Collaborative Project

# ASPIRE

## Advanced Sensors and lightweight Programmable middleware for Innovative Rfid Enterprise applications

# FP7 Contract: ICT-*215417*-CP

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## WP6 – Application Integration, Trials and Evaluation

## ASPIRE Middleware Pilot Applications (Liaison Projects & New Pilots)

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## Approvals

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## Document history

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| **0.1** | 15 Apr 10 | Structure and First Version of the Document | Nikolaos Konstantinou (AIT), John Soldatos (AIT), Nikos Kefalakis (AIT) |
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## Executive summary

This deliverable contains all the details on the pilot trials, which have been carried out for demonstrating the benefits of the ASPIRE middleware platform. These pilot trials mainly consist of controlled and carefully designed experiments that have been organized either by those partners of the consortium who have previous experience on demos or similar events for small and medium enterprises (SMEs), or by other institutions that have accepted to test the ASPIRE middleware platform during their trials. The pilots aim at covering different business sectors, scenarios and applications related to RFID (Radio Frequency Identification) systems, thus giving a diverse set of outcomes that provide a better perspective on how ASPIRE can help in the reduction of the Total cost of ownership (TCO) associated to RFID systems as well as to confirm the ease of implementation of ASPIRE open source software (OSS) components into current IT SME infrastructures.

Besides containing specific details for each one of the trials, this deliverable also presents a set of demos designed to fully showcase the functionality offered by the ASPIRE middleware.

As stated in previous project documents (e.g., in the description of work in [1]), ASPIRE is developing an Open Source RFID middleware platform, which has been jointly set up by the partners and the OW2 consortium. 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). The ASPIRE middleware platform aims at being: (a) lightweight, so that it can be easily adopted by the low processing database servers of the SMEs; (b) programmable, so that integrators can rapidly deploy or adjust the components to new applications; (c) open source and royalty-free, so that the total cost of ownership is considerably reduced for SMEs; (d) privacy friendly, in order to cope with current and future issues inherent to RFID applications; and (e) innovative, in order to fill several gaps in the design of middleware platforms and RFID standards and interfaces.

The ease of development and cost-effectiveness enabled by the platform will be manifested during the pilot trials across different application domains, namely: logistics for the product packing and apparel sector, and retail scenarios for the apparel sector. The different pilot trials described in this deliverable are the following:

- A pilot for STAFF S.A. (leading Greek apparel manufacturer), which focuses on two distinct yet complementary scenarios, namely logistics and retails for the apparel-textiles industry.

- A 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.

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

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

- A 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.

Details on each one of these pilots are given in the main body of this document. Finally, it is also worth mentioning that this deliverable is complementary to previous documents such as D2.6, D2.2 and D6.1, which have already provided, respectively, the specification of scenarios and trials, the end-user requirements for the middleware platform, and the actual planning and execution of the ASPIRE pilots.

# 1 Introduction

## 1.1 Background

### 1.1.1 Brief background on RFID and middleware platforms

RFID is the technology that will probably have the major impact on our daily lifestyle by using a network of fixed or mobile distributed readers to automatically collect radio identification signals coming from low cost/size tags [2]. RFID has obtained lots of benefits from recent advances in low cost microelectronics and radio-frequency transceivers, thereby becoming the best candidate to replace current solutions for automatic identification such as optical bar scanners [3, 4].

The definition of "RFID system" has changed over time and according to the particular architecture design. The first definitions found in the literature considered RFID systems as simply composed of readers and tags [4]. Readers or interrogators, which have higher processing capabilities than tags, request and process information from tags. Conversely, tags or transponders have the only function of responding to reader's requests by sending an identification signal modulated by a specific purpose chip [5]. Active tags are powered by an in-board battery, which enhances both their reading ranges and their cryptographic features at the expense of a limited life-time and higher costs [6, 14]. In contrast, passive tags scavenge their power from the energy radiated by the readers, thus being long lasting and inexpensive, but with limited reading ranges and reduced cryptographic features [7, 8].

The origins of the RFID technology date back to the 1940s, when the principles behind radar technology and the theory of reflected power, which constitute the basics of modern RFID, were initially developed [9]. However, commercial RFID deployments did not see the light until the late 60s and early 70s, which preceded the massive adoption experienced during the last three decades. This rapid evolution has highlighted the importance of the middleware and back-end processing functionalities within RFID systems [3] [10]. Today, we can certainly say that a modern RFID system is composed of readers, tags and a middleware platform.

RFID technologies and standards have evolved to reflect the needs of new applications such as supply chain [11], retail [12] and engineering management [13]. Nevertheless, the development of middleware platforms still has several open issues that must reflect the rapid evolution of RFID technology as well as the restrictions imposed by market, software development tools and SMEs requirements. It is known that for RFID to have success, SMEs play an important role since they represent the major contributors to European and other major economies in the world. However, SMEs are still reluctant to adopt the RFID technology since the total cost of ownership related to its implementation is high, which in addition to many issues coming from security, privacy, regulatory and other fields, make such implementation difficult to complete. Therefore, modern RFID systems must consider this heterogeneous and complex landscape that involves several different areas of knowledge. Current middleware platforms only partially address the challenges brought by RFID systems such as privacy, security, royalty-free, open source, programmability, modularity, scalability, etc. (see deliverable D2.1 [15] for a summary of the state-of-the art on middleware platforms), thus calling for an innovative approach to tackle such issues.

#### *1.1.2 The ASPIRE middleware platform*

Taking into account the aforementioned status and open issues of RFID technology and middleware solutions, ASPIRE aims at producing a middleware platform and added-value sensing components that will fill the main gaps related to RFID systems and more importantly will reduce the deployment costs for SMEs.

The solutions brought forward by ASPIRE will be open source and royalty-free, thus bringing to an important reduction of the TCO, and at the same time will be programmable and lightweight, in order to be backwards compatible with current IT SME infrastructures. Additionally, ASPIRE will be privacy friendly, which means that future privacy features related to RFID systems can be easily adopted by the platform. Finally, ASPIRE will also fill the gaps in the development of new middleware architecture modules that are in the process of being standardized.

In order to have a more realistic vision of how the ASPIRE middleware platform will bring so many benefits to RFID implementations, and thus cause an important change in the implementation paradigm of these systems, a set of trials or controlled experiments have been envisioned. Details are given in the following subsections.

### 1.2 Methodology of choosing pilots

The pilot trials described in this document have been designed in order to satisfy as much as possible the end-user requirements stated in deliverable D2.2, and also to test as much as possible the potential benefits of the middleware platform proposed by ASPIRE. The main outcomes from the analysis on the end-user requirements in D2.2 are summarized as follows:

1. SMEs are still reluctant to adopt the RFID technology due to the high implementation costs and the lack of an attractive business model that ensures their return of investment.

2. SMEs IT infrastructures are scarce and limited to a few PCs with a medium bandwidth Internet connection.

3. SMEs are not literate in technology issues such as RFID, but in some cases they are open to new technologies, which may improve their business processes.

4. SMEs have some needs on traceability, stock, cold chain and engineering management that are not addressed by current identification technologies, although they are not sure that RFID might fulfill all of their needs.

5. SMEs might be benefitting by a technology that allows them to sense certain environmental parameters such as temperature and position.

On the other hand, the ASPIRE middleware platform (available as part of the ASPIRE Open Source project at http://wiki.aspire.ow2.org) is being designed and implemented in order to satisfy most of the above needs [16]. Mainly, it aims at reducing the implementation costs of the RFID technology via lightweight, open source and programmable software components. This lightweight nature will also allow it to be installed in low complexity hardware components at the SMEs premises, while it will also allow SMEs to deploy a wide variety of applications using RFID. The middleware platform will also provide added-value services such as temperature and positioning information sensing, which are important for cold chain management applications, for example.

Therefore, the pilots presented in this document have been selected, or in some cases modified, in order to answer to the above-mentioned SME requirements and for measuring the performance of the main ASPIRE middleware components related to such issues.

## 1.3 Scope of pilot projects

In relation to the overall objectives of the project, the objectives of the trials are the following:

- To verify that the developed middleware is programmable enough to be used by SMEs from different sectors (e.g., textiles, fashion, industry).

- To verify that there is no problem to deploy ASPIRE Middleware on SMEs current IT infrastructures as well as on low-cost hardware (i.e., to validate the lightweight nature of the middleware).

- To verify the scalability of the ASPIRE middleware by, e.g., being able to work both with 500 RFID tag detections and 50.000 tag detections.

- To verify that the ASPIRE middleware is easy to use (based on feedback from the SMEs regarding its programmability and the difficulties encountered in using it).

- To correct problems that could occur while deploying or using early versions of the ASPIRE middleware.

- To verify that the use of the RFID technology and the ASPIRE middleware results in real cost savings for SMEs.

- To verify that the ASPIRE middleware can be effectively adapted for mobile RFID solutions with low cost (significantly lower than the cost required today).

- To verify that software components can be effectively reused in other similar or more advanced applications without major modifications (modularity).

The methodology and key performance indicators to achieve and assess the above goals are described later in this document.

### *1.3.1 Supported middleware features*

The pilot trials have been envisioned so as to test most of the features of the middleware platform. For details of the ASPIRE middleware architecture we refer the reader to deliverable D4.1 [16]. A summary of those middleware features to be tested in the pilots follows:

- A Hardware Abstraction Layer (HAL), which configures the underlying RFID readers and forwards data to an EPCglobal Application Level Events (ALE) implementation. Currently, HAL is able to configure both RP- and LLRP-enabled devices, capture RFID data and forward it under a unified networked interface.

- ALE, which performs filtering and aggregation of RFID data coming from several different readers compliant with the EPCglobal ALE protocol.

- ASPIRE Business Events Generator (BEG), which translates Application Level Events into business events, according to an IS protocol and stores those business events in a repository. The BEG layer does not correspond to the EPCIS capturing application; BEG comprises an ASPIRE custom layer that bridges the gap between ALE and EPCIS roles. The gap is left intentionally by the EPC to be covered by Business Process Management engines such as MS BizTalk and SAP MII servers. It is important to stress that ASPIRE does not merely implement the standards, but develops innovative software tiers that may be subjected to standardization.

- The ASPIRE middleware components for producing the necessary configuration files for the underlying software components. The ASPIRE middleware components for accessing an EPC-IS repository.

Figure 1 illustrates the components of the middleware platform previously described.

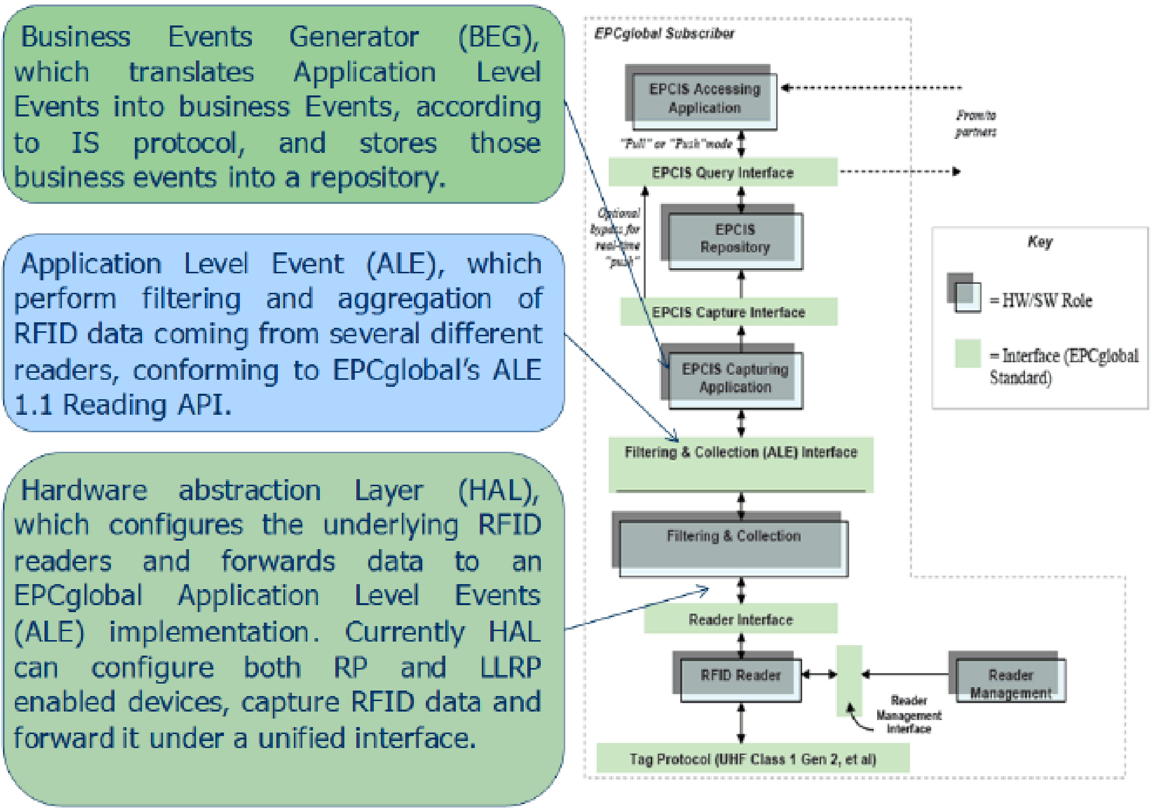



**Figure 1: ASPIRE middleware components to be tested in the trial (N.B.: EPC Global subscribers are not the sole target of Aspire)**

### *1.3.2 Sectors targeted by the pilot trials*

The ASPIRE's trials target the following specific industries and sectors:

- Packaging and Logistics (SENSAP's Greek Trial).
- Intra Enterprise Logistics Process Management (PV Lab`s French Trial).
- Fashion and Textiles, Liaison with the Greek Thessaly – Pole of Innovation.
- Healthcare.

As previously mentioned, the consortium selected to implement the trials in the above sectors after receiving the feedback from the RFID information days and visits to companies for the RFID trials (mainly done by SENSAP and AIT). The first selection is for the SENSAP's warehouse and its aim is to solve a common issue for a large number of SMEs: the warehouse inventory problem. In contrast, the French trial (PV Lab Trial) is going to cover the manufacturing sector and related processes such as asset management. The liaison trial focuses the interest on a particularly important sector for the RFID technology: the fashion industry. The fashion industry is attractive for RFID implementations since it has a clear ROI and it is the best application field to evaluate software and business models for most of the important variables of the RFID technology (i.e., logistics, warehouse, items level and marketing tools). The last two trials cover all the procedures and sectors of Textiles and Fashion-Apparel industry (vertical approach). This approach will provide to the consortium feedback from larger scale deployments and economics. The SENSAP trial will facilitate the warehouse inventory in order to provide a scalable and configurable expertise in warehouse inventory procedures.

Finally, the trial in the healthcare sector will provide a pilot of innovative intelligent set of scalable services that will support the independent living of elderly people in general. The following table provides an overview of the main characteristics of the trials that are described in the rest of the document. In essence it also provides a short comparison of the trials.

| **Company name** | SENSAP S.A | STAFF Jeans C.O | Pole Traceability Lab |
|---|---|---|---|
| **Country** | Greece | Greece | France |
| **Sector** | Packaging | Apparel | Demo |
| **Focus** | Logistics/Supply Chain | Logistics/Supply Chain and Retail | Intra Enterprise Logistics Process Management Demonstration |
| **Level of tagging** | Pallet | Item | Pallet/Item (demo) |
| **Number of tagged objects** | Thousands | Hundreds of thousands | Hundreds |
| **Hardware** | RFID Readers | RFID Readers, Touch Screens | RFID Readers |
| **Middleware** | ASPIRE Middleware | ASPIRE Middleware | ASPIRE Middleware |
| **Integration with other software** | SENSAP ERP System | Logistics Vision WMS System | ASPIRE Demo Applications |
| **Added-value features** | Temperature Monitoring | - | - |

**Table 1: Overview of ASPIRE pilots' characteristics (and short comparison)**

### *1.3.3 Targeted use cases*

The trials described in this document will tackle the following business and use cases aspects:

1. Intra Enterprise Logistics Process Management.

2. Traceability and Asset Tracking.

3. Inventory and Ubiquitous Sensing.

The French trial will be focused on manufacturing and process management whilst the Greek one will be focused on traceability and asset tracking, both of them having sensing and control extensions. Asset tracking and traceability solutions will be complemented with warehouse management and integrated with SMEs business processes. Trials will also focus on the following specific aspects:

- Applications in which there is a lot of tags and a lot of detections.
- Applications where mobility is important.
- Applications that need the monitoring of physical parameters (e.g., temperature, humidity, etc.).

The scenarios of the RFID trials are based on actual procedures which currently exist in the different companies and that are expected to be enhanced with the RFID technology. This real RFID platform will be a field for developing and evaluating the ASPIRE's middleware capabilities. Based on the market needs, which were collected during the RFID information days, the online survey and the commitment of the companies, the consortium decided to proceed with the trials in the aforementioned industrial sectors.

### *1.3.4 Expected outcomes*

The main expected outcomes of the pilot trials are a set of evaluation metrics aiming at:

- Verifying that the ASPIRE Open Source Middleware can support realistic pilot deployments.
- Ensuring that the ASPIRE middleware can lower the integration effort and cost associated with pragmatic trials. Hence, at the end of the pilot trials, the consortium will also be able to measure the advantages of the ASPIRE platform from the perspective of the RFID integrators.
- Auditing the ability of the ASPIRE middleware to adapt to different use cases and trials scenarios.
- Perform a techno-economic analysis of the trials.

The evaluation will also audit the ability of Open Source ASPIRE middleware to support real RFID deployments and overall reduce the integration effort for RFID deployments. ASPIRE will also audit the level at which the deployment will improve the business processes of the different SMEs at the lowest cost. These measurements or performance metrics will be chosen in order to clarify to the SMEs the advantages of the platform in relation with their previous processes or to other identification technologies such as optical bar scanners. Overall, the proposed performance metrics and evaluation methodologies will give light on how the ASPIRE software is easier to deploy, easier to understand and at the same time if it allows producing a wide variety of RFID applications.

### 1.4 Scope of the document

The scope of this document is to present a detailed description of each pilot trial.

### 1.5 Deliverable structure

The structure of this deliverable is as follows: Section 2 gives an overview of pilots and demos; Sections 3-7 describe the pilot trials and Section 8 the demos; Section 9 draws the general conclusions of the deliverable.

# 2 STAFF Pilot

## 2.1 Overview

Staff S.A. is an apparel manufacturer and one of the leading companies in the Greek market of denim apparel. In this pilot, RFID technology is used in order to facilitate the following processes, necessary for STAFF's operations:

- Automatically count the apparels during Receiving, Shipping and Inventory
- Automatically verify the Picking and Packing of apparel
- Identify the authenticity of the apparel when it returns from sales, especially through the e-shop,
- Enable multimedia promotion at retail stores through services such as the "Interactive multimedia display" service and "Smart shelf cabinets" service
- Perform rapid inventory of clothes in the warehouse shelves or in the shelves of retail shops

The basic design parameters for the STAFF RFID solution were:

- The full use of the portable Barcode Scanners which the company already had in its possession.
- The interconnection of the AspireRfid based traceability platform with the installed ERP software system of the company, in order to provide comprehensive services and WMS.
- The possibility of extending the system to be able to manage similar processes in other facilities and sites of the company within and outside Greece (including production and retail facilities).

Following section elaborate on the trial objectives and use cases, as well as on the main elements of the hardware and software solution. Note that a video illustration of the trial is available at YouTube: http://www.youtube.com/watch?v=DmmC2QJmqNo

## 2.2 Objectives and Main Use Cases

### *2.2.1 Main Objectives and Traceability Operations*

The STAFF pilot emphasizes on apparel logistics, with a view to optimizing, automating and controlling the following processes:

- Receiving apparel goods
- Collecting and packaging of products
- Shipment of Sales orders.
- Inventory of products.

In addition to the above processes, the pilot has emphasized on the documentation and tracing of the products' state as they move through the company's supply chain. The tracing of the apparel products is documented based on the products' unit, trace and class.

For the documentation and tracing of the apparel product units in the supply chain, the following information is traced:

- The location of the products within specific processes of the supply chain.
- The phase/disposition of the product in the scope of a given business process.

The location and disposition of a product, are coded based on the (GS1, 2008) standard, and traced by the RFID middleware. Every business step within a business process incurs changes in the disposition of the products. SENSAP's extensions over the AspireRfid middleware provide the intelligence for deducing/inferencing the status of the products are they flow through various business steps and processes.

### *2.2.2 Traceable Objects-Entities and Related Reports*

The following table (Table 2) illustrates the (RFID-tagged) objects that are traced in the scope of the STAFF pilot. As evident from the table, the application traces apparel products as they are order and traverse the STAFF central warehouse, along with logistical units which drive the packaging of the items. The traceability of these objects is possible given that all these objects are tagged with RFID labels, which are printed through an RFID printer and a related software solution (developed by SENSAP). Hence, the RFID software/middleware undertakes to continually reading the labels of the items, processing the tag streams and ultimately generating and storing business events with the objects' status on the information sharing database of the RFID solution. Having the information in the information sharing database at hand, the pilot RFID system can keep track of the tagged items, their state and related business events. The whole pilot system adopts the ASPIRE architecture, described in relevant WP2/WP3 deliverables (notably D2.3 and D3.4).

| Traceable Object | Description | Encoding Schema |
|---|---|---|
| Ordered Product Units (Apparel) | Refers to the product class, trace and serial number of each ordered product unit | SGTIN (Serialized Global Trade Identification) |
| Products Units to be stored in the warehouse | Refers to the product class, trace and serial number of each product unit produced | SGTIN (Serialized Global Trade Identification) |
| Logistical Packaging Unit | Serial number of each logistical unit that contains STAFF products | SSCC (Serial Shipping Container Code) |

**Table 2: Objects that are traced in the scope of the STAFF Pilot**

The main object model of the traceable products is depicted in the following figure (Figure 2):

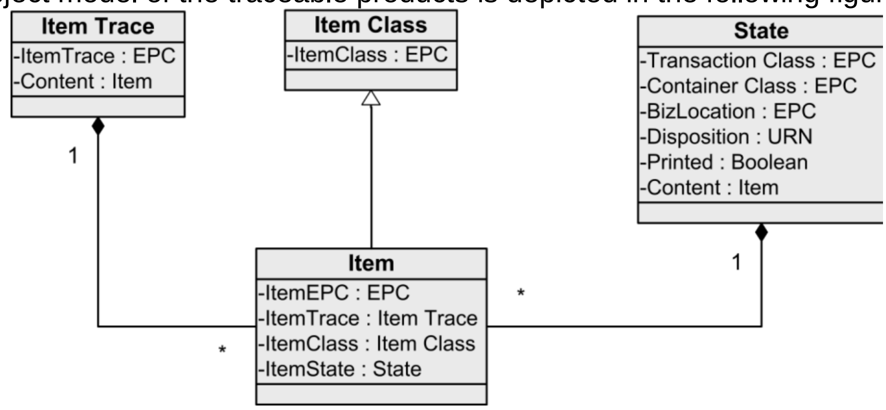



**Figure 2: Object Model for the representation of traceable STAFF objects/items**

The object model illustrates that for each item the software underpinning the pilot will keep track of each class, trace and state. The state representation is characterized by the occurring transaction, the container class, the business location of the item and the disposition of the item (in the scope of the running transaction). The object model is compatible with the EPC-IS object representation.

The RFID application developed from STAFF is capable of fully tracing and documenting the above –mentioned items. Accordingly, the application manages/produces the following messages and reports:

- **Sales Order**: The pilot RFID system keeps track of sales orders, which contain the class and the quantity of the order products, as well as the properties of the order such as the order date and the customer identifier/code.
- **Sales Order Confirmation**: A sales order confirmation contains the class, the trace and quantity of the ordered products, along with the properties of the order. It also contains the serial numbers (i.e. EPCs) of the products, as well as their association with logistic units (i.e. the containers, palettes, boxes they are packaged in).
- **Product Collection Note**: Contains the class the quantity of the products to be packaged, along with the sales order to which the packaging note corresponds. It is issued upon the packaging of products into logistical units. The product codes are usually printed in a human readable format.
- **Packaging Note**: Contains the class the quantity of the packaged products, along with the code of the sales order that led to this packaging note. It also contains information about the customer, as well as properties of the package. The codes of the packaged products appear in a human readable format. The packaging note is issued in response to the issue/execution of a product collection note.
- **Shipment Note**: Contains the class and the quantity of the packaged products, as well as the code of the sales order that led to the packaging of the products in logistics units for this shipment. It also contains customer information as well as other properties of the shipment processes (e.g., date).
- **Delivery Note**: Contains the class and the quantity of the products of the packing, along with the code of the reception process. It can also contain additional information/data about the delivery/reception process.
- **Inventory Note**: Contains the class and the quantity of the products, as well as the code of the inventory process. It also contains additional properties of the inventory process (e.g., date and/or person in charge of the inventory process).

All the above entities and reports are automatically handled by the RFID system, through appropriate inspection and analysis of RFID data and events residing in the EPC-IS repository. The system audits automatically the correctness and consistency of the above reports (e.g., the consistency of a shipment note within its corresponding sales order), thus obviating the need for several error prone human mediated processes (such as counting products during a shipment or delivery).

### *2.2.3 Use Cases*

Following tables illustrate the main use cases implemented by STAFF's RFID pilot system. These include:

- The Import Items use case (Table 3), which assigns a unique identifier to the products.
- The Label Items use case (Table 4), which associates the labels with physical product identifiers.
- The Print Items use case (Table 5), which prints the physical RFID labels and tags the items/products.
- The Build Reports use case (Table 6), which creates (the above-mentioned) reports in various formats.
- The Import SCC use case (Table 7), which deals with the coding and labelling of logistics unit, where the products will be packaged.

- The Print SCC items use case (Table 8), which concerns the physical tagging of the logistics unit (with RFID tags).
- The Ship Items use case (Table 9), which entails the auditing and documentation of the appropriate packaging of the products in logistical units, as well as of the correctness of the related shipping process.
- The Receive Items use case (Table 10), which concerns auditing and documentation of the reception of goods in an automatic manner via the RFID system.
- The Pick and Pack items use case (Table 111), which automatically audits the correct packaging of products in the scope of an order's fulfilment.
- The Ship PCS Items use case (Table 12), which concerns the automated auditing and documentation of a shipment process in response to a customer order.

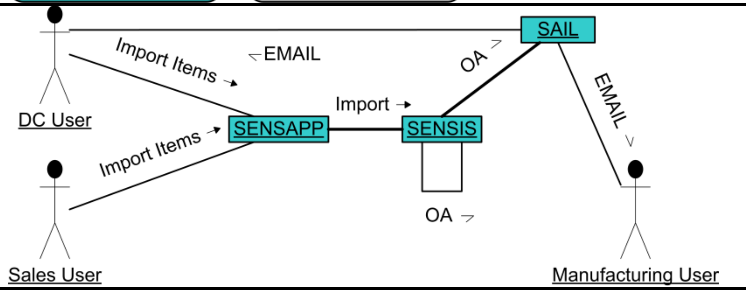
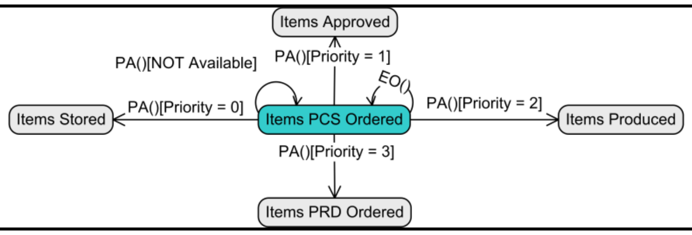
| Use Case | Import Items |
|---|---|
| Goal | This use case concerns the registration of sales order in the RFID system, which includes the coding (i.e. ID assignment) to each product unit. |
| Precondition | Availability of Master Data (i.e. from the STAFF WMS) |
| Primary Actors | Warehouse User, Sales Department User |
| Secondary Actors | - |
| Trigger | Sales Order |
| Extensions | Import Master Data (class and process) |
| Business Rules |  |
| Collaboration |  |

**Table 3: Import Items Use Case**

| Use Case | Label Items |
|---|---|
| Goal | This use case associates products with RFID labels. The association for the products is performed one by one. Hence, the state of the physical products becomes identical to the tags that will be used to label them, |
| Precondition | Products have a logical identity |
| Primary Actors | User/Employee of the STAFF Warehouse |
| Secondary Actors | - |
| Trigger | E-mail notification |
| Business Rules |  |

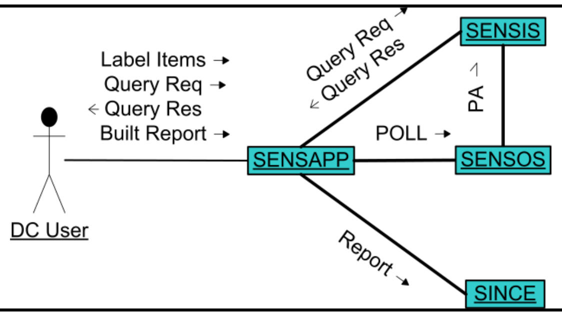
| | |
|---|---|
| Collaboration |   |

**Table 4: Label Items Use Case**

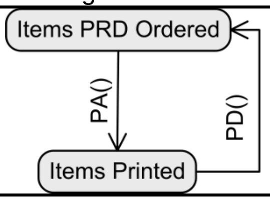
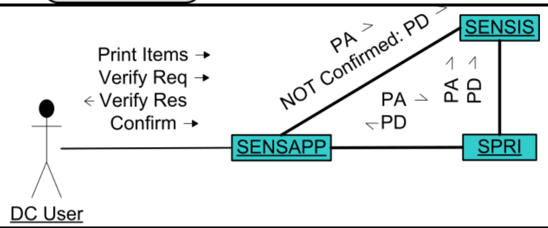
| Use Case | Print Items |
|---|---|
| Goal | Physical labels are printed in order to label the physical products. The association/labeling are done one by one. |
| Precondition | Products have a logical identity |
| Primary Actors | User/Employee of the STAFF Warehouse |
| Secondary Actors | - |
| Trigger | E-mail notification |
| Extensions | Printing Confirmation |
| Business Rules |   |
| Collaboration |   |

**Table 5: Print Items Use Case**

| Use Case | Built Report |
|---|---|
| Goal | This use case concerns the creation of reports in various formats (e.g., DOC, PDF, XLS, XML) |
| Precondition | - |
| Successful End Condition | Report Generated |
| Failed End Condition | System Error |
| Primary Actors | User/Employee of the STAFF Warehouse |
| Secondary Actors | - |
| Trigger | - |
| Extensions | - |
| Workflow | - |
| Business Rules | - |
| Collaboration | - |

**Table 6: Build Report Use Case**

| Use Case | Import SSC Items |
|---|---|
| Goal | This use case concerns the registration and coding of logistics units (i.e., containers, palettes, carton boxes). |
| Precondition | Availability of Master Data |
| Primary Actors | User/Employee of the STAFF Warehouse |
| Secondary Actors | - |
| Trigger | Product Collection Note |
| Extensions | Import Master Data (Class and process) |

**Table 7: Import SCC Items Use Case**

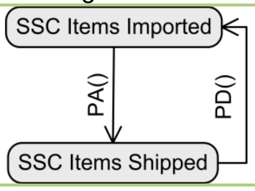
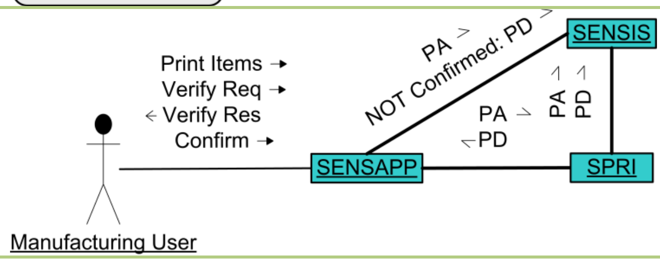
| Use Case | Print SSC Items |
|---|---|
| Goal | This use case concerns the one-to-one association of logistics units with physical RFID tags (i.e. the tagging of logistics units). |
| Precondition | The logistics units possess a logical identity/ |
| Primary Actors | User/Employee of the STAFF Warehouse |
| Secondary Actors | - |
| Trigger | Products collection note |
| Extensions | Printing Confirmation |
| Business Rules |   |
| Collaboration |   |

**Table 8: Print SCC Items Use Case**

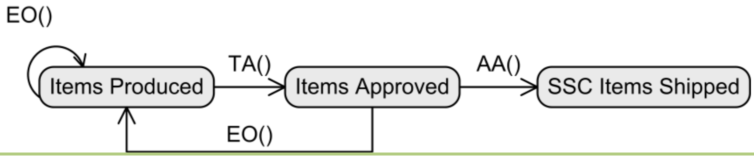
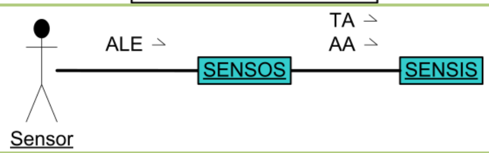
| Use Case | Ship Items |
|---|---|
| **Goal** | This use case entails the auditing and documentation of the appropriate packaging of the products in logistical units, as well as of the correctness of the related shipping process. |
| **Precondition** | |
| **Primary Actors** | RFID/AutoID Reader (without human intervention) |
| **Secondary Actors** | User/Employee of the STAFF production department |
| **Trigger** | Product Collection Note |
| **Extensions** | - |
| **Business Rules** |   |
| **Collaboration** |   |

**Table 9: Ship Items Use Case**

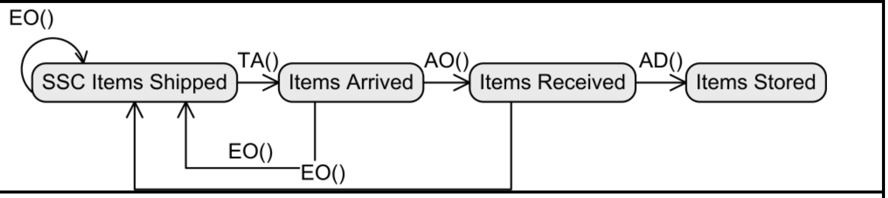
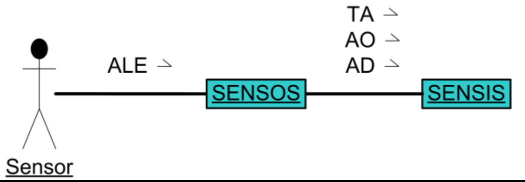
| Use Case | Receive Items |
|---|---|
| Goal | The use case concerns the auditing and documentation of the correctness of a good's reception process via the RFID system. |
| Precondition | - |
| Primary Actors | RFID/AutoID Reader (without human intervention) |
| Secondary Actors | User/Employee of the STAFF Warehouse |
| Trigger | Shipment Note |
| Extensions | - |
| Business Rules |   |
| Collaboration |   |

**Table 10: Receive Items use case**

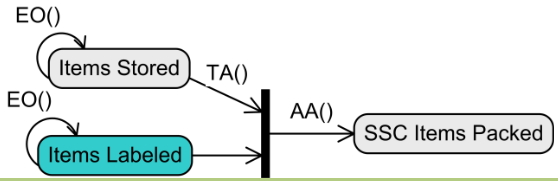
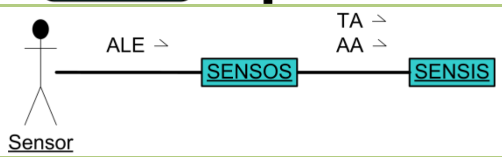
| Use Case | Pick-Pack Items |
|---|---|
| Goal | Auditing and documentation of the appropriate collection of products, as well as of their correct packaging in order to fulfill customer orders. |
| Precondition | - |
| Primary Actors | RFID/AutoID Reader (without human intervention) |
| Secondary Actors | User/Employee of the STAFF production department |
| Trigger | Product Collection Note |
| Extensions | - |
| Business Rules |   |
| Collaboration |   |

**Table 11: Pick and Pack Items Use Case**

| Use Case | Ship PCS Items |
|---|---|
| Goal | Auditing and documentation of order shipment |
| Precondition | - |
| Primary Actors | RFID/AutoID Reader (without human intervention) |
| Secondary Actors | User/Employee of the STAFF production department |
| Trigger | Product Collection Note |
| Extensions | - |

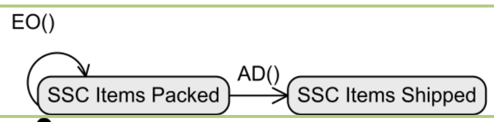
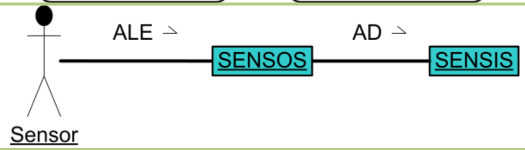
| | |
|---|---|
| Business Rules |  |
| Collaboration |  |

**Table 12: Ship PCS Items Use Case**

Note that these use cases illustrate the main functionalities offered by the pilot RFID system, which at the same time describing the main steps involved in the workflow of logistics management via the ASPIRE based RFID system in the STAFF warehouse.

In order to carry out the procedures of picking and packing, first the orders coming from the customers are registered in the system, either through the User Interface or by uploading a spreadsheet. These data can be imported independently of the shop ordering or receiving process, at any time. The apparel which has been received during one or more receiving procedures is assigned to the admitted customer orders. The system's User Interface allows the charging of amounts of apparel arrived in shipments for customers.

Next, after the completion of the amount charging process to deliveries, a picking list is issued. The picking process is performed by item, so the Picking list bundles the apparel with the same item by colour, size and delivery. The process of Picking and Packing includes the transport of items from the received logistic units into the Delivering logistic units. By using portable scanners, the system checks whether the movement between logistic units is correct or not and notifies the user accordingly. Moving items is also possible between the delivery packages. The system monitors and controls the correctness of this movement. When the Picking and Packing processes are complete, the delivery packages pass through the RFID portal, and then the final Packing Note and Delivery Note are issued.

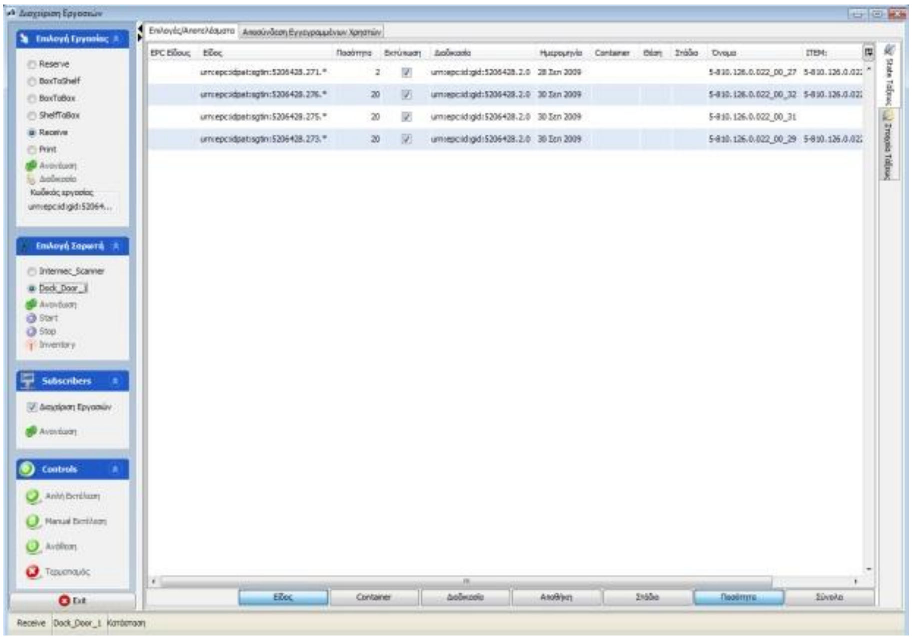


**Figure 3 SENSAP's tag printing solution**

In Figure 3Figure 3 above, a screenshot is displayed of the RFID tags printing interface. Figure 4 demonstrated the equipment for printing the tags. In (a) is the RFID tag printer, in (b) the label feed mechanism and in (c) the labels that contain the RFID tags.

(a) (b) (c)

**Figure 4 Printing equipment**

Technically, the company's operations are achieved by being based on the serial number that all of the company's products have. The identification of each product is then achieved productively through the RFID antenna system.

## 2.3 Hardware Components and Devices

### *2.3.1 Hardware Components and Devices*

Table 133 below depicts the hardware devices comprising the STAFF trial deployment.

| Hardware Unit/Device | Description |
|---|---|
| Workstation | This is the central server of the system, which hosts the JavaEE infrastructure server and the SBOX Suite. It hosts also specialized software for supporting thin-client connections. |
| Mobile Terminal | This is a mobile computing system (running Windows Mobile operating system), which can connect to the workstation via a wireless connection in order to enable wireless access to the SBOX suite. |
| Desktop Terminal | This is a laptop computer, which enables (client) access to the configuration capabilities of the SBOX middleware (via several AspireRfid tools). |
| Reader Device | RFID reader, which connects to the middleware in order to provide the read tag streams (which are accordingly processed by the middleware).The reading device at STAFF provide barcode reading capabilities as well. |
| RFID/AutoID Printer | Autonomous RFID Printer (with barcode support), which connects to the middleware in order to drive the printing of physical RFID/barcode labels. |
| Network | Wireless Network providing TCP/IP connectivity between the various hardware devices. |

**Table 13: Hardware Used in the scope of the STAFF pilot**

### *2.3.2 Bill-of-Materials of Hardware used in STAFF*

The previous paragraph has provided a high level description of hardware components and devices entailed in the STAFF pilot. A more detailed BOM (Bill-of-Materials) for this specific trial is detailed in Table 144, which illustrates the hardware used along with its more specific role in the pilot. Note that the following table includes additional infrastructural and actuating components, which are not part of

| Hardware Component(s) / Consumable Tags | Description | Use in the pilot |
|---|---|---|
| Tunel Portal - $8m^3$ | This is a Tunel Portal from aluminium and Plexi-Glass. A SUN Ray machine, an RFID Reader, four Far - Field RFID Antennas, and another four 4 x Near - Field RFID Antennas (max) can be put on this portal. The portal includes also coaxial cables with a length of six meters. | The portal is used to support the receiving and shipping processes/use cases of the pilot, where batch reading of packaged tagged products occurs are packages pass through the portal. |
| Tunel Portal Conveyor - 8m | This is an automatic conveyor belt (8m) with a remote control. | Used to facilitate packages (e.g., containers) to move/flow through the portal |
| Tunel Portal Actuators (two sets) | A Tunel Portal actuator set includes two optical switches, one LED and one Peeble II Controller for the IMPINJ Speedway RFID Reader. | Support actuating functionalities associated with the use of the portal (e.g., indications about the packages, the status of the processes etc.) |
| SUN Ultra 24 Workstation | SUN Microsystems workstation with the following characteristics: Workstation SUN Ultra 24: 1 x Intel Core2 Quad Extreme Q9650 3.0 GHz, 1333 MHz FSB, 8GB RAM (1GB x 8, 667MHz, ECC, DDR2), 1 x 250GB HDD (7,3k, SATA 3.0 Gbs) - RAID1, 1 x 1GbE , 4 x PCIe, 6 x USB 2.0, 1 x DVD+/-RW, 1 x NVIDIA FX370 Graphics Accelerator, 1 x SUN TFT 19" Colour, 1 x Keyboard, 1 x Optical Mouse, Desktop Chassis, SOLARIS 10 | This workstation host the RFID middleware of the solution (based on a JavaEE environment) |
| CISCO SD2008 Switch | The switch has the following specifications: Switch CISCO SR2024C, 8 x 10/100/1000 GbE RJ45, Desktop Chassis | Networking device used to support the networking communications of the solution |
| SUN Ray 2 Thin Client (two pieces) | Terminals adopting the Ultra - Thin Client SUN Ray 2 architecture. Specifications: 2 x USB 2.0, 1 x Serial, 1 x SIM Card, 17" SUN TFT Colour, Keyboard, Mouse, SUN VDI v3.0 Software | Terminals used by the employees of the STAFF warehouse in order to monitor and control the RFID deployment. |
| IMPINJ Speedway Reader (two pieces) | The IMPINJ Speedway RFID GEN 2 RFID Reader supporting the pilot solution. The specifications of the reader include: EPC CL1G2, LLRPv1.0.1, 865 MHz - 956 MHz, 4 x Mono-Static Antennas (Reverse gender TNC), Near & | It is used to support reading of tags during the RFID-enabled business processes. The reader supports the LLRP protocol and interfaces to the RFID solution via the |

| | | |
|---|---|---|
| | Far Field, RF +32.5 dBm, Sensitivity -80 dBm, 10/100 Base-T Ethernet, 1 x RS-232, DHCP, HTTP, Telnet, SSH, SNMP, mDNS, DNS-SD. | AspireRfid LLRP HAL. |
| IMPINJ Brickyard Antenna (two pieces) | RFID Reader Antenna, IMPINJ Brickyard CS-777, 865MHz – 956MHz | UHF antenna attached to the IMPINJ RFID reader. |
| IMPINJ Guardwall Antenna (two pieces) | RFID Reader Antenna, IMPINJ Guardwall | RFID antenna attached to the IMPINJ RFID reader. |
| MTI MT242017 Antenna (two pieces) | Far-Field RFID Reader Antenna MTI-Wireless MT-242017/NRH: Mono-Static, 865MHz – 956MHz, 10 Dbic min, VSWR 1.3:1 | RFID antenna attached to the IMPINJ RFID reader. |
| MTI MT242032 Antenna (two pieces) | 10 dbic | RFID antenna attached to the IMPINJ RFID reader. |
| PRINTRONIX SL4M RFID Printer | High Speed RFID/barcode printer Printronix SL4M with the following specifications: EPC CL1G2 / ISO180006C, EAN128, THERMAL TRANSFER, 203 dpi, RS232, PARALLEL, USB, 10/100 Base-T Ethernet. | RFID printer used for printing physically RFID and barcode labels |
| INTERMEC IP30A Mobile Terminal (two pieces) | INTERMEC Mobile RFID Readers | Used for Mobile Scanning (e.g., during pick & pack and inventory processes) |
| Satellite Label | RFID Label, IMPINJ Satellite, Monza 3 Chip (96bit R/W), EPC CL1G2, 1.34" x 2.13", TT Paper, Far & Near Field Operations | RFID Tags used during the STAFF pilot (for item level tagging of the apparel products) |

**Table 14: Bill-of-Materials (BOM) for the STAFF Pilot**

Note that RFID technology is combined with 2D Datamatrix Barcode coding. Each apparel label carries in the same time an RFID tag and a unique datamatrix id in order to be compatible with the pre-existing infrastructure. The whole system is based on the labels that include the RFID tags uniquely featuring the apparels. These labels, in addition to specific technical features related to the possibility of detection by RFID antennas should reflect, in a legible and elegant way, the necessary information such as size, colour and price. In the same time, they must have the appropriate size, be durable and most importantly, the lowest possible cost.

## 2.4 Software Components

### *2.4.1 Main Software Components*

The following table (Table 15) lists the main software components that have been deployed as part of the STAFF pilot:

| Software Module(s) | Description |
|---|---|

| | |
|---|---|
| Software Modules for Apparel Logistics Process Control and Monitoring | A collection of software modules/libraries based on JavaEE technology. These are based on AspireRfid modules and form the SBOX Suite. |
| JavaEE Compliant Application Server | An infrastructure server, which hosts the above-mentioned JavaEE modules. |
| Enterprise Information System / WMS | STAFF's (Logistics Vision) WMS system, which is interfaced to the SBOX Suite based on middleware bridges utilizing JAX-WS / JCA technologies, while also enabling exchange of files. The interfacing adopts the AspireRfid Connector concept and related middleware libraries. |

**Table 15: Main Software Items Used in the scope of the STAFF pilot**

### *2.4.2 Logical Architecture*

The software of the pilot is based on a number of JavaEE compliant software modules, which have been developed and integrated based on the AspireRfid middleware. The integration has taken place based on the architecture, which is depicted in Figure 5).

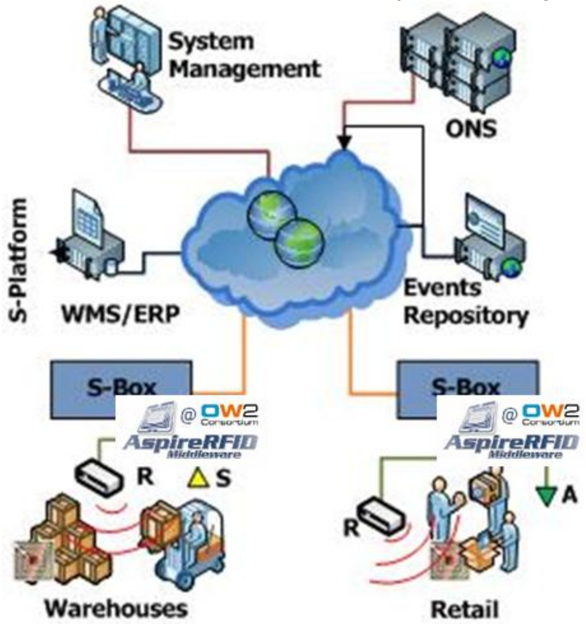



**Figure 5 Apparel Sector Trial - Solution Architecture**

Note that the logical architecture of the pilot comprises the following components:

- The SBOX suite currently deployed the STAFF warehouse. The SBOX suite has been integrated based on the AspireRfid middleware, thanks to the provisions of the LGPL license.
- A system management application, which facilitates the management of the devices entailed in the solution. A screenshot of the device management solution provided by SENSAP is displayed in Figure 6.
- The company's WMS/ERP system (i.e. Logistics Vision) that offers integration with the rest of the company's enterprise data/information
- An Object Naming Server (ONS) server, which is required for the integration of the present solution into inter-enterprise scenarios (e.g., with STAFF's suppliers and retailers). Note however that the ONS server is not used in the context of the current STAFF deployment.

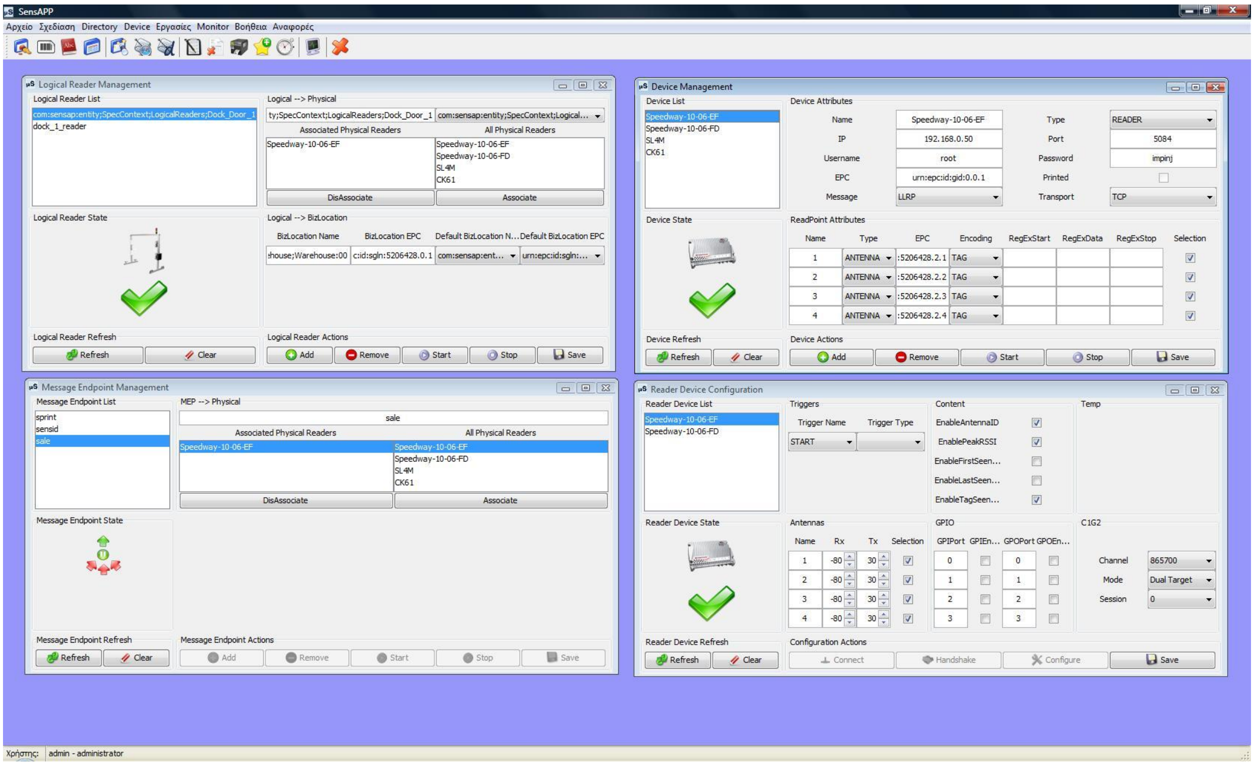


**Figure 6 SENSAP device management solution screenshot**

Note that the company's WMS system is used in order to print labels and data, which are entered from the "Shop order note" form (i.e. data type, colour, size, and quantity). The input required in order to print the labels can be done either through the RFID system User Interface or massively through a spreadsheet. Besides the printing of the tags for the ordered items, tags are printed for the packaging units. Both labels, packaging and apparel, are sent to the plant's production site. From there, the apparel is returned tagged at a unit level, in packaging which is also uniquely tagged.

For the labelling of the apparel, the EAN128 coding with application identifiers 01-GTIN and 21-SERIAL was chosen. The total code is printed using two-dimensional Barcode string, type DATAMATRIX and the chip is encoded with code length 96 bits type EPC SGTIN. This allows the identification of apparels in a serial number level, both through RFID and Barcode scanners. In addition, the GTIN code is printed with the classic EAN13 coding, for compatibility with older ERP systems. For the labelling of the packaging units, the EAN128 coding has been selected with application identifier 00-SSCC and a two-dimensional Barcode string, type Datamatrix.

## 2.5 Conclusions and Future Outlook

In the scope of the pilot STAFF installed a fully automated management and traceability system of stocks based on RFID technology. The installation and deployment of the RFID system was based on the AspireRfid platform and tools. Nevertheless, SENSAP integrated a number of added-value functionalities and features over the AspireRfid components, in order to address business requirements peculiar to STAFF. Such added-value components included an RFID printing solution, a device management solution, as well as tools and techniques for customizing RFID-enabled workflows pertaining to STAFF's business operations. Note that these solutions were not available by AspireRfid during the pilot deployment. Following the deployment of such functionalities for STAFF, the project partners are currently enhancing the AspireRfid project in order to support business intelligence, design of RFID-enabled workflows, as well as management of devices. The later enhancements are part of the WP3 and WP4 of the project and relate to the ASPIRE BI solution, the ASPIRE BPWME (Business Process Workflow Management Editor), and the ASPIRE (JMX-based) end-to-end management solution. The STAFF experience has provided feedback to the project team in order to fine-tune these developments, which will be thoroughly presented in coming WP3/WP4 deliverables (notably D3.5 (on end-to-end management) and D4.5 (on the ASPIRE Integrated Development Environment).

In terms of business benefits, the pilot achieved:

- The acceleration and intensification of the basic processes involved in the warehouse, such as Shipping and Receiving, Picking and Packing, and Inventory control
- The restraint of costs involved in these procedures.
- The reduction on human error, which has been proven to be an important financial loss for the STAFF Company.

Among the most important observations is that the adoption of an RFID-based solution drastically improved the installation's reliability, which became around 0.3%. In other words, the system "ignores" less than 3 items per 1000, reducing 10 times the physical scanning procedure errors which were made with the use of older technologies. With the use of RFID, an operator is able to receive about 10.000 items in a single shift, work that previously required at least three shifts. Additionally, the possibility of reading the contents of the received packages allows in many cases to handle the package as is, without unpacking, picking and repacking.

The system has been intensively tested in practice. Now it is fully operational, documenting the track of more than 800.000 items per year which are uniquely tagged. It should be underlined that the pilot RFID system at STAFF is an operative RFID system, which will be sustained beyond the end of the ASPIRE project. This is a result of the fact that STAFF sees business benefits associated with the operation of this pilot RFID system. In the scope of a following ASPIRE deliverable (namely D6.3), these business benefits will be quantified and assessed.

Note also that ASPIRE has given to this company the opportunity to create an RFID strategy, which includes the evolution of the system at the central warehouse in order to support production operations, as well as the deployment of RFID enabled processes (i.e. smart POS, promotion management) in the retail shop of the company. STAFF is pursuing its strategy through its participation in the ICT-PSP project RFID-ROI-SME (http://www.rfid-roi-sme.eu), where it is deploying some of the above-mentioned RFID functionalities. Through the exploitation of RFID in other business areas and processes, STAFF aspires to gain multiplicative benefits and economies of the scale, given that the (quite expensive) tagging of products will be exploited to acquire additional business benefits (e.g., in the areas of customer satisfaction, promotions management, management of returned products).

As a final note, we underline that the STAFF deployment has not taken advantage of latest features of the AspireRfid middleware, tools and programmability environments. In particular, the integration of the trial did not exploit the capabilities of the APDL (Aspire business Process Definition Language) for specifying and deploying the solution. This is currently attempted based on the reverse engineering of the STAFF processes in order to be described in APDL. Results and insights on this process will be provided in the concluding deliverables of WP4 and WP6 of the project.

# 3 SENSAP Pilot

## 3.1 Overview

The trial organized at SENSAP focuses on the deployment of an integrated RFID warehouse management solution with emphasis on stock control and management. The deployment replaced the company's existing barcode based system, which is associated with a host of human mediated and often inaccurate inventory process. As already outlined the RFID deployment at SENSAP aimed at evaluating RFID technology as a technological vehicle to support SENSAP's plans to handle a growing number of items, which at the same time optimizing the distribution of SENSAP's products in the company's warehouse, in a way that boosts agility and improves response to customer demands. At the same time, SENSAP wanted to be able to accurately monitor stock levels in order to optimize customer orders and minimizing the amounts of "sleeping" inventory.

Note that the pilot deployment relies on the trading activities of the company, which (based on its forerunner. VICOP) is active for more than 50 years in the manufacturing of mechanical equipment and components for the packaging industry. Moreover, it is noteworthy that (contrary to the STAFF pilot) the pilot deployment at SENSAP was implemented as a prototype system that will be evaluated in the scope of the project. Based on the results of the evaluation, the company will decide about sustaining the pilot beyond the end of the project.

## 3.2 Objectives, Use Cases and Benefits

The objectives, use cases and (expected) benefits of this pilot have been detailed in Deliverable D6.1 of the project, which has reported on the detailed planning of pilots and demonstrations of the ASPIRE project. In the sequel, we summarize objectives, use case and expected benefits, for the sake of completeness of this description.

### *3.2.1 Pilot Objectives*

The main objectives of the pilot include:

- To demonstrate the operation of an RFID enabled warehouse for pallet, carton and item level inventory in terms of the products sold by SENSAP.
- To automate processes such as receiving, shipping, pick and pack, and inventory management
- To optimize the management of stock level with real-time visibility.
- To allow for business utilization of RFID dynamic data from two distant places.
- To implement RFID enabled operations for stock control and management.
- To demonstrate ubiquitous added-value sensing capabilities in order to monitor the temperature of certain (temperature-sensitive) items and issue related alarms.
- To integrate the ASPIRE low-cost reader (developed in WP5 of the project) in the trial solution.

Note that the logistics part of the pilot features many similarities to the STAFF deployment, as is also outlined in the use cases of the following paragraph. However, the SENSAP pilot includes unique functionalities associated with the mixing/use of sensor data within the RFID tag streams (i.e. added value sensing), as well as the integration/use of the ASPIRE low-cost reader. Indeed, the abovementioned functionality are important for the ASPIRE project as a whole, since the demonstration of ubiquitous added-value sensing capabilities and of the low-cost reader are among the main objectives of the project.

### *3.2.2 Main Use Cases*

The main use cases of the pilot include:

- **Tagging of Pallets and Items**: In the scope of the pilot, physical RFID labels are printed and objects are tagged upon their arrival at the SENSAP warehouse. Different tags will be printed and used in order to tag pallets, containers and storage spaces (e.g., selves).
- **Receiving Goods**: The system supports RFID-enabled reception of goods. During this reception palettes and containers pass through an RFID dock door portal. The reception of good is consider a distinct business transaction in the system, which is typically associated with a dispatch (consignment) note (or delivery note) regarding the expected items. The RFID system keeps track of all the palettes received, along with information about the business location (i.e. the warehouse), the state/disposition of the objects (including their temperature profile)), as well as the reading points entailed in the receiving process.
- **Moving Goods**: This is the business process of tracking items as they move within the warehouse. This use case hinges on the tagging of storage spaces in the company, which enables the logical partition of SENSAP warehouse into multiple (logical) warehouses. Movement of goods takes place between selves and carts, which are classified as logical warehouses within the central warehouse. The detection of movement is based on reading RFID tags as they pass through dock-door portals, or via mobile readers. In all cases the RFID system detects the placement of items in the warehouse, along with the aggregations (e.g., being in palettes or carts), where they participate.
- **Order Collection**: One of the main use cases supported by the pilot is the order collection process, which is carried out in response to a sales order. A relevant picking list is created and used to pick items and puts them in appropriate containers such as carts. The picking process involves collecting the required items from the selves, which the packing process involves their packaging in containers and carts. The RFID system audits the correctness of the process, and signals its completion i.e. when all the products within the picking list have been collected and packaged.
- **Order Shipment**: The order shipment use case following the order collection process. It concerns the creation of packages for the orders to be shipped, based on removal of items out of the pick & pack carts. The process is driven by a packing list corresponding to the items to be shipped. As items are moved from picking carts to containers for the shipment, the system audits the correctness of the process (i.e. whether the packing list coincides with the shipment list). As soon as the process is correct the systems signifies the graceful completion of the order shipment process.
- **Inventory**: The inventory use case hinges on the scanning of the items in the warehouse selves via mobile RFID readers used by SENSAP employees. The system automatically stores the status of the items and their placement within the warehouse. The use case ensures the correctness and accuracy of the process, through checking the matching between the list of expected items, and the list of actually observed items.
- **Temperature Monitoring**: The temperature monitoring use case is part of all the above logistics use cases. It entails the maintenance and monitoring of a temperature profile for each container of items. The temperature profile comprises a history of the temperature of the items; along with the time intervals each temperature was observed. This is achieved by sampling of the temperature of the containers/items, whenever they are read by RFID readers. In particular, temperature data are integrated to the read RFID

tag streams and accordingly stored to the RFID information sharing repository of the solution.

### *3.2.3 (Expected) Benefits*

The detailed evaluation of the pilot falls in the scope of one of the coming ASPIRE deliverables, namely D6.3. Nevertheless, an early (qualitative assessment) of the trial reveals the following benefits:

- **Real-time inventory**: The RFID system provides SENSAP with information about the stock-levels of its products in real-time. This information is recorded in the company's ERP system, based on appropriate connectors to the RFID middleware. The placement of items is continuously conveyed to the ERP of the warehouse, as products move within warehouse spaces that are equipped with RFID readers. Furthermore, mobile readers are used to facilitate SENSAP employees in performing inventory functions in an accurate and fast manner, given that the use of RFID obviates the need for low-throughput item level scanning processes (i.e. as was the case of the legacy bar-code system).
- **Temperature monitoring**: Along with real-time inventory and stock management, the pilot will allow SENSAP to monitor the temperature of its products, with a view to maintaining a temperature state profile for each product. This will allow the issuance of notifications in cases where the quality of the products is under jeopardy due to high temperature.
- **Easy detection and (re)location of Misplaced items**: The new system allows SENSAP to easily and flexibly locate items that have been placed in wrong positions within the warehouse. This is part of the inventory/scanning process outlined above and can lead to a suggestion (by the system) of the correct placement of the misplaced item(s).
- **Confirmation at dispatch**: The RFID system enables the company to automatically and accurately verify and confirm packing lists in the scope of order shipments. This ensures that shipments are error-free.
- **Elimination of picking errors**: The automated auditing and verification of assembled orders during the "picking" process, allows the elimination of picking errors, which can more easily occur in the scope of bar-code based processes for "confirmation at dispatch".
- **Improved utilization of warehouse space**: The real-time inventory and location of misplaced items leads to a more efficient utilization of warehouse space. This leads subsequently to a reduction of logistics costs.

## 3.3 Hardware Components, Devices and Bill-of-Materials

A detailed BOM (Bill-of-Materials) for this specific trial is detailed in Table 16, which illustrates the hardware used along with its more specific role in the pilot. Note that the following table includes additional infrastructural and actuating components, which are not part of

| Hardware Component(s) / Consumable Tags | Description | Use in the pilot |
|---|---|---|
| Tunel Portal - $8m^3$ | This is a Tunel Portal from aluminium and Plexi-Glass. A SUN Ray machine, an RFID Reader, four Far - Field RFID Antennas, and another four 4 x Near - Field RFID Antennas (max) can be put | The portal is used to support the receiving and shipping processes/use cases of the pilot, where batch reading of packaged tagged products |

| | | |
|---|---|---|
| | on this portal. The portal includes also coaxial cables with a length of six meters. | occurs are packages pass through the portal. |
| Tunel Portal Conveyor - 8m | This is an automatic conveyor belt (8m) with a remote control. | Used to facilitate packages (e.g., containers) to move/flow through the portal |
| SUN Ultra 24 Workstation | SUN Microsystems workstation with the following characteristics: Workstation SUN Ultra 24: 1 x Intel Core2 Quad Extreme Q9650 3.0 GHz, 1333 MHz FSB, 8GB RAM (1GB x 8, 667MHz, ECC, DDR2), 1 x 250GB HDD (7,3k, SATA 3.0 Gbs) - RAID1, 1 x 1GbE , 4 x PCIe, 6 x USB 2.0, 1 x DVD+/-RW, 1 x NVIDIA FX370 Graphics Accelerator, 1 x SUN TFT 19" Colour, 1 x Keyboard, 1 x Optical Mouse, Desktop Chassis, SOLARIS 10 | This workstation host the RFID middleware of the solution (based on a JavaEE environment) |
| CISCO SD2008 Switch | The switch has the following specifications: Switch CISCO SR2024C, 8 x 10/100/1000 GbE RJ45, Desktop Chassis | Networking device used to support the networking communications of the solution |
| SUN Ray 2 Thin Client (two pieces) | Terminals adopting the Ultra - Thin Client SUN Ray 2 architecture. Specifications: 2 x USB 2.0, 1 x Serial, 1 x SIM Card, 17" SUN TFT Colour, Keyboard, Mouse, SUN VDI v3.0 Software | Terminals used by the employees of the SENSAP warehouse in order to monitor and control the RFID deployment. |
| IMPINJ Speedway Reader (two pieces) | The IMPINJ Speedway RFID GEN 2 RFID Reader supporting the pilot solution. The specifications of the reader include: EPC CL1G2, LLRPv1.0.1, 865 MHz - 956 MHz, 4 x Mono-Static Antennas (Reverse gender TNC), Near & Far Field, RF +32.5 dBm, Sensitivity -80 dBm, 10/100 Base-T Ethernet, 1 x RS-232, DHCP, HTTP, Telnet, SSH, SNMP, mDNS, DNS-SD. | It is used to support reading of tags during the RFID-enabled business processes. The reader supports the LLRP protocol and interfaces to the RFID solution via the AspireRfid LLRP HAL. |
| IMPINJ Brickyard Antenna (one piece) | RFID Reader Antenna, IMPINJ Brickyard CS-777, 865MHz – 956MHz | UHF antenna attached to the IMPINJ RFID reader. |
| MTI MT242017 Antenna (four pieces) | Far-Field RFID Reader Antenna MTI-Wireless MT-242017/NRH: Mono-Static, 865MHz – 956MHz, 10 Dbic min, VSWR 1.3:1 | UHF antenna attached to the IMPINJ RFID reader. |
| MTI MT243009 Antenna | Far-Field RFID Reader Antenna MTI-Wireless MT-242017/NRH: Mono-Static, 865MHz – 956MHz, 13 Dbic min, VSWR 1.3:1 | UHF antenna attached to the IMPINJ RFID reader. |
| MTI MT900016 Mounting Kit | Mounting Kit for MTI Antennas | Used to mount MTI Antennas to the Readers |
| PRINTRONIX | High Speed AutoID/RFID/BarCode | Used to print the physical |

| | | |
|---|---|---|
| SL4M RFID Printer | Printer Printronix SL4M, with the following specifications: EPC CL1G2 / ISO180006C, EAN128, THERMAL TRANSFER, 203 dpi, RS232, PARALLEL, USB, 10/100 Base-T Ethernet. | labels attached to items and logistical units for the SENSAP products. |
| CSL CS101 Mobile Terminal (one piece) | Mobile RFID & Barcode Scanner with the following specifications: CS101, 197 x122 x 223 mm3, 1.2 kg, Reading Speed 150 Tags/sec at 7meters (passive tags), ISO18000-6C, EPC UHF Class 1 Gen 2, WIN MOBILE 6.0, USB, WiFi (802.11 b/g), IP65, Base station (USB, SERIAL, ETHERNET), adapter. | Used for mobile scanning in support of inventory and pick & pack processes of the pilot |
| INTERMEC IP30A Mobile Terminal (one piece) | Mobile RFID & Barcode Reader/Scanner | Used for mobile scanning in support of inventory and pick & pack processes of the pilot |
| Schemetch Reader | Bluetooth Mobile Reader (part of the ASPIRE low-cost reader solution) | Used for mobile scanning in (additionally to the other readers). Used to validate the WP5 low-cost reader solution of the ASPIRE project |
| Armadilo | Embedded, Linux-based, Network Device, ARM processor, Bluetooth, GPRS, Ethernet, USB | Used as a network bridge between the ASPIRE low-cost reader and the ASPIRE middleware. It also hosts the LLRP proxy part of the low cost reader. |
| SUN Spot Sensor | Wireless sensor network (WSN) mote by Sun Microsystems. The device is built upon the IEEE 802.15.4 standard and Squawk Java Virtual Machine. | Used as a sensing note for the temperature sensing use case. A temperature sensor will be attached to the board. |
| SENSAP Satellite Label (tags/consumable) | RFID Label, IMPINJ Satellite, Monza 3 Chip (96bit R/W), EPC CL1G2, 1.34" x 2.13", TT Paper, Far & Near Field Operation | This type of tag is used to tag items/products in the scope of the pilot |
| CONFIDEX Survivor Tag | The Class 1 Gen2 UHF RFID Tag Confidex Survivor™ is specially designed for optimal performance during transport. Its specifications include: NXP UCODE G2XM chip, 240bits R/W memory, reading range up to 12m (2W ERP). It can be adapted/mounted to metal surfaces. | This type of tag is used to tag containers/pallets in the scope of the pilot |

**Table 16: Detailed Bill-of-Materials (BOM) for the SENSAP pilot**

## 3.4 Software/ Middleware

The software used in the pilot is based on the integration of the AspireRfid middleware and tools. It adopts the EPCglobal middleware architecture, in the way this architecture has been integrated in the ASPIRE architecture (described in Deliverable D2.3). Interested readers are advised to refer to this deliverable for the detailed description of the adopted architecture. The solution is compatible with standards from ISO and EPCglobal, in particular the EPC LLRP, EPC ALE, EPCIS, EPC TDS standards, while it also supports the GS1128 (GS1, 2008) coding standards.

The software of the solution has been integrated by SENSAP and includes the core AspireRfid libraries, along with a wide range of custom development that SENSAP implemented especially for this trial. The solution can manage all AutoID/RFID devices outlined in the previous section, as well as sensing and embedded devices. The solution utilizes both wireline (i.e., through the CISCO device) and wireless networks within the company. The business processes outlined above rely on the collection and processing (i.e. filtering and analysis) of RFID and sensor data derived from the above-mentioned devices. Filtered data are accordingly used to generate business events, which are persisted in the information sharing repository (i.e. the RFID database of the solution). This information flow is compatible with the ASPIRE architecture.

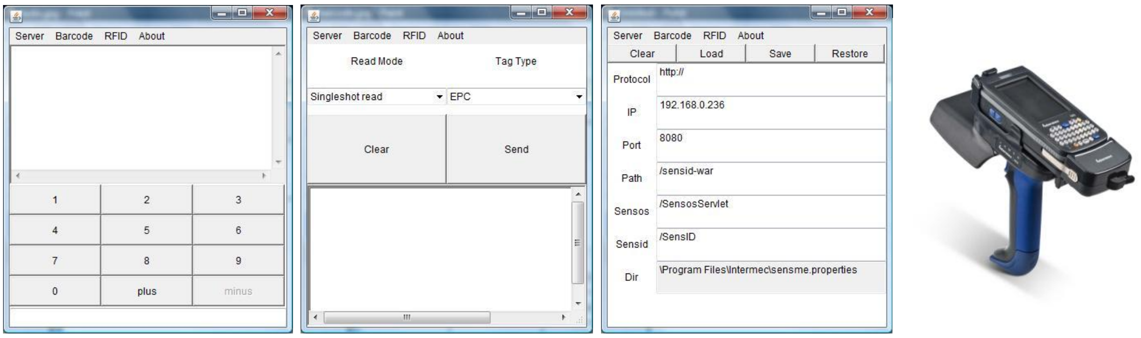
On top of the EPCIS repository of the solution, SENSAP has developed inference software for Business Rules Management, which facilitates the state, class and trace of tagged items, as the later move through the supply chain. The inference engine applied business rules pertaining to the SENSAP use cases in order to continually track the status and position of the tagged items. The status is stored in the information sharing repository. Furthermore, the status is augmented with the temperature profile of each item, which is monitored via the Sun Spot temperature sensor node. Accordingly, the information about the status of the items is conveniently accessed, processed and displayed in order to serve the target use cases. In particular, traceability information about the tagged items is used as follows:

- It is displayed through the mobile RFID readers (except for the Scemtec reader which does not provide an appropriate display capability).
- It is included in reports which are produced by the system. Reports can be produced in PDF, MS Winword DOC and XLS formats.
- It is used to validate and audit the correctness of various processes including reception of goods, shipment of goods, order collection and pick & pack.
- It is used to drive several actuators (such as LEDs, the RFID printer, the conveyor belt), in order to convey appropriate status and/or alarm messages.

Note that SENSAP has recently deployed the MBS (Microsoft Business Solutions) Navisio ERP system. A connector from the RFID information sharing database to this ERP system has been developed, based on the related AspireRfid connector interface. In addition to JAX-WS (WEB Service), SENSAP uses also JCA (Java Connector Architecture) and ESB (Enterprise Service Bus) connector interfaces.

SENSAP has also integrated software for monitoring a set of parameters that facilitate the calculation of KPIs (Key Performance Indicators – KPI). Recently AspireRfid tools (such as the AspireBI tool) allow for the creation of Business Intelligence dashboards. These tools are also deployed in the SENSAP pilot to facilitate calculation of such KPIs, but also to boost the company's ability to create additional custom reports in the future.

SENSAP has also developed a solution for mobile RFID reader devices. Figure 7 demonstrates screenshots of this solution in (a), (b) and (c), while in (d) depicts one of the portable handheld readers on which the application operates.




(a) (b) (c) (d)

**Figure 7: SENSAP mobile reader device solution**

## 3.5 Conclusions and Outlook

SENSAP is committed to RFID technology since the company acts as an RFID technology integrator for its customers. This pilot deployments has provided a golden opportunity for the company itself to become a recipient of its own services and accordingly to explore the benefits of an RFID deployment in its own warehouse. Hence, the SENSAP pilot deployment has been recently finalized as a prototype system of a fully automated warehouse with ubiquitous sensing (notably temperature sensing) capabilities. This prototype system will be evaluated in the next months and as part of deliverable D6.2. Accordingly, the deployment will be sustained and extended, as soon as it delivers the expected benefits and a clear financial benefit (despite the tagging cost).

At the time of writing this deliverable, SENSAP has already observed business benefits stemming from the deployment. These include:

- Real-time inventory, since at all times, the availability is visible throughout the whole supply chain.
- The ability to immediately locate misplaced items, which is a functionality that is integrated to the inventory procedure. The accuracy of the latter procedure has been certainly improved (based on the RFID system). This benefit will be quantified in the scope of Deliverable D6.3.
- The elimination of picking errors, which can be among the sources of financial loss for the company. SENSAP can now automatically verify the correctness of the picking procedures.
- The accuracy and correctness of the shipment processes, through the verification and confirmation of the packing lists prior to any order shipment.
- Overall, the minimization of several human-mediated error prone and time consuming processes.

- The ability to monitor temperature, as a means to ensure quality control of the company's products. Indeed, as several items (notably plastic strips with temperature sensitive glue) are temperature sensitive, the respective functionality is extremely important for the company.

In addition to these benefits, the SENSAP pilot has also provided another proof-of-concept application of the AspireRfid middleware and tools. Furthermore it has used the ASPIRE low-cost Scemtec reader, in order to validate this development. Note however that temperature sensing has been based on SUN Spot motes, rather than temperature sensors integrated within the Scemtec reader board. This is because the later board is still under development. SENSAP will be keen on replacing or complementing the SUN Spot solution, with the Scemtec solution, once the later is completed.

Similar to the STAFF pilot, an APDL based description of the pilot processes is also in progress, with a view to using and evaluating the programmability functionalities of the ASPIRE middleware and tools.

# 4 PV Lab

## 4.1 Overview

The trial embedded into PV Lab focuses on ASPIRE's deployment on the legacy demonstration applications of the Lab. Each existing demonstration, which simulates a single step of an internal business process, is managed in a standalone approach, has to be managed and supervised through ASPIRE's middleware tools.

The scopes of the trial are:

- to evaluate the easiness of deployment and configuration of ASPIRE's tools, as if PV Team was a RFID system integration SME,
- to illustrate the management of a full internal business process the RFID and ASPIRE's middleware, as illustrated in the following figure.

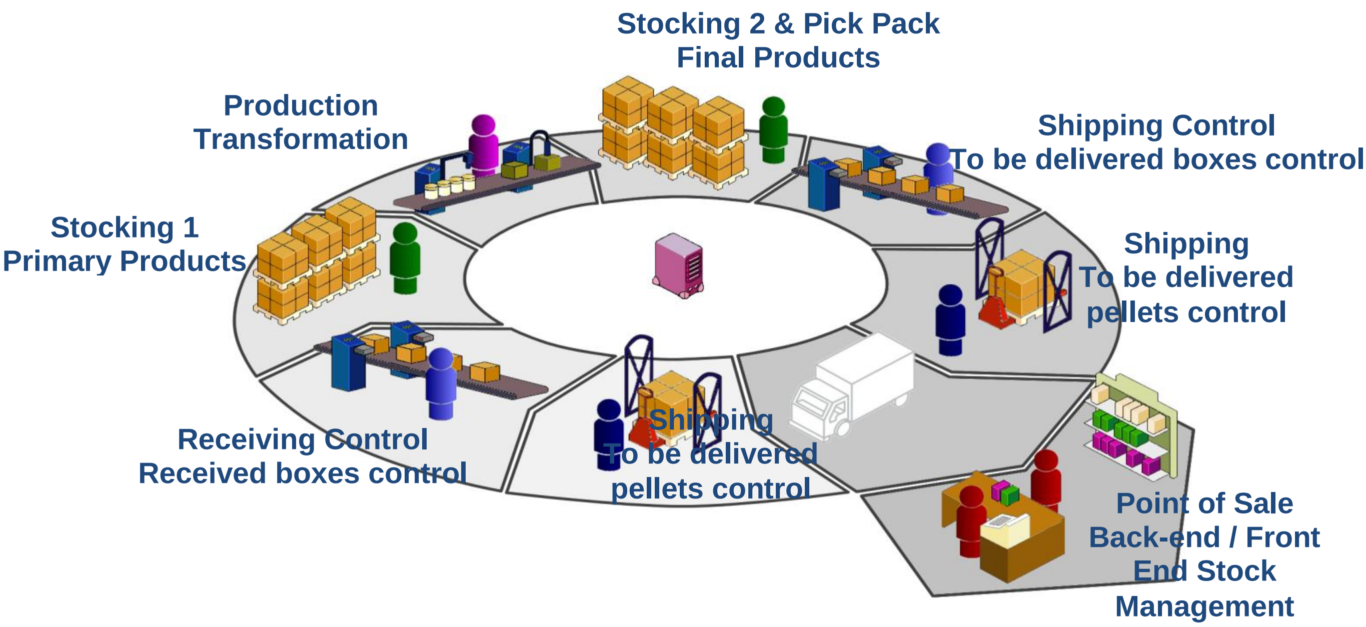



**Figure 8: Scheme of the full business process management illustrated in PV Lab's trial**

## 4.2 Objectives

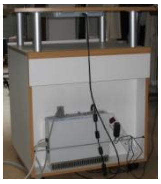
Trial's objectives are:

- Showing the use of Aspire's Middleware for different single steps of business processes.
- Secure the development of ASPIRE's academic partners through the implementation as a "pre-industrial ASPIRE version" that will allow RFID integrators and SME to see an RFID deployment, using ASPIRE Middleware, very close from what they need to use in their own business,
- Highlight how easy or hard it is, at the state of the art, to deploy the Aspire RFID middleware on each existing application and how we can manage and coordinate the different area on a single computer,

- Evaluate which parts can be reuse by integrators, focusing on the development time needed to adapt aspire modules with existing tools, the reusability of the modules, their adaptability, their robustness,
- Implement step by step and independently each module of the en-to-end architecture of ASPIRE (HAL, EPC ALE, Filtering, BEG, JMX, EPCIS, ONS, IDE…) through the benchmark with existing Fosstrak developments.

## 4.3 Hardware

The following BOM (Bill of Materials) describes the hardware elements and their use into PV Lab's Trial

| Hardware Module | Description | Use in the pilot |
|---|---|---|
| TAGSYS L200 HF Reader  | TAGSYS' L200 HF reader supports multi-protocols, ISO 15693 compatible and operates at 13.56MHz. It offers 4 configurable I/O ports easing the connection of a wide choice of RFID antennas. L200 HF Reader has 4 channels | 2 L200 HF Reader are used in the pilot, one at the box control demonstration (receiving control and shipping control process) and another at Point of Sale Demonstration. |
| TAGSYS' 50x50 HF RFID  | TAGSYS' 50x50 HF RFID Tunnel is a dedicated solution to identification of RFID tagged objects which are stacked in bags or boxes. | The tunnel (joint to TAGSYS L200 HF Reader) is used to support the box control demonstration at receiving control and shipping control phases of the full business process illustrated |
| DEISTER UDL500 UHF reader  | The UDL500 UHF Reader is an especially suited for the retail and logistics market reader. It allows as well long range identification as high volume reading of UHF Tags. It supports ISO 18000-6 Type A/B (e.g. Philips UCode, EM 4223), EPC Class1, Gen 1, ATMEL TAGIDU, EM 4422 protocols. | This compact reader is used in the pick and pack demonstration of the full business process. This reader reads the RFID printed label emitting by the DATAMAX Printer to digitally associate picked items to their shipping box. |
| IPICO DF Medium Range Conference Reader  | IPICO's DF Medium Range Conference Reader is a specific reader operating a forward link at 125 kHz to power the tag and a return link at 6.8 MHz to read the tag. It implements also the populate UHF anti-collision algorithm, allowing the simultaneous reading of around 100 tags. | 2 readers are combined to act as a portal reader in the receiving / shipping pellet control demonstration, in order to read all the boxes' RFID labels carried by the pellet.<br><br>1 reader is used at the Point of Sale demonstration to read the tags transmitted from the back end to the front end of the retail area at restocking process step. |

| | | |
|---|---|---|
| IPICO UHF Mobile Reader with Bluetooth TM Connectivity  | This reader is a handheld reader supporting EM4022, 4122, 4222, 4422, 4444 and X4TTO range of UHF tags. | This reader is used in the receiving / shipping pellet control demonstration in order to "pick" the tag identifier of the pellet. Through this reading, an associated delivery order is downloaded to the GUI. The compliance between the delivery order and the pellet's content (boxes) is checked by the previously described IPICO's portal |
| DATAMAX printer H-4212  | H-4212 is a flexible RFID 39 labelling solution supporting RFID encoding into tags embedded in SSCC labels. | This printer is used in the pick and pack demonstration. After having picked the good items, placed them into the box, and validated the delivery preparation, an RFID label is printed through this printer to be placed on the box. The ID of this label is read by the Deister Reader to confirm the association between selected items and the delivery box. |
| SATO printer CL408e  | CL408e RFID printer supports EPC Class 0+, 1, Gen 2, I-Code, Tag-it encoding. | This printer is used in the box control demonstration (at receiving control and shipping control phases). If the content of the box is error, it allows the re-printing of a UHF RFID label. |
| Workabout Pro PSION Teklogix Handheld reader (PDA)  | This reader is a mobile PDA running on a Windows CE5 operating System, allowing WiFi 802.11a/b/g, Bluetooth Class II,V 2.0, GPRS and 3G communications. It embeds an optional HF reader supporting ISO 15693, Philips® Icode™; TI Tagit™; Tagsys (C210, C220, C240, C270) tags. | This module is used in the pick and pack demonstration. Each item to be picked as mentioned in the order preparation form editing by the GUI is picked and read by this reader, validating the item picking in the software application. After the picking and reading of each item, the preparation order is validated and an associated label printed by the Datamax printer. |

**Table 17: Bill of Hardware Materials used in PV Lab trial**

**Additional equipments**
The following table describes 2 other equipments newly implemented in the trial, in order to also test the LLRP protocol.

| | | |
|---|---|---|
| Impinj Speedway Reader  | This reader is a UHF reader supporting EPCglobal UHF Class 1 Gen 2 / ISO 18000-6C air interface protocols and EPC Global LLRP 1.01 protocol | This reader will be used (in association with 2 of the following antenna) to simulate UHF RFID portal, to potentially replace the IPICO's dual frequency portal module. |
| Impinj Antenna KATHREIN 52010086  | This UHF antenna is an industrial directional antenna. | 2 antennas connected to the previous reader to simulate a receiving / shipping pellet control portal. |

**Table 18: Recently Added Hardware modules added to PV Lab's Trial**

## 4.4 Software / Middleware

Before implementing ASPIRE's Middleware, the existing IT infrastructure was only composed of several computers on the same network. All computers were connected by Ethernet to an Ethernet switch or by Wi-Fi and were receiving IP dynamically from a server. One computer acted as a server and runs a Microsoft Active Directory server and a DHCP server on Microsoft Windows 2003 Server. Other computers were running under Windows XP. A different demonstration application runs on each of them. Each application was then completely independent and there is no logical link between them.

By this trial, a step by step full implementation of ASPIRE's middleware architecture is realized.

Each stand alone demonstration stays running on the legacy VB application that manages the demonstration. The connection to ASPIRE's environment is done by HAL, ALE, Filtering & Collection, Business Event Generation, EPC IS Repository and IDE ASPIRE's middleware modules deployment.

A Database connection is also proposed in order to appreciate the capacity of the architecture to support a warehouse management GUI through existing WMS software (Producim).

The following figure describes the implementation realized containing:

- In green : the implementation of existing ASPIRE's middleware modules,
- In orange: adaptations and own developments to support ASPIRE's environment in PV Lab.

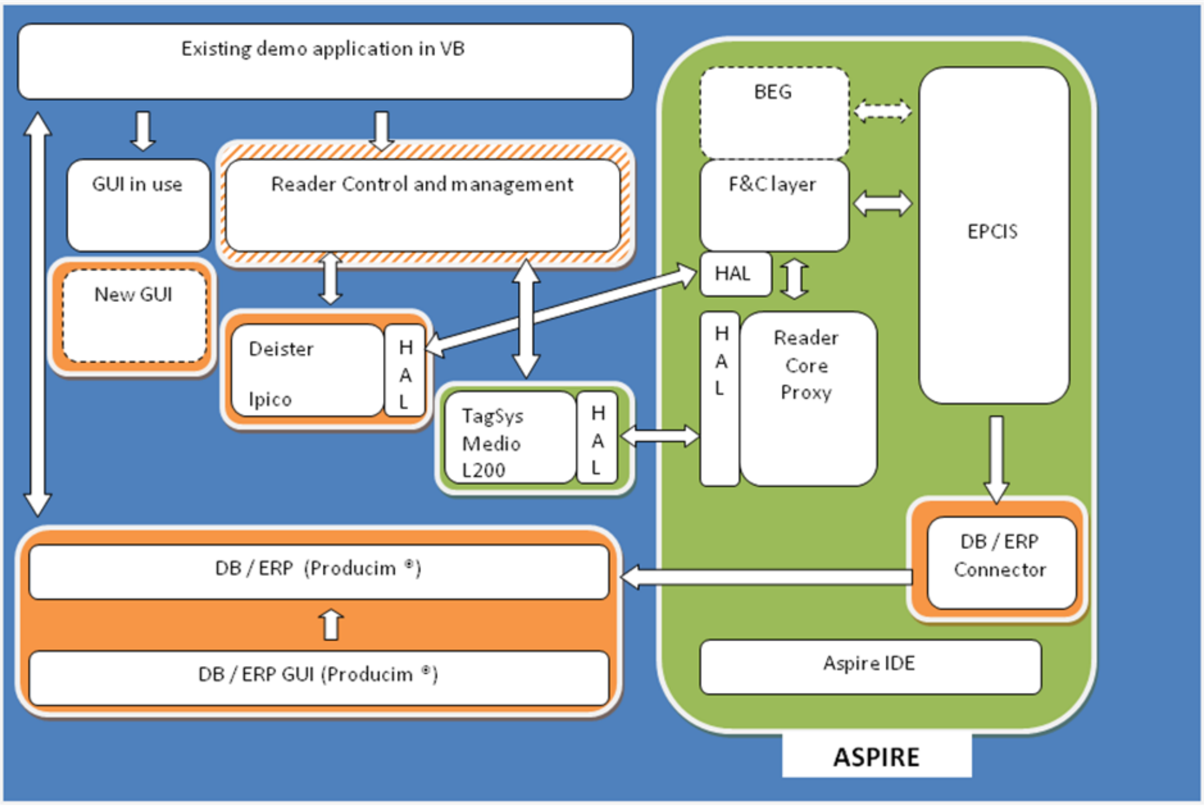



**Figure 9: Software / Middleware modules deployment into PV Lab's trial**

## 4.5 Architecture

The architecture under deployment (physical and logical) is illustrated in the two following figures, embedding Hardware and software components described in the subsections 5.1 & 5.2:

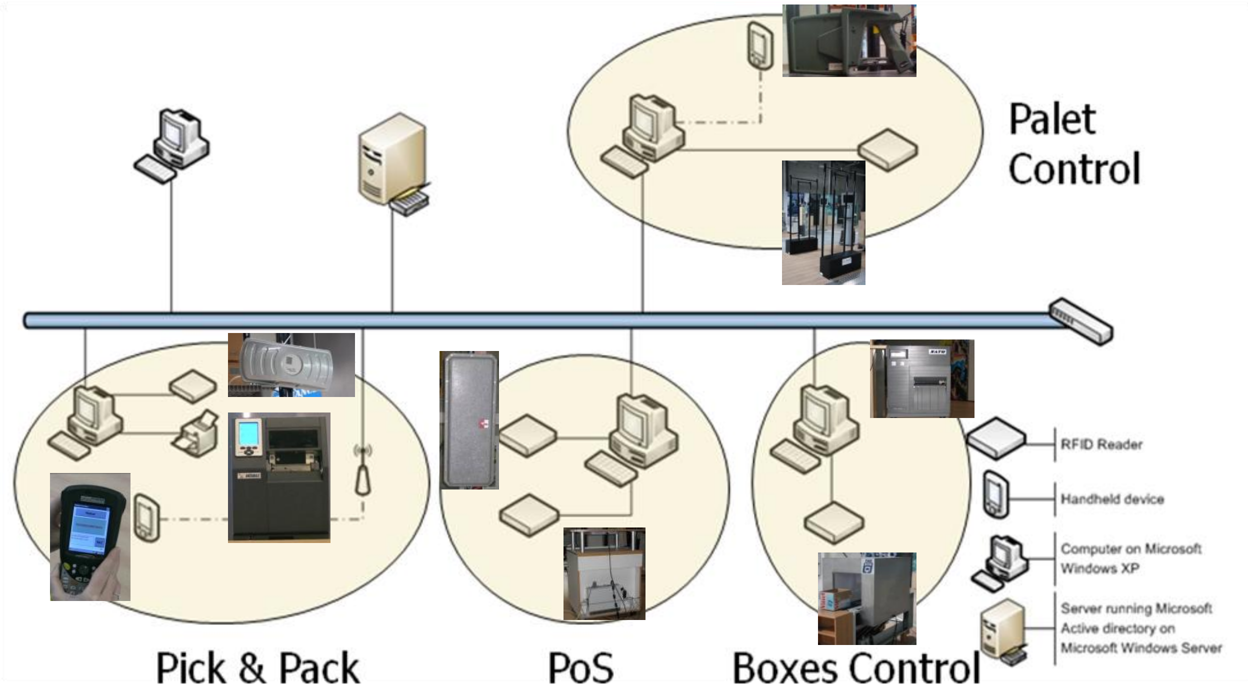



**Figure 10: Physical and IT infrastructure set up into PV Lab with ASPIRE**

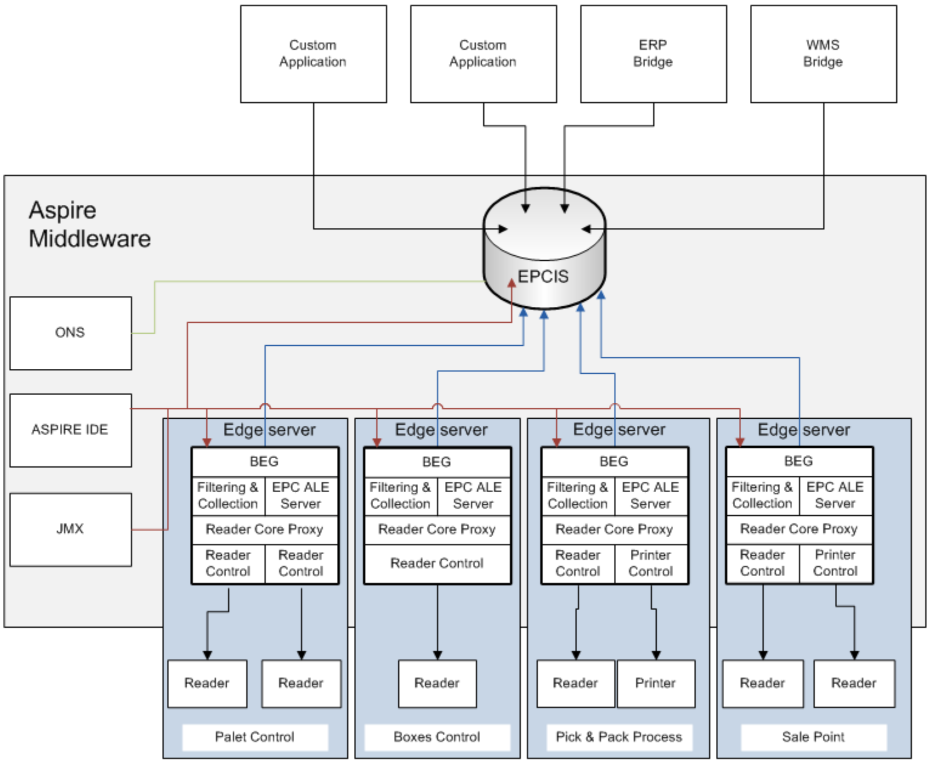



**Figure 11: Architecture of the ASPIRE based solution deployed into PV Lab**

## 4.6 Conclusions

At the time of writing this deliverable, the deployment process is not ended and stays in progress of around 65% of programmed plan.

This deployment will be concluded at the end of month 32. The required re-egineering process describes in D6.1 Section 2.3.1.5 is almost done but the implementation process took delay due to a recent personal change (software engineer) into the team.

By the recent introduction of a new software engineer in PV, the implementation process has been revised in order to secure at best ASPIRE's functionality into the Lab. The validation is actually running as follows:

- Securing ALE, Reader protocol & filtering and collection layer with a robust reader protocol (LLRP with Impinj Reader),
- Securing BEG functionality with this reader,
- Securing IDE and EPC IS Repository functionality,
- Global Implementation with Impinj Reader,
- Extension with developed other reader drivers (Tagsys L200, Deister, IPICO's Medium Range Conference reader),
- Connection between EPC IS repository and internally available WMS software.

# 5 Niki Award Ceremony Pilot System and Related Demonstration

The ASPIRE middleware was deployed in the Niki Award Ceremony, an event that took place on December 17th 2009, in honour of Thanasis Economou, a Greek NASA scientist.

**Figure 12: The RFID Enabled Reception at the Niki Award Ceremony**

The registration management of the ceremony was based on a novel RFID application which was developed based on know-how gained in the scope of the project.

## 5.1 Objectives

The scope of the deployment was to support registration management for a real-life event. To this end, each of the guests was provided a passive RFID tag attached on his/her card. A video demonstration of the registration management application is available at YouTube: http://www.youtube.com/watch?v=DljvjG8kEvM.

## 5.2 Hardware

The hardware that supported the event included:

- An RFID reader. More specifically, an Impinj reader that is standards-compliant (EPC CL1 GEN2, EPC LLRP) was used with 3 antennas.
- An RFID server running an ASPIRE LLRP HAL server

## 5.3 Software/ Middleware

The software was supported by ASPIRE's LLRP HAL module. The module in fact can be considered as an intermediary between the reader on one side and the server on the other. Three client applications served as visitor reception points. Screenshots of the graphical user interface of the secretariat registration/reception application are illustrated in Figure 13. Each of the client applications was configured to communicate with one of the reader's antennas.

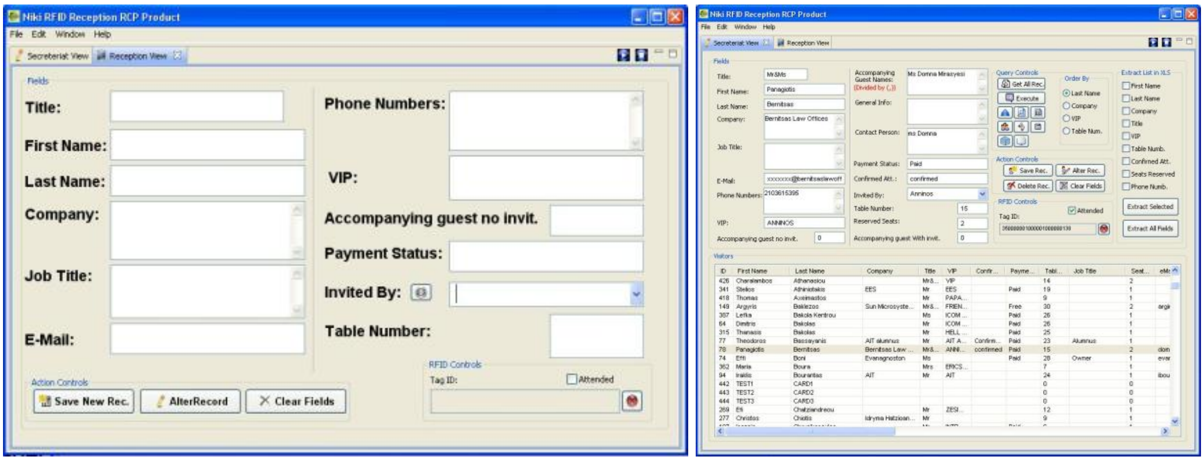


**Figure 13: Registration/Reception management application screenshots**

## 5.4 Architecture

The components comprising the underlying infrastructure that supports the event are the following:

- AspireRfid LLRP HAL module
- One LLRP RFID server, developed from scratch
- A MySQL database server
- 3 client applications, each serving as a visitor RFID reception point
- 1 client application for visitors without invitations

As it is depicted in Figure 14 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.

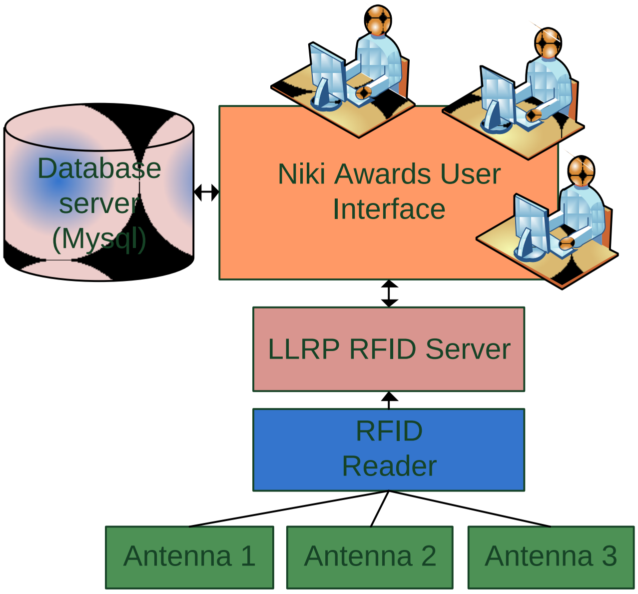



**Figure 14: Logical architecture of the infrastructure deployed at the Niki Awards ceremony**

## 5.5 Conclusions

The use of RFID technology greatly assisted the registration procedure. Statistics on guests and registration were automatically generated
More than 300 guests passed the reception without forming queues of more than two persons. In comparison with a traditional reception system or no system at all, we can argue that the deployed system was characterized by increased speed and efficiency.

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 ability was provided of doing last minute change at the reserved tables
- The interface provided the possibility of running combined queries
- The system allowed exporting the records, the combined queries or statistic information in XLS format, rendering it capable of being integrated with third party software and further exploited.

# 6 Animal Hospital Demo

The 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 management system is developed, integrated with innovative RFID technology, to efficiently manage the medical resources in terms of user application requirements.

## 6.1 Objectives

The Oncovet RFID management 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.

## 6.2 Hardware

Desktop PCs (Windows XP/Vista/7 or Linux)
UHF RFID handheld reader (Scemtec SIH900)
UHFRFID tags

## 6.3 Software/ Middleware

The Oncovet RFID management system developed in Java includes the following modules:

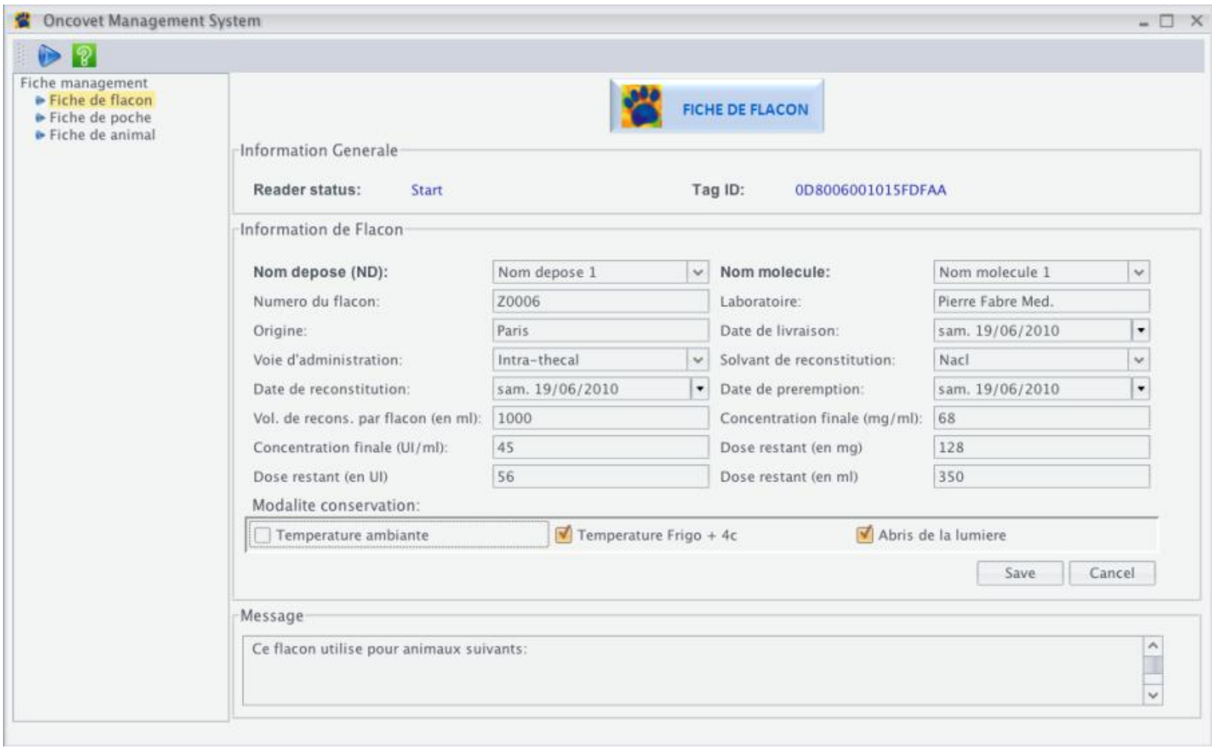



**Figure 15: Graphical interface of Oncovet RFID management system**

- Interface between RFID reader and PC: reads data from RFID-reader to PC.
- Aspire WP5 LLRPLite Server: serves as an intermediary between Scemetec RP and standard LLRP.

- 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 current status of treated animals.
- Data base module: manages all the data related to the treated animals, delivered medicines as well as the medical records.

Figure 15 shows the graphical interface of Oncovet RFID management system, an example to manage the delivered medicine and monitor its current using status.

## 6.4 Architecture

The components (illustrated in Figure 16) include 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 then gathered in the data base, and used to support the functionalities such as object Identification and medical procedure traceability.

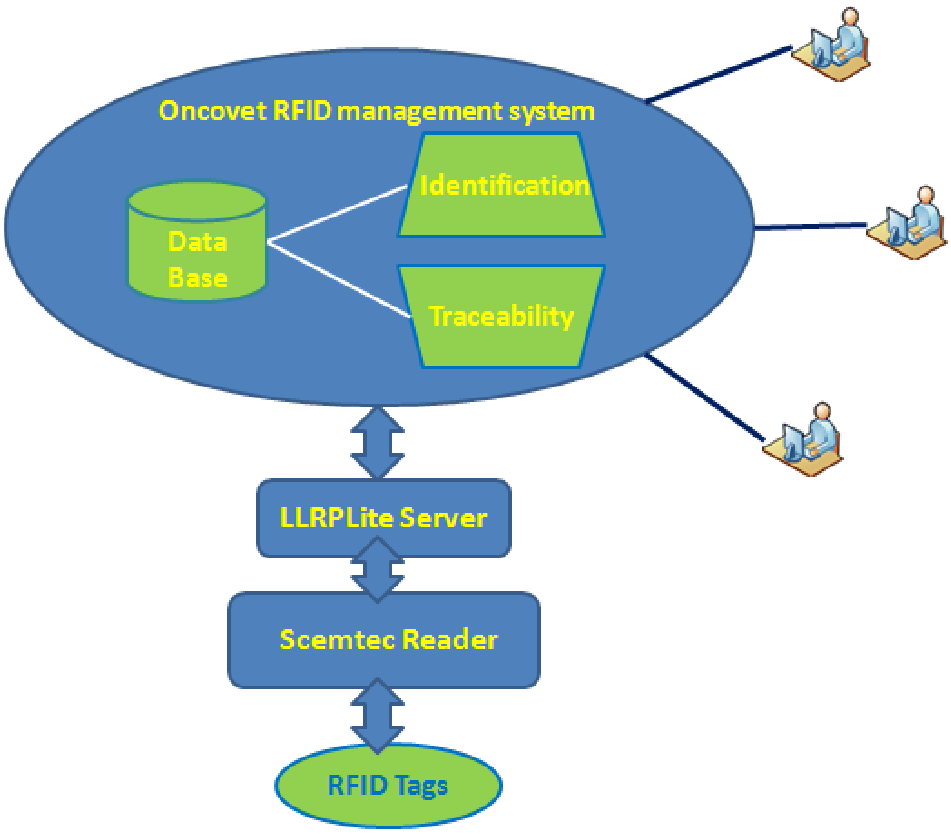



**Figure 16: Architecture of Oncovet RFID management system**

## 6.5 Conclusions

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. This information can also be categorized automatically according to user's requirements.
We are pushing forward such management system to wider application field.

# 7 Demonstrations of ASPIRE Middleware and Tools

The following set of demos were designed in order to fully showcase the functionality offered by the ASPIRE middleware. This Section provides a detailed conceptual and technical description of the demos. In Figure 17 below is a photo of an RFID reader (Intermec), used to help designing, developing, debugging and deploying RFID applications.


**Figure 17: Intermec RFID reader, used in order to put the demos into action**

## 7.1 Simple F&C test with the Simulator Reader device

The purpose of this demo is to showcase the elementary functionality offered by the middleware. This demo can serve as the basis for the development of more complicated scenarios.

### *7.1.1 Requirements*

Hardware (minimum)

- none

Software

- Java 1.6 or higher
- F&C Server
- Reader Core Proxy

### *7.1.2 Download and run instructions*

In order to run the demo, one has to follow these instructions

- Start the Reader Core Proxy server
- Use the Physical Reader Configurator tool to upload the "ReaderDevice_AccadaSimulator.xml" physical reader specifications. The file can

also be found at the ApireRFID Forge. From the "Management" tab, click "Upload configuration file" and hit "Start". This will start the “Accada Reader Simulator”.

- Start the Apache Tomcat Web server with the aspireRfidALE.war deployed. This starts the F&C Server.
- Open the LRSpecConfiguratorView. Click "Define" to define a reader with Reader Name: “AccadaSimulatorWithRPProxy” and LRSpec: “DynamicRpLogicalReader_FosstrakSimulatorReaderProxy.xml”.

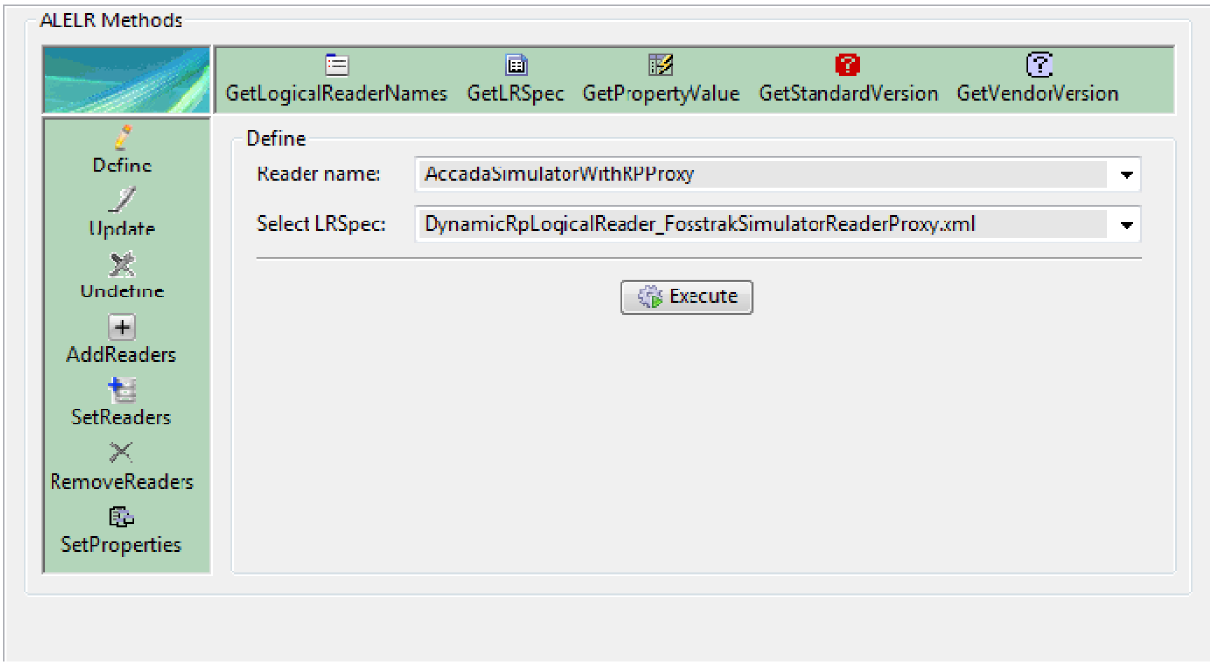



**Figure 18: Defining a new reader through the LRSpec configurator tool**

The following is a listing of the logical reader specifications that define the reader. Technically, these are the contents of an xml file uploaded to the F&C server.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<ns3:LRSpec xmlns:ns2="urn:epcglobal:ale:wsdl:1"
xmlns:ns3="urn:epcglobal:ale:xsd:1">
    <isComposite>false</isComposite>
    <readers/>
    <properties>
        <property>
            <name>ReaderType</name>

<value>org.ow2.aspirerfid.ale.server.readers.rp.RPAdaptor</value>
        </property>
        <property>
            <name>Description</name>
            <value>This Logical Reader consists of shelf 1,2,3,4 of the
physical reader named AccadaRPSimulator</value>
        </property>
        <property>
            <name>PhysicalReaderName</name>
            <value>AccadaRPSimulator</value>
        </property>
        <property>
```

```
            <name>ReadTimeInterval</name>
            <value>1500</value>
        </property>
        <property>
            <name>PhysicalReaderSource</name>
            <value>Shelf1,Shelf2,Shelf3,Shelf4</value>
        </property>
        <property>
            <name>NotificationPoint</name>
            <value>http://localhost:9090</value>
        </property>
        <property>
            <name>ConnectionPoint</name>
            <value>http://localhost:8000</value>
        </property>
    </properties>
</ns3:LRSpec>
```

This way the F&C server will connect with the Reader Core Proxy and the Accada Simulator.

- Now, open the ECSpecConfiguratorView. Hit "Define" to define the ECSpecs. You may enter “AleSimpleTest” (or whatever else you prefer) as a Spec Name. As an ECSpec file, choose “ECSpec_AccadaSimulator_AleSimpleTest.xml”. Hit "Execute".

```
<?xml version="1.0" encoding="UTF-8"?>
<ale:ECSpec xmlns:ale="urn:epcglobal:ale:xsd:1"
        xmlns:epcglobal="urn:epcglobal:xsd:1"
        xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        schemaVersion="1.0" creationDate="2003-08-06T10:54:06.444-05:00">
        <logicalReaders>
                <logicalReader>AccadaSimulatorWithRPProxy</logicalReader>
        </logicalReaders>
        <boundarySpec>
         <repeatPeriod unit="MS">5000</repeatPeriod>
         <duration unit="MS">4500</duration>
         <stableSetInterval unit="MS">0</stableSetInterval>
        </boundarySpec>
        <reportSpecs>
        <reportSpec reportName="ObjectEvent" reportIfEmpty="false"
reportOnlyOnChange="false" includeSpecInReports="true">
                        <reportSet set="CURRENT" />
                        <groupSpec>
                                <pattern>urn:epc:pat:gid-
96:145.56.*</pattern><!-- Small Packets -->
                                <pattern>urn:epc:pat:gid-
96:145.87.*</pattern><!-- Medium Packets -->
                                <pattern>urn:epc:pat:gid-
96:145.233.*</pattern><!-- Small Packets Contents -->
                                <pattern>urn:epc:pat:gid-
96:145.255.*</pattern><!-- Medium Packets Contents -->
                                <pattern>urn:epc:pat:gid-
96:82.20.*</pattern><!-- warehousemen -->
                                <pattern>urn:epc:pat:gid-
96:145.12.*</pattern><!-- Invoice -->
                        </groupSpec>
```

```
                              <output includeRawHex="true"
includeRawDecimal="true" includeEPC="true" includeTag="true"
includeCount="true" />
                    </reportSpec>
          </reportSpecs>
</ale:ECSpec>
```

- Start the “ASPIRE TCP Message Capturer” by executing the command: “java –jar aspireTcpMessageCapturer-(version)-jar-with-dependencies.jar 9999”
- Go back to the ECSpecConfiguratorView to subscribe the previously defined ECSpec to the “ASPIRE TCP Message Capturer” application. Hit "Subscribe" on the left. Set as Notification URI: “http://localhost:9999”, select the “AleSimpleTest” as the ECSpec name (or whichever you used to define the ECSpec) and hit Execute.
- Go to the Accada Reader Simulator. From the "Tag" menu, choose "Add new Tag". Copy and paste some demo tags from the “SimpleAleTest_EPC_Tags.txt” to the Accada Simulator Reader and place them on its antennas
- Captured reports should appear to the “ASPIRE TCP Message Capturer”.

## 7.2 Warehouse Packet Delivery (3 Tier Use)

The objective of ASPIRE’s Warehouse ALE Demo is to provide a GUI of a Warehouse Delivery Counter which will be automatically populated with RFID Tag data from the Filtering and Collection server captured reports. This way, we are able to demonstrate a warehouse delivery scenario using only three tiers of the AspireRFID middleware (Hardware Abstraction Layer, Reader Core Proxy and F&C Server).

### *7.2.1 Requirements*

Hardware (minimum)
- none

Software
- Java 1.6 or higher
- F&C Server
- Reader Core Proxy

### *7.2.2 Download & run instructions*

- Download and unzip the demo warehouse application at the ApireRFID Forge.
- For running the application you can follow two ways:
    - At a command prompt go to the unzipped folder and execute: “java -jar aspireWarehouseAleDemo.jar” This way you will be able to see the debug messages from the aspireWarehouseAleDemo Application (the incoming XML reports from the F&C server and their analysis).
    - Alternatively, you can just double click the “aspireWarehouseAleDemo.jar” in the unzipped folder.
- Start the Reader Core Proxy server
- Use the Physical Reader Configurator tool to upload the “ReaderDevice_AccadaSimulator.xml” physical reader specifications. The file can also be found at the ApireRFID Forge. Specifically, from the "Management" tab, click "Upload configuration file" and hit "Start". This will start the “Accada Reader Simulator”.

- Start the Apache Tomcat Web server with the aspireRfidALE.war deployed. This starts the (F&C Server).
- Open the LRSpecConfiguratorView. Click "Define" to define a reader with Reader Name: “AccadaSimulatorWithRPProxy” and LRSpec: “Dynamic_AccadaSimulator_RpReader.xml”.

This way the F&C server will connect with the Reader Core Proxy and the Accada Simulator.

- Open the ECSpecConfiguratorView. Hit "Define" to define the ECSpecs. You may enter “WarehouseAleDemoEcspec” (or whatever else you prefer) as a Spec Name. As an ECSpec file, choose “ECSpec_AccadaSimulator_WarehouseAleDeliveryCounterDemo.xml”. Hit "Execute".

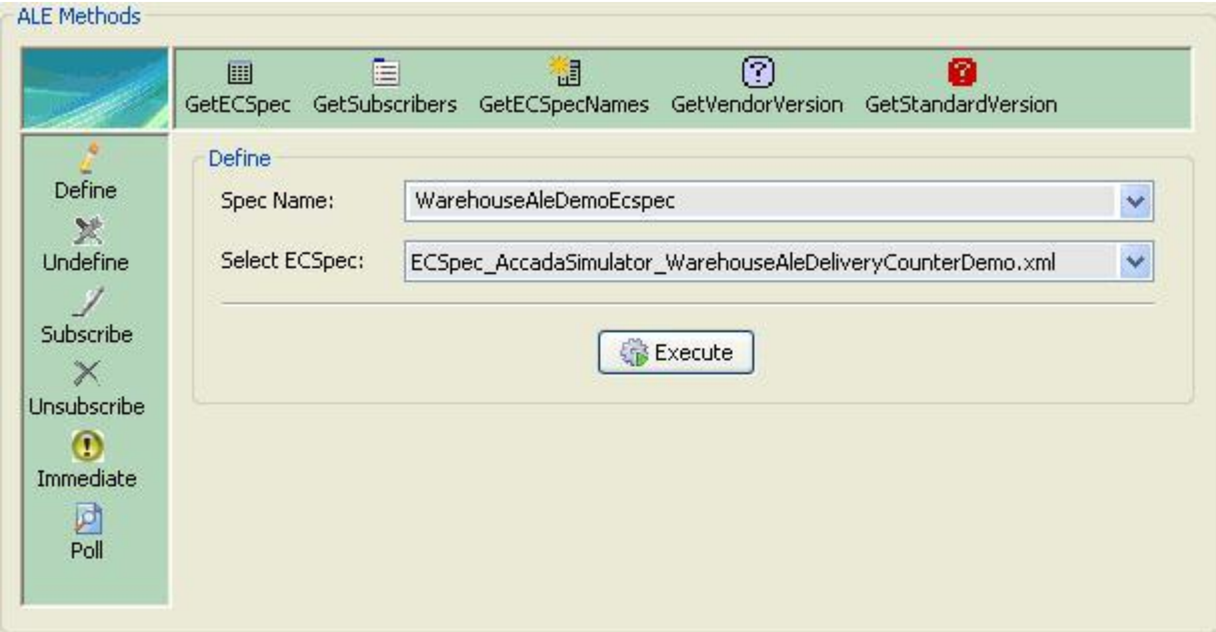



**Figure 19: Defining new Event Cycle specifications using the ECSpec configurator tool**

The following is a listing with the ECspecs. In fact these are the contents of the ECSpec_AccadaSimulator_WarehouseAleDeliveryCounterDemo.xml file, containing the report specifications. We can see in the xml file that the F&C server is configured to report every 4500 msec about any additions that may occur regarding specific tags.

```
<?xml version="1.0" encoding="UTF-8"?>
<ale:ECSpec xmlns:ale="urn:epcglobal:ale:xsd:1"
        xmlns:epcglobal="urn:epcglobal:xsd:1"
        xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        schemaVersion="1.0" creationDate="2003-08-06T10:54:06.444-05:00">
        <logicalReaders>
                <logicalReader>AccadaSimulatorWithRPProxy</logicalReader>
        </logicalReaders>
        <boundarySpec>
         <repeatPeriod unit="MS">5000</repeatPeriod>
         <duration unit="MS">4500</duration>
         <stableSetInterval unit="MS">0</stableSetInterval>
        </boundarySpec>
        <reportSpecs>
```

```
        <reportSpec reportName="warehouseDeliveryCounterDemo"
reportIfEmpty="false" reportOnlyOnChange="false"
includeSpecInReports="true">
                        <reportSet set="ADDITIONS" />
                        <groupSpec>
                                <pattern>urn:epc:pat:gid-
96:145.233.*</pattern><!-- Small Packets Contents -->
                                <pattern>urn:epc:pat:gid-
96:145.255.*</pattern><!-- Medium Packets Contents -->
                                <pattern>urn:epc:pat:gid-
96:82.20.*</pattern><!-- warehousemen -->
                                <pattern>urn:epc:pat:gid-
96:145.12.*</pattern><!-- Invoice -->
                        </groupSpec>
                        <output includeRawHex="true"
includeRawDecimal="true" includeEPC="true" includeTag="true"
includeCount="true" />
                </reportSpec>
        </reportSpecs>
</ale:ECSpec>
```

- Start the “aspireWarehouseAleDemo” application and hit the “Activate Door” button.

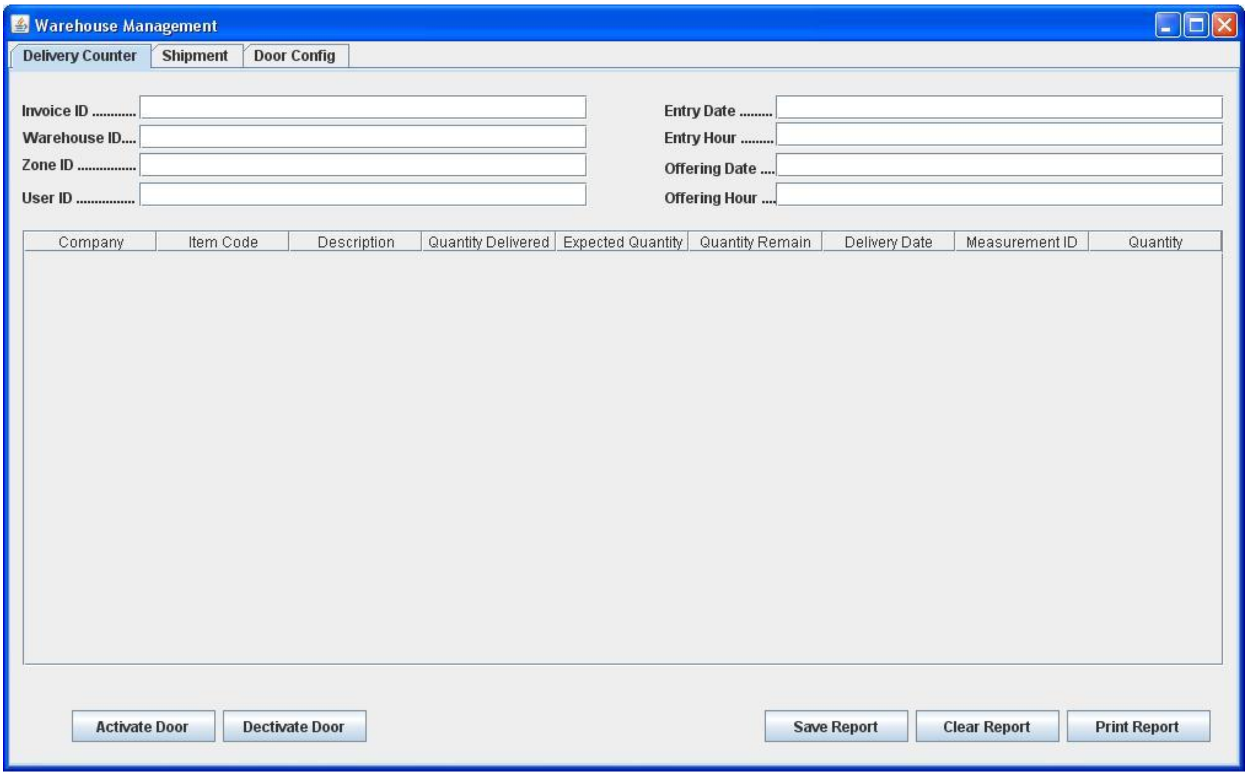



**Figure 20: Warehouse Management Application**

- Go back to the ECSpecConfiguratorView to subscribe the previously defined ECSpec to the aspireWarehouseAleDemo application. The application is listening by default at port 9999. Hit "Subscribe" on the left. Set as Notification URI: “http://localhost:9999”, select the “WarehouseAleDemoEcspec” as the ECSpec name (or whichever you used to define the ECSpec) and hit Execute.

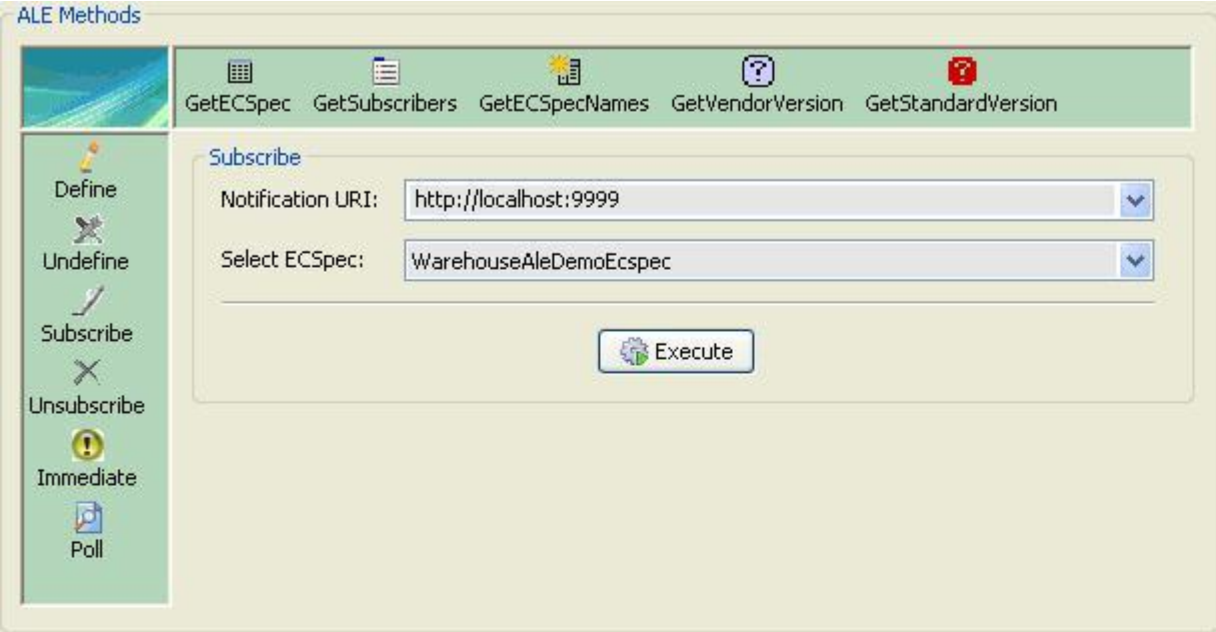



**Figure 21: Subscribing a new client application to the F&C server through the ECSpec configurator tool**

- Copy and paste some demo tags from the "WarehouseAleDemo_EPC_Tags.txt" to the Accada Reader Simulator (Tag -> Add new Tag) and place them on its antennas

The number of tags supported for this demo is:

- Small Packet Contents: 4
- Medium Packet Contents: 5
- Warehousemen: 1
- Invoice: 1

The items expected from the "aspireWarehouseAleDemo" application can be changed from the "WarehouseParameters.xml" placed inside the "aspireWarehouseAleDemo" jar file inside the "resources" folder. In the listing below are the contents of the WarehouseParameters.xml file, containing the configuration parameters of the application.

```
<?xml version="1.0" encoding="UTF-8"?>
<parameters>
        <zoneID>1.145.21.345</zoneID>
        <warehouseID>1.145.22.23</warehouseID>
        <warehousemenGroupName>urn:epc:pat:gid-
96:82.20.*</warehousemenGroupName>
        <invoiceGroupName>urn:epc:pat:gid-96:145.12.*</invoiceGroupName>
        <!-- Merchandise data -->
        <merchandise>
                <packetsContent>
                        <packetsGroupName>urn:epc:pat:gid-
96:145.233.*</packetsGroupName>
                        <company>ALTERA</company>
                        <description>Altera Microcontroler
8081</description>
                        <measurementID>ITEM</measurementID>
                        <quantity>4</quantity>
                        <expectedQuantity>4</expectedQuantity>
```

```
                </packetsContent>
                <packetsContent>
                        <packetsGroupName>urn:epc:pat:gid-
96:145.255.*</packetsGroupName>
                        <company>ALTERA</company>
                        <description>Altera Microcontroler
6502</description>
                        <measurementID>ITEM</measurementID>
                        <quantity>5</quantity>
                        <expectedQuantity>5</expectedQuantity>
                </packetsContent>
        </merchandise>
</parameters>
```


Captured tags should appear to the “aspireWarehouseAleDemo” application.

## 7.3 Warehouse Packet Delivery (6 Tier Use)

The objective of ASPIRE’s Warehouse EPCIS Demo is to provide a Virtual Warehouse Management system GUI that supports receiving scenarios from a read point and will use the whole AspireRFID Architecture.

The tags that will pass through the specific read point will be filtered from the F&C Server and will be sent within a report to the Business Event Generator engine. Then, the BEG engine will translate them to event data taking in consideration the transaction defined at the master data and store them to the EPCIS Repository. The Event data will be retrieved from the EPCIS repository with the help of the Connector and send to the Warehouse Management System.

This way, we are able to demonstrate a warehouse delivery scenario using all 6 tiers of the AspireRFID middleware (Hardware Abstraction Layer, Reader Core Proxy, F&C Server, Business Event Generator, EPCIS Repository and the Connector).

### *7.3.1 Delivery scenario*

According to the delivery scenario, company ACME, which is a Personal Computer Assembler and owns a Central building with three Warehouses, 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. Warehouse1 has 2 Sections and Section1 has an entrance point where the goods are delivered. 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.

For the solution, 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.

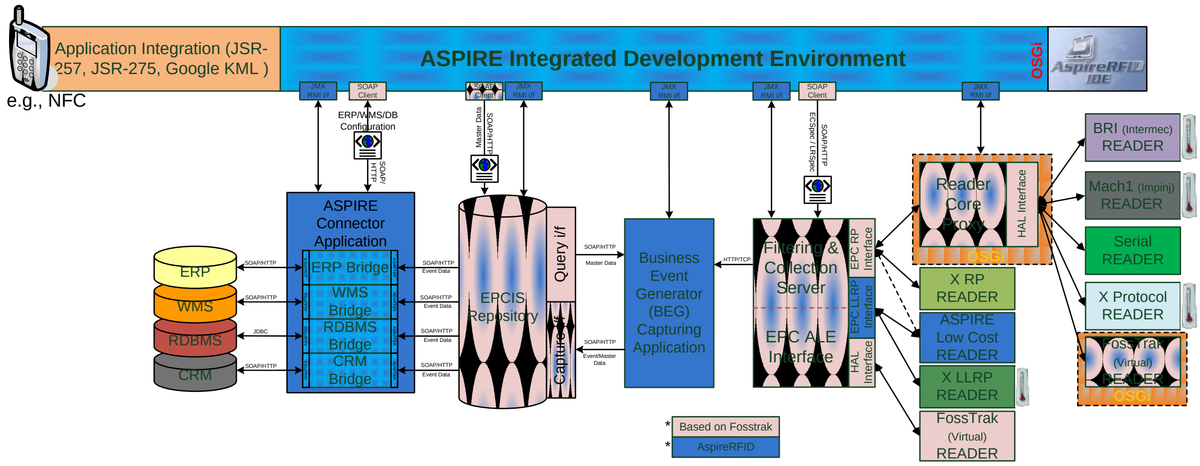



**Figure 22: ASPIRE middleware architecture**

The delivery process can be described as follows:

1. ACME gives an order with a specific deliveryID to the Microchip Manufacturer.
2. With the above action AspireRfid Connector subscribes to the AspireRfid EPCIS Repository to retrieve events concerning the specific deliveryID.
3. The order arrives to ACME's premises.
4. ACME's RFID portal (ReadPoint1) reads the deliveryID and all the products that follow with the help of WarehouseRfidReader1.
5. AspireRfid ALE filters out the readings and sends two reports to AspireRfid BEG, one with the deliveryID and one with all the products tags.
6. AspireRfid BEG collects these reports, binds the deliveryID with the products tags and sends this event to the AspireRfid EPCIS Repository
7. AspireRfid EPCIS Repository informs the Connector for the incoming event which in his turn sends this information to ACME's WMS.
8. When the WMS confirms that all the requested products was delivered it sends a "transaction finish" message to the AspireRfid Connector which in his turn unsubscribe for the specific deliveryID and sends a "transaction finish" to the RFID Repository.

### *7.3.2 Requirements*

Hardware (minimum)

- none

Software

- Java 1.6 or higher
- Connector
- EPCIS Repository
- Business Event Generator
- F&C Server
- Reader Core Proxy

### *7.3.3 Download & run instructions*

- Download and unzip the aspireWarehouseEpcisDemo application, available at the ApireRFID Forge.
- For running the application you can follow two ways:

    - At a command prompt go to the unzipped folder and execute the following command:“java -jar aspireWarehouseEpcisDemo.jar” This way you will be able to see the debug messages from the aspireWarehouseEpcisDemo Application.
    - Alternatively, you can just double click the “aspireWarehouseEpcisDemo.jar” in the unzipped folder.
- Start the Reader Core Proxy server
- Use the Physical Reader Configurator tool to upload the “ReaderDevice_AccadaSimulator.xml” physical reader specifications. The file can also be found at the ApireRFID Forge). Specifically, from the "Management" tab, click "Upload configuration file" and hit "Start". This will start the “Accada Reader Simulator”.
- Start the Apache Tomcat Web server with the “aspireRfidALE.war” (F&C Server), the “aspireRfidEpcisRepository.war” (EPCIS Repository) and the “connector.war” (Connector) deployed (can be found at the AspireRFID’s Forge under the AITdev Servers package).
- Set the EPCIS Repositorydatabase with the help of this sql script “EpcisRepo_With_WarehouseEpcisDemo_Data.sql”.
- Open the LRSpecConfiguratorView. Click "Define" to define a reader with Reader Name: “AccadaSimulatorWithRPProxy” and LRSpec: “Dynamic_AccadaSimulator_RpReader.xml”.

The following list is with the contents of the Dynamic_AccadaSimulator_RpReader.xml file. A logical reader is defined and its corresponding properties: name, description, read intervals, notification point and connection point.


```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<ns3:LRSpec xmlns:ns2="urn:epcglobal:ale:wsdl:1"
xmlns:ns3="urn:epcglobal:ale:xsd:1">
    <isComposite>false</isComposite>
    <readers/>
    <properties>
        <property>
            <name>ReaderType</name>

<value>org.ow2.aspirerfid.ale.server.readers.rp.RPAdaptor</value>
        </property>
        <property>
            <name>Description</name>
            <value>This Logical Reader consists of shelf 1,2,3,4 of the
physical reader named AccadaRPSimulator</value>
        </property>
        <property>
            <name>PhysicalReaderName</name>
            <value>AccadaRPSimulator</value>
        </property>
        <property>
            <name>ReadTimeInterval</name>
            <value>1500</value>
        </property>
        <property>
            <name>PhysicalReaderSource</name>
            <value>Shelf1,Shelf2,Shelf3,Shelf4</value>
        </property>
```

```
        <property>
            <name>NotificationPoint</name>
            <value>http://localhost:9090</value>
        </property>
        <property>
            <name>ConnectionPoint</name>
            <value>http://localhost:8000</value>
        </property>
    </properties>
</ns3:LRSpec>
```

This way the F&C server will connect with the Reader Core Proxy and the Accada Simulator.

- Start the “aspireWarehouseEpcisDemo” and at the Shipment tab for the invoice id choose the “urn:epc:id:gid:239.30.58933” one and hit the Submit button.

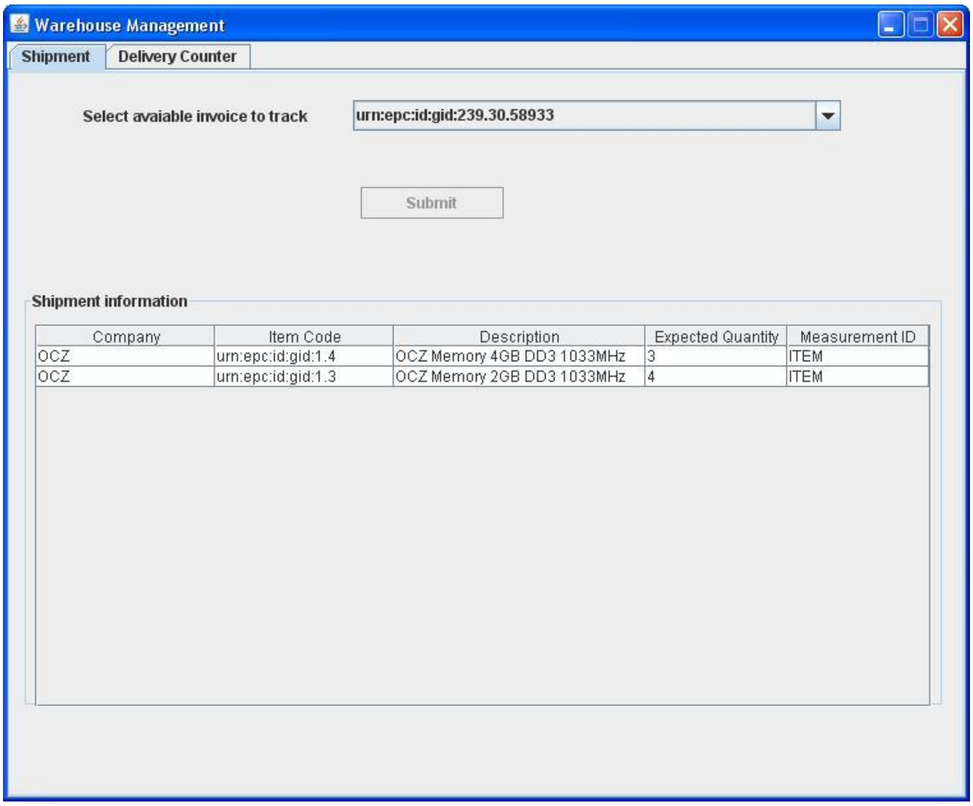



**Figure 23: Warehouse management application**

When hitting the submit button the application will send a request to the connector to report back to it at a stable set interval with every event that occurred to the EPCIS repository with the specific transactionID. The connector in his turn subscribes to the EPCIS repository for the specific transactionID. If the process is successful the application will change to the Delivery Counter tab and will wait for the specific events to occur.

- Open from the BEG plug-in the BEG Configuration View. Hit the refresh button next to the “Available Business Events” combo box and a list of available events will appear. Choose the “Warehouse1DocDoorReceive” event, set “8888” at the “ALE

Subscription Port" text field and hit the "Start Event Generation" button (see Figure 24 below).


**Figure 24: Using the BEG Configurator tool to configure event generation**

- Open from the BEG plug-in the BEG Observation view. Hit the refresh button next to the "Choose Event to Observe" combo box and a list of all served events will appear. Choose the "urn:epcglobal:fmcg:bte:acmewarehouse1receive" event and every tag that passes through the BEG that is connected with this event will appear to this view.

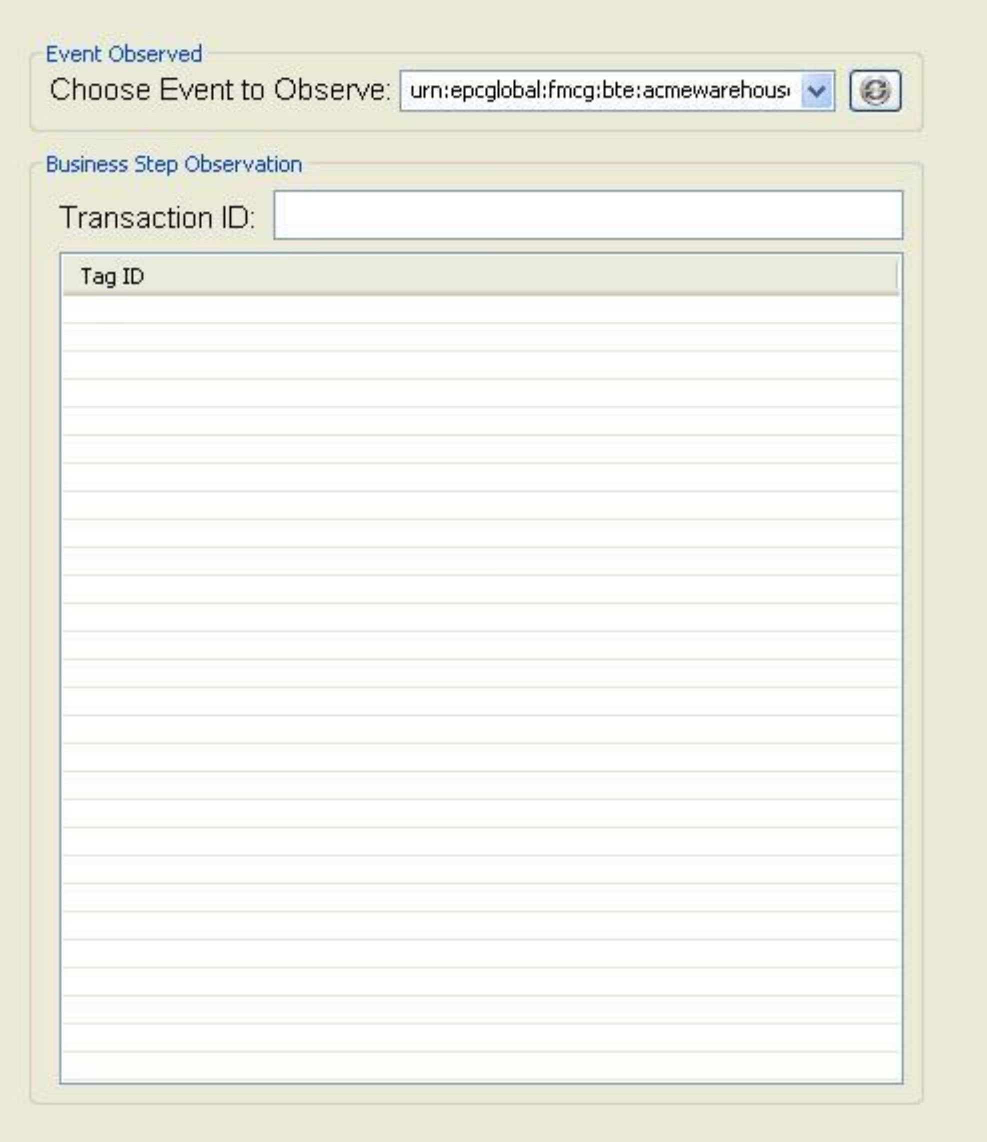



**Figure 25: Observing BEG for events through the BEG Observation View**

- Use from the ALE Server Configurator the ECSpecConfigurator tool to define an ECSpec with ECSpec Name: "WarehouseEpcisDemoEcspec" (or whatever else you prefer) and ECSpec: "ECSpec_AccadaSimulator_ObjectEventFiltering.xml".

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<ns2:ECSpec includeSpecInReports="false"
xmlns:ns2="urn:epcglobal:ale:xsd:1">
    <logicalReaders>
        <logicalReader>AccadaSimulatorWithRPProxy</logicalReader>
    </logicalReaders>
    <boundarySpec>
        <repeatPeriod unit="MS">4500</repeatPeriod>
        <duration unit="MS">4500</duration>
        <stableSetInterval unit="MS">0</stableSetInterval>
    </boundarySpec>
    <reportSpecs>
```

```
        <reportSpec reportOnlyOnChange="false"
reportName="bizTransactionIDs_1234" reportIfEmpty="true">
            <reportSet set="CURRENT"/>
            <filterSpec>
                <includePatterns>
                    <includePattern>urn:epc:pat:gid-
96:145.12.*</includePattern>
                    <includePattern>urn:epc:pat:gid-
96:239.30.*</includePattern>
                </includePatterns>
                <excludePatterns/>
            </filterSpec>
            <groupSpec/>
            <output includeTag="true" includeRawHex="true"
includeRawDecimal="true" includeEPC="true" includeCount="true"/>
        </reportSpec>
        <reportSpec reportOnlyOnChange="false"
reportName="transactionItems_1234" reportIfEmpty="true">
            <reportSet set="ADDITIONS"/>
            <filterSpec>
                <includePatterns>
                    <includePattern>urn:epc:pat:gid-
96:145.233.*</includePattern><!-- Small Packets Contents 1-->
                    <includePattern>urn:epc:pat:gid-
96:1.3.*</includePattern><!-- Small Packets Contents 2-->
                    <includePattern>urn:epc:pat:gid-
96:1.4.*</includePattern><!-- Small Packets Contents 3-->
                    <includePattern>urn:epc:pat:gid-
96:145.255.*</includePattern><!-- Medium Packets Contents -->
                </includePatterns>
                <excludePatterns/>
            </filterSpec>
            <groupSpec/>
            <output includeTag="true" includeRawHex="true"
includeRawDecimal="true" includeEPC="true" includeCount="true"/>
        </reportSpec>
    </reportSpecs>
    <extension/>
</ns2:ECSpec>
```

- Use from the ALE Server Configurator the ECSpecConfigurator tool to subscribe the already defined ECSpec to the BEG engine which is waiting for the specific filtered reports. Set as Notification URI: “http://localhost:8888”, select the “WarehouseEpcisDemoEcspec” as the ECSpec name (or whichever you used to define the ECSpec) and hit Execute.

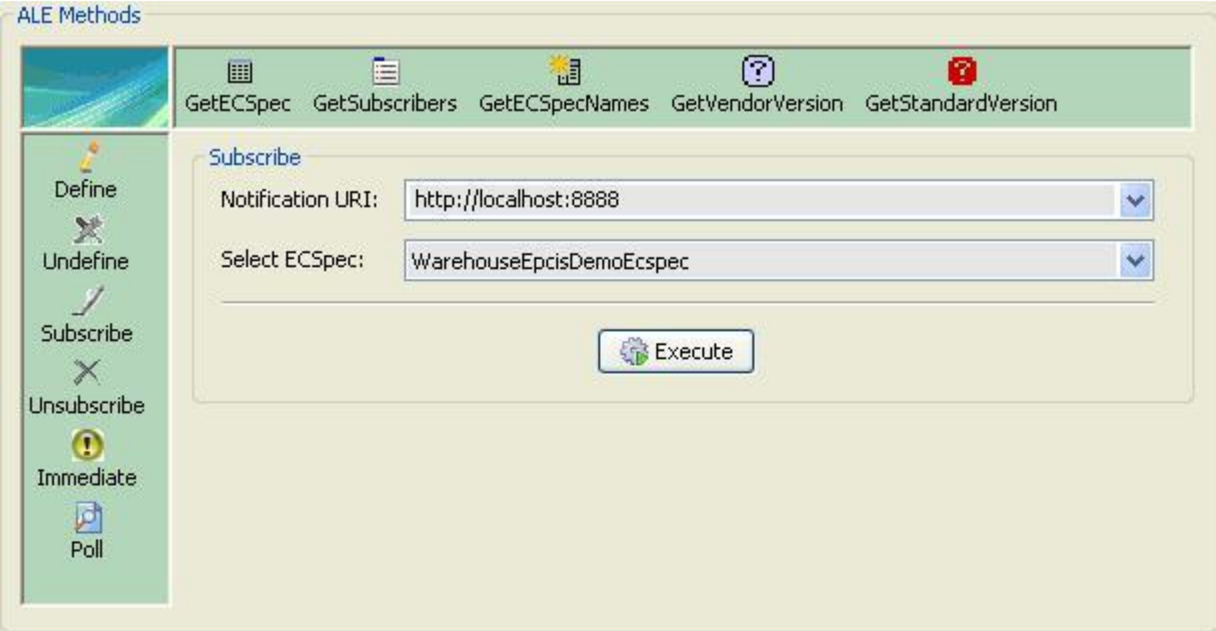



**Figure 26: Subscribing a new F&C client using the ECSpec Configurator tool**

- Copy and paste the demo tags from the "WarehouseEpcisDemo_EPC_Tags.txt" for the urn:epc:pat:gid:239.30.58933 invoice id group to the Accada Simulator Reader and place them on its antennas (first you need to place the invoice id tag "3500000EF00001E00000E635" so as to start the transaction and then the rest of the products). Figure 27 and Figure 28 below demonstrate the respective required steps.

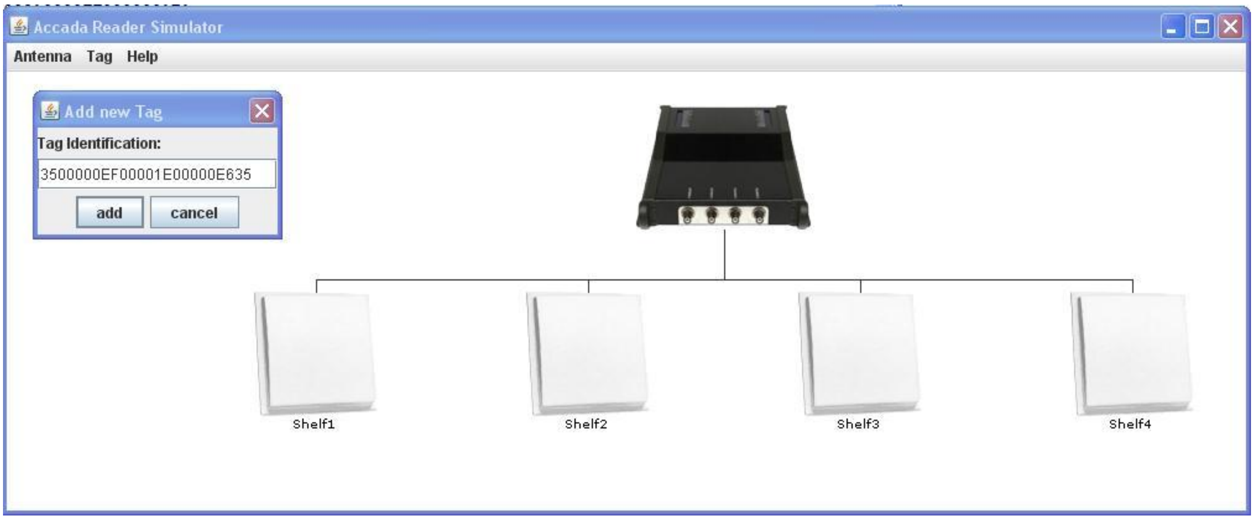



**Figure 27 inserting a new RFID tag using the Accada reader simulator**

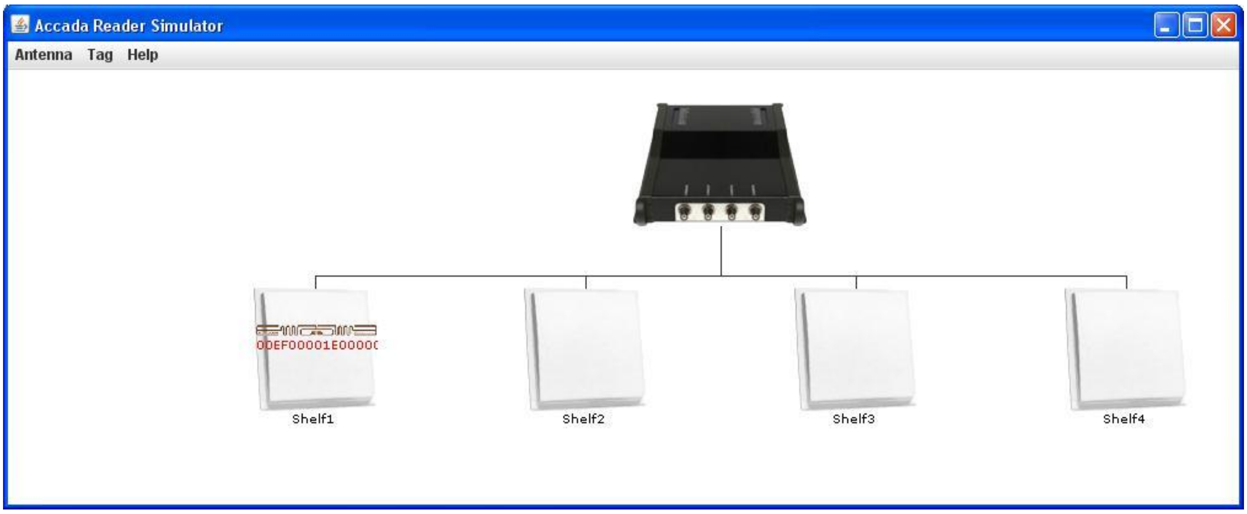



**Figure 28: Placing the new RFIDtag on top of a shelf**

The tags supported for this demo are the following:

```
<invoice>urn:epc:pat:gid-96:239.30.*</invoice>
urn:epc:pat:gid-96:239.30.58933 = 3500000EF00001E00000E635
<SmallPacket2ContentsGroupName>urn:epc:pat:gid-
96:1.3.*</SmallPacket2ContentsGroupName>4
urn:epc:pat:gid-96:1.3.127 = 35000000100000300000007F
urn:epc:pat:gid-96:1.3.128 = 350000001000003000000080
urn:epc:pat:gid-96:1.3.129 = 350000001000003000000081
urn:epc:pat:gid-96:1.3.130 = 350000001000003000000082

<SmallPacket3ContentsGroupName>urn:epc:pat:gid-
96:1.4.*</SmallPacket3ContentsGroupName>3
urn:epc:pat:gid-96:1.4.55 = 350000001000004000000037
urn:epc:pat:gid-96:1.4.56 = 350000001000004000000038
urn:epc:pat:gid-96:1.4.57 = 350000001000004000000039
```

The items expected from the “aspireWarehouseEpcisDemo” application can be changed from the WarehouseParameters.xml file placed inside the “aspireWarehouseEpcisDemo” jar file.

```
<?xml version="1.0" encoding="UTF-8"?>
<parameters>
        <invoices>
                <invoice>
                        <invoiceGroupName>urn:epc:id:gid:145.12.654645
                        </invoiceGroupName>
                        <!-- Merchandise data -->
                        <merchandise>
                                <packetsContent>

        <packetsGroupName>urn:epc:id:gid:145.255
                                        </packetsGroupName>
                                        <company>ALTERA</company>
```

```
                                        <description>Altera Microcontroler
8081</description>
                                        <measurementID>ITEM</measurementID>
                                        <quantity>5</quantity>

        <expectedQuantity>5</expectedQuantity>
                                </packetsContent>
                                <packetsContent>

        <packetsGroupName>urn:epc:id:gid:145.233
                                        </packetsGroupName>
                                        <company>ALTERA</company>
                                        <description>Altera Microcontroler
8085</description>
                                        <measurementID>ITEM</measurementID>
                                        <quantity>4</quantity>

        <expectedQuantity>4</expectedQuantity>
                                </packetsContent>
                        </merchandise>
                </invoice>
                <invoice>
                        <invoiceGroupName>urn:epc:id:gid:239.30.58933
                        </invoiceGroupName>
                        <!-- Merchandise data -->
                        <merchandise>
                                <packetsContent>
                                        <packetsGroupName>urn:epc:id:gid:1.4
                                        </packetsGroupName>
                                        <company>OCZ</company>
                                        <description>OCZ Memory 4GB DD3
1033MHz</description>
                                        <measurementID>ITEM</measurementID>
                                        <quantity>3</quantity>

        <expectedQuantity>3</expectedQuantity>
                                </packetsContent>
                                <packetsContent>
                                        <packetsGroupName>urn:epc:id:gid:1.3
                                        </packetsGroupName>
                                        <company>OCZ</company>
                                        <description>OCZ Memory 2GB DD3
1033MHz</description>
                                        <measurementID>ITEM</measurementID>
                                        <quantity>4</quantity>

        <expectedQuantity>4</expectedQuantity>
                                </packetsContent>
                        </merchandise>
                </invoice>
                <invoice>
                        <invoiceGroupName>urn:epc:id:gid:145.12.76427
                        </invoiceGroupName>
                        <!-- Merchandise data -->
                        <merchandise>
                                <packetsContent>

        <packetsGroupName>urn:epc:id:gid:145.255
```

```
                                        </packetsGroupName>
                                        <company>ALTERA</company>
                                        <description>Altera Microcontroler
8081</description>
                                        <measurementID>ITEM</measurementID>
                                        <quantity>5</quantity>

        <expectedQuantity>5</expectedQuantity>
                                </packetsContent>
                                <packetsContent>

        <packetsGroupName>urn:epc:id:gid:145.233
                                        </packetsGroupName>
                                        <company>ALTERA</company>
                                        <description>Altera Microcontroler
8085</description>
                                        <measurementID>ITEM</measurementID>
                                        <quantity>4</quantity>

        <expectedQuantity>4</expectedQuantity>
                                </packetsContent>
                                <packetsContent>
                                        <packetsGroupName>urn:epc:id:gid:1.4
                                        </packetsGroupName>
                                        <company>OCZ</company>
                                        <description>OCZ Memory 4GB DD3
1033MHz</description>
                                        <measurementID>ITEM</measurementID>
                                        <quantity>3</quantity>

        <expectedQuantity>3</expectedQuantity>
                                </packetsContent>
                                <packetsContent>
                                        <packetsGroupName>urn:epc:id:gid:1.3
                                        </packetsGroupName>
                                        <company>OCZ</company>
                                        <description>OCZ Memory 2GB DD3
1033MHz</description>
                                        <measurementID>ITEM</measurementID>
                                        <quantity>4</quantity>

        <expectedQuantity>4</expectedQuantity>
                                </packetsContent>
                        </merchandise>
                </invoice>
        </invoices>
</parameters>
```

- Captured tags should appear to the “aspireWarehouseEpcisDemo” application and when all the expected products appear a transaction ended message dialog will pop up.

## 7.4 Pick and Pack Demo

The objective of this demo is to showcase the feasibility of implementing a Pick and Pack scenario in transferring goods. The "pick and pack" is one of the most important processes in companies in the sector of packaging consumables. Picking and packing takes place in a company's Warehouse or a location in general where the goods are gathered and from there disseminated to their final destinations such as retail shops.

According to the scenario, the company has received an order from a client (e.g. one of the chain of retail stores) requiring several items. When the company receives the request, it prints an invoice; the corresponding items are picked and next packed into some package, together with the invoice.

This demo presents an application where, in a configuration file, the EPC code of the invoice and the respective EPC codes of the consumables are defined and, with the help of the simulator, it is assured that only these consumables and only these can be found together.

### *7.4.1 Download & run instructions*

- Start the Reader Core Proxy server
- Use the Physical Reader Configurator tool to upload the "ReaderDevice_AccadaSimulator.xml" physical reader specifications. The file can also be found at the ApireRFID Forge). Specifically, from the "Management" tab, click "Upload configuration file" and hit "Start". This will start the "Accada Reader Simulator".
- Start the Apache Tomcat Web server with the "aspireRfidALE.war" (F&C Server).
- Open the LRSpecConfiguratorView. Click "Define" to define a reader with Reader Name: "AccadaSimulatorWithRPProxy" and LRSpec: "DynamicRpLogicalReader_FosstrakSimulatorReaderProxy.xml".
- This way the F&C server will connect with the Reader Core Proxy and the Accada Simulator.
- Start the "RfidWarehousePnpDemo" application. Figure 29 below is a screenshot of the application.

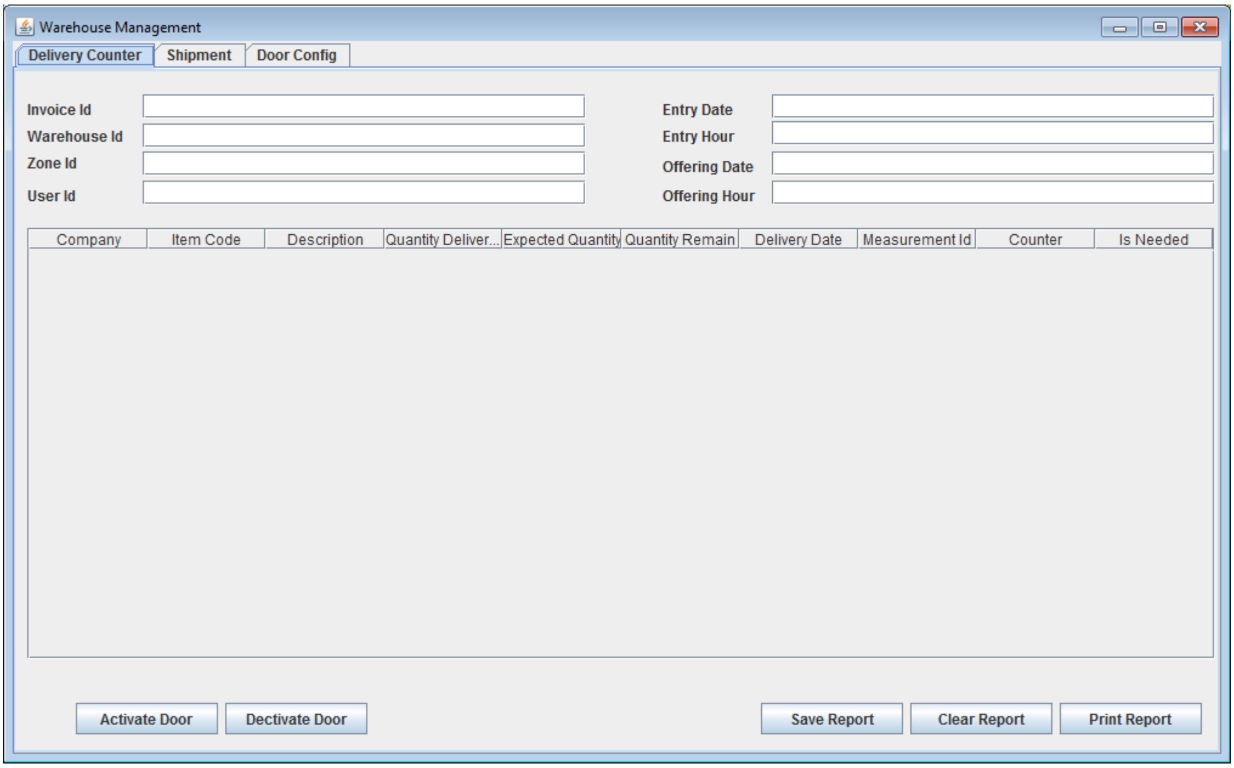



**Figure 29: Warehouse management application for the Pick and Pack demo**

- Place the xml file: ECSpec_FosstrakSimulator_WarehousePnpDemo.xml in the folder AspireRFID/IDE/ECSpecs in your AspireRFID installation.
- Open the ECSpecConfiguratorView. Hit "Define" to define the ECSpecs. You may enter “WarehousePnpDemoEcspec” (or whatever else you prefer) as a Spec Name. As an ECSpec file, choose the "ECSpec_FosstrakSimulator_WarehousePnpDemo.xml" that you just copied to the AspireRFID/IDE/ECSpecs folder. Hit "Execute".
- While still in the ECSpecConfiguratorView, hit "Subscribe" to tell the ALE to send reports to the URL that the RfidWarehousePnpDemo is listening. As a notification URI, choose http://localhost:9999 (unless you changed the application's default listening URI, in the Door Config tab in the application). As an ECSpec name, choose "WarehousePnpDemoEcspec" or whatever you entered in the previous step as name for your ECSpec. Hit "Execute".
- Now the application receives reports from the simulator. Hit "Activate Door" in the Warehouse Management application.
- Open the Accada Reader Simulator. Copy and paste some demo tags from the "WarehousePnpDemo_EPC_Tags.txt" file to the Accada Reader Simulator (Tag -> Add new Tag) and place them on its antennas. The next listing displays these tags:

```
Invoice 1     Hex
146.55.112    35000009200003700000070
   RAM
   57.88.16      35000003900005800000010
   57.88.17      35000003900005800000011
   CPU
   124.50.29     35000007C00003200000001D
```

```
   HDD
   91.206.53     35000005B0000CE000000035
Invoice 2     Hex
146.55.113    35000009200003700000071
   Monitor
   37.192.211    3500000250000C00000000D3
   Case
   101.224.58    3500000650000E000000003A
   Keyboards
   261.197.135   3500001050000C5000000087
   261.197.136   3500001050000C5000000088
```

Note that for each item, there is an "Expected Quantity" field, indicating whether all the expected items have yet been delivered or not. Figure 30 below shows the application after it has recognized an Invoice, and populated the corresponding fields.

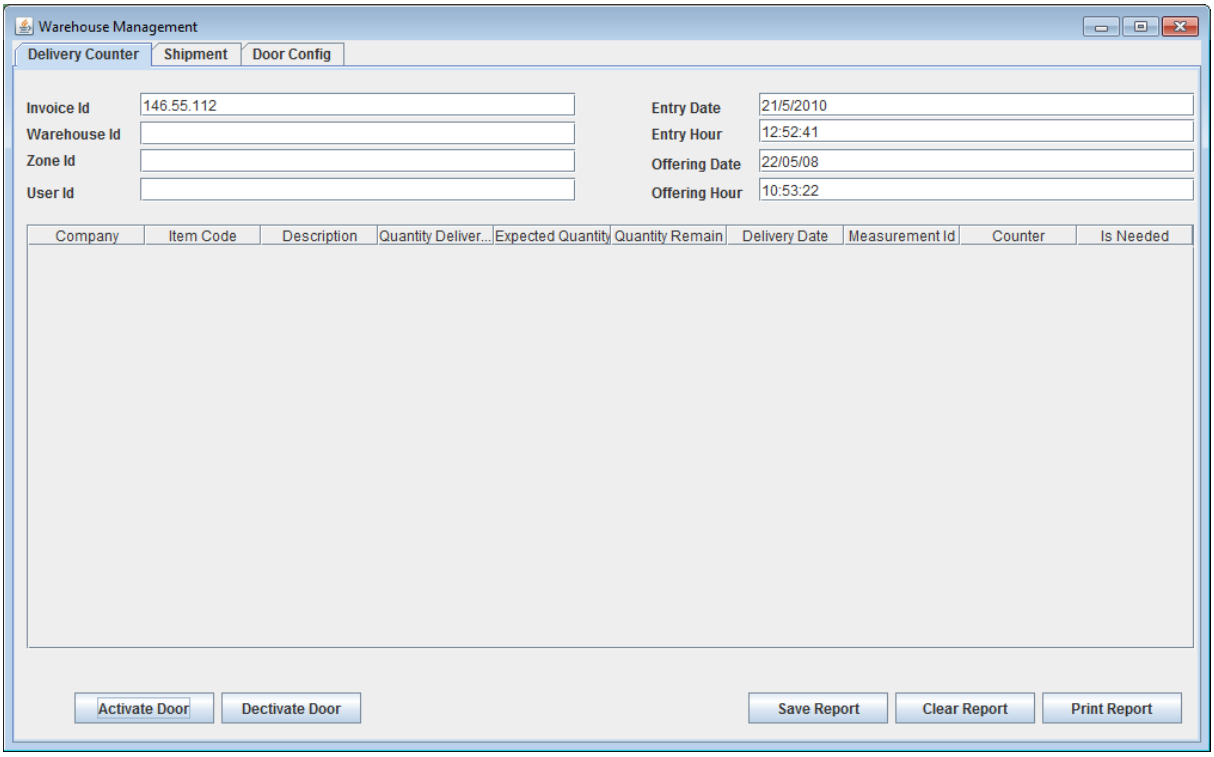



**Figure 30: Pick and Pack demo: An invoice was recognized**

In Figure 31 below, we can see the application in action, where it is displayed that 2 correct items have been identified (green rows) and one item that shouldn't be there (red row).

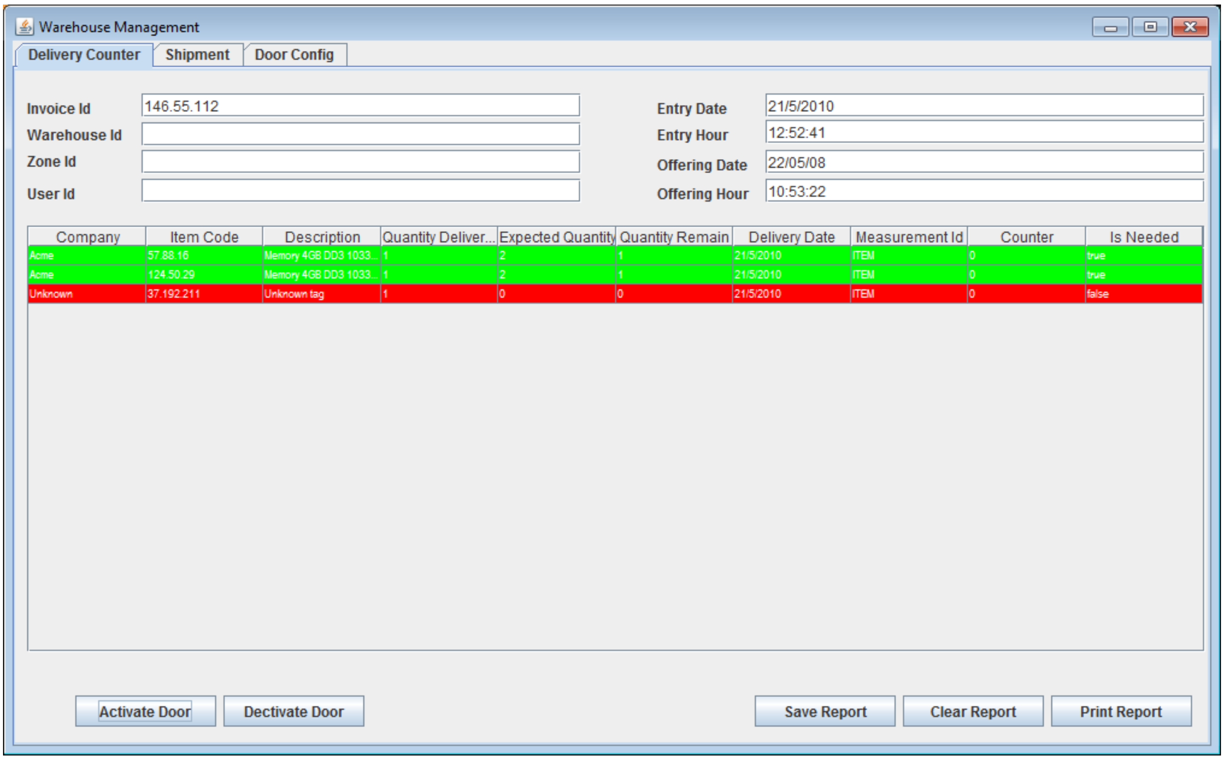



**Figure 31: Pick and Pack demo: Items are coloured green if they should be part of the packet or red otherwise**

After all the items required by the invoice and only these items are recognized (no unknown tags are present), the application will display the items in orange color, as in Figure 32 below, indicating that the process is complete.

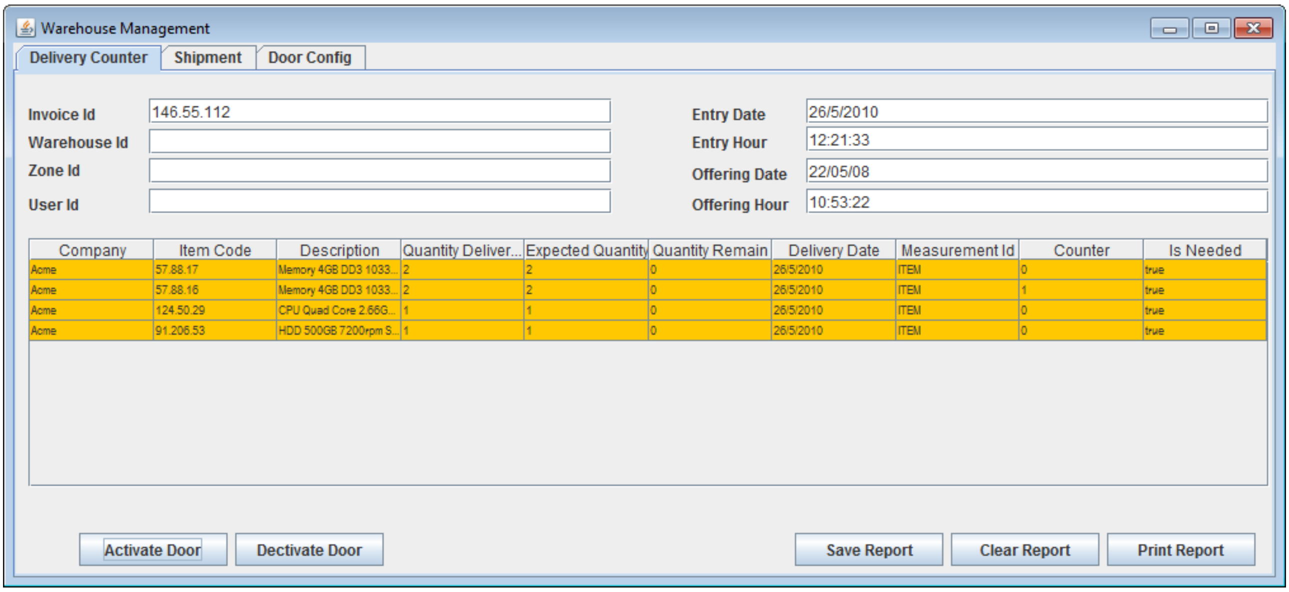



**Figure 32: Pick and Pack demo: An invoice is considered complete when the items described and only they are recognized**

# 8 Conclusions

This deliverable has described several pilots and demonstrations, which have been setup by the ASPIRE partners, using the AspireRfid middleware and tools. From a business process and functional viewpoint, the pilots and the demonstrations cover a wide range of operational RFID systems spanning the areas of warehouse management, logistics, supply chain management, registration management, asset management and tracking. From a technological viewpoint the pilots and the demonstrations cover the vast majority of ASPIRE technical developments including the ASPIRE middleware libraries (developed in WP3 of the project), the ASPIRE integrated development environment and tools (developed in WP4 of the project), as well as the ASPIRE low-cost reader (developed in WP5 of the project). On top of these developments the project partners have integrated RFID software applications pertaining to the needs of each pilot and demonstration.

One of the main conclusions stemming from this deliverable is that the ASPIRE developments can generally boost and facilitate RFID application development, in a wide spectrum of application areas. Nevertheless, it must be pointed out the several of the ASPIRE utilities (such as the integrated development environment (ASPIRE IDE)) are oriented towards logistics and supply chain management applications, which are however dominant in both ASPIRE and the RFID/AutoID industry. However, a wider collection of applications (e.g., for registration management) can leverage some of the ASPIRE libraries (such as the hardware abstraction drivers for various readers and the infrastructure management applications).

Another important conclusion is that ASPIRE should be seen as a middleware and tooling framework facilitating RFID deployment, rather than an off-the-shelf readily product for RFID solutions. The main implication of this remark is that RFID integrators (such as SENSAP, INRIA) have still to allocate significant effort in order to integrate and deploy an operational RFID solution. Hence, in practice, RFID integrator will be required to build several RFID software applications and integrate them to the underlying ASPIRE middleware (possibly using the ASPIRE tools). As a result, integration effort is still required, despite the functionalities provided by ASPIRE (such as Hardware Abstraction, Business Event Generation, Master Data Management). However, the abovementioned ASPIRE functionalities provide a proven boost to the RFID application development process, given that they are integral and indispensible components of any non-trivial RFID deployment.

As a direct consequence of the above conclusions, the end-users of the ASPIRE middleware and tools are primarily ICT companies working on the integration of low-cost RFID solutions, rather than on the end-users (i.e. adopters) of RFID technology. Nevertheless, some experiences prove that the ASPIRE tools can also be used (directly) by end-users during the management and maintenance of the solution.

The above conclusions on the use and benefits of ASPIRE results are based on the early deployments of the platform in the scope of the pilots. These conclusions will be extended based on ongoing activities with the ASPIRE middleware and tools, which include:

- The exploitation of ASPIRE programmability features in the scope of existing systems and deployments. Note that existing pilots (e.g., the STAFF and SENSAP) pilots used ASPIRE tools (from ASPIRE WP4), but did not fully leverage the ASPIRE programmability features (such as the APDL and the BPWME tool). The main reason for this was that these features were under heavy development during the pilot deployment. The project investigates now the use of APDL in the scope of these pilots, which is expected to lead to additional conclusions related to the use/exploitation of ASPIRE's programmability capabilities.

- The organization and conduction of additional pilots using ASPIRE developments. As part of WP7 of the project, ASPIRE has established liaisons with the ICT-PSP projects RFID-ROI-SME (http://www.rfid-sme.eu/) and RFID F2F: RFID from Farm-to-Fork, which intend to (partly) use ASPIRE middleware and tools. These additional pilots are expected to open new horizons to the further development and exploitation of the project, while they will also lead to additional remarks that will complement the conclusions of this section.
- The use of ASPIRE from users and contributors of the AspireRfid (http://wiki.aspire.ow2.org/) open source project. There are a number of users and potential contributors spread across various countries including China, Brazil and Thailand. These people are planning the use of ASPIRE in additional applications, which can lead to additional conclusion about the use of ASPIRE results in realistic pilot applications.

Except for conclusion associated with the ASPIRE technological developments, the present deliverable has led to conclusions relating to the benefits of RFID technologies in different application domain. As evident from the relevant description, all deployments have led into tangible benefits, which will be thoroughly investigated and quantified in the scope of coming ASPIRE WP6 deliverables (notably D6.3). While the business benefits of RFID deployment are undeniable, there are still questions, about the economical/financial benefits mainly to the still high cost of RFID tags. ASPIRE techno-economic studies will delve into the issue of techno-economic evaluation.

## Acronyms

| | |
|---|---|
| AAU | Aalborg University |
| AIT | Athens Information Technology |
| ASPIRE | Advanced Sensors and lightweight Programmable middleware for Innovative Rfid Enterprise applications |
| ALE | Application Level Event |
| API | Application Programme Interface |
| BEG | Business Event Generator |
| EPC | Electronic Product Code |
| ERP | Enterprise Resource Planning |
| F&C | Filtering and Collection |
| HAL | Hardware Abstraction Layer |
| ISO | International Standard Organisation |
| KPI | Key Performance Indicator |
| IT | Information Technology |
| LLRP | Low Level Reader Protocol |
| ONS | Object Name Service |
| OSS | Open Source Software |
| RFID | Radio Frequency Identification |
| ROI | Return of Investment |
| RP | Reader Protocol |
| SME | Small and Medium Enterprise |
| TCO | Total Cost of Ownership |
| WMS | Warehouse Management System |
| WP | Work package |

## List of Figures

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