bit EPC (Electronic Product Code). Note that NXP Alien Squigle labels were initially used, while the Monza labels were provided by company Impinj. Due to the use of satellite antennas, the Monza tags were found to render greater Signal-to-Noice Ratio (SNR), along with better impedance matching. The reason for this was that the antennas featured both far-field and near-field sensing.
- The change of the electromagnetic coupling. The initial far-filed sensing was replaced by a combination of far-field and near field sensing. Near field sensing was primarily deployment for clothes (e.g., jeans) with metallic accessories in order to alleviated scattering problems.
- The change and structuring of the reader cables (CAT-5 and coax cables). The goal was to eliminate messy cables featuring sensitivity with respect to their environment. Furthermore, the length of the cables was selected in a way that optimized the reading efficiency of the system.
- The optimization of the positioning of the antennas for the specific trial deployment. While an initial site survey had provided a sub-optimal positioning of the antennas, during the course of the pilot operation SENSAP experimented with the positioning towards improving reading accuracy. This involved lengthy trial processes.

3.2.2 Usability and Utility

Upon the request of end-user STAFF, a number of interfaces for managing and configuring the deployment were implemented. Note that these applications pertain to the STAFF deployment and are not part of the AspireRFID suite of tools. These included:

- A localized (in Greek) application for managing the vocabularies entailed in the STAFF master data. A snapshot of this application is depicted in Figure 1.
- A localized (in Greek) application for managing the orders of STAFF. A snapshot of this application is depicted in Figure 2.
- Various interfaces for printing labels, as well as for managing and generating reports. Snapshots are shown in Figure 4 and Figure 5, while Figure 3 depicts a preview of the tag/labels printing process.
- An interface for managing tasks within the company, including the people and equipment where these tasks are assigned to (Figure 6).

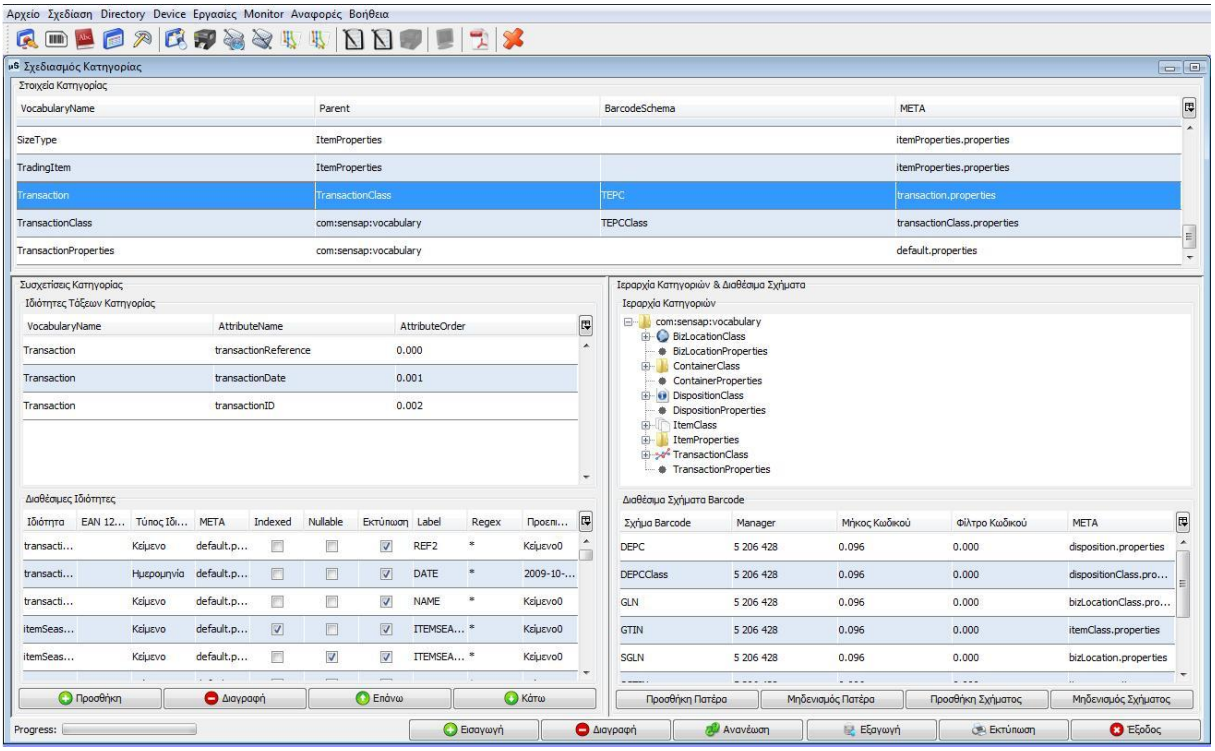

Figure 1: Interface for Managing the Master Data Vocabularies at STAFF (localized/Greek version)

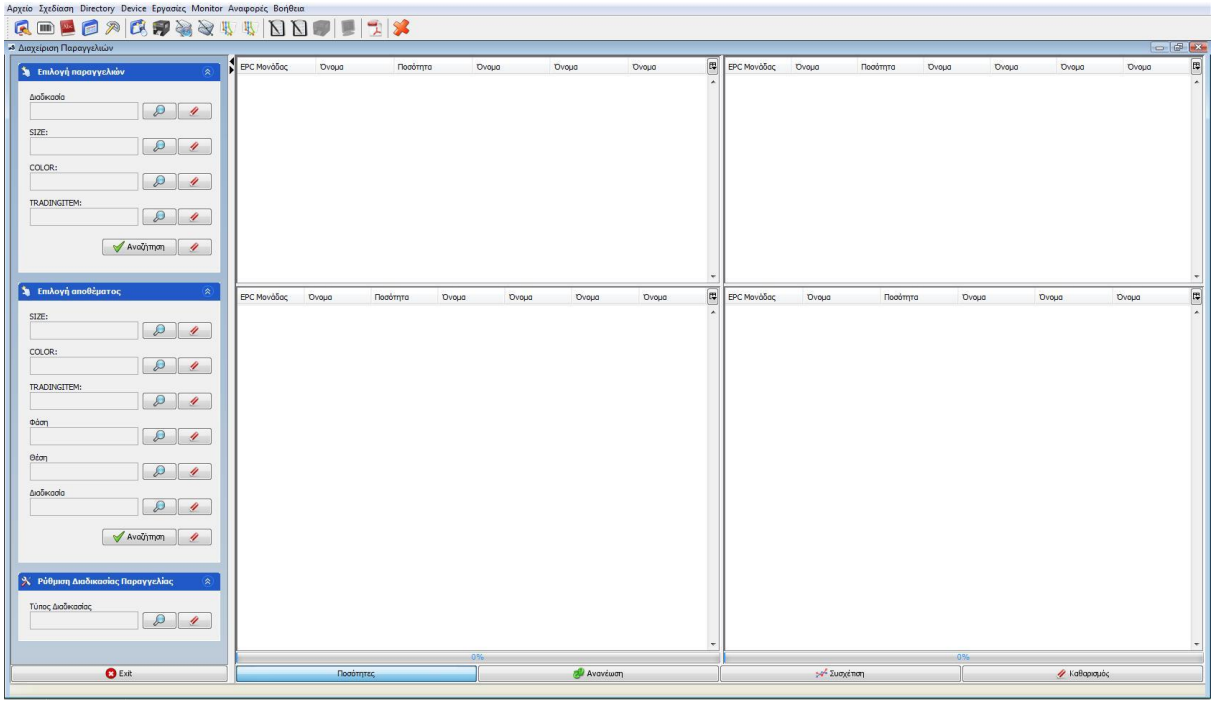

Figure 2: Order Management interface (Localized/Greek version)

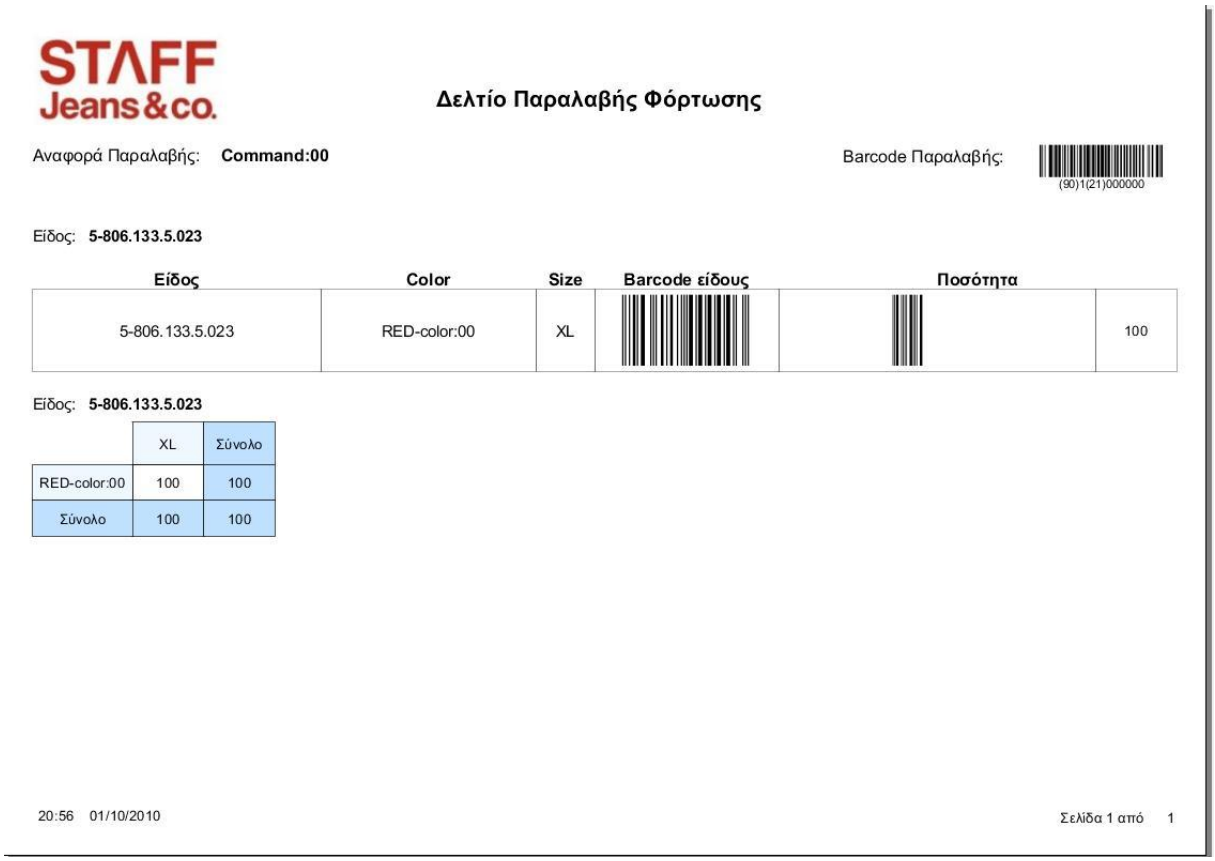

Figure 3: Preview of the STAFF Labels printing process

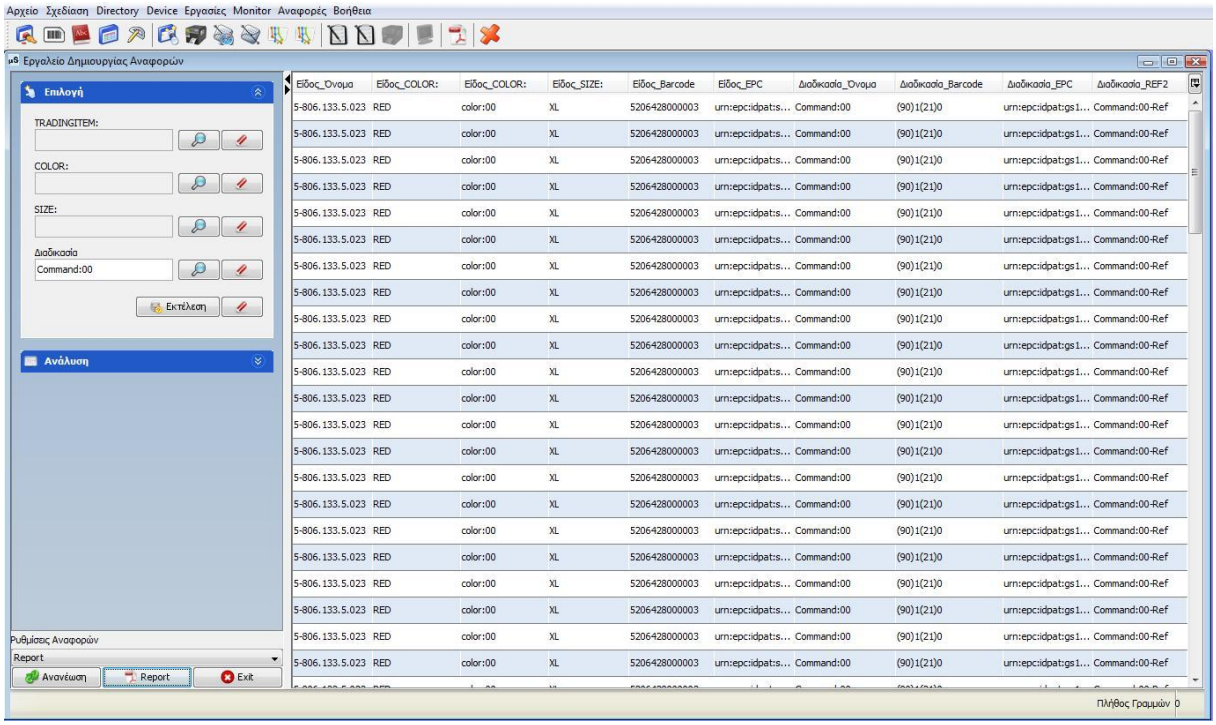

Figure 4: Interface for Report Management at STAFF (partly localized in Greek)

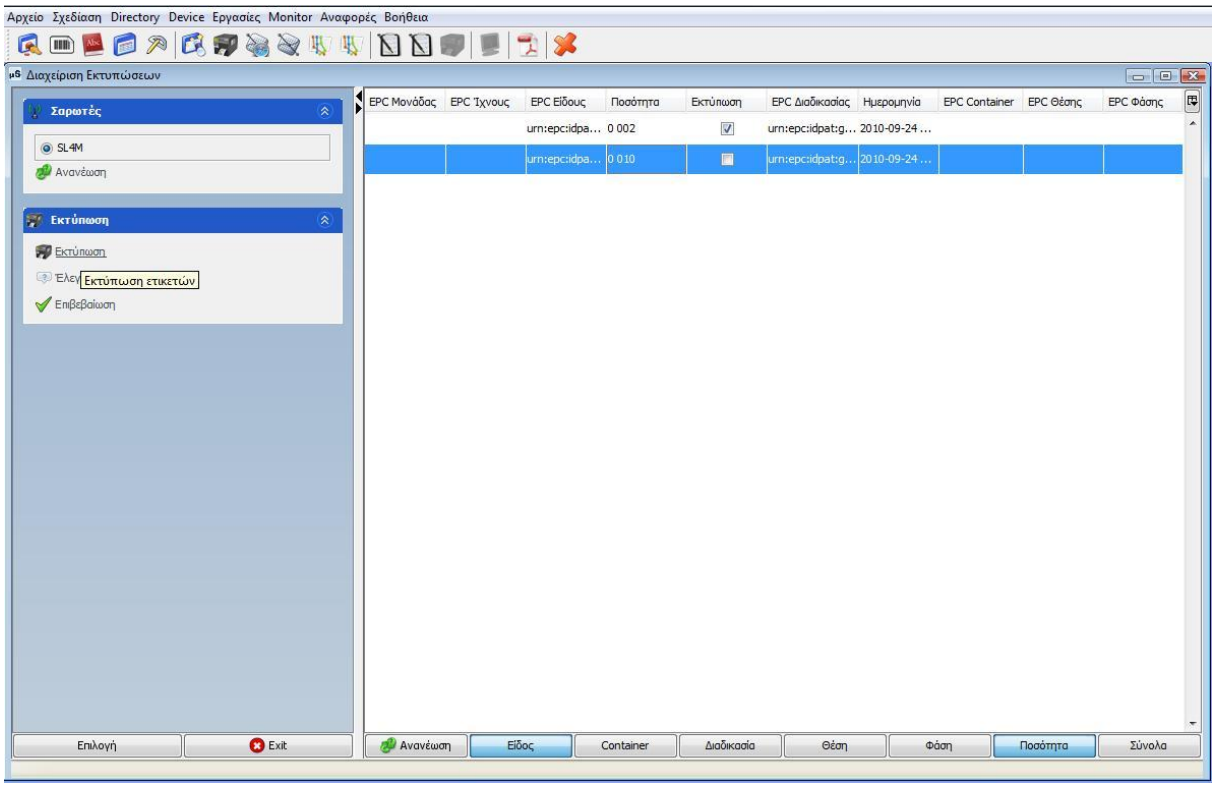

Figure 5: Tags/Labels Printing Interface

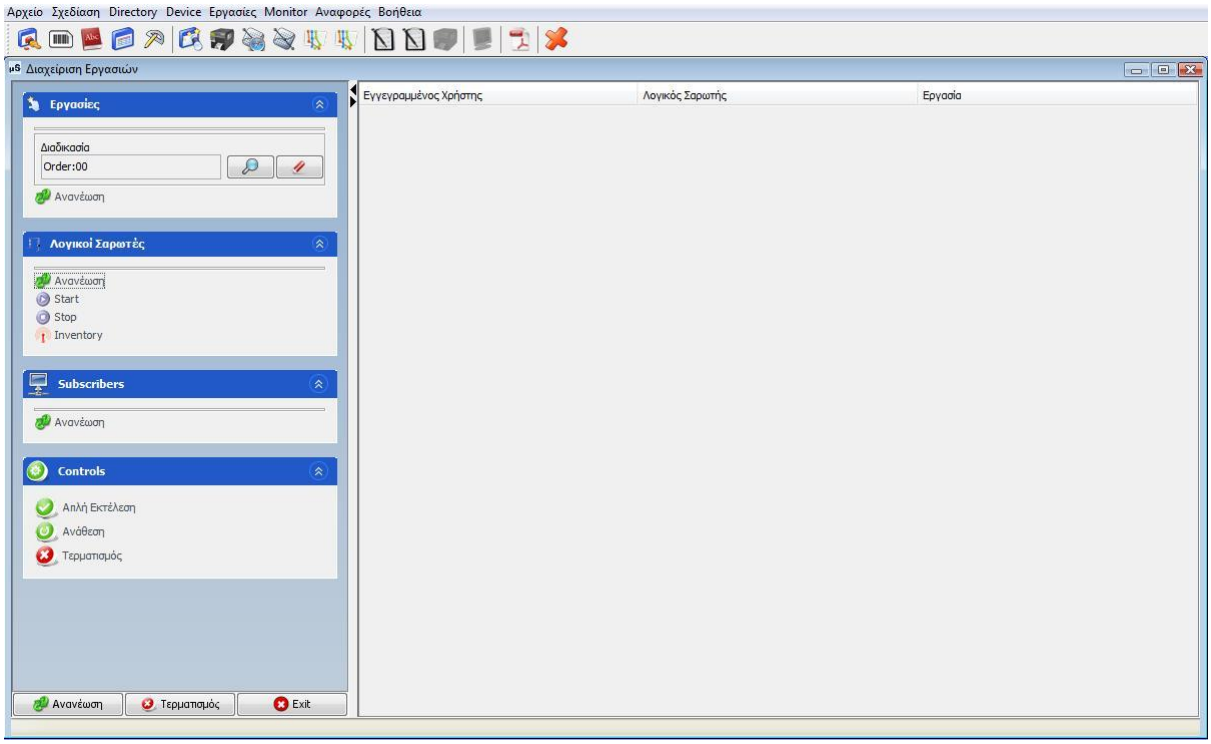

Figure 6: Localized Interface for managing tasks within STAFF (including people/devices entailed in the task)

3.2.3 Changes in the Shipping Process

In terms of the shipping process, SENSAP changes the RFID-enabled implementation of the process in order to support fill-in process, which was deemed more appropriate than an order picking process in the scope of the STAFF central warehouse (which is a distribution center). As described in deliverable D6.2 the order shipment process was initially implemented based on order picking i.e. through picking items comprising a sales order and accordingly auditing the order fulfilment. This was changed in order to allow employees to place items in a number of open orders, as those items arrive at the warehouse (i.e. the distribution center). In this model, STAFF maintains a number of open sales orders, which are gradually filled with available items. This model is more appropriate for a distribution process, comparing to the item-level picking process until an order is filled. The later is more appropriate for small-to-medium scale warehouses and hence it was initially implemented to allow for a proof-of-concept of the shipping process.

3.3 Business Process Reengineering

The pilot system deployment at STAFF has resulted in reengineered processes for receiving, shipping and inventory process. The receiving and shipping processes were radically reengineered in order to be carried out via the RFID system. The STAFF personnel was trained accordingly.

In terms of the receiving and shipping processes, the apparel items had to pass through the RFID dock doors, which replaced the conventional barcode scanning processes. On the contrary the inventory process was performed in a similar (to

the legacy process) way, even though some barcode scanners were replaced by mobile hand-held readers. However, the pilot has also introduced the process of preparing and printing RFID tags/labels, which was not part of conventional business processes of the company.

Section 4 SENSAP Pilot

Similar to the STAFF pilot, the SENSAP piliot has been analyzed in Deliverables D6.1 and D6.2. Following paragraphs provide technical details associated with the integration of the AspireRFID middleware, additional development carried out, as well as actions taken towards improving the system during the course of its actual operation.

4.1 Application Development and Integration

The pilot at the SENSAP warehouse has also adopted the AspireRFID architecture. It uses the AspireRFID middleware in order to implement:

- Collection of RFID data from the physical readers, through reading the tagged items. The AspireRFID middleware and more specifically the its Hardware Abstraction Layer (HAL) for LLRP Impinj readers was used to interface with the RFID hardware of this trial. In addition, this pilot interfaced the ASPIRE low-cost reader (based on the Scemtec prototype), which was combined with temperature sensing of the containers, with a view to establishing and maintaining a temperature profile for the items.
- Filtering the RFID sensor streams according to application needs, and accordingly creating the appropriate application level events according to the relevant EPC-ALE specification.
- Mapping the filtered readings to business semantics as required by the target applications and business processes. To this end, the pilot employed the Business Event Generator module of the AspireRFID middleware.

4.2 Improvements over the initial deployment

The trial deployment at SENSAP has been finalized (i.e. as a first functional roll-out) in June 2010. In the coming months additional developments have targeted the improvement of the operation of the pilot system, with a view to better fulfilling needs of the company that could be addressed through the use of the RFID technology. Following the introduction (and deployment) of the Microsoft Navision ERP in the company, additional developments have been carried out in order to integrate the RFID system with the ERP system. Overall, the following improvements have been carried out since June 2010:

4.2.1 Tagging and Labeling

The following improvements have been carried out in terms of tagging:

- All products in the trial are now tagged on the basis of new labels (including standard bar-code & EPC). Moreover, creasing matrix products have been enhanced with 2D barcodes, as a result of their manufacturing. In order to benefit from this enhancement, the tag data translation module of the AspireRFID module has been configured appropriately.
- AI99 support has been implemented as an enhancement to the tag data translation, in order to accommodate proprietary tags (i.e. beyond GS1 tagging).

Following the installation and deployment of the Microsoft Navision ERP system the tagging process was changed in order to become associated with SENSAP's order to its suppliers and associated buying processes. Specifically, the (currently) deployed tagging process is as follows:

- Upon the reception of the goods corresponding to one SENSAP's buying order to each supplier, this order is accessed in the ERP system and subsequently displayed at the RFID system.
- The products (i.e. packages) comprising the received goods are accordingly tagged, using a set of new RFID labels/tags.
- SENSAP Logistics employees scan the packages items in order to associate the RFID tags of the packages (products) with their barcodes.

As a result of this process all the products have RFID tags upon their reception and can be traced in the warehouse. The use of RFID in this context provides distinct advantages over barcodes, given that it enables item-level serializability.

4.2.2 ERP Integration

SENSAP has recently deployed the Microsoft Navision ERP, which was gradually integrated with all the warehouse processes of SENSAP with a view to supporting it's buying, selling and warehouse processes. Consequently, integration between the ERP and RFID system was implemented based on the connector library of the AspireRFID middleware.

4.2.3 User Interfaces

A number of user interfaces enabling management of devices in the SENSAP pilot have been implemented. These interfaces are additional to those implemented as part of the AspireRFID management functionality. A relevant snapshot is provided in Figure 7.

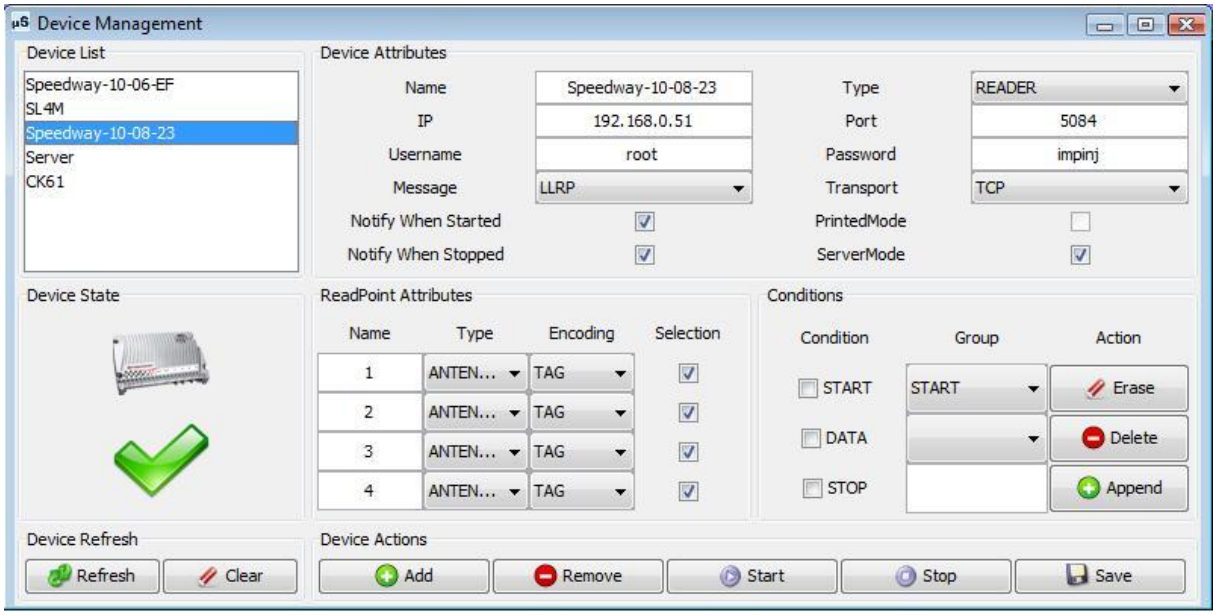

Figure 7: Additional Interfaces for Device Configuration and Management implemented as part of the SENSAP pilot

4.3 Business Process Reengineering and Improvement

Additional developments in this trial have focused on business process improvement for SENSAP associated with the RFID-enablement of the buying, inventory and selling processes associated with the commercial activities of SENSAP in the area of packaging products. In the sequel we outlined how these processes were supported based on the integration with the ERP and associated advancement of the tagging processes.

4.3.1 Buying Processes – Reception & Tagging of Products

Following the first deployment of the SENSAP trial, emphasis was put on the integration of the RFID solution into the buying process of SENSAP, which is directly associated with the reception of products and their placement in the SENSAP warehouse. For each buying process the company maintains an order within its InnovEra ERP (which is based on Microsoft NAV), which has been integrated with the deployed RFID system. Upon the arrival of products (in response to an order), the following workflow take places:

- The order is found on the ERP system and accordingly transferred to the RFID system.
- The products are tagged as they are received. Tagging attaches an RFID label to each one of the products.
- Employees scan (using mobile readers/scanners) the products in order to associate each RFID label with the barcode of the product. The associations are maintained in the database of the RFID system.
- The packaging products are received in the warehouse i.e. this is recorded in the RFID system.

The above-mentioned tagging process ensures the item-level tagging and traceability of the products within SENSAP's warehouse. Furthermore, it allows temperature sensing for each product based on the WP5 ASPIRE reader.

A key element for business process improvement in this RFID enabled buying process is the ability of the RFID system to automatically identify and track incomplete (pending) orders i.e. buying orders of SENSAP for which one or more items have not been delivered. Based on this ability the system can track order residuals within incomplete orders. Hence, it can identify multiple incomplete orders and track the relevant residuals. This tracking functionality is then exploited in order to aggregate multiple residuals into new orders, while considering the previous orders complete (i.e. ignoring items that were not received from the pending orders).

4.3.2 Selling Processes – Shipping of Products

In the scope of selling processes, the RFID system retrieves sales orders from the ERP system and according audits the order picking process within the warehouse. In the scope of the order picking process the RFID system audits that the items picked and assembled into the order correspond to the sales order that has to be filled. Upon the assembly and verification of the order, shipping of items occurs by passing the packaged order through a dock-door portal.

4.3.3 Business Benefits

The main business benefits stemming from the above process are in the areas of:

- **Automated Reception of Products**: Through the use of the RFID system the reception of products is automated i.e. does not require manual counting of the received products. One may however argue that this benefit is outweighed by the need for labeling/tagging the products. Note however that tagging occurs through randomly (i.e. without any special order) attaching labels to the items, which is in general much faster than manual counting of all the received products.
- **Automated entry of order data:** In addition to obviating the need for manual counting, the RFID system obviates the need for manual data entry of the ordered data. These can be automatically read through the RFID systems and hence manual error-prone data entry is not required.
- **Item-Level Traceability**: Following the tagging process, the RFID system enable complete traceability of the products at an item-level. This allow for several benefits such as the control of the temperature at an item level.
- **Management of Residual Orders**: The system support management of residual orders, which facilitates the handling of incomplete orders and overall saves a lot of time to the company. Moreover, based on the integration with the ERP, orders are handled in conjunction with the automated replenishment processes (i.e. automated ordering when stock levels are below some minimum threshold).

Section 5 Animal Hospital Demo

5.1 Additional Application Development and Integration

Oncovet RFID management system is one of the demonstration work developed by INRIA-Lille in the context of Aspire project. Our partner Oncovet is an animal hospital located in Lille, France.

This system has been deployed based on the ASPIRE middleware. Basically, it adopts two principal modules developed in the scope of the ASPIRE middleware architecture:

- Aspire ALE: allows reading, accumulating, filtering the tag based objects and generate the resulting reports in response to user's requirements.
- Aspire WP5 LLRPLite Server: serves as an intermediary between specific reader protocol (i.e. Scemtec reader [8] in this demo) and the standard LLRP [3].

This system is used for the identification of animals, delivered medicines; tracking the current status of treated animals and the medical records; as well as the traceability of medical procedures. Figure 5.1 shows the graphical interface of Oncovet RFID management system.

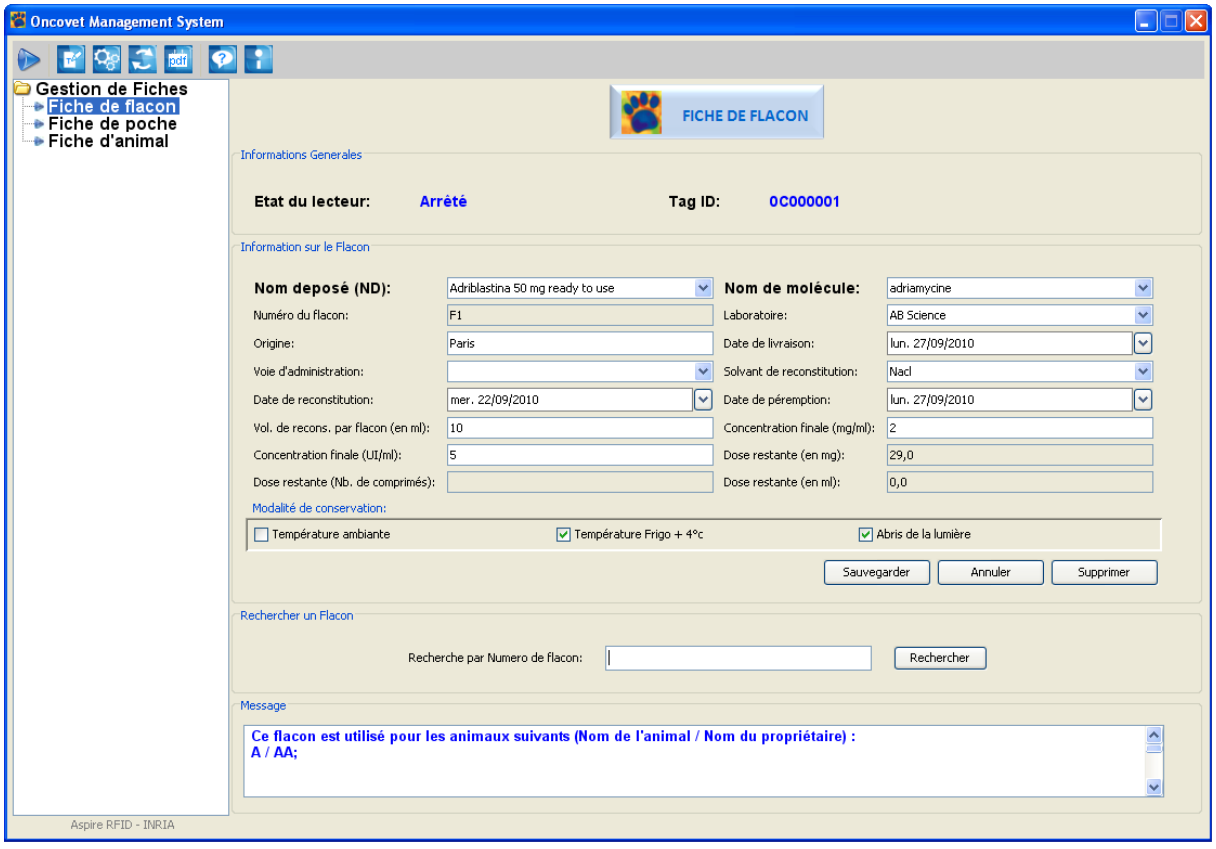

Figure 8: Graphical interface of Oncovet RFID management system

Oncovet RFID management system includes the following modules:

- R/W Interface between RFID reader and PC: Read/Write data between RFID reader and PC.
- Aspire WP5 LLRPLite Server: serves as an intermediary between Scemtec RP and standard LLRP.
- Aspire ALE module: allows reading, accumulating, filtering the tag based objects and generate the resulting reports in response to user's requirements.
- Identification module: identifies animals, delivered medicines as well as the related files and resources.
- Traceability module: offers the traceability of medical procedures, medical records, and monitors the status of treated animals in real time.
- Data base module: manages all the data related to the treated animals, delivered medicines as well as the medical records.
- Auto Notification module: notifies automatically users the important issues by sending emails. (i.e. a list of medicines which will be expired in N days).
- Dose calculation module: calculates an optimal medical dose for each treatment according to different parameters (i.e. Medicine, animal species, weight, volume, etc.)
- Fault tolerance module: Ability of input errors tolerance and error auto-detection/auto-correction.
- File management module: allows auto-editing data (database, configuration and input data) and converting them to pdf file format.

The components (illustrated in Figure 9) show the main architecture of Oncovet RFID management system.
Tags are read by Scemtec handheld reader, the tag data can be captured either directly by the management system or by the LLRPLite server, in this case, reader configuration and reader commands will be translated into LLRP standard format and create a standard interface for LLRP compliant server.
Tag data information will be accumulated and filtered by ALE module, and then gathered in the data base, and used to support the functionalities such as object Identification and medical procedure traceability.

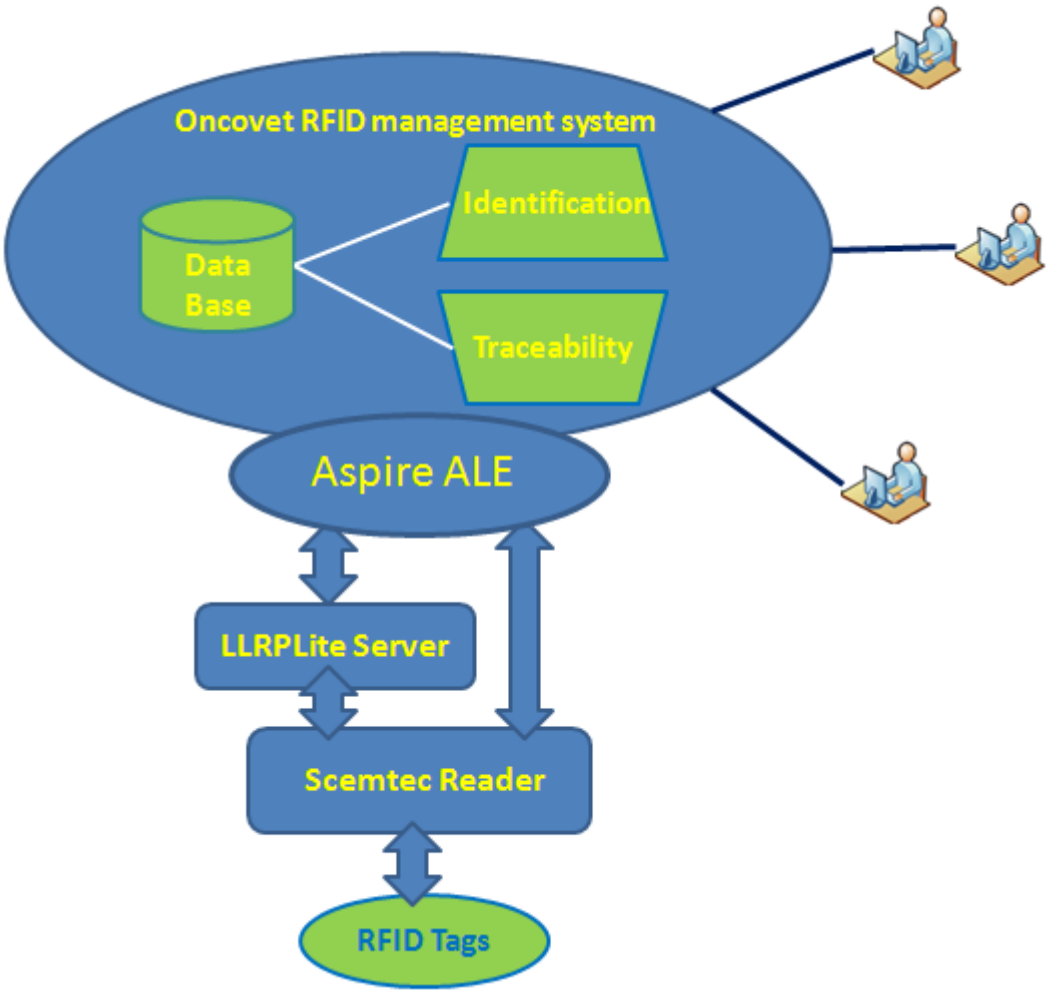

Figure 9: Architecture of Oncovet RFID management system

5.2 Business Process Improvement

Oncovet is a specialized veterinary practice (Lille, France) dedicated to the diagnosis and treatment of cancer in animals, they provide compassionate, state-of-the-art cancer care to pets, while striving at all times to actively pursue better ways to diagnose, treat and prevent cancer in all animals.

Although their excellent medical skills bring up many successful stories on animal treating, they still use traditional ways to manage the medical system:

1) They still use adhesive labels to identify some of the medical instruments (i.e. injectors, medical bags, etc.), which make the traceability complicated and inefficient.
2) They still use Excel/Word to manage their database and edit medical files. The interface is not friendly for management of medical treatment data.
3) Medical dose is calculated by an external calculator.

4) The management is not intelligent and lack of the functionality of error auto-detection.
5) Traditional way of file management, some of their management files have to be filled manually.
6) Labour cost is huge (Much time should be sacrificed to deal with thousands data manually).
7) Identification of animals is done through time-costly research of animal's name and the name of the owner.

These traditional ways of management lead to significant degradation on the management efficiency. Some technical staff in Oncovet always complain of the chaos and the inefficiency of such management system (i.e. inaccurate traceability, complicated file management, non-friendly working interface, etc.)

That's why we offer our solution (named Oncovet RFID management system) which brings a radical change on the way of the medical management.
We integrate some of the new RFID technologies and several intelligent modules in this system to remedy their shortages and satisfy the requirements of establishing a performance enhanced system, which effectively:

1) Enhances the performance of traceability for medical procedure with the integration of RFID technology.
2) Offers intelligent ways to manage medical database, support quick identification and quick tracking of medical files and instruments.
3) Offers intelligent way to manage files: generate pdf file automatically from database and system configured files.
4) Offers intelligent way for the error auto-detection.
5) Offers efficient way to optimize doses for the medical treatments.
6) Make the medical management much easier and efficient, and significantly economize HR/ labour costs.
7) Identification of animals is by a RFID badge (held by animal owner), which allows the veterinary to check animals' historical medical treatments very quickly (i.e. List animal's information on diagnostic PC when the animal gets approach the RFID reader).

5.3 Support action Process Improvement

The innovative RFID technology significantly increases the efficiency of the management of the medical resources and procedures.
All the useful information related to medical objects (i.e. animals, medicines, etc.) and medical procedures (i.e. injection status) can be managed easily and are transparent to application users.

Premier feedbacks from users are very positive; this intelligent management system eases the heavy management work and significantly reduces the human

resource cost, which dramatically improves their management efficiency by up to 60%.

This intelligent management system integrates the conception of module-based design; different involved modules can be flexibly configurable, which allows this system much more easily to be deployed in different applications/fields.
This system can also be used in big hospitals where hundreds of thousands of medical data should be treated per-day.
Similarly, such system, after some modifications on the graphical interface and some application-compliant modules, can also be used in different fields such like home automation, transport management, library management, etc.

Section 6 Pilot Systems and Related Demonstrations

6.1 Niki Award Ceremony Pilot System and Related Demonstration

For two consecutive years (2009 and 2010) the AIT's NIKI Award Ceremony (http://www.ait.gr/ait_web_site/award_niki.jsp) used a novel RFID Registration and Reception management system. Each guest invitation had a passive RFID tag attached on it and was required for their entrance. More than 300 guests was invited in 2009 and more than 350 in 2010.

6.1.1 System Description

The relatively simple infrastructure used was consisted of the following:

- One LLRP RFID server (module) which was using the AspireRFID LLRP HAL module. The RFID server was "running" at one of the reception's laptops.
- One MySQL Database server. The MySQL Database server was "running" at one of the reception's laptops
- One LLRP Reader with 3 antennas.
- 3 Client applications which served as visitor RFID reception points and were bind with the different RFID antennas
- 1 Client application for visitors without Invitations

A fail safe mechanism was set up to every laptop used so as it could take over, and become the system's "server", in case of a failure.

The system was offering two interfaces. One advanced with complete control of the system and the database, which was called "Secretariat view" Figure 10, that was meant to be used at the reception's preparation. And one simple one that meant to be used at the reception, called "Reception view" Figure 11.

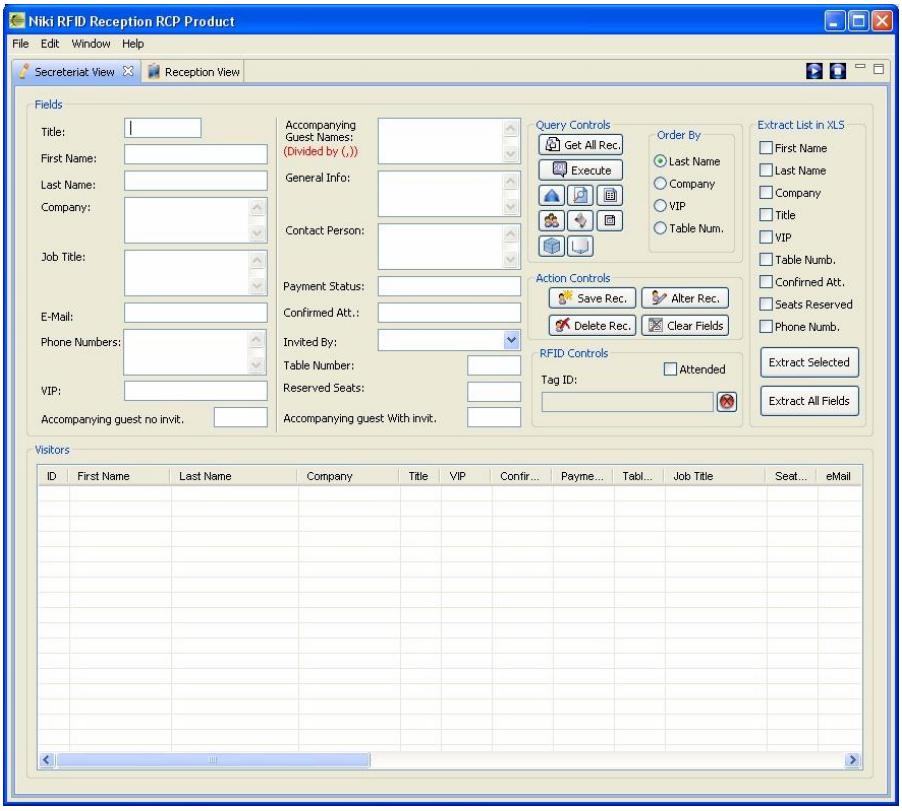

Figure 10 Niki's Secreteriat View

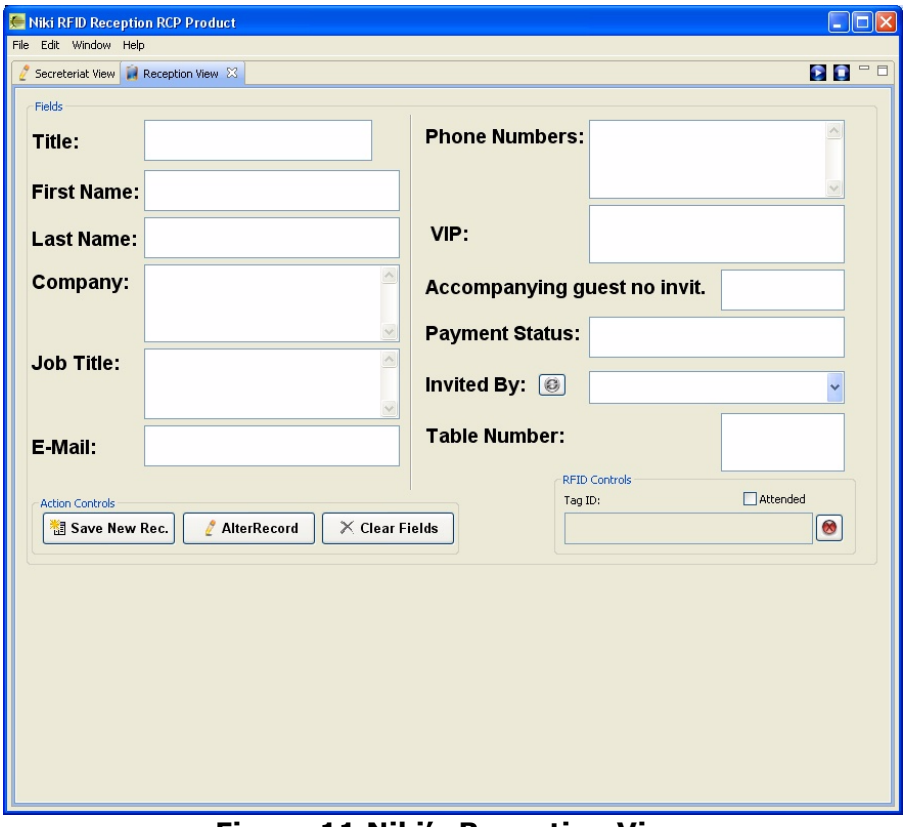

Figure 11 Niki's Reception View

As it is depicted in Figure 12 below, each of the applications communicates with the LLRP RFID server in order to receive reads by the reader. These tag reads are then stored in the database server that holds all the information related to the event.

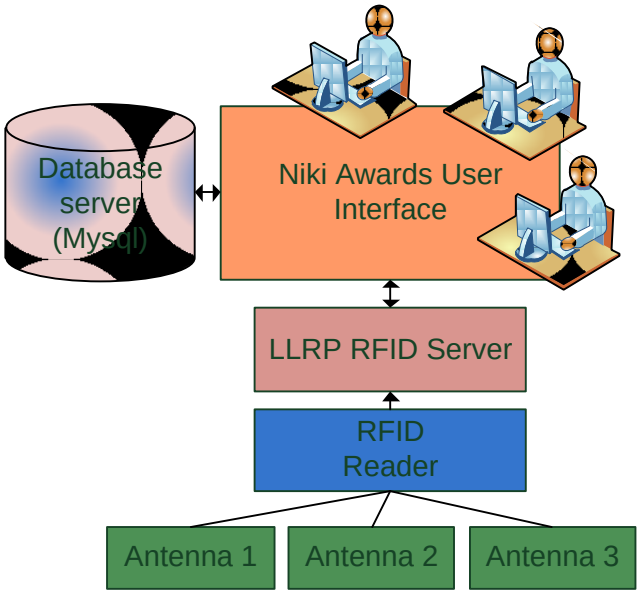

Figure 12: Logical architecture of the infrastructure deployed at the Niki Awards ceremony

The System's deployment/setup is shown in Figure 1 below.

Figure 13 Niki 2010 Reception Setup

The System's reader and cable management is shown in Figure 1 below.

Figure 14 Cables and Reader placement under the table (disassembling after the event)

6.1.2 System in action

In Figure 13 and Figure 14 below the system is depicted for the two years that was applied, 2009 and 2010 respectively, in action.

Figure 13 Niki 2009 reception in action

Figure 14 Niki 2010 Event in action

In Figure 15 below we can have a picture of the volume of guests invited to the Event.

Figure 15 Event's main room (left and right side)

A Video of the 2009 event is available at the YouTube at http://www.youtube.com/embed/DljvjG8kEvM?rel=0

6.1.3 System's Added Value

The added value in comparison with traditional registration systems can be summed up in the following list:

- Real time Statistics on Guests and Registration were automatically produced. The system automatically logged the guests that have arrived so it was capable of reporting at any given time:
  - The free seats per table,
  - The number of guests arrived/missing,
  - The number of guests arrived/missing per table,
  - The number of reserved seats per table,
  - The VIPs arrived/missing
- Ability to do last minute change at the reserved tables.
- For the two consecutive years, which the specific system was used, more than 300 and 350 guests passed from the reception without, at any given time, generating queues more than two persons.
- The system gives the ability to the user to run combined queries.
- Ability of exporting the records, combined queries or statistic information data in XLS format.

Section 7 Third-Party Projects

7.1 Overview of Third-Party Projects

The following table (Table 2) provides facts and figures on the size of the AspireRFID community and the users of the AspireRFID middleware and tools. Note that the reported users represent known users in particular:

- Users that have collaborated with ASPIRE and used AspireRFID, as part of ASPIRE's official liaisons with other projects. This is the case for other EU projects such as ICT PSP projects RFID F2F and RFID-ROI-SME.
- Users that have requested support from the AspireRFID developer's community, which currently comprises mainly members of the ASPIRE project.

AspireRFID Project Characteristic	Value
Number of Developers/Contributors	>30
Number of downloads (since Feb 2009)	>300
Number of Web Hits (since Feb 2009)	> 14500
Wiki	http://wiki.aspire.ow2.org/
Indicative List of Known Users (include both academic and industrial users in know projects)	1. RFID-ROI-SME ICT-PSP project 2. (Companies SATA/RETE (Italy)), 3. RFID F2F ICT-PSP project, 4. IE Technology Co., Ltd (IET) (Thailand), 5. Informe Air - Inteligência Empresarial (Brazil)

Table 2: Facts, Figures and Known Users of the AspireRFID project

In the sequel we briefly report on known projects deployed using AspireRFID. In addition to these projects, there have also been several inquiries about AspireRFID, which have possibly led to additional AspireRFID deployments. However, we restrict our presentation to the case that have evidently been deployed. In the scope of deliverable D6.3, we will also present the wider interest in the AspireRFID middleware and tools.

7.2 AspireRFID use within the RFID-ROI-SME project (AIT)

The RFID-ROI-SME project (www.rfid-roi-sme.eu) is an EC co-funded project in the scope of the ICT-PSP programme. Its main objective is to deploy eight pilots for SMEs, across six different countries spanning different sectors and application domains. In particular, the RFID-ROI-SME pilot deployments target the areas of cable logistics, document management, e-ticketing, paper manufacturing, and apparel retail, plastic logistics, security management and workers' safety. Three out of these eight pilots are directly or indirectly deploying the ASPIRE middleware.

7.2.1 Document Management Pilot

AspireRFID is used for the document management pilot of RFID-ROI-SME, where IT solution providers SATA has deployed an automated document management system for company RETE which deals with the collection and management of tax documents. The rationale behind the deployment of an RFID system for document management stems from the need to manage physical folders and boxes, while at the same time handling the logical image of the same entities across the whole RETE organization based on the access authorizations granted to various user profiles. In this context, RFID technology is used to enable track and trace functionalities for:

1. **Physical objects**: Each folder is uniquely identified by an RFID tag. Likewise each box (containing folders) is uniquely identified by another RFID tag. In the same way sites (i.e. desks, external doors) within the company are also uniquely identified.
2. **Logical objects**: The information associated with each folder includes: the physical folder unique identifier, the box, the site, the branch, the account type, the tax payment date, the group, the person in charge, the process state associated with the tax document or folder (e.g., document collection, in process, suspended for clarifications, sent, archived), the checklist of documents to be collected, information of the previous accounting year, as well as scanned copies of critical documents. Based on the physical tags outlined above it is possible to trace and trace logical objects on the basis of the above requirements.

Hence, the RFID-enabled document management application must cope with two distinct requirements: (a) Manage the events associated with tag reading of physical objects, taking into account that one reader is available at each office and (b) Allow different accounting employees, in the same branch as well as in other branches or at the headquarters, to access and update the (logical) folder information.

The application has been deployed based on AspireRFID middleware, as shown in Figure 16.

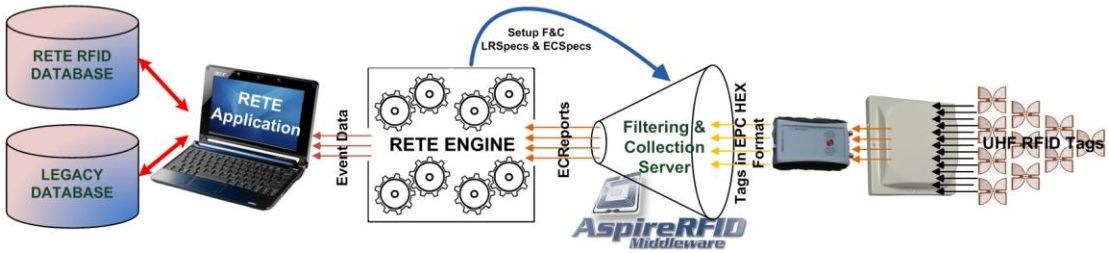

Figure 16: RETE Document Managment Application Deployment based on AspireRFID

The AspireRFID modules that are used include the Hardware Abstraction Layer (HAL), which resides at the Filtering and Collection (F&C) module, the Filtering and Collection module and the various clients required for the configuration and management of the aforementioned module. The role of the HAL layer is to unify the way the ASPIRE middleware interacts with the RFID readers from multiple

vendors that support varying protocols. This is based on the introduction of a hardware abstraction layer (HAL) and the provision of a fixed instruction set to upstream middleware layers which consume RFID readings from the hardware. For the specific pilot a FEIG MRU80-M2 UHF RFID reader is going to be used so an equivalent HAL is going to be developed for the specific reader as shown in Figure 17 below.

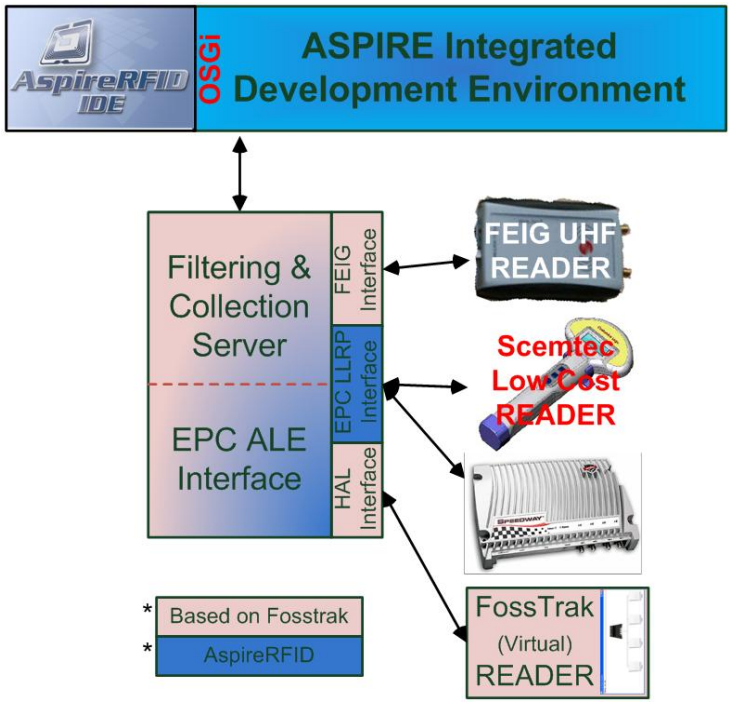

Figure 17: AspireRFID HAL and IDE Modules

Since the RFID systems can generate a large number of object reads, the pilot deployment leverages middleware in order to: (a) drive as much filtering and counting of reads as low in the architecture as possible, and (b) Minimize the amount of "business logic" embedded in the Tags. These objectives are facilitated by the Filtering and Collection Middleware, which provides a flexible interface to a standard set of accumulation, filtering, and counting operations that produce "reports" in response to client "requests." The client is responsible for interpreting and acting on the meaning of the report. Depending on the target deployment the client of the ALE interface may be a traditional "enterprise application," or it may be new software designed expressly to carry out an RFID-enabled business process which operates at a higher level than the "middleware" that implements the ALE interface. In the scope of the RETE pilot, the RETE Engine module, consumes the results of ALE filtering. Thus, once the Feig reader (used in the RETE pilot) captures relevant tag data, it notifies the F&C middleware which combines the data in a report that is sent according to a pre-determined schedule to the RETE subscribed module. The middleware provides specific filtering functionality depending on the already defined specifications. Hence, redundant events from the reader from a specific location are not included to the dispatched report. Moreover the RFID tag classes will be grouped

with specific report names so as to ease the distinction of the different scanned items at the RETE module.

The whole process is configured and monitored using the ASPIRE IDE (Integrated Development Environment) tools. These tools are used to configure the filtering and collection module, while also managing and monitoring the operation of the physical reader. The use of these tools has facilitated the deployment and operation of the solution. In terms of the ASPIRE-enabled deployment paradigms, the RETE pilot has followed the paradigm that involves configurability based on the ASPIRE tools. SATA and AIT (both partners of the RFID-ROI-SME project) will investigate the potential of using the AspireRFID programmability tools and techniques for a later deployment of the pilot.

7.2.2 AspireRFID in Intelligent Packaging and Apparel Retail

In addition to the deployment of the RETE pilot on document management based on AspireRFID, two more pilots of the RFID-ROI-SME project are indirectly using AspireRFID middleware libraries. In particular:

- The RFID-ROI-SME pilot on intelligent packaging is deployed in SME company KOSKINIDIS. It aims at providing an RFID/AutoID infrastructure for tracking and tracing source materials, second materials, manufacturing assets (i.e. notably depreciation of machines and cutting tools), and production process, with a view to facilitating quality control processes and calculation of production-related KPIs,
- The RFID-ROI-SME pilot on apparel retail is deployment for SME company STAFF and is a direct extension of the STAFF apparel pilot that has been deployed as part of the ASPIRE project. In particular, the pilot deploys RFID in one of the retail shops of STAFF, with a view to providing a set of advanced customer services such as an intelligent mirror for providing information to the customers, as well as an intelligent Point-of-Sale (POS) enabling automated check-out (i.e. without manual one-to-one scanning of apparel items at the cashier). The retail system is integrated to the RFID deployment at STAFF's central warehouse, with a view to facilitating better stock management. Note that the software enabling this extension has been partly produced in the scope of ASPIRE, using AspireRFID middleware libraries.

The above two pilots are deployed on the basis of SENSAP's software suite (called S-Box), which has been partly based on AspireRFID libraries. Note however that the S-Box platform includes additional modules (developed by SENSAP) beyond the open source AspireRFID middleware and tools. While those two deployments cannot be directly considered as AspireRFID deployment, they manifest the potential of exploiting AspireRFID for building new products and/or providing new services. Likewise, they are not apt for evaluating the AspireRFID middleware, yet they are relevant to the ASPIRE exploitation strategy.

7.3 AspireRFID use within the RFID-F2F project (AIT)

The RFID Farm-to-Fork (http://www.rfid-f2f.eu/) project is a recently launched European project funded through the CIP ICT PSP programme. The aim of the

project is to showcase RFID technology to SMEs in the food & drink industry and to identify and trace food information to fulfil society's needs.

The first close interaction between AspireRFID and F2F project was conducted at June of 2010 in Athens. There, a one day workshop was arranged mainly to present the AspireRFID capabilities and define the requirements from the F2F pilots' perspective. From that day AspireRFID provides support, thru mail exchange, to the F2F developers so as to understand and use the F2F platform.

7.4 AspireRFID use within IE Technology Co. Ltd (IET) (AIT)

IET (http://www.iet.co.th/) is a Thailand leading RFID solution provider which offers a complete one-stop RFID service ranging from consultation, system integration, hardware and software design to product customization.

IET, among others, provides Warehouse management and Inventory Solutions that improves work in process for check in&out product for customer, reduce error for checking products out by human, improve the capability in providing an exact amount of products in warehouses in real-time, better warehouse management, reduces storage space and labor costs and improves asset utilization.

In April of 2010 IET contacted the AspireRFID open source community expressing its interest for using the AspireRFID platform and collaborating with it towards improving the provided solution. AspireRFID provided support thru mail exchange and audio conferences so as to fully download run and understand the different bits and pieces of the AspireRFID platform.

So far IET has deployed and using at its projects the Filtering and Collection module, based on its proprietary extensions. In particular, IET has created an "LDSpec" modelled off of the LRSpec, to operate other devices. This specification is being extended specifically for IET's first deployment, which is a "7-Segment" light that shows license plates that match the RFID tags that have been read. Moreover IET is working towards incorporating EPCIS functionality so as to support more complicated scenarios based on the AspireRFID middleware.

7.5 AspireRFID use within Informe Air- Inteligência Empresarial (AIT)

Informe Air (http://www.informeair.com.br/) is a company whose mission is to provide business intelligence to its customers. For this reason, works on a platform that integrates solutions based on information and communication technology (ICT), engineering (electronic, mechanical and teleconference), RFID and the improvements and process management.

Informe Air is the first company within the complex of Porto Digital working with radio frequency identification (RFID) technology to capture important data for making information available in real time. Using a set of innovative technologies such as RFID technology, we develop applications to monitor and track assets, manage inventory, streamline processes, make inventories more efficiently and

effectively act on safety and originality of products, among countless other applications that come the increasingly intensive use in conjunction with the information systems within organizations.

In June of 2010 Informe Air contacted the AspireRFID open source community expressing its interest for using the AspireRFID platform and collaborating with it towards improving the provided solution. Three months later, after the close collaboration of AspireRFID/Informe Air, the later provided a list of enhancements/bugfixes and a new flavour of the AspireRFID middleware that was meant to be used at Informe Air's future projects.

A non exhaustive list of changes, in a number of AspireRFID modules, done by Informe Air is presented below:

ALE

- A re-connection mechanism that re-initiates the reader in case the connection is lost was implemented.
- The ReportGenerator, Report, EventCycle and LLRP classes were re-implemented using java.util.concurrency classes such as Observer and Observable. There is NO wait() and notify()/notifyAll() calls. We also eliminated the IndentifyThread and related start/stop methods. In Informe Air's opinion, the use of such low-level concurrency commands (wait,notify,etc) brings much risk for concurrency related bugs. Informe Air used consumer/producer design pattern to implement the cited classes and therefore, in their opinion, making the code much easier to understand.
- A jsp page with the ALE status was implemented at ALE context root: http://localhost:8080/aspireRfidALE/
- A servlet that extends the CXFServlet was implemented so resources can be destroyed when the web server shuts down.

EPCIS

- We included part of the BEG code that does the capture of business event in the EPCIS
- We changes the name of some tables at the SQL scripts in order to make it Linux compatible (case sensitiveness problem)

PE

- Informe Air merged the BEG module into the PE (Informe Air think that there is no need to maintain so many modules)
- The code that access the ALE and the EPCIS web services were moved to the respective components so they can be re-used.
- An apdl file with 14 different Elementary Business Processes was implemented. This allows Informe Air to test the whole system for a larger configuration of readers and event cycles.

Overall changes

- It was implemented jUnit testes for the ALE and PE components.
- The use of java.util.List was substituted by java.util.Set when suitable.
- Part of the code that seemed not necessary or confusing was removed.
- The jars used by ALE and PE were updated to the LATEST available (CXF and Fosstrak dependencies)

Section 8 Conclusions

It's no doubt that the business benefits of RFID deployment for SMEs are undeniable; the problem of relative high costs of RFID tags still exists nowadays. We keep eyes on the ASPIRE techno-economic studies, and offers efficient and low costs solutions to application end-users.

D6.2 has given a detailed description on the pilot and demos which are setup by Aspire partners. These pilots/demos are based on ASPIRE middleware and covers a wide range of operational RFID systems spanning the areas of logistics, supply chain management, registration management, asset management and hospital field. In this deliverable, we prove how the ASPIRE middleware platform is able to facilitate RFID application development and bring benefits to practical RFID implementations for SMEs, as well as a radical change in the current RFID deployment paradigm.

We also give an insight into how these involved end-users have approached such implementations and the business benefits have been derived in a number of business sectors. By analysing the deployed pilots and demos, at least 6 main areas of benefit can be identified:

- Improved Productivity and Cost Avoidance
- Decreased Cycle Time and Taking Costs Out
- Reduced Rework
- Improved Utilisation of Resources
- Increased Revenues
- Efficient Management

Compared to the initial version D6.2, this deliverable describes improvements and new developed modules involved in these pilots and demonstrations, which allows significantly improving operation efficiency in the different application fields. Furthermore, Business Process Improvement is carefully studied in the present deliverable, ASPIRE middleware based solutions cover all the necessary aspects of business interests, and pick the required modules that are necessary to successfully implement in different specific projects.

Meanwhile, we are aware that the ASPIRE middleware and tools have been largely adopted as third-party applications in different RFID related research and engineering projects across the world (Europe, Asia, South America, etc.). These projects show a significant potential of using ASPIRE far beyond several demos/pilots described by ASPIRE consortium members.

The primary feedbacks from end-users of the pilots and demos argue that use of ASPIRE-middleware integrated RFID technology enables procedures to be measured better, and therefore leads to increase business productivity and reduce associated costs.

We believe that the ASPIRE middleware offers a low-cost and powerful framework that allows end-users to efficiently handle different RFID related applications and brings significant business benefits for the users.

List of Figures

List of Tables

Acronyms

ALE	Application Level Event
API	Application Programme Interface
BEG	Business Event Generator
EPC	Electronic Product Code
GLN	Global Location Numbers
HAL	Hardware Abstraction Layer
ISO	International Standard Organisation
LLRP	Low Level Reader Protocol
RFID	Radio Frequency Identification
RP	Reader Protocol
SME	Small and Medium Enterprise
SSCC	Serialized Shipping Container Code
TCO	Total Cost of Ownership
WP	Work package

Section 9 References and bibliography

[1] Fosstrck Project. http://www.fosstrak.org/
[2] EPCglobal, "The Application Level Events (ALE) Specification, Version 1.1", February. 2008, available at: http://www.epcglobalinc.org/standards/ale
[3] EPCglobal, "Low Level Reader Protocol (LLRP), Version 1.0.1, August 13", 2007, available at: http://www.epcglobalinc.org/standards/llrp
[4] Jayavel Sounderpandian, Rajendra V. Boppana, Suresh Chalasani, and Asad M. Madni. Models for Cost-Benefit Analysis of RFID Implementations in Retail Store. IEEE SYSTEMS JOURNAL, VOL. 1, NO. 2, DECEMBER 2007
[5] Strüker, Jens, Gille, Daniel. THE SME WAY OF ADOPTING RFID TECHNOLOGY – Empirical Findings from a German Cross-Sectoral Study
[6] Getting the most out of RFID: A starting guide to radio frequency identification for SMEs. By Department of Communications, Information Technology and the Arts (DCITA). © Commonwealth of Australia 2006
[7] P.Monar, Mario Gronert, Timea Czirner, Petya Bozhkova, John Soldatos, Tom Brookes. RFID-ROI-SME DELIVERABLE D1.1 "SME End-User Requirements"
[8] Bluetooth UHF Proximity Handheld Grip 868MHz: SIH-900. http://www.scemtec.com/stt/en/products/handheld.htm#SIH-900

Appendix – Indicative Configuration files used in the Pilot Deployment

```
<?xml version="1.0" encoding="ISO-8859-7" standalone="yes"?>
<ns2:ECSpec includeSpecInReports="false" creationDate="2010-04-
19T18:15:16.010+03:00" schemaVersion="0" xmlns:ns2="urn:epcglobal:ale:xsd:1">
    <logicalReaders>
        <logicalReader>dock_door_1</logicalReader>
    </logicalReaders>
    <boundarySpec>
        <startTrigger>urn:epc:idpat:sgln:5206428.*.*</startTrigger>
        <stopTrigger>urn:epc:idpat:sgln:5206428.*.*</stopTrigger>
    </boundarySpec>
    <reportSpecs>
        <reportSpec reportOnlyOnChange="false" reportIfEmpty="true"
reportName="Receive">
            <reportSet set="CURRENT"/>
            <filterSpec>
                <includePatterns/>
                <excludePatterns/>
            </filterSpec>
            <groupSpec>
                <pattern>urn:epc:idpat:sscc:5206428.*</pattern>
                <pattern>urn:epc:idpat:gs1:5206428.314.*</pattern>
                <pattern>urn:epc:idpat:sstn:5206428.3.*</pattern>
                <pattern>urn:epc:idpat:ssdn:5206428.10000.*</pattern>
                <pattern>urn:epc:idpat:sgtin:5206428.*.*</pattern>
                <pattern>urn:epc:idpat:sgln:5206428.*.*</pattern>
            </groupSpec>
            <output includeCount="false" includeRawDecimal="false"
includeRawHex="false" includeTag="false" includeEPC="true"/>
            <extension>
                <groupAlias groupAlias="nParentGroup"
groupName="urn:epc:idpat:sscc:5206428.*"/>
                <groupAlias groupAlias="sensorObservationGroup"
groupName="urn:epc:idpat:gs1:5206428.314.*"/>
                <groupAlias groupAlias="nTransactionGroup"
groupName="urn:epc:idpat:sstn:5206428.3.*"/>
                <groupAlias groupAlias="nDispositionGroup"
groupName="urn:epc:idpat:ssdn:5206428.10000.*"/>
                <groupAlias groupAlias="dataGroup"
groupName="urn:epc:idpat:sgtin:5206428.*.*"/>
                <groupAlias groupAlias="nBizLocationGroup"
groupName="urn:epc:idpat:sgln:5206428.*.*"/>
            </extension>
        </reportSpec>
    </reportSpecs>
    <extension>
        <ECLogicalReadersExtension>
            <logicalReaderExtension logicalReaderName="dock_door_1">
                <physicalReader>Speedway-10-06-EF</physicalReader>
            </logicalReaderExtension>
        </ECLogicalReadersExtension>
    </extension>
</ns2:ECSpec>
```

Table 3: Baseline ECSpec for the Receiving process at STAFF

```
<?xml version="1.0" encoding="ISO-8859-7" standalone="yes"?>
<ns2:ECSpec includeSpecInReports="false" creationDate="2010-05-
31T00:00:00.000+03:00" schemaVersion="0" xmlns:ns2="urn:epcglobal:ale:xsd:1">
    <logicalReaders>
        <logicalReader>dock_door_1</logicalReader>
    </logicalReaders>
    <boundarySpec>
        <startTrigger>urn:epc:idpat:sgln:5206428.*.*</startTrigger>
        <stopTrigger>urn:epc:idpat:sscc:5206428.*</stopTrigger>
    </boundarySpec>
    <reportSpecs>
        <reportSpec reportOnlyOnChange="false" reportIfEmpty="true"
reportName="PickPack">
            <reportSet set="CURRENT"/>
            <filterSpec>
                <includePatterns/>
                <excludePatterns/>
            </filterSpec>
            <groupSpec>
                <pattern>urn:epc:idpat:sscc:5206428.*</pattern>
                <pattern>urn:epc:idpat:gs1:5206428.314.*</pattern>
                <pattern>urn:epc:idpat:ssdn:5206428.10000.*</pattern>
                <pattern>urn:epc:idpat:sgln:5206428.*.*</pattern>
                <pattern>urn:epc:idpat:sgtin:5206428.*.*</pattern>
                <pattern>urn:epc:idpat:sstn:5206428.4.*</pattern>
                <pattern>urn:epc:idpat:sstn:5206428.3.*</pattern>
            </groupSpec>
            <output includeCount="false" includeRawDecimal="false"
includeRawHex="false" includeTag="false" includeEPC="true"/>
            <extension>
                <groupAlias groupAlias="nParentGroup"
groupName="urn:epc:idpat:sscc:5206428.*"/>
                <groupAlias groupAlias="sensorObservationGroup"
groupName="urn:epc:idpat:gs1:5206428.314.*"/>
                <groupAlias groupAlias="pDispositionGroup"
groupName="urn:epc:idpat:ssdn:5206428.10000.*"/>
                <groupAlias groupAlias="pBizLocationGroup"
groupName="urn:epc:idpat:sgln:5206428.*.*"/>
                <groupAlias groupAlias="dataGroup"
groupName="urn:epc:idpat:sgtin:5206428.*.*"/>
                <groupAlias groupAlias="nTransactionGroup"
groupName="urn:epc:idpat:sstn:5206428.4.*"/>
                <groupAlias groupAlias="pTransactionGroup"
groupName="urn:epc:idpat:sstn:5206428.3.*"/>
            </extension>
        </reportSpec>
    </reportSpecs>
    <extension>
        <ECLogicalReadersExtension>
            <logicalReaderExtension logicalReaderName="dock_door_1">
                <physicalReader>Speedway-10-06-EF</physicalReader>
            </logicalReaderExtension>
        </ECLogicalReadersExtension>
    </extension>
</ns2:ECSpec>
```

Table 4: Baseline ECSpec for the Pick and Pack process at STAFF

```
<?xml version="1.0" encoding="ISO-8859-7" standalone="yes"?>
<ns2:ECSpec includeSpecInReports="false" creationDate="2010-04-
19T18:15:16.010+03:00" schemaVersion="0" xmlns:ns2="urn:epcglobal:ale:xsd:1">
    <logicalReaders>
        <logicalReader>dock_door_1</logicalReader>
    </logicalReaders>
    <boundarySpec>
```

```
        <startTrigger>urn:epc:idpat:sgln:5206428.*.*</startTrigger>
        <stopTrigger>urn:epc:idpat:sgln:5206428.*.*</stopTrigger>
    </boundarySpec>
    <reportSpecs>
        <reportSpec reportOnlyOnChange="false" reportIfEmpty="true"
reportName="AddSSCC">
            <reportSet set="CURRENT"/>
            <filterSpec>
                <includePatterns/>
                <excludePatterns/>
            </filterSpec>
            <groupSpec>
                <pattern>urn:epc:idpat:sstn:5206428.2.*</pattern>
                <pattern>urn:epc:idpat:ssdn:5206428.10000.*</pattern>
                <pattern>urn:epc:idpat:sscc:5206428.*</pattern>
                <pattern>urn:epc:idpat:sgln:5206428.*.*</pattern>
            </groupSpec>
            <output includeCount="false" includeRawDecimal="false"
includeRawHex="false" includeTag="false" includeEPC="true"/>
            <extension>
                <groupAlias groupAlias="nTransactionGroup"
groupName="urn:epc:idpat:sstn:5206428.2.*"/>
                <groupAlias groupAlias="nDispositionGroup"
groupName="urn:epc:idpat:ssdn:5206428.10000.*"/>
                <groupAlias groupAlias="dataGroup"
groupName="urn:epc:idpat:sscc:5206428.*"/>
                <groupAlias groupAlias="nBizLocationGroup"
groupName="urn:epc:idpat:sgln:5206428.*.*"/>
            </extension>
        </reportSpec>
    </reportSpecs>
    <extension>
        <ECLogicalReadersExtension>
            <logicalReaderExtension logicalReaderName="dock_door_1">
                <physicalReader>Speedway-10-06-EF</physicalReader>
            </logicalReaderExtension>
        </ECLogicalReadersExtension>
    </extension>
</ns2:ECSpec>
```

Table 5: Baseline ECSpec for the Container Tagging process at STAFF

```
<?xml version="1.0" encoding="ISO-8859-7" standalone="yes"?>
<ns2:s2Spec creationDate="2010-07-29T12:41:04.083+03:00" schemaVersion="0"
xmlns:ns2="urn:com:sensap:sbox:sensos:s2xml">
    <s2SpecName>AddSSCC</s2SpecName>
    <ecSpecName>AddSSCCECReport</ecSpecName>
    <saleService>tcp://sale</saleService>
    <task>
        <taskName>AddSSCC</taskName>
        <bizStep>add a new container</bizStep>
        <checkTransition>false</checkTransition>
        <pState>false</pState>
    </task>
    <transitionRule>
        <transitionRuleName>AddSSCC:PA</transitionRuleName>
        <priority>0</priority>
        <pState>
            <stateRuleName>AddSSCC:A</stateRuleName>
            <printed>false</printed>
            <itemQuantity>
            </itemQuantity>
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
```

```
                <max>311040000000</max>
            </dTime>
        </pState>
        <nState>
            <stateRuleName>AddSSCC:B</stateRuleName>
            <printed>true</printed>
            <itemQuantity>
            </itemQuantity>
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
                <max>311040000000</max>
            </dTime>
        </nState>
        <sisEventType>PrintEvent</sisEventType>
        <actionType>ADD</actionType>
        <serviceURI></serviceURI>
    </transitionRule>
</ns2:s2Spec>
```

Table 6: Sample Configuration file for state management of objects/items in the scope of the containers tagging process at STAFF

```
<?xml version="1.0" encoding="ISO-8859-7" standalone="yes"?>
<ns2:s2Spec creationDate="2010-04-19T18:26:58.267+03:00" schemaVersion="0"
xmlns:ns2="urn:com:sensap:sbox:sensos:s2xml">
    <s2SpecName>Receive</s2SpecName>
    <ecSpecName>ReceiveECReport</ecSpecName>
    <saleService>tcp://sale</saleService>
    <task>
        <taskName>Receive</taskName>
        <bizStep>receive task</bizStep>
        <checkTransition>false</checkTransition>
        <pState>false</pState>
        <transaction>urn:epc:id:sstn:5206428.3.2</transaction>
    </task>
    <transitionRule>
        <transitionRuleName>Receive:AA</transitionRuleName>
        <priority>1</priority>
        <pState>
            <stateRuleName>Receive:B</stateRuleName>

<transactionClassEPC>urn:epc:idpat:sstn:5206428.3.*</transactionClassEPC>
            <bizLocationEPC>urn:epc:id:sgln:5206428.0.0</bizLocationEPC>
            <dispositionEPC>urn:epc:id:ssdn:5206428.10000.2</dispositionEPC>
            <printed>true</printed>
            <itemQuantity>
            </itemQuantity>
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
                <max>311040000000</max>
            </dTime>
        </pState>
        <nState>
            <stateRuleName>Receive:C</stateRuleName>
            <containerEPCPattern>urn:epc:idpat:sscc:5206428.*</containerEPCPattern>

<transactionClassEPC>urn:epc:idpat:sstn:5206428.3.*</transactionClassEPC>
            <bizLocationEPC>urn:epc:id:sgln:5206428.0.0</bizLocationEPC>
            <dispositionEPC>urn:epc:id:ssdn:5206428.10000.2</dispositionEPC>
            <printed>true</printed>
            <itemQuantity>
            </itemQuantity>
```

```
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
                <max>311040000000</max>
            </dTime>
        </nState>
        <sisEventType>AggregationEvent</sisEventType>
        <actionType>ADD</actionType>
        <serviceURI></serviceURI>
    </transitionRule>
    <transitionRule>
        <transitionRuleName>Receive:TA</transitionRuleName>
        <priority>1</priority>
        <pState>
            <stateRuleName>Receive:A</stateRuleName>

<transactionClassEPC>urn:epc:idpat:sstn:5206428.1.*</transactionClassEPC>
            <dispositionEPC>urn:epc:id:ssdn:5206428.10000.1</dispositionEPC>
            <printed>true</printed>
            <itemQuantity>
            </itemQuantity>
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
                <max>311040000000</max>
            </dTime>
        </pState>
        <nState>
            <stateRuleName>Receive:B</stateRuleName>

<transactionClassEPC>urn:epc:idpat:sstn:5206428.3.*</transactionClassEPC>
            <bizLocationEPC>urn:epc:id:sgln:5206428.0.0</bizLocationEPC>
            <dispositionEPC>urn:epc:id:ssdn:5206428.10000.2</dispositionEPC>
            <printed>true</printed>
            <itemQuantity>
            </itemQuantity>
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
                <max>311040000000</max>
            </dTime>
        </nState>
        <sisEventType>TransactionEvent</sisEventType>
        <actionType>ADD</actionType>
        <serviceURI></serviceURI>
    </transitionRule>
    <transitionRule>
        <transitionRuleName>ReceiveBox:TA</transitionRuleName>
        <priority>1</priority>
        <pState>
            <stateRuleName>ReceiveBox:A</stateRuleName>
            <dispositionEPC>urn:epc:id:ssdn:5206428.10000.0</dispositionEPC>
            <printed>true</printed>
            <itemQuantity>
            </itemQuantity>
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
                <max>311040000000</max>
            </dTime>
        </pState>
        <nState>
            <stateRuleName>Receive:B</stateRuleName>
```

```
<transactionClassEPC>urn:epc:idpat:sstn:5206428.3.*</transactionClassEPC>
            <bizLocationEPC>urn:epc:id:sgln:5206428.0.0</bizLocationEPC>
            <dispositionEPC>urn:epc:id:ssdn:5206428.10000.2</dispositionEPC>
            <printed>true</printed>
            <itemQuantity>
            </itemQuantity>
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
                <max>311040000000</max>
            </dTime>
        </nState>
        <sisEventType>TransactionEvent</sisEventType>
        <actionType>ADD</actionType>
        <serviceURI></serviceURI>
    </transitionRule>
    <transitionRule>
        <transitionRuleName>ReReceive:AA</transitionRuleName>
        <priority>1</priority>
        <pState>
            <stateRuleName>Receive:C</stateRuleName>
            <containerEPCPattern>urn:epc:idpat:sscc:5206428.*</containerEPCPattern>

<transactionClassEPC>urn:epc:idpat:sstn:5206428.3.*</transactionClassEPC>
            <bizLocationEPC>urn:epc:id:sgln:5206428.0.0</bizLocationEPC>
            <dispositionEPC>urn:epc:id:ssdn:5206428.10000.2</dispositionEPC>
            <printed>true</printed>
            <itemQuantity>
            </itemQuantity>
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
                <max>311040000000</max>
            </dTime>
        </pState>
        <nState>
            <stateRuleName>Receive:C</stateRuleName>
            <containerEPCPattern>urn:epc:idpat:sscc:5206428.*</containerEPCPattern>

<transactionClassEPC>urn:epc:idpat:sstn:5206428.3.*</transactionClassEPC>
            <bizLocationEPC>urn:epc:id:sgln:5206428.0.0</bizLocationEPC>
            <dispositionEPC>urn:epc:id:ssdn:5206428.10000.2</dispositionEPC>
            <printed>true</printed>
            <itemQuantity>
            </itemQuantity>
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
                <max>311040000000</max>
            </dTime>
        </nState>
        <sisEventType>AggregationEvent</sisEventType>
        <actionType>ADD</actionType>
        <serviceURI></serviceURI>
    </transitionRule>
</ns2:s2Spec>
```

Table 7: Sample Configuration file for state management of objects/items in the scope of the STAFF receiving process

```
<?xml version="1.0" encoding="ISO-8859-7" standalone="yes"?>
<ns2:s2Spec creationDate="2010-05-31T00:00:00.000+03:00" schemaVersion="0"
xmlns:ns2="urn:com:sensap:sbox:sensos:s2xml">
    <s2SpecName>PickPack</s2SpecName>
```

```
    <ecSpecName>PickPackECReport</ecSpecName>
    <saleService>tcp://sale</saleService>
    <task>
        <taskName>PickPack</taskName>
        <bizStep>pick and pack</bizStep>
        <checkTransition>true</checkTransition>
        <pState>true</pState>
        <transaction>urn:epc:id:sstn:5206428.5.3249</transaction>
    </task>
    <transitionRule>
        <transitionRuleName>PickPack:AA</transitionRuleName>
        <priority>0</priority>
        <pState>
            <stateRuleName>PickPack:B</stateRuleName>

<transactionClassEPC>urn:epc:idpat:sstn:5206428.4.*</transactionClassEPC>
            <bizLocationEPC>urn:epc:id:sgln:5206428.0.0</bizLocationEPC>
            <dispositionEPC>urn:epc:id:ssdn:5206428.10000.5</dispositionEPC>
            <printed>true</printed>
            <itemQuantity>
            </itemQuantity>
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
                <max>311040000000</max>
            </dTime>
        </pState>
        <nState>
            <stateRuleName>PickPack:C</stateRuleName>
            <containerEPCPattern>urn:epc:idpat:sscc:5206428.*</containerEPCPattern>

<transactionClassEPC>urn:epc:idpat:sstn:5206428.4.*</transactionClassEPC>
            <bizLocationEPC>urn:epc:id:sgln:5206428.0.0</bizLocationEPC>
            <dispositionEPC>urn:epc:id:ssdn:5206428.10000.5</dispositionEPC>
            <printed>true</printed>
            <itemQuantity>
            </itemQuantity>
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
                <max>311040000000</max>
            </dTime>
        </nState>
        <sisEventType>AggregationEvent</sisEventType>
        <actionType>ADD</actionType>
        <serviceURI></serviceURI>
    </transitionRule>
    <transitionRule>
        <transitionRuleName>PickPack:TA</transitionRuleName>
        <priority>0</priority>
        <pState>
            <stateRuleName>PickPack:A</stateRuleName>

<transactionClassEPC>urn:epc:idpat:sstn:5206428.5.*</transactionClassEPC>
            <bizLocationEPC>urn:epc:id:sgln:5206428.0.0</bizLocationEPC>
            <dispositionEPC>urn:epc:id:ssdn:5206428.10000.6</dispositionEPC>
            <printed>true</printed>
            <itemQuantity>
            </itemQuantity>
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
                <max>311040000000</max>
            </dTime>
```

```
        </pState>
        <nState>
            <stateRuleName>PickPack:B</stateRuleName>

<transactionClassEPC>urn:epc:idpat:sstn:5206428.4.*</transactionClassEPC>
            <bizLocationEPC>urn:epc:id:sgln:5206428.0.0</bizLocationEPC>
            <dispositionEPC>urn:epc:id:ssdn:5206428.10000.5</dispositionEPC>
            <printed>true</printed>
            <itemQuantity>
            </itemQuantity>
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
                <max>311040000000</max>
            </dTime>
        </nState>
        <sisEventType>TransactionEvent</sisEventType>
        <actionType>ADD</actionType>
        <serviceURI></serviceURI>
    </transitionRule>
    <transitionRule>
        <transitionRuleName>PickPackBox:AA</transitionRuleName>
        <priority>0</priority>
        <pState>
            <stateRuleName>PickPackBox:A</stateRuleName>

<transactionClassEPC>urn:epc:idpat:sstn:5206428.4.*</transactionClassEPC>
            <bizLocationEPC>urn:epc:id:sgln:5206428.0.0</bizLocationEPC>
            <dispositionEPC>urn:epc:id:ssdn:5206428.10000.5</dispositionEPC>
            <printed>true</printed>
            <itemQuantity>
            </itemQuantity>
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
                <max>311040000000</max>
            </dTime>
        </pState>
        <nState>
            <stateRuleName>PickPack:C</stateRuleName>
            <containerEPCPattern>urn:epc:idpat:sscc:5206428.*</containerEPCPattern>

<transactionClassEPC>urn:epc:idpat:sstn:5206428.4.*</transactionClassEPC>
            <bizLocationEPC>urn:epc:id:sgln:5206428.0.0</bizLocationEPC>
            <dispositionEPC>urn:epc:id:ssdn:5206428.10000.5</dispositionEPC>
            <printed>true</printed>
            <itemQuantity>
            </itemQuantity>
            <dTime>
                <avg>5184000000</avg>
                <min>0</min>
                <max>311040000000</max>
            </dTime>
        </nState>
        <sisEventType>AggregationEvent</sisEventType>
        <actionType>ADD</actionType>
        <serviceURI></serviceURI>
    </transitionRule>
</ns2:s2Spec>
```

Table 8: Sample Configuration file for state management of objects/items in the scope of the pick&pack process at STAFF

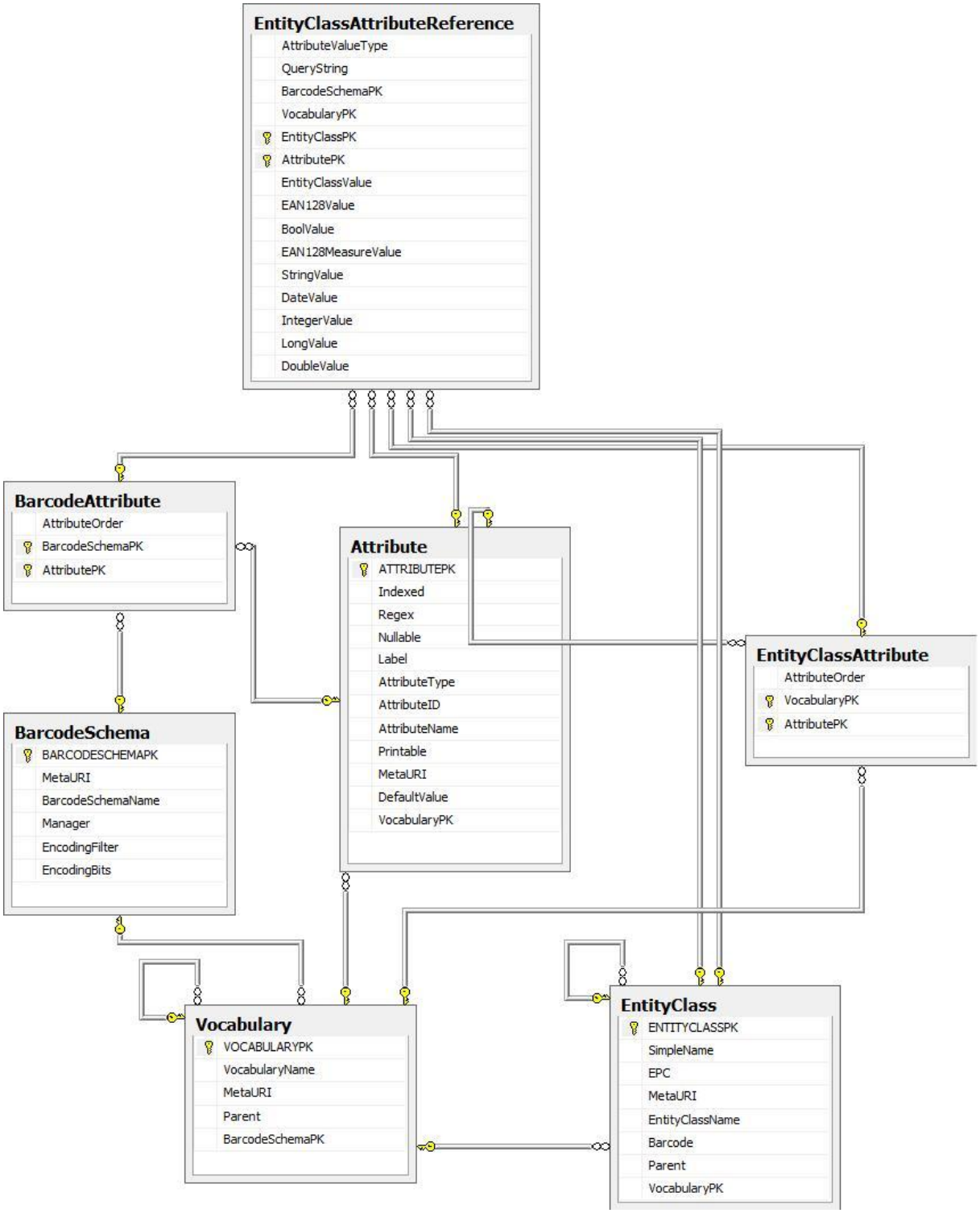

Figure 18: Database schema holding the master data vocabularies for STAFF