

SOA ARCHITECTURE TO EXTEND SMARTCITIES TICKETING AND OPERATIONAL MANAGEMENT SOLUTIONS TO INTEGRATE WITH A PUBLIC TRANSPORTS CRM

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ABSTRACT

Due to the evolution of electronic tickets, a great progress has been happening in the public transports ticketing systems. This progress has provided the emergence of new opportunities in this field. As all transactions of customers can be stored, it is possible to use them in order to know the customers' pattern of usage and use this information to create directed marketing campaigns. These activities can be supported by a CRM system.

It is difficult to design a totally generic CRM system, due to the heterogeneity in the public transports organizations.

This thesis defines a set of necessary services for a CRM system for various types of public transports organizations. The validation is done through a prototype based on a real ticking system.

Keywords — Ticketing, public transportation, CRM system, directed marketing

1. INTRODUCTION

Before the massification of the big supermarket and malls, people went to their neighborhood general store to purchase goods. The proprietor and the small staff recognized the customer by name and knew the customer's preferences and wants. The customer, in turn, remained loyal to the store and made repeated purchases. This customer relationship disappeared as the nation grew, the population moved from the farm communities to large urban areas, the consumer became mobile, and supermarkets and department stores were established to achieve economies of scale through mass marketing.

Although prices were lower and goods more uniform in quality, the relationship between the customer and the merchant became nameless and faceless. The personal relationship between merchant and customer became a thing of the past. As a result, customers became fickle, moving to

the supplier who provided the desired object at lowest cost or with the most features.

The last several years saw the rise of Customer Relationship Management (CRM) as an important business approach. Its objective is to return to the world of personal marketing. The concept itself is relatively simple. Rather than market to a mass of people or firms, market to each customer individually. In this one-to-one approach, information about a customer (e.g., previous purchases, needs, and wants) is used to frame offers that are more likely to be accepted. This approach is made possible by advances in information technology [1].

The goal to get with a CRM system is not well defined, but different goals are enumerated below [2]:

- Increase margins
- Win rates
- Improved customer satisfaction rates
- Increased customer retention and loyalty
- Decreased general sales and marketing administrative costs

1.1. Public transports CRM

When public transports companies started to use electronic tickets, it started to be possible to identify who is using them. So it opened an opportunity to use CRM system in public transports business. For instance, CRM system can identify situations when a group of people don't use public transports during the weekend. So, it can generate a special campaign offering a discount in the weekend price [3].

These kinds of systems in public transports are also beneficial for the companies. They can, for instance, discover new business opportunities analysing the customers' usage patterns. This way, they can improve customer satisfaction and increase their loyalty [4, 5].

1.2. Public transports

In order to introduce the public transports terminology, there are some definitions below:

Physical support – represents the object where the public transport contract is stored.

Public transport contract – it's the contract between a public transport operator and the customer.

Route – it's the path where the customer can use the transportation mean. A route is characterized by a time to start, time to end and a fixed number of stops

Trip – it's the route instantiation and is characterized by the real time of start and end.

Transaction – it can be from two different kinds: sale transaction and usage transaction. The first one is generated when a customer buys a public transports contract and the second one when he uses this contract.

1.3. Public transports abstract entities

Public transport operators can have different rules of each other. An operator can have as different rules as abstract entities which it represents. These abstract entities are described below [6]:

Clearing Operator – The entity that collects the transactions from all Service Providers. This entity can also be responsible for the revenue share between all the others entities.

Collection Agent – The entity that sales physical supports issued by the Issuer to the User. It also charges them with contracts and collects the money from the User.

Issuer – It's the entity which issues the physical supports.

Service Provider – The entity who actually transports the User.

User – This entity uses the Service Provider services, it can buy physical supports, which are issued by the Issuer, to the Collection Agent. In this paper it is the customer.

Authority – It's the entity which control the others entities. It can, for instance, fix prices.

These are the abstract entities defined, but in a real situation they may not represent a company. A real company can have the responsibilities of more than one entity. There is two different examples below.

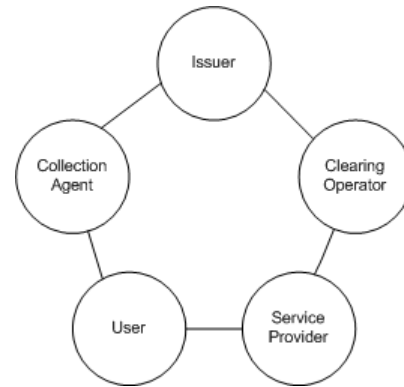


Figure 1: Example where all the entities represent a different company.

In this example, all the entities represent a different company, so each company has the rules of the entity that it represents.

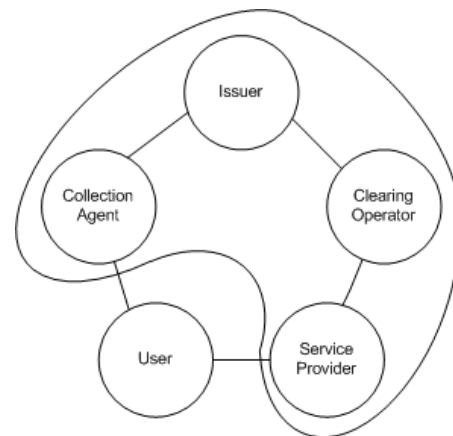


Figure 2 Example where all the entities are merged, except User.

In this example, all the entities except User are merged, so it's a real company with all the rules of all entities.

1.4. Problem

After all the evolution in public transports ticketing systems, the market is open to new business opportunities. With the new ticketing technology, it's possible to know who the customer is and what he usually buys. This process can be helped by a CRM system.

As it was seen before, there is a big difference, how the public transports operator organizes itself. That's make it difficult to standardize these kind of systems.

This study proposes to define a set of essential services to a public transportation CRM system and test it with a real system.

2. SOLUTION ARCHITECTURE

Based on the abstract entities described in section 1.3 and in the information that each of them has, it has been identified CRM related processes. The services needed in each process were identified while the processes were analyzed. In the first phase, it was defined the needed informational entities to represent in the CRM system. Due to the big organizational differences, it was defined a service orchestration layer, in order to integrate the legacy systems with the CRM system. For the last, it was defined the final architecture.

2.1. Identified Processes

As a result of a study of some existent systems and interviews with public transports specialists from Link Consulting, it was identified four processes:

Events management – which represents all the actions needed to manage events from customer, such as information requests or complaints.

Event handler – which represents the actions to handle a new event and solve it.

Information advertisement – which represents the way to do directed marketing. So only the related customers would receive the announcement.

Aggregation of information for studies of service usage – which represents the actions to aggregate all the transactions information, in order to try to find new services and business opportunities.

2.2. Informational entities to CRM system

After analyze the processes in the previous section, it was defined the informational entities needed to use in a CRM system. These entities are enumerated below:

- Customer
- Public transport contract
- Physical support
- Sale transaction
- Validation transaction
- Route
- Trip
- Event

2.3. Service orchestration layer

This layer is responsible for the interface between the abstract entities and the CRM system. This layer is responsible for all data adaptations, in order to normalize the data to the CRM system. Figure 3 represents this layer and there are represented the services names offered by it.

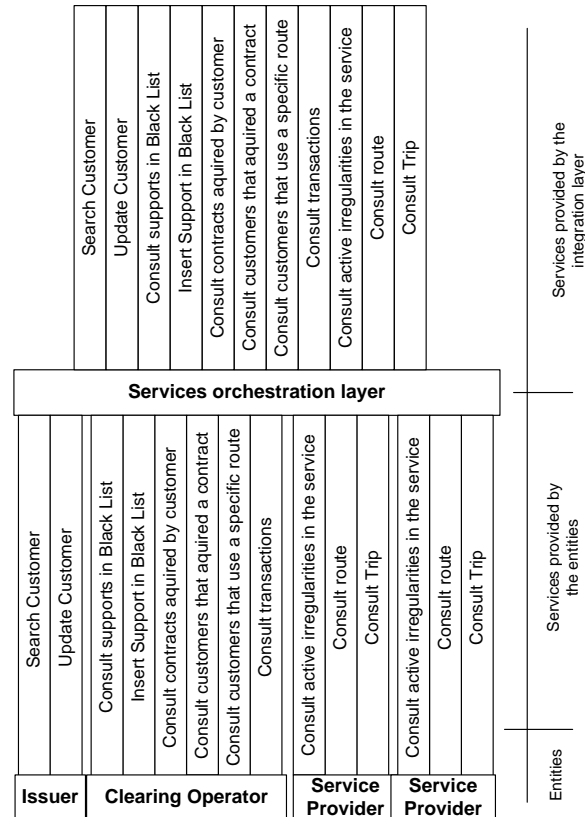


Figure 3 Service orchestration layer representation

2.4. Solution Architecture

To summarize the study, it has been defined three layer architecture:

- Entities legacy system
- Service orchestration layer
- CRM system

The Figure 4 shows how this solution is organized.

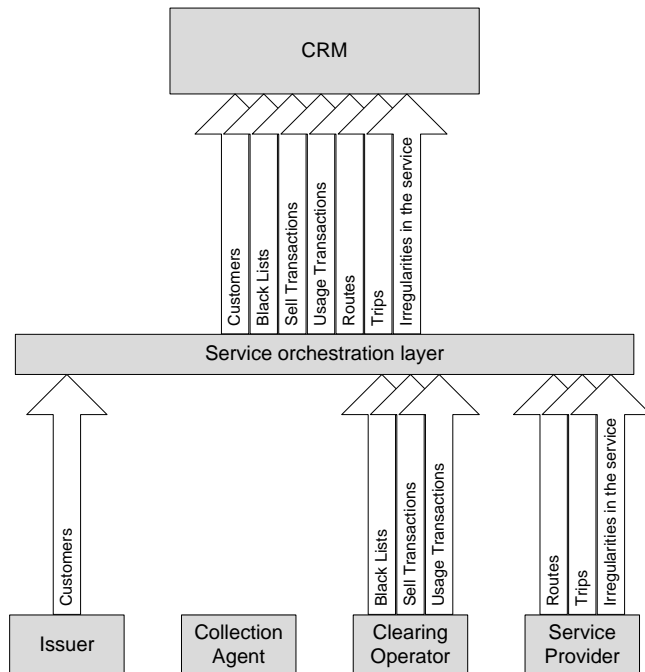


Figure 4 Solution architecture.

3. IMPLEMENTATION

The prototype was developed using a real ticketing system which is used in Lisbon. This system has only the information of Issuer and Clearing Operator. The prototype is only integrated with it, so it won't have available the services related to the Service Provider entities.

It was developed three layers:

Ticketing system – where it was developed a WebServices layer to be invoked by the services orchestration layer.

Services orchestration layer – where is done all the adaptation of the data model and the service orchestration to the CRM system.

CRM system – it was done a customization of the data model, in order to adapt this system to the public transportation business. The CRM system uses the services from the services orchestration layer.

The customer information importation procedure does a total importation every time it runs. So, its performance is very low. But, the objective of this prototype was just an academical proof of concept.

4. TESTS

Some tests were done to validate the created prototype. These tests fall into two categories: functional tests and performance tests.

4.1. Functional Tests

The functional tests were carried out to the importation operation of the ticketing system's information to the CRM system. When validating its correct operation it is also validated the proper functioning of the services orchestration layer and as well as the ticketing system's services.

Initial Information Import

Objective: The purpose of this test is to verify the proper functioning of the import when the database is still empty in the CRM system.

Procedure: Run the import procedure, having the ticketing system with data and the CRM system empty.

Expected result: It is expected that all customers, as well as all information associated with these is imported successfully and the result is reflected in the CRM system.

Result: After running the import procedure, the CRM system was populated with all available information on the ticketing system.

Consequent Information Import

Objective: The purpose of this test is to verify the proper functioning of the import having already been done this procedure before.

Procedure: Run the import procedure after the occurrence of changes in the ticketing system.

Expected result: It is expected that the information that has changed is imported successfully.

Result: After the execution of the import procedure, the database was cleaned and imported, again, with the all the changes that occurred reflected.

4.2. Performance Tests

A performance test to the mechanism of import of the ticketing system's information for the CRM system was made. There was variation in the number of customers that were imported in order to get information about the kind of growth the duration of the import procedure. The test results are presented in Table 1.

Imported customer number	Duration in seconds
1	1,37
5	5,53
10	10,55
50	57,47
100	115,57
500	635,67
1000	1083,51
5000	5486,19

Table 1 Importation test duration.

Analyzing the table, it appears that the duration of import grows linearly with the number of customers imported. However, imports are too long for a real system. Per example, for a system with one million customers, this system would take about twelve days to complete import. These values are, mostly, due to the constant use of Web services, as this technology involves the repeated serialization and deserialization of the exchanged objects. Moreover, the three components of this prototype are on different machines and this also causes delay in process.

5. CONCLUSION

With the evolution of electronic tickets, a great progress has been happening in the public transports ticketing systems. This progress has provided the emergence of new opportunities in this field. With the new ticketing technology, it's possible to know who the customer is and what he usually buys. So, it is possible to use them in order to know the customers' pattern of usage and use this information to create directed marketing campaigns. These activities can be supported by a CRM system.

It is difficult to design a totally generic CRM system, due to the heterogeneity in the public transports organizations.

This study defined a set of necessary services for a CRM system for various types of public transports organizations. It was based on some useful identified processes for this field. With this analysis, it was possible to define the basic entities which this kind of system has to represent.

Basing on the solution architecture and on the real ticketing system, it was developed a prototype to prove a practical application of this specification. The goal of this prototype was to be generic, to get it, the performance was sacrificed. The low system performance is shown in the Tests section, where it's possible to see that is intolerable to

have this system in a production environment. These problem are caused by the multilayer architecture based in WebServices.

5.1. Future Work

As future work, it's proposed some topics to enhance this solution.

First of all, there is a need to develop one of the identified processes, in order to see a practical and useful application of this work.

Optimize the integration between the ticketing system and the CRM system.

Optimize the customer information importation, in order to not import all in once, but to have a change to import the data just when it is needed.

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