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XISA for smartTAGSs

eXtended Information System Architecture for SmartTags

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1. Introduction

This project comes is emerging from other project named TSMART [1] (Tags for SMART Travellers). The TSMART project intends to develop a multimodal platform that support passenger and luggage reconciliation, covering the entire trip, between the starting point ant the end point, using RFID technology to track the items.

One key aspect of human long distance mobility is the problem of dealing with their luggage. There are two issues that raise the problem to be analysed:

- The international long trips growth, with the globalization, where trips evolves frequently several means of transport (air, road, rail, sea).

- The passenger and luggage management and all of the inherent handling problems like lost, re-route and delay.

Thus, the fundamental contribution of this project is to know how to use advanced RFID tags to provide a completely new way of handling passenger and luggage reconciliation in a multimodal human transportation. The purpose is to apply the information system architecture methodology that covers information and functionalities residing in RFID tags, to a real case in the area of passenger and luggage transportation. Furthermore, it seeks to use a new methodology representing a SOA architecture from the business processes, to guarantee the alignment between IT and the business.

2. State of the Art

It was identified the need to follow passengers and luggage in the course of trips to avoid problems with their baggages. Consequently, three ways of tracking items were studied:

- Logistics tracking systems: tracking made by control points, through of readers that are in specific locations, that let us know where the items passed but not where are the items actually. The items have a predefined route and during their journey they are going to be read by the readers, identifying the locations in order to inform if the items are in the right location. The proposed architecture for TSMART will be based on this type of tracking system [2].

- Cellular networks: real time tracking systems, that had been studied due to the network always know where is the item, even if it is not in its home network. There is an agreement between operators to allow mobiles from visitor networks to execute all their normal operations, as in their home network. The necessary integration between operators in cellular networks is a key aspect that will be addressed in the proposed architecture [3].

- Global Positioning Systems: real time tracking systems which allow too the user to know where is an item actually. This research implies the uses of satellites and a receiver attached to the item, but it is a very expensive approach for the problem. Otherwise this type of systems had a great difficulty to identify items in infra-structures and to distinguish near locations [4].

It was studied a little bit of RFID technology and it was decided to use RFID tags as identifiers that have the key to access the information in a database. The other option, to use RFID tags as containers of information, has been set aside to construct a more realistic proposal.

3. Methodology

In this chapter will be presented the new methodology that was under investigation by the business consulting team of LINK. Framework BPB-SOA (Business Process Based - Service

Oriented Architecture) launches the desired universe of speech around services, and the SOP (Services On Processes) methodology explains how to concretize the framework artifacts [5].

3.1 Framework BPB-SOA

The usual way to identify services nowadays has been bottom-up. It starts to create elementary services around the existing applications and then in a second phase it will aggregate those services in more complex services. However this custom brings problems such as the proliferation of services, ignores the dependency between applications and services and don't take account the alignment of information, applications and business.

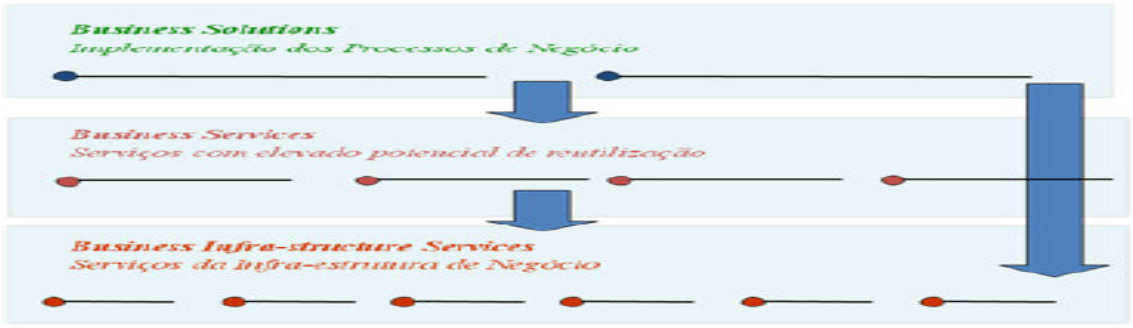


Figure 1 – Framework BPB-SOA [5].

Figure 1 represents the framework which is currently developed by the business consulting team of LINK inserted in a research project. It intends to define the service oriented architecture universe of speech, with the identification of the services based on the business processes. In stead of a bottom-up, this framework uses a top-down approach.

Business Solutions: This layer represents the services that implement the organization business processes. The end user interacts with this systems and the business logic is detailed in a set of non-automatic and automatic activities.

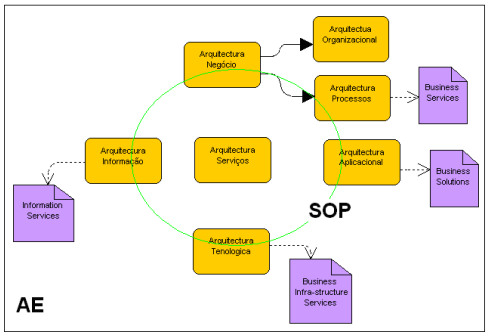
Business Services: This layer looks for patterns of activities that are being repeated or do have the chance to be repeated in the business solutions. It is useful because these activities could be isolated in a pattern, and thus to be reused by all of the business solutions that want to use that set of activities.

Information Services: Some Business Services aim exclusively to manage the information of the organization, like creation, reading, updating and deleting. Thus the Information Services match a sub-set of Business Services, but the only propose is to guarantee the consistency of the business information.

Business Infra-structure Services: The Business Infra-structure Services are all the systems native services. They are linked with the technological layer and are independent of the business type. To send an email is an example of this type of service.

3.2 Services on Processes Methodology

Services on Processes Methodology implement the above stated artifacts. Figure 2 shows the relation between the SOP methodology and the Information Systems Architecture. As we can see, SOP methodology evolves various architectures of Enterprise Architecture (EA), which are obtained using Information Systems Architecture: Organizational, Process, Information, Applications and Technology Architectures.



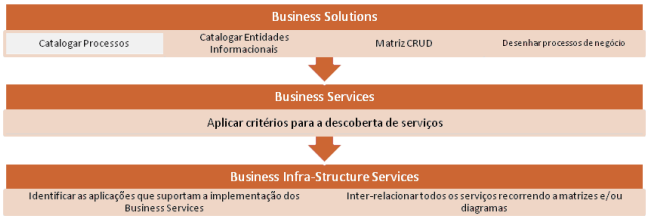


Figure 2 – Relation between SOP and EA. Figure 3 – SOP Methodology [5].

The figure 3 presents the steps of the new methodology to obtain a Service Architecture. To obtain the Business Solutions we have to perform a lot of architectures described above. Business Services are obtained in two ways: applying a set of heuristics to the business processes diagrams, to analyze activities reutilization, or possible activity reutilization; analyzing the CRUD matrix to view the reutilization of Information Services. Business Infra-structure Services offer an overview of the services and their relations.

4. Proposed Architecture

4.1 Problem Analysis

This section presents the handling luggage problems that can occur during a passenger's trip. Figure 4 outlines the trip's plan, containing three locations and the luggage. There are three main problems about luggage handling. The first one is a passenger that departures from Lisbon to Madrid, for instance, and his luggage remains at Lisbon. This situation happens frequently, and the operators do not know or they are not warned about that (Figure 5).

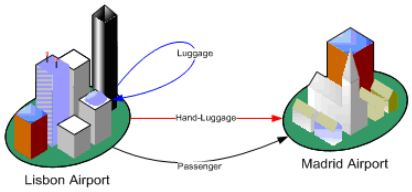


Figure 4 – Passenger's trip plan. **Figure 5 – The luggage remains at the airport.**

Picture 6 presents another usual case, where the passengers' luggage is delivered to a different airport, included in a set of baggages of other trip. The airport's operator could understand that there is a lost luggage, but sometimes he doesn't have information about the luggage trip, where it comes from and where it goes to. Additionally, when the passenger arrives at Madrid airport, he goes to the baggage claim and waits a lot of time until he understands that his luggage is lost. So, he confronts the airport's operator about his situation, and several times the operator does not know where his luggage has been lost.

This question raises another problem. For example, all passengers' luggage departures from Lisbon to Madrid and when they arrive the passenger do not find it in the baggage claim belt. This can happen because the luggage was lost in Madrid's airport. Although, the operator can not

distinguish this situation from the previous one because they don't have valuable information about luggages.

Figure 6 – The luggage goes to another airport. **Figure 7 – The lost hand-luggage.**

Finally, figure seven depicts the scenario of a lost hand luggage. A passenger forgot his own hand luggage in the shopping area while he was walking to the boarding area and eventually he would departure without noticing that didn't have his hand luggage.

Basically the system intends to solve this stated problems based on the reconciliation of passengers and luggage.

4.2 Organizational Architecture

Organizational Architecture evolves different concepts like macro-processes, organizational units, mission, vision and objectives. In this part, the most important concepts are mission, vision and objectives. Based on BMM (Business Motivation Model) it will be described by the intention of the business.

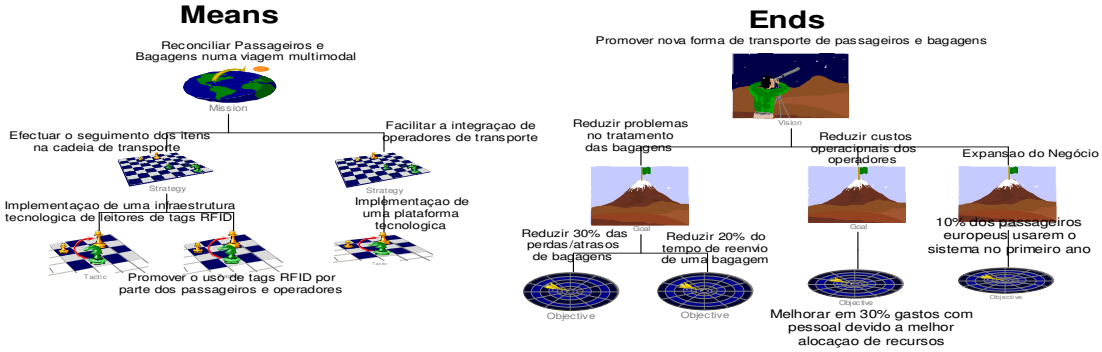


Figure 8 - TSMART business plan resume.

4.3 Process Architecture

Process Architecture presents the structure of the business processes. It explains how the enterprise creates value. Process Decomposition is showed in figure 8.

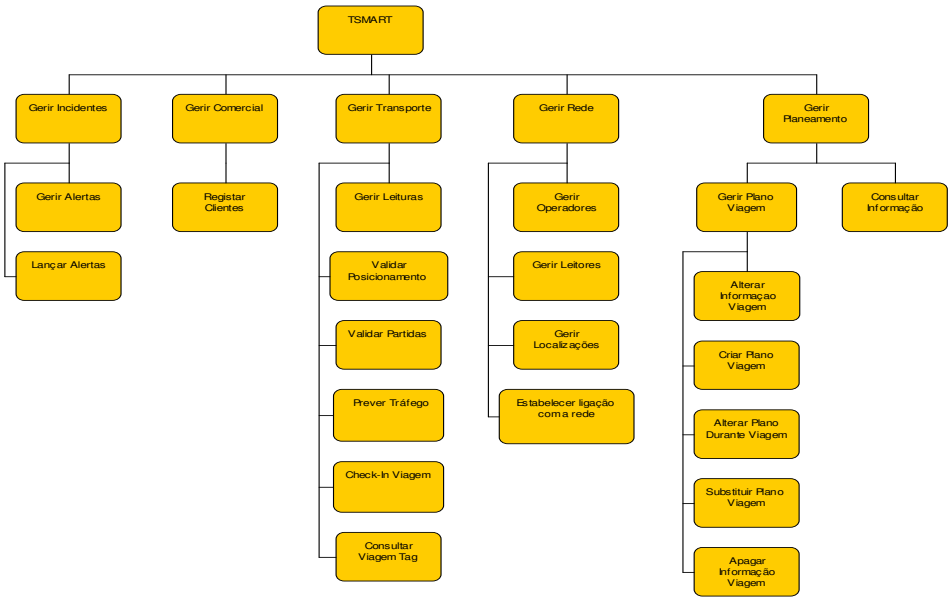


Figure 9 - Business Process Decomposition.

Each business process represented in the picture has a purpose for his existence, based on the business objectives outlined in the previous section. Table 1 presents the objective of each business process.

Business Process	Objective
Alerts Management	Mechanisms to facilitate warnings resolutions.
Alerts Launching	Warning creation when luggage problems will rise.
Clients registration	Allow client registration on the system.
Reading management	Make reconciliation between passengers and luggage.
Position validation	Verify if passenger is in the right place for departure.
Verify departures	Verify if all luggages are in the transport before departure.
Traffic prevision	Estimate of traffic in the operator
Check-In	Tags registration.
Consult Tag Trip	Wireless tag reading.
Operator Management	Operator's registration.
Readers Management	Reader's registration.
Location Management	Location and route registration.
Network linking	Allows reader linking with the network.
Change Trip Plan	It allows a client to change trip plan.
Create Trip Plan	It allows a client to create a trip plan.
Change Trip Plan during Trip	It allows an operator to change the trip plan.
Replace Trip Plan	Substitute passenger's trip plan.

Table 1 - Business Processes objectives.

4.4 Information Architecture

Information Architecture structures the informational entities necessary to pursuit the organization business processes. The information entities that will support TSMART project are:

ID	Name	Objective
E 01	Operator	Identifies one operator that has access to the network. It has a set of locations.
E 02	Reader	Identifies one RFID reader of the operator.
E 03	Client	Identifies an individual or a company that access to the network. Now he can reserve trips.
E 04	Passenger	Identifies a person that will do the trip. Could be a client or a person registered by the client.
E 05	Trip	Represent a set of route. It is associated with tags and passengers and can be made by any type of transportation.
E 06	Route	Route between two locations. One departure and one arrival location.
E 07	Tag	Identifies a tag of a passenger or luggage. It allows to follow any type of item.
E 08	Location	Identifies one transportation location.
E 09	Warning	Identifies an occurred incident with one tag.

Table 2 - Informational entities and their description.

		E01	E02	E03	E04	E05	E06	E07	E08	E09
		Operator	Reader	Client	Passenger	Trip	Route	Tag	Location	Warning
E01	Operator		1						2	
E02	Reader	1						3	4	5
E03	Client				6	7				
E04	Passenger			6		8		9		
E05	Trip			7	8		10	11		
E06	Route					10			12	
E07	Tag				9	11				13
E08	Location						12			14
E09	Warning							13	14	

Figure 10 - Entity relationships Matrix.

N.°	Link (Entity/Entity)		Link Justification
1	Operator	Reader	Operator chooses readers to operate in his network.
2	Operator	Reader	Operator has locations where it transports passengers.
3	Reader	Tag	Reader read tags RFID.
4	Reader	Location	Reader is registered in a location.
5	Reader	Warning	Warnings are issued in a reader.
6	Client	Passenger	Client notes trips for passengers.
7	Client	Trip	Client chooses the trip plan.
8	Passenger	Trip	Passenger is associated with a trip.
9	Passenger	Tag	Passenger has a set of tags, representing him and his luggage.
10	Trip	Route	A trip has a lot of routes.
11	Trip	Tag	Tag has a predefined trip that will do.
12	Route	Location	A trip is composed by two locations, one of departure and another of arrival.
13	Tag	Warning	Warnings regards to tags.
14	Location	Warning	Warnings are generated in a location.

Figure 11 - Entity relationships description.

4.5 Application Architecture

Application Architecture identifies the information systems of the organization. An application is characterized by his name, mission, process and information supported and the relation with others systems. In this architecture it is crucial to align processes and information, and that relation will present the desired applications using a set of rules obtained by the CRUD matrix (Figure 12).

BPMN Process / Entity	EH-Cliente	EH-Passageiro	EH-Viagem	EH-Tag	EH-Aviso	EH-Troço	EH-Operador	EH-Leitor	EH-Local
FX - Registar Cliente	CRUD								
FX - Consultar Informaçao	R	R	R	R	R	R			
FX - Criar Plano Viagem	R	C	C			R			
FX - Alterar Informacao Viagem		RU	RU			R			
FX - Substituir Plano Viagem			CR	RU					
FX - Alterar Plano Durante Viagem		RU	RU	RU		R			
FX - Apagar Informação Viagem		D	D						
FX - Check-In		R	R	C		R			
FX - Gerir Leituras				RUD				R	
FX - Validar Partida		R		R		R			
FX - Validar Posicionamento		R		R		R			
FX - Prever Tráfego		R	R	R		R			
FX- Consultar Viagem da Tag			R	R		R		R	
FX - Lança Alertas				R	C			R	
FX - Gerir Alertas			R	R	RUD	R			
FX - Gerir Operadores						C	CRUD	D	CD
FX - Gerir Leitores							R	CRUD	R
FX - Gerir Localizaçoes						CRUD	R		CRUD
FX - Estabelecer ligação com a rede								RU	R

Figure 12 - CRUD Matrix.

4.6 Technology Architecture

Technology Architecture describes a totally distributed architecture, so that there are not any global node and aspects like scalability, and the integration of operators can be made without overload. Figure 13 represents the proposed architecture. Each entity that chooses to use TSMART will have a concentrator with all business logic and some attached readers. The communication between readers and the server could be wired or wireless, and the set of concentrators will communicate with each other using P2P (Peer-to-peer) technique, through a network like internet.

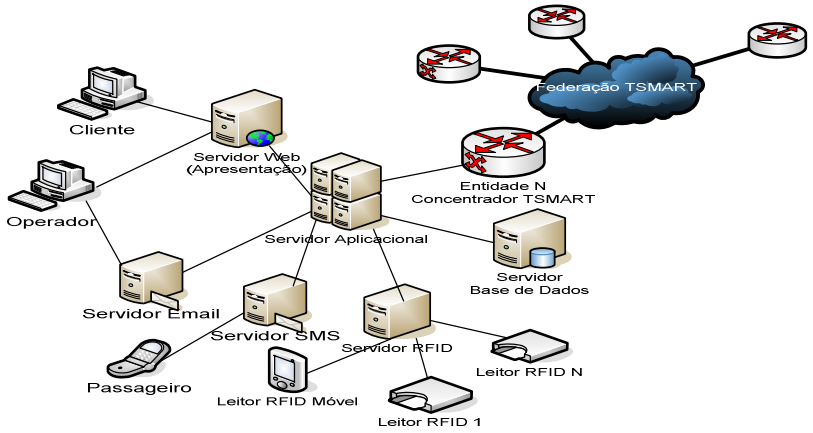


Figure 13 - Technology Architecture.

The concentrator only maintains the information necessary to execute the reconciliation between passengers and their luggage. That information will follow the passenger during the trip, so it will be transferred between concentrator during the journey to stay where it is more important, avoiding the concentrator to maintain big quantity of information. An additional research based on P2P is all we need to obtain information about a tag that raises in a not expected location.

4.7 Service Architecture

Figure 14 presents the service architecture. Here we have the relation between the services, following the SOP methodology presented above. The business solutions represent the applications suggested in the CRUD matrix, in a relation one-to-one.

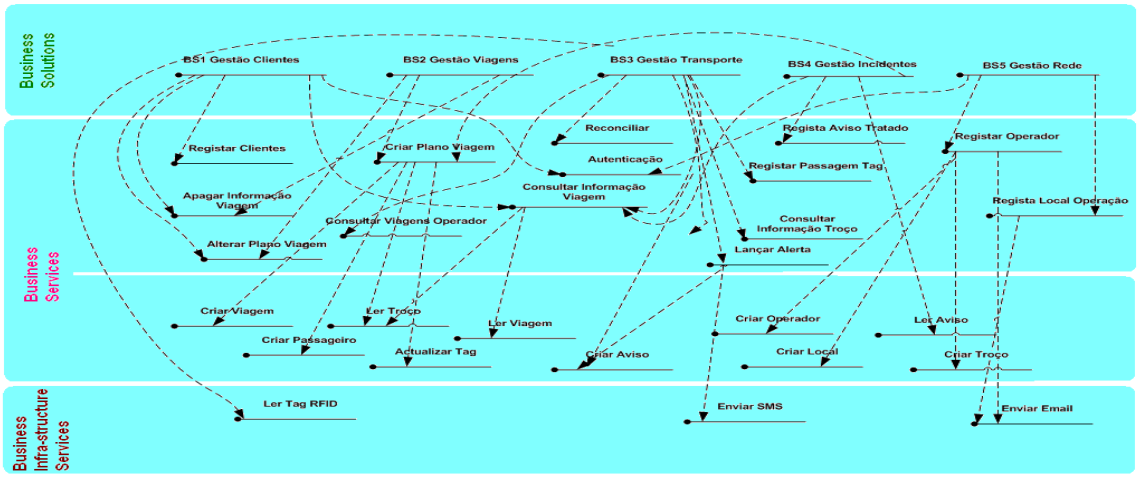


Figure 14 - Service Architecture.

The business services are divided in two layers:

- Business services, suggested by analyzing the reutilization of the activities in the business process diagrams.

- The information services layer. From the CRUD matrix we can get the information services and verify their reutilization. It is not represented the complete information services because each informational entity has four associated services representing the creation, reading, updating and deleting actions on the entity.

So we can see which business services the business solutions use, and the reutilization of information services by the business services and business solutions, and finally the reutilization of the technical services.

It is important to reveal that the type of infra-structure service that will be used depends on the type of technology architecture used. For example, in the prototype it is used a centralized architecture, so the technical services evolve database services. Otherwise, in a real scenario, will be used a distributed technology architecture, which represents a lot of P2P communication services. Although the business services will be the same, the only difference is the type of infra-structure service that the business service will use to solve its problem.

5. Prototype

The prototype implemented has a centralized architecture, thus the information is always on the same database. The three tier architecture had been applied to the prototype [6]:

- Presentation layer made with ASP.NET technology, representing the semi-automatic activities in the business processes. It was done a site with human interface interaction to simulate the events triggered by users [7].

- Business logic layer made with BizTalk Server 2006. There were implemented some orchestrations representing the services suggested in the service architecture. Here we have the information services responsible to encapsulate the complexity of managing the information [8].

- Data layer, made with SQL Server 2005, where the information is saved.

Besides this three layer architecture, it was integrated with a real RFID reader, which will trigger some other events to be treated in the business logic layer. Integration between RFID reader and business logic is made by BizTalk RFID (Figure 15).

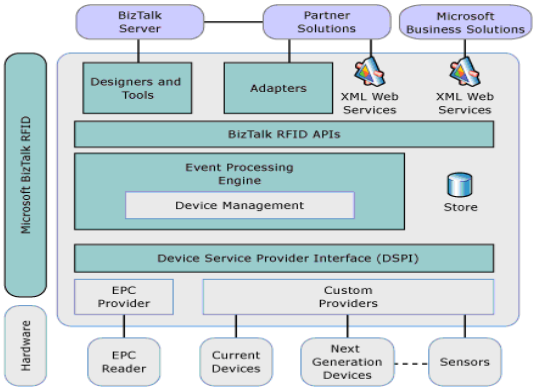


Figure 15 - BizTalk RFID architecture [9].

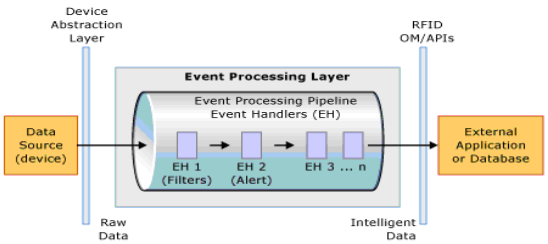


Figure 16 - Event Processing Layer [10].

BizTalk RFID architecture is composed by several layers. The most important are [9]:

- Hardware layer which corresponds to any reader.

- Device service provider interface (DSPI) where the information read is transformed to a type of information understood by BizTalk RFID. Thus, any type of hardware can be used since the hardware provider constructs a DSPI for that hardware, so that BizTalk RFID understands the tag information, because it only understands its own type of information [9].

- Event Processing Layer. Through Event Processing Engine [10] we can transform any type of raw in intelligent data. To do so it is possible to implement handlers that execute C# code or business rules. After that, just left send the intelligent information to the business logic (Figure 16).

6. Validation

The purpose of this part of the work is to verify if the business processes and the services suggested match the stated problem. So it presents a set of screen shots of the prototype simulating the business processes. Figure 17 outlines client side screen shots. On the left side the client is reserving a trip composed by two or more locations and then it gives passenger's information.

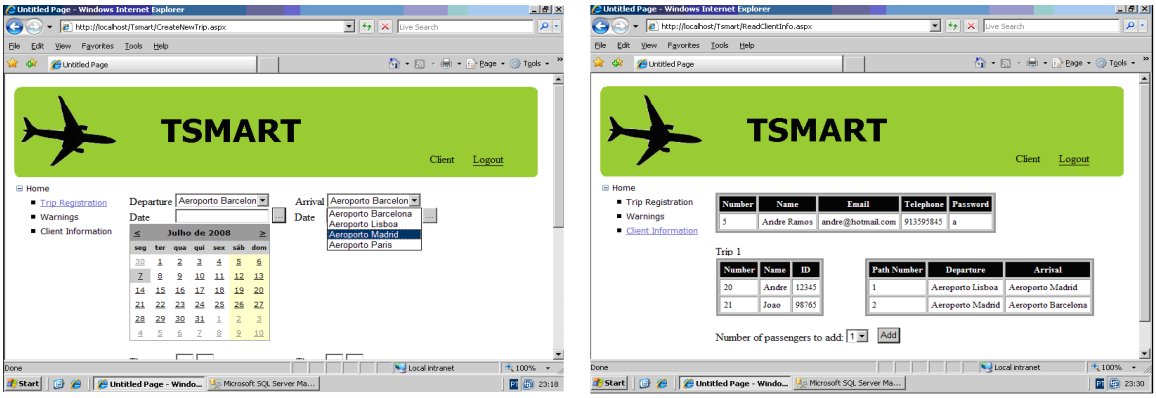


Figure 17 – Client's side prototype screen.

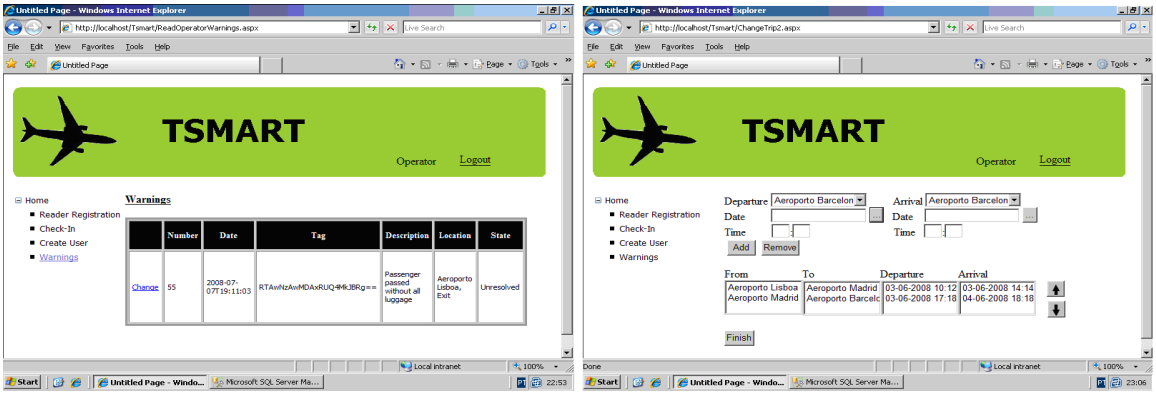


Figure 18 – Operator's side prototype screen.

After that, it was used real RFID tags and a reader to generate events to the business logic. It was tested all the cases stated in 4.1, and warnings were issued, as we can see in image 18 (left

side). The operator has the possibility to view tag's trip information and even change it in the blue button on the screen. If we do that we access to the right side screen and choose another route for the tag.

7. Conclusion

After the development of this work, and considering the ideas of the TSMART project, we can conclude that it was successful according to the following criteria:

- The Business Model can not be copied from another business because it is a new way of doing passenger transportation. So it is extremely important to make a business processes architecture to promote and facilitate the difficult communication between the business people and the IT people.

- It guides the real implementation of the platform and it allows us to measure and manage the different problems that appear. In other way, it helps user's formation because they know what activities they must do. In other words, it provides rastreability, because all the artifacts are documented.

- It is essential that we have integration between operators las we have in cellular networks. If they don't do so, valuable information can not flow through operators and the problem of lost luggage will not be addressed, the clients will continue unsatisfied and the operators lose a lot of money.

- BizTalk RFID is a good way to read RFID tags, because it provides an easy way to integrate any type of readers with the Microsoft platform and it allows transforming the read events with C# code or business rules.

The innovative work we did act as a starting point to solve the luggage reconciliation complexity int the future transportation within the technology society we are building.

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