UNIVERSIDADE DE LISBOA

Faculdade de Ciências

Departamento de Informática

SMS Gateway and Communication Interfaces for a Callcenter

David Alberto Neto Pacheco dos Reis

PROJECTO

Projecto orientado pelo Prof. Dr João Pedro Neto
e co-orientado por João Paulo Pereira

Mestrado em Engenharia Informática

2008

Declaration

David Alberto Neto Pacheco dos Reis, student nº 31601 of Faculdade de Ciências Universidade de Lisboa, declares to give the copy rights of its Report of Projecto em Engenharia Informática, named “SMS Gateway and Communication Interfaces for a Callcenter”, accomplished during the year 2007/2008 to Faculdade de Ciências Universidade de Lisboa for effects of archive and consultation on its libraries and publication on electronic format on the Internet.

David Alberto Neto Pacheco dos Reis aluno nº31601 da Faculdade de Ciências Universidade de Lisboa, declara ceder os seus direitos de cópia sobre o seu Relatório de Projecto em Engenharia Informática, intitulado “SMS Gateway and Communication Interfaces for a Callcenter”, realizado no ano lectivo de 2007/2008 á Faculdade de Ciências Universidade de Lisboa para o efeito de arquivo e consulta nas suas bibliotecas e publicação do mesmo em formato electrónico na Internet.

Lisboa, 20 de Junho de 2008

Abstract

After the boom of the Internet we are assisting to a new boom on the mobile services offerings. TIM w.e. is a young Portuguese company that has taken advantage from this new area and on the few years of its existence grown into a multinational company.

The work here presented shows one of the core tasks developed at TIM w.e.: the integration with mobile carriers and brokers. On this work will be presented the several steps needed to integrate new carriers into the existing platform and all the process involved on the task.

The particular case presents the integration of a Broker from Brazil with TIM w.e. platform. This Broker aggregates four mobile carrier connections (Claro, TIM, BRT and OI).

The development of this project is divided on two main phases: the SMS Gateway that allows the exchange of messages between the platforms and the Callcenter communication interfaces that are used by the broker and mobile carriers to manage their users on TIM w.e. database.

This project was implemented into a complex platform and network structure composed by clustered databases, replicated application servers, firewalls and load balancers. This project is now on production and is transacting millions of SMS per day.

This report also gives a brief description of the company, internal structure, workflow and the products it develops internally.

Resumo

Após a explosão da internet estamos actualmente a assistir á explosão dos serviços para telemóveis. A TIM w.e. é uma jovem empresa portuguesa que tirou vantagem desta área e nos poucos anos da sua existência consegui transformar-se numa empresa multinacional.

O trabalho aqui apresentado descreve uma das tarefas mais importantes efectuadas na TIM w.e., a integração de novos operadores na plataforma e todo o processo envolvido nesta tarefa.

Este caso particular apresenta a integração de um broker do Brasil com a plataforma da TIM w.e.. Este broker agrega ligações a quatro operadores moveis (Claro, TIM, BRT e OI).

O desenvolvimento deste projecto está dividido em duas fases principais: O *Gateway SMS* que permite a troca de mensagens entre as plataformas, e as interfaces de comunicação para o *Callcenter* que são utilizadas pelo broker e pelos operadores moveis para gerir os seus utilizadores na base de dados da TIM w.e.

Este projecto foi implementado numa plataforma complexa com um estrutura composta por várias base de dados, servidores aplicacionais replicados, anteparas e controladores de carga. Este projecto já se encontra em produção e está a transaccionar milhões de mensagens por dia.

Este relatório inclui também uma breve descrição da empresa, estrutura interna, fluxo de trabalho e outros produtos desenvolvidos internamente.

Greetings

I want to thank my guide professor João Pedro Neto and my supervisor João Paulo Pereira for all their availability and help provided during the development of this project.

A big thank to all my work colleagues that had the patience to answer my doubts and were always available to help and teach when I needed.

I must also thank my family, university colleagues and friends for their support and encouragement on the good and bad moments.

To finish I want to give a special thanks to my parents for all their effort and faith during the last five years and for giving me the opportunity to take this degree.

Index

Figures Index

Tables Index

1 - Introduction

1.1 - TIM w.e.

TIM w.e. is a Portuguese company that works on the area of mobile entertainment. The actual core business is based on the sale of mobile contents as images, ringtones, mp3, java games and text services directly to customers or through third parties.

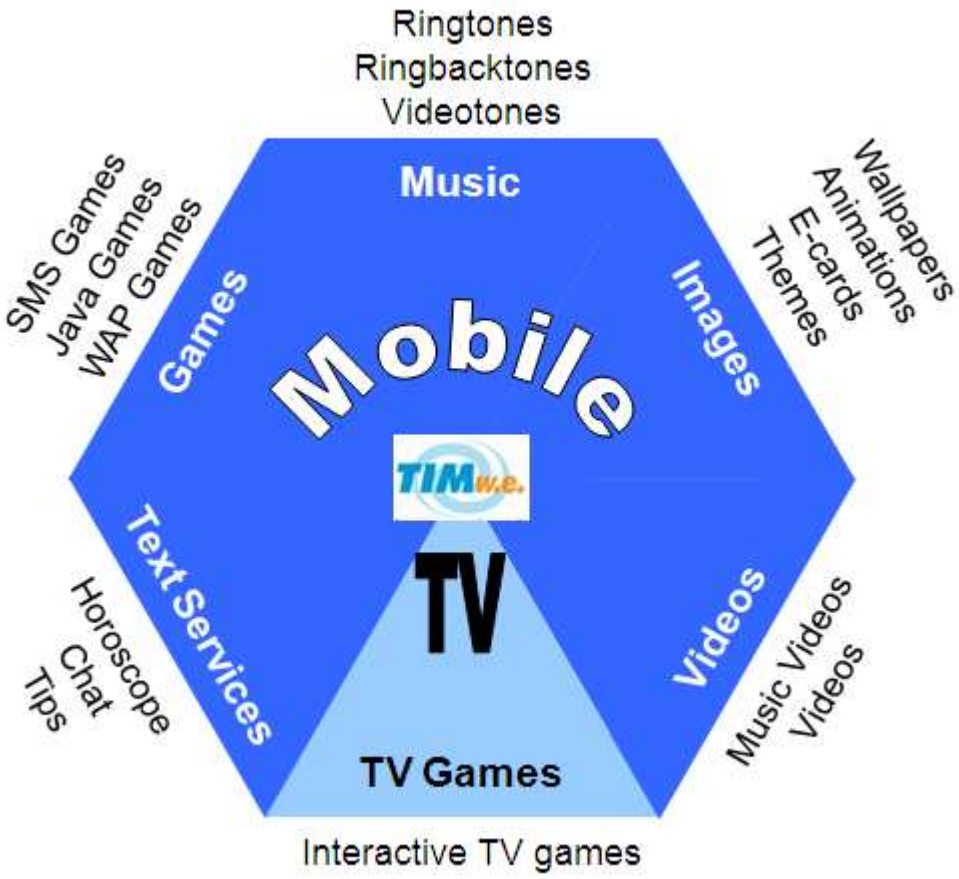


Figure 1 TIM w.e. Products

Actually the main services offered by TIM w.e. are white brand[1], subscription [2]and one shot[3]. These products are delivered by TIM w.e. proprietary platform mainly over sms, mms, wap and web.

[1] *White Brand:* Delivery of contents using our platform for a third party company (ex. TMN, Vodafone).
[2] *Subscription:* Contract service that offers weekly or daily contents for a weekly fee.
[3] *One Shot:* Delivery one content requested for a fee. No contract.

1.1.1 - Evolution

TIM w.e. is a young Portuguese company that appeared around 2002 and initially dedicated itself to contents creation and selling to national mobile carriers. In 2003 the platform for contents distribution was created and started to sell its contents directly to customers using its own brand. On 2004 it started international expansion, beginning by Latin America. On 2005 it launched the subscription model in Portugal and because of its enormous success it was expanded to all the countries that TIM w.e. operated at that time. The year of 2006 was the year of international expansion, by the end of 2006 TIM w.e. counted 19 offices abroad and operations over 56 countries.

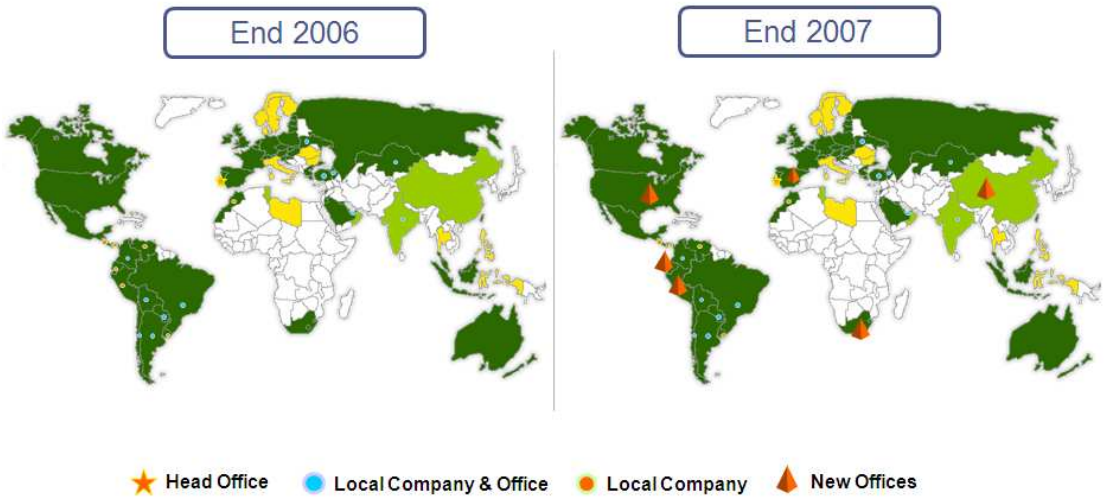


Figure 2 TIM w.e. International Presence

By the end of 2007 TIM w.e. counts more than 260 employees, about 120 on Headquarters in Lisbon and the rest on the offices abroad. Also by the end of 2007 TIM w.e. counted 256 connections with world mobile carriers, directly or indirectly using brokers[4]. To have an idea TIM w.e. is now connected with about two thirds of all mobile carriers in the world and has the capacity to reach more than two billion potential clients.

TIM w.e. has attained enormous success in the few years of its existence, and is now trying to position itself as one of the biggest players in the mobile entertainment market. Actually it is a multinational, multicultural company and has the know-how to sell on almost all markets in the world. All this thanks to the great flexibility of its platform, strategic partners, and the aggressive publicity on magazines, television and internet.

Actually there is an effort to diversify the services offered. There are already new products as: *Matchmaking*[5]*, Recharging*[6] *and Gambling*[7].

[4] *Brokers*: Are entity's that connect to one or more mobile carriers using a common interface.
[5] *Matchmaking:* Online paid matchmaking service that also offers sms services.
[6] *Recharging:* Payment services using mobile phone.
[7] *Gambling: Online gambling services*.

1.1.2 - Internal Structure

TIM w.e. is divided in several main departments: BO (Back Office), Marketing, PROD (contents creation, device configuration, graphic design) and IT (Information Technology).

The department of BO is responsible for the resolution of problems reported to the callcenter by the customers, the introduction and maintenance of contents and devices configuration on the database. On their work they use an application developed by IT named *NEO M3*[8] *that enables them to access the database and change data using a friendly interface*.

The Marketing is responsible for the publicity campaigns, contracts with content providers and carriers, investments and new functionalities requirements. They are the main key connecting all departments.

PROD is responsible for the creation and design of graphics and animations to contents and publicity, like TV Spots, magazine ads, images for websites, sounds and even text contents for the text clubs.

And IT is responsible for the entire infrastructure and platform used by TIM w.e.. IT mainly answers to marketing requests for new features on the platform, reports and troubleshooting. Ahead will be presented more detailed information about the work developed by the IT department.

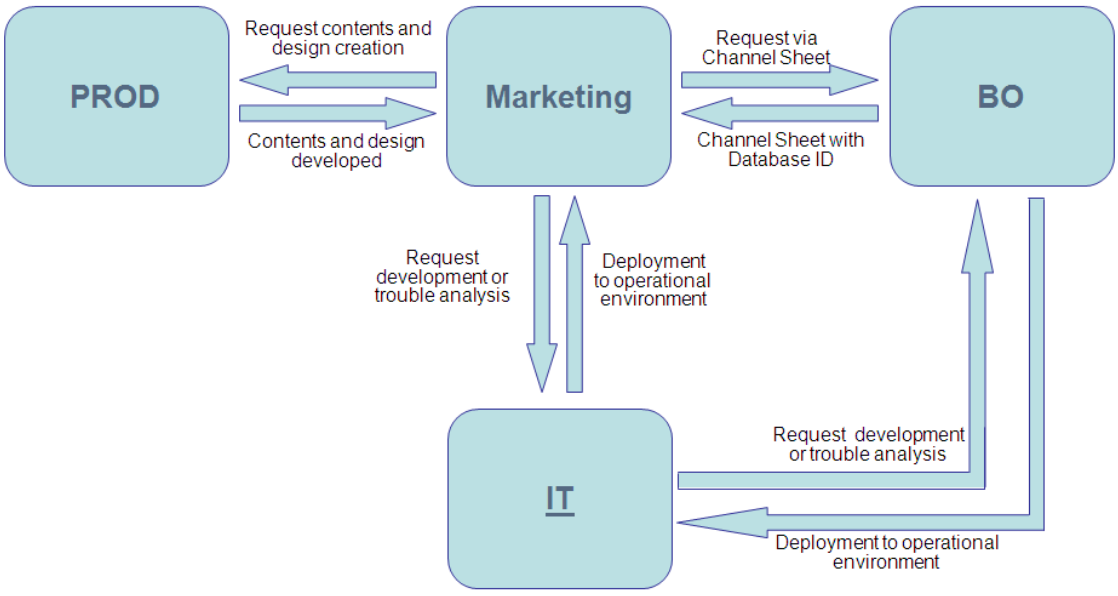


Figure 3 Interaction between departments

[8] *NEO M3*: Is a proprietary application of TIM w.e. used to manage contents (games, wallpapers, text, etc.).

1.2 - Project Description

This project describes the creation steps of a SMS Gateway and the integration of several Callcenter interfaces to a broker in Brazil. This project has extreme importance because it was applied to an expanding market that is expected to offer high level of product penetration. The development of the SMS Gateway allowed TIM w.e. to offer its services to four more operators in Brazil using this broker connection.

This entire project was integrated into an existing platform. The SMS Gateway was fully integrated in the existing platform so it is the most dependent module since its inputs and outputs were already predefined. The Callcenter had more liberty because it is a standalone development, but required more analysis in order to acquire all of its requisites.

This project has an extensive analysis and design phase because it was crucial to reduce and prevent design errors that could delay all the development and make impracticable to deliver the interfaces on the predefined deadlines.

Before starting the development of this project there was an initial phase were all the technologies used and all the existing projects were introduced. This has given an idea of how the platform works and how its several components are interconnected.

Since TIM w.e. is a company that has a significant size it uses several workflow processes to help manage the workflow of all tasks. This project was no exception and all of its tasks were controlled using an IT workflow process.

Resuming this report displays all the phases of analysis, design, human resources involved, technologies used, database tables used, deployment and architecture diagram and the description of the tests applied on the system. Also very important are the descriptions of TIM w.e. IT department and the initial work developed before the project.

1.3 - Report Structure

In the first chapter is presented some information about TIM w.e., its evolution and its internal structure. It is also presented the project description and the report structure.

The second chapter gives information about the IT department were this project was developed. The purpose of this chapter is to give an overview of how the department works.

The third chapter presents the work that was done before this project started. Here is presented the main products developed at TIM w.e. and a brief explanation of their implementation and utility. Reading this chapter will give a picture of how all the platform works and the products it have integrated.

In the fourth chapter is described the objects, methodologies applied on this project and the calendar for their execution.

The fifth chapter contains all the work developed on this project. Is described all software engineering steps of the project, analysis and decisions.

In the sixth chapter are the conclusions of this project, it also contains the future works and the personal experience.

Next is a chapter with the extensive abstract in Portuguese of this project.

The last chapter has the bibliography that was used during the development of this project.

2 - IT Department

2.1 - IT Structure

The department of IT is composed by several areas. There exist core developers, operations developers, systems and operations architects, troubleshooting analysts, quality assurance testers and internal support technicians. Next is presented a brief description of the most important areas in the IT department:

Core developers: are responsible for the development of core applications and technologies and the management of the core applications on the platform.

Operation developers: are assigned to specific countries or areas and are responsible for the resolution of operational problems and for the development of customs projects for those countries.

Systems and operations architects: are allocated to monitoring the systems (database, networking, hardware, application servers, etc.) 24/7 and the deployments to production of all developments.

Troubleshooting analysts: analyze the problems that BO and Marketing departments cannot solve and require a deeper analysis.

Quality assurance testers: are responsible for testing all the developments made by the developers before they move into production environment.

Internal supports technicians: do the maintenance off the entire network infrastructure and support all the departments providing new hardware, software and solving minor issues.

2.2 - Brazil Team

This project was allocated to the operation development team of Brazil. Brazil region is a big bet of TIM w.e. because of the high penetration rate of its products. When this project finished it was expected more than one million clients and more than one million message transactions per day for this connection alone. Today these values had already been achieved.

The Brazil IT team is composed by one project manager, one tester, one system and operations architect and four operation developers. There is also an office in São Paulo with five Marketing managers that are responsible for making the new requests for services and making the contacts with local mobile carriers and publicity contractors.

2.3 - Development Tools

Each developer has a laptop with Windows XP and a bundle of development software. On TIM w.e. is mainly used java programming language and some SQL for DML [9]and DDL[10].

All the development is done on Eclipse Europa IDE[11] with the application server Apache Tomcat. For database is used SQL Developer tool. For tests on wap navigation is used Openwave [12] simulator.

On the management of project versions and concurrency is used SVN[13], and for the dependencies resolution, compilation, and deployment is used Maven 2[14]. Both of these tools are fully integrated into Eclipse IDE and their use greatly improves productivity on all the phases of the codification.

All developers use a local database oracle that makes possible to run some DDL tests and run some services locally.

On development is also used some tools developed internally which enables the developer to simulate the transmission of messages into our systems and to list all its flow.

Is also used several tools to access servers file systems and to open UNIX consoles on production and development in order to access to log files and start and stop services.

2.4 - Development Environment

The IT environment is divided into four environment blocks: DEV, LAB, PRE-PROD and PROD.

DEV: this is the developer local environment, where the developer will work in and make initial tests and debugging.

LAB: This is an optional environment, created specially to test newly created services or connections to brokers or carriers.

PRE-PROD: This environment is a staging environment between the DEV/LAB and the PROD environments. Here the quality team will make all quality tests to decide whether the software has enough quality to go into the Production environment or not;

PROD: This is the final and most important environment of all. After all quality tests, the software is passed (deployed) from the PRE-PROD to the PROD environment. When in PROD environment, services and features can be tested live as an end-user experience.

[9] *DML*: SQL Data Manipulation Language
[10] *DDL*: SQL Data Definition Language
[11] *IDE*: Integrated Development Environment
[12] *Openwave*: Is a Phone Simulator
[13] *SVN*: is a version control system
[14] *Maven*: is a software tool for Java project management and build automation

In each one of the different environments (DEV, LAB, PRE-PROD and PROD), different departments (Development, Quality Assurance and Marketing) will be able and must test the new services and features.

2.4.1 - Testing methodology of the New Services

The following figure 4 will explain how the testing methodology will be conducted until the service is considered released.

Some definitions:

Component – Piece of software responsible for providing certain features, APIs, etc.

Development Stage – Stage where the software development is done.

Unit tests – In order to ensure minimum code errors engineers must run a battery of tests before committing their code to the version control system. These tests are also known as 'pre-checkin tests'.

Pre-Integration Stage – Stage where all software components are grouped to form a product.

Simple Tests – When the implementation of a feature is in its infancy, it is useful to create a few simple tests to check the basics. These tests are also known as isolation tests (since the features are typically tested in isolation) or ping tests (in computing terms, to ping something means to check that it is alive). Simple tests consist of a test as simple as a reduced test, but designed to be easy for QA[15] to use, rather than for engineers, and therefore may have the appearance of a complicated test.

Integration Stage – Stage after the initial Pre-Integration and after running the Simple-Tests with success.

Smoke Tests – Each day, before allowing work to begin on the code base, the previous day's work must pass an extremely simple set of tests known as "smoke tests". Bugs found this way is known as "smoke test blockers", and with good reason: all work is blocked until the bugs are fixed. This is to ensure that the bugs are fixed quickly.

QA Tests – Before releasing every test case is run through a test build of the product and manually inspected for errors. This is a very time consuming process, but (assuming the person running the tests are familiar with them and the specification being tested) it is a very good way of catching bugs, and setting up regressions.

Automation Tests – These tests run unattended and can therefore cover large areas of the product with minimum effort. Automation is the holy grail of QA. Unfortunately, there are many aspects that are hard to impossible to automate, such as printing.

[15] *QA*: Quality Assurance

Load&Stress Tests – These tests are directly related with the Automation Tests, and intend to reproduce the same or higher load and stress volume of requests that the product will suffer when it goes live.

"Top 100" Tests – The web's most popular pages are regularly checked by visual inspection to ensure that they display correctly. (It is hard, if not impossible, to automate this task, because these pages change very, very frequently.) Bugs found through this technique are important, because many users would encounter them should a product be released with such a defect. In practice, many rendering issues found on top100 pages are actually caused by errors on the pages themselves.

Continuous Improvement – Delivering incremental improvements to existing functionality. Continuous Improvement may involve minor changes or may initiate significant pieces of work. Planning for Continuous Improvement is the key. Sometimes projects stop funding after they have been implemented into production, or only set aside funding for warranty or future functional enhancements. Continuous Improvement should be explicitly planned for each implementation increment.

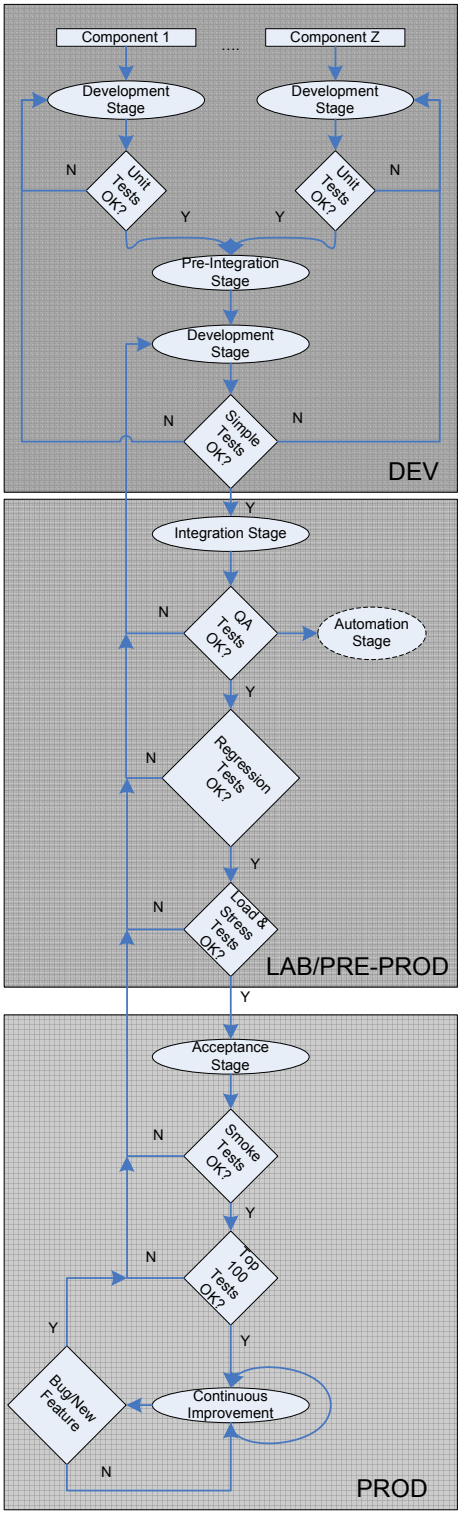


Figure 4 Quality Assurance Test Sequence

This procedure is valid for launching new services or connections to brokers or carriers. New connection for new clubs, with new webspots, websites, WAP sites, SMS Flows, and everything that requires a new software development from scratch.

2.5 - Workflow Management

All the workflow is managed by an online CRM [16]tool named Salesforce (www.salesforce.com). This tool is used to create, control, assign, and measure workers performance using cases. These cases are most of the time assigned per developer, so, all developers are always working on different tasks, but with a common goal, the PM[17] is the one responsible for allocating the different tasks to the developers. Next will be presented a short description of an IT Operation Development case and explained the different roles involved and the lifecycle of the case until it is finished.

Phase of Creation: Usually the cases are created by the Marketing for new features or by the PM for some internal development. The requester can create a case and leave it on draft until he has all information, or it is the right time to submit to development.

Phase of Validation: The PM looks at the submitted case and assigns it to the developer. The developer before starting the development must check that he has all information needed to solve the case and if so he set the case status to development otherwise he sends the case to missing data so the requester must provide the missing information.

Phase of Development: The developer solves the case and sends it to Testing status.

Phase of Testing: On this phase the case can be tested by the QA team or by the requester. Usually using the testing team is the best option because they have rigorous testing plans. If the case passes the tests the tester sets the case to IT Approved Status or to Stage Approved if tested by the requester. If the case fails the tests it is sent back to development status.

Phase of Deployment: On this stage the developer sets the cases that are with the status of IT Approved or Stage Approved to deployment status. He also has to create a new case to the System and production architect that contains the new files, jars, etc. that are to be placed on production environment. This new case is set as a child of the original.

Phase of Approval: On the final stage the child case created warns the requester (developer) that it is finished. The developer then checks if the deployment is right on production, and if so he sets the parent case to Final Approval status for the requester approval. After the case is checked with success the requester closes the case or if not it is sent back to development phase for corrections.

[16] *CRM*: Customer relationship management
[17] *PM*: Project Manager

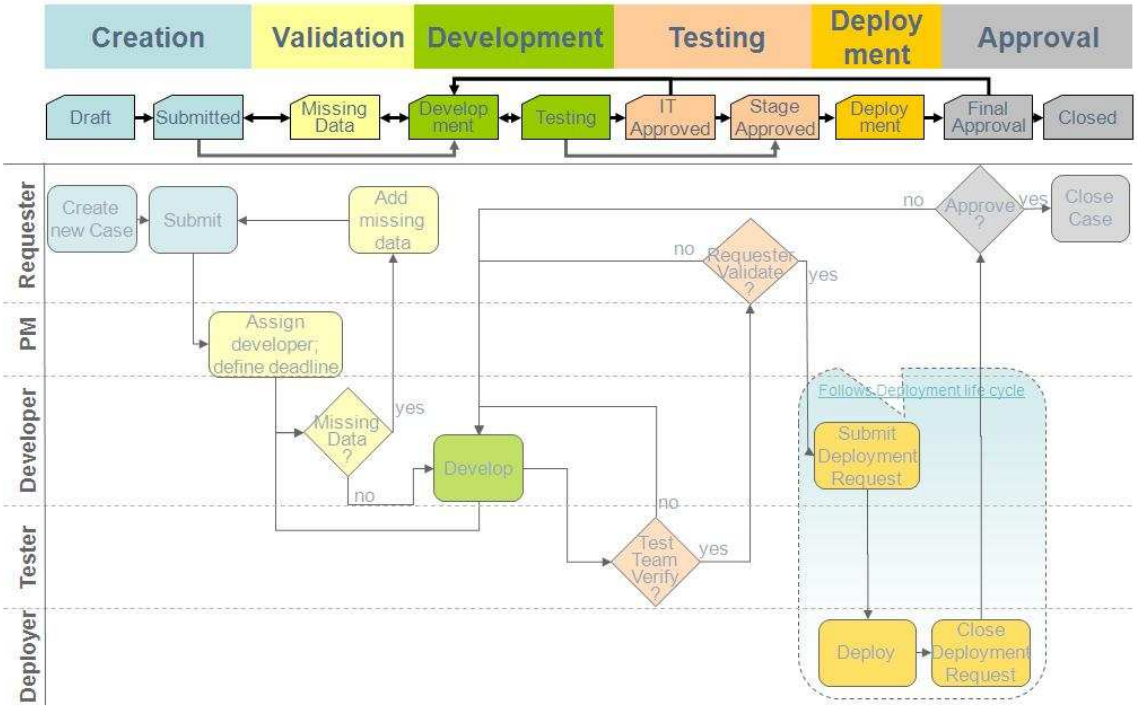


Figure 5 IT Development Case Flow

Also as an alternative we make use of Microsoft Outlook and Skype to communicate with coworkers and external entities.

3 - Initial Work

There exist several products offered by TIM w.e.. Before the main project all these projects were presented and a few developments were done in order to better understand the platform. Next will be present these main products, their finality and a few information about its implementation.

3.1 - Webspots Project

The Webspots are in fact a website project that allows the customers to subscribe to the products using the internet as a medium. The webspots are usually composed by three pages; the first one is the landing page where the user inserts the mobile phone number and the carrier. The second is the prospection page were the user inserts the password sent to him previously via SMS. Next if he introduced the right password he proceeds to the confirmation page where he receives the content and a confirmation message via SMS.

This website project is very adaptable because it is used in all countries TIM w.e. operates. It can adapt texts, checkboxes, mobile selection page, banners, contents, clubs, images, flash, basically everything.

This project was build in Java and JSP and makes use of the Apache Struts framework (Robinson & Finkelstein, 2004). This framework allows the separation of the business layer from the presentation layer, because it makes use of the model-view-controller paradigm. An also very important fact of this project is that it is intensively based on properties files, which allow its extreme customization. The downside is the complex integration of new features and alteration of the existing ones.

3.2 - New Countries, Services and Clubs integration

The platform of TIM w.e. works mainly around countries, services and clubs.

Countries: They are the containers of services and clubs, one country can have several services and clubs for each service.

Services: Are the identification of a specific bundle of products (ex. text products, content products) these bundles are offered with several subscription options (Clubs). The services are also divided by operators to facilitate the reporting and analysis systems.

Clubs: The clubs correspond to a specific type of offer for a certain type of product, for example an offer of contents may contain the Dance Club (music tones) and Games Club (java games). The clubs represent the final product that is purchased by the clients and is usually in the shape of subscriptions services.

This structure of countries, services and clubs is used to enforce the independence of the platform from the carrier connections. Using this schema all countries on the world were TIM w.e. operates have the same internal structure. This allows any developer that understands the platform to work on any country. This also has a major impact on the reporting and analysis systems, because it ensures homogeneity to all the data in the system.

The creation of new countries, services or clubs is mainly done by properties files and a few database entries. The properties files usually contain the links to the content views, texts and the schema definitions of the clubs, but there is freedom to customization because many services have country specific requirements. The database entries are used to define the country, the services and the name of its configuration files. The database also contains clubs, their keywords and the Java classes responsible for resolving the requests.

The text schemas used by the services are also very important and are used to answer to common actions like new subscriptions, renews , cancels or already ins. These schemas are composed of text messages and specific actions for the particular action they represent.

The Java classes mentioned before are very important on this process because they were design to be easily extended. When the default class is not enough the developer can easily adapt the class to the new requisites.

Behind all this is the platform that is feed by the database entries and controls the flow of the messages (SMS) on the system. There exist several modules that monitor the system and are responsible for invoking the classes needed to resolve the jobs.

3.3 - Wap Sites

The Wap Sites are basically web sites for mobile devices. TIM w.e. uses the Wap Sites as a medium to deliver its contents. These sites also offer the same functionalities as the Web or SMS service.

The Wap Sites are a Java Project composed by several classes that represent pages, these classes are already pre-build for several tasks, like contents display, subscription and many others. The developer doesn't need to know WML [18]or xHTML [19]because the classes generate it internally, the only work needed is to extend some default classes and adapt its layout. Of course the developer as to know this project very well because there is a lot of customization, like devices detection, phone number resolution, IP Gateway check and many others.

To resume the Wap Sites are a Java Project that is contained as a Web Project and as its layout and specific customization on its classes, all communication are made via http and exists the

[18] *WML*: Wireless Markup Language is a XML language intended for device that implement WAP such as Mobile phones.
[19] *xHTML*: eXtensible Hypertext Markup Language is a adaption of HTML based on XML

possibility to maintains sessions like a normal http connection. All the texts displayed on the wap site are defined on properties files and its classes are resolved from database entries.

3.4 - Xconns (Carrier Connections: Billing;SMS Gateway)

The Xconns or carrier connections are one of the most important parts of the platform, they provide the bridge between TIM w.e. platform and the carriers platform. The Xconns can implement different types of communication protocols, all depends on the mobile carrier requisites.

The development of an Xconns requires that the developer knows the internal platform and the technology involved on the communication protocol. Usually this type of integrations requires many tests on development and production. Down is the picture of TIM w.e. internal structure where is possible to understand the Xconn underlying utility.

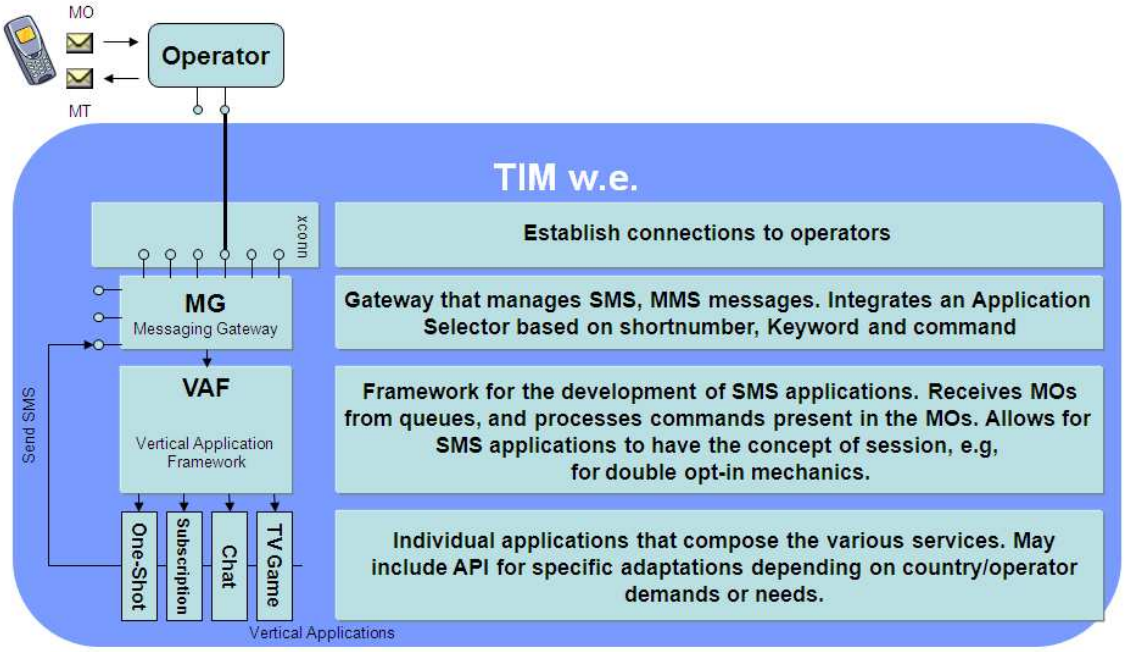


Figure 6 TIM w.e. Platform Internal Structure

3.5 - Initial Work Calendar

Tasks List			
Name	**Duration**	**Start**	**End**
Presentation	**7 days**	**03-09-2007**	**11-09-2007**
Adaptation	5 days	03-09-2007	07-09-2007
Working Tools and Development Environment	4 days	06-09-2007	11-09-2007
Basic Development	**15 days**	**12-09-2007**	**02-10-2007**
WebSpots	4 days	12-09-2007	17-09-2007
New Club Creation	6 days	18-09-2007	25-09-2007
WapSites	5 days	26-09-2007	02-10-2007
Advanced Development	**21 days**	**03-10-2007**	**31-10-2007**
Webspot Mechanic	5 days	03-10-2007	09-10-2007
SMS Mechanic	5 days	10-10-2007	16-10-2007
WapSite Mechanic	5 days	17-10-2007	23-10-2007
Xconns	6 days	24-10-2007	31-10-2007

Table 1 Initial Work Calendar

The Gantt map is in **Annex 1**.

4 – Project Objectives and Methodologies

4.1 - Objectives

The objective of this Project was to create several communication interfaces with a telecommunications broker (www.purebros.com). This broker aggregates connections to four mobile carriers in Brazil. The implementation of these interfaces is separated by two main objectives: the creation of the main message exchange interfaces and the Callcenter interfaces.

Message Exchange Interfaces: These interfaces consist of message delivery and receiving interfaces, billing and many others. In order to build these interfaces it was necessary to follow the integration steps of an external communication entity with the internal platform.

Callcenter Communication Interfaces: The Callcenter interfaces give the broker the capability to deliver to the mobile carriers a tool that is used to control their customers actions and status on TIM w.e. system. These interfaces were implemented outside the normal context of the platform so they were very hard to implement because it was necessary to know the entire platform and sometimes even change some aspects of the country implementation so it could start gathering the information required by the broker and carriers.

4.2 - Methodology Approach

4.2.1 - Methodology

This project is divided in two main phases:

1. The creation of the essential communication links with the broker.
2. The creation of the Callcenter communication interfaces afterward.

Each of the phases had a standalone development. For every development step was defined a deadline, this deadlines were very crucial and each phase deadline even more since there exists commercial objectives to accomplish after those deadlines.

4.2.2 - Waterfall Model

This project followed a waterfall development model, with the small difference that the specification and de design phase occurred at the same time and the implementation, testing and maintenance were separated by the communication interfaces and callcenter interfaces.

4.2.3 - Requisites and Analysis Specification

On this phase was gathered all the requisites of the application. The Analysis had the objective of producing the requisites specification of the application and the system specification.

4.2.4 - Project Design

On this phase was build the conceptual model of the system, divided by separated models, more or less independent. It is also studied and defined all the system modules, their communication and system interactions.

4.2.5 - Implementation

On this phase the project was coded to a programming language in this particular case Java. It was also when all modules were joined and their interaction validated with the system underlying (TIM w.e. Platform) and with the external entities (Broker).

4.2.6 - Testing

On this phase the project was tested by the Quality Assurance team with the objective of validating that all requisites defined were achieved and the application was error and bug free.

4.2.7 - Maintenance

This phase is optional and has the objective to update the application with new features and changes or correct possible bugs not detected during the tests.

It is not possible to estimate the time spent on this phase.

4.3 - Project Calendar

Tasks List			
Name	**Duration**	**Start**	**End**
Requisites and Analysis	**5 days**	**05-11-2007**	**10-11-2007**
System Specification	**15 days**	**12-11-2007**	**01-12-2007**
Project Design	**20 days**	**03-12-2007**	**05-01-2008**
Implementation	**50 days**	**07-01-2008**	**17-05-2008**
Broker Communication Interfaces	**50 days**	**07-01-2008**	**15-03-2008**
MO Receiving	5 days	07-01-2008	12-01-2008
MT Delivery	5 days	14-01-2008	19-01-2008
Async Notification	5 days	21-01-2008	26-01-2008
Credit Check	5 days	28-01-2008	02-02-2008
Billing	5 days	04-02-2008	09-02-2008
Subscription/Unsubscription	5 days	11-02-2008	16-02-2008
Content Delivery	5 days	18-02-2008	23-02-2008
Target Check (Phone number Carrier Check)	3 days	25-02-2008	28-02-2008
Development Tests	40 days	14-01-2008	08-03-2008
Production Tests	40 days	21-01-2008	15-03-2008
Callcenter Interfaces	**50 days**	**10-03-2008**	**17-05-2008**
Device Change	5 days	10-03-2008	15-03-2008
Device Information	5 days	17-03-2008	22-03-2008
Event List	5 days	24-03-2008	29-03-2008
Subscription Information	5 days	31-03-2008	05-04-2008
Send Last Content	5 days	07-04-2008	12-04-2008
Subscription	5 days	14-04-2008	19-04-2008
Unsubscription	5 days	21-04-2008	26-04-2008
Development Tests	40 days	17-03-2008	10-05-2008
Production Tests	40 days	24-03-2008	17-05-2008
Maintenance and Improvements	***...***	***17-03-2008***	***...***

Table 2 Project Calendar

The Table 2 task list has some differences from the preliminary report because some interfaces were optional and were decided to not implement. They were removed from this project task list.

The duration dates were also corrected because several tasks were underestimated on the preliminary analysis.

The Gantt map is in **Annex 2**.

5 - The Project

On this section is presented all the analysis and design models developed for this project, it is also described the options and decisions taken on the implementation.

5.1 - Requisites Analysis

On the project requisites are the necessities presented by the client in this case the broker and by the adjacent platform on which this project is build. This specification describes all the functional aspects of the system, the structural logic, functional and all possible system actions.

5.1.1 - Broker Requisites

This broker integration required that several communication interfaces were implemented by TIM w.e. These interfaces are used for message exchange and control.

The broker also required that TIM w.e. supplies several communication interfaces for its Callcenter that would allow them to monitor and control their users actions on TIM w.e. platform. These Callcenter interfaces are used by the broker to provide a user interface to the mobile carriers they aggregate.

For this integration the broker supplied a document that specifies all of its communication interfaces and the formats we must implement in order to communicate.

5.1.2 - TIM w.e. Platform Requisites

Since this project have been integrated into an already existing platform, it needed to meet some specifications and use already existing systems, databases and programming models.

This project had also to take in account the internal message flow and the reporting needs of the underlying platform.

The Platform requisites are very important because it was needed to fulfill all the internal requisites, in order to maintain the compatibility with all the services that exist and will be provided using this new connection.

5.1.3 - Interfaces Definition

Below is presented a short description of all the interfaces that are going to be developed on this project.

MO Receiving: This interface is responsible for the receiving the messages from the broker and translation into a platform friendly format. The messages received are stored on a database.

MT Delivery: This interface as the important task of sending messages. It receives messages that are stored in the database and translates them from the internal format to the broker's format and sends them.

Async Notification: The Notifications are the result status of the messages sent by TIM w.e. to the users mobile phones. With notifications is possible to know if the messages were received or not by the clients. This allows measuring performances and even deciding further actions to the messages. This is only needed because the broker cannot assure synchronous message delivery status. The Notifications are composed by two main tasks: one that receives the messages notifications and places them on a database and the other that reads those messages from the database and updates their final status.

Credit Check: This operation contacts the broker to acquire a ticket to bill a client and gives it back to the system.

Billing: The Billing is used to bill a client using a ticket. Previous to use this operation the system must acquire the valid ticket from a credit check operation.

Channel Subscription/Unsubscription: This operation is used to subscribe or unsubscribe clients from the broker database. This is needed because some carriers of Brazil are very restrictive on their connections and require that their direct partners maintain their client database updated. So before any client is subscribed we must check it we can subscribe it on the broker database.

Channel Content Delivery: This operation is called on a valid daytime to deliver content for several channels (products). This operation works like a broadcast and when called the broker sends a message to all clients that belong to a specified channel.

Target Check: This operation allows the system to validate a user mobile carrier on the broker, this is very important for services on the web or offline, on which the user gives its phone number and we must validate it so we can sent the messages to the right carrier.

Device Information: This operation allows the broker to retrieve from TIM w.e. customer database the device information of a client.

Device Change: This operation allows the broker to define a client device on TIM w.e customer database.

Event List: This operation allows the broker to retrieve all events information from a specific customer for a specific time period. This information must be parsed so it fits the broker format requisites.

Subscription Information: This operation is similar to the Event List but provides more detailed information about the customer, because it also retrieves subscription information from the subscriptions database.

Send Last Content: This operation allows the broker to resend the last content (message) from a certain service (product) to the client. This is possible because all messages are saved on the database and can be retrieved and resent.

Subscription: This operation can be used by the broker to subscribe a client to a certain service on TIM w.e. platform. This operation executes several steps that are required when creating a new subscription.

Unsubscription: This operation can be used by the broker to unsubscribe a client from a certain service on TIM w.e. platform. It will proceed with all operations needed to cancel a subscription.

5.1.4 - Presumed Implementation Environment

Since this project is based on an API[20] supplied by the broker it was decided to specify how all these components would be implemented on the TIM w.e. platform. This task is necessary before further analysis because already exists a procedure and several APIs to help implement and integrate new interfaces on TIM w.e. platform.

The Communication interfaces have been integrated onto the existing platform and the Callcenter interfaces have been implemented as a standalone service, but using already existing APIs.

All the design was produced based on the next assumptions.

[20] *API* - Application Programming Interface

5.1.4.1 – Objects and Package Types Decision

Next is presented the description of the objects and package types that were used by each interface.

Message Exchange Servlets

- MO Receiving
- Async Notification Receiver

Callcenter Servlets

- Device Information
- Device Change
- Event List
- Subscription Information
- Send Last Content
- Subscription
- Unsubscription

The servlets are objects that receive and generate a response based on a request (http). These objects run inside Web Containers that run on application servers.

Purebros API:

- Target Check
- Billing
- Credit Check
- Channel Subscription/Unsubscription

The Purebros API corresponds to a package of several java classes that will allow several operations on the broker. This package will be used by any application that needs it.

IXconn Interface

- MT Delivery

The IXconn interface is used by TIM w.e. platform and represents the interfaces that a communication class should implement. This Interface in particular is used to specify the interfaces for the MT Delivery.

BroadCast Extended Object

- Channel Content Delivery

The broadcast object is used by TIM w.e. platform and implements a message broadcast mechanism. This object can be extended and reused for custom functionalities.

PosPr Extended Object

- Notification Monitor

The Post Processing object is used by TIM w.e. platform and implements common functionalities used after an action has been completed, on this particular case the message confirmation. This object can be extended and reused for custom functionalities.

Properties Files

- All the volatile information as login, passwords and the services mapping with the broker are stored on these files.

These text files contain definitions that change very often. They are loaded on demand into the classes that need to read their information. On TIM w.e. these files are heavily used.

5.2 - Use Cases

The use case diagram describes the functionalities of the proposed system. These diagrams have the objective of describing the functional requisites of the system and delivering a consistent and clear vision of what the system should do.

To represent all this information is used UML[21] (Nunes & O'Neill, 2004). This modeling language assists on the design of the system and has the capacity to represent the actions and communications between the several objects that define the system.

5.2.1 - The Components

All the design was made using two possible actors for the actions.

Broker: Represent the role done by the broker as an external entity.

System: Represent the role done by the TIM w.e. platform as an internal entity.

Use Cases: Represent the possible actions done by the actors.

[21] *UML* - Unified Modeling Language

5.2.2 - Use Cases Diagrams

5.2.2.1 - Broker Communication Use Case Diagram:

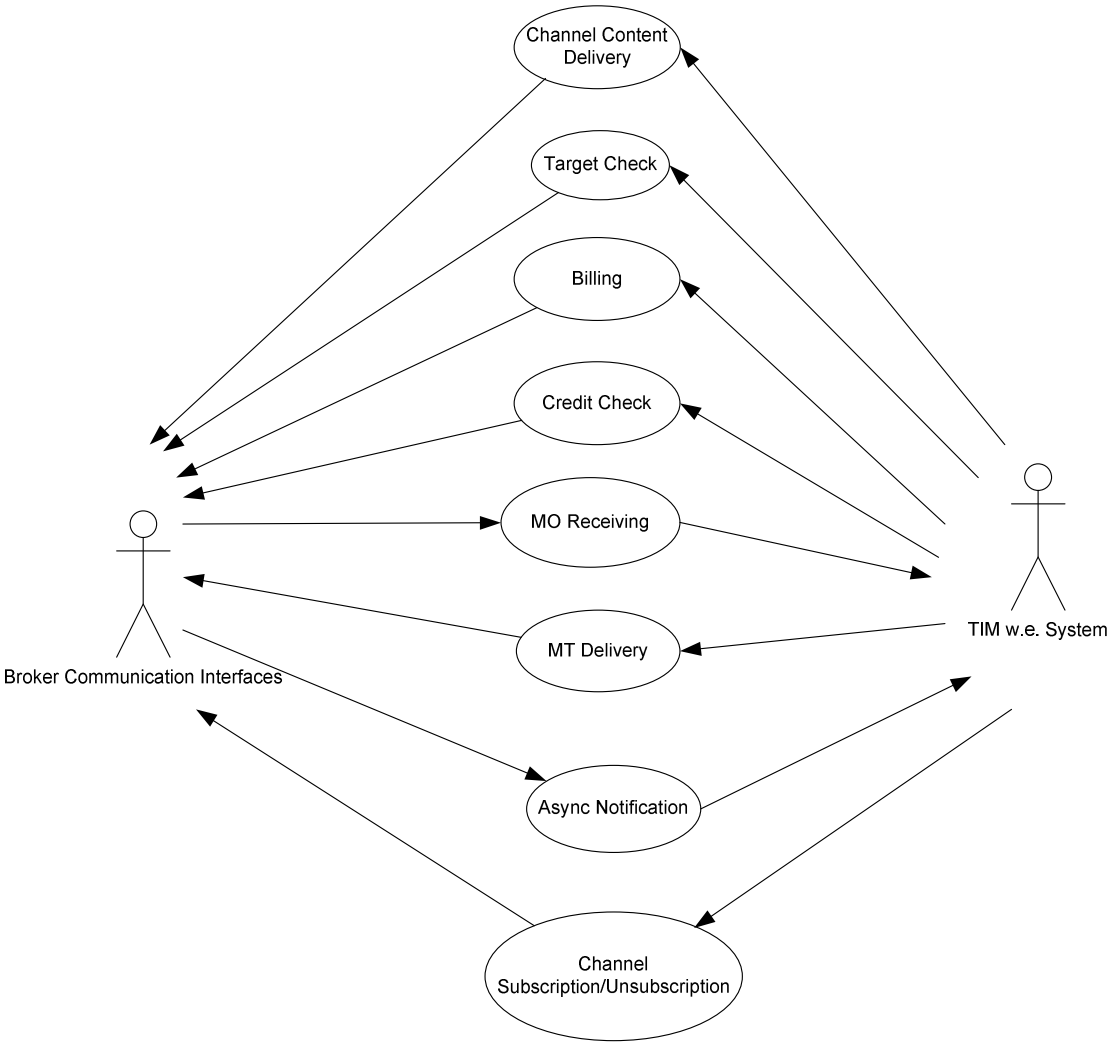


Figure 7 Broker Communication Interfaces Use Case Diagram

On this diagram there are several actions and reactions between the actor Broker and the system.

None of these use cases are dependent because all represent possible asynchronous actions that can be activated by one of the sides.

5.2.2.2 - Broker Callcenter Use Case Diagram:

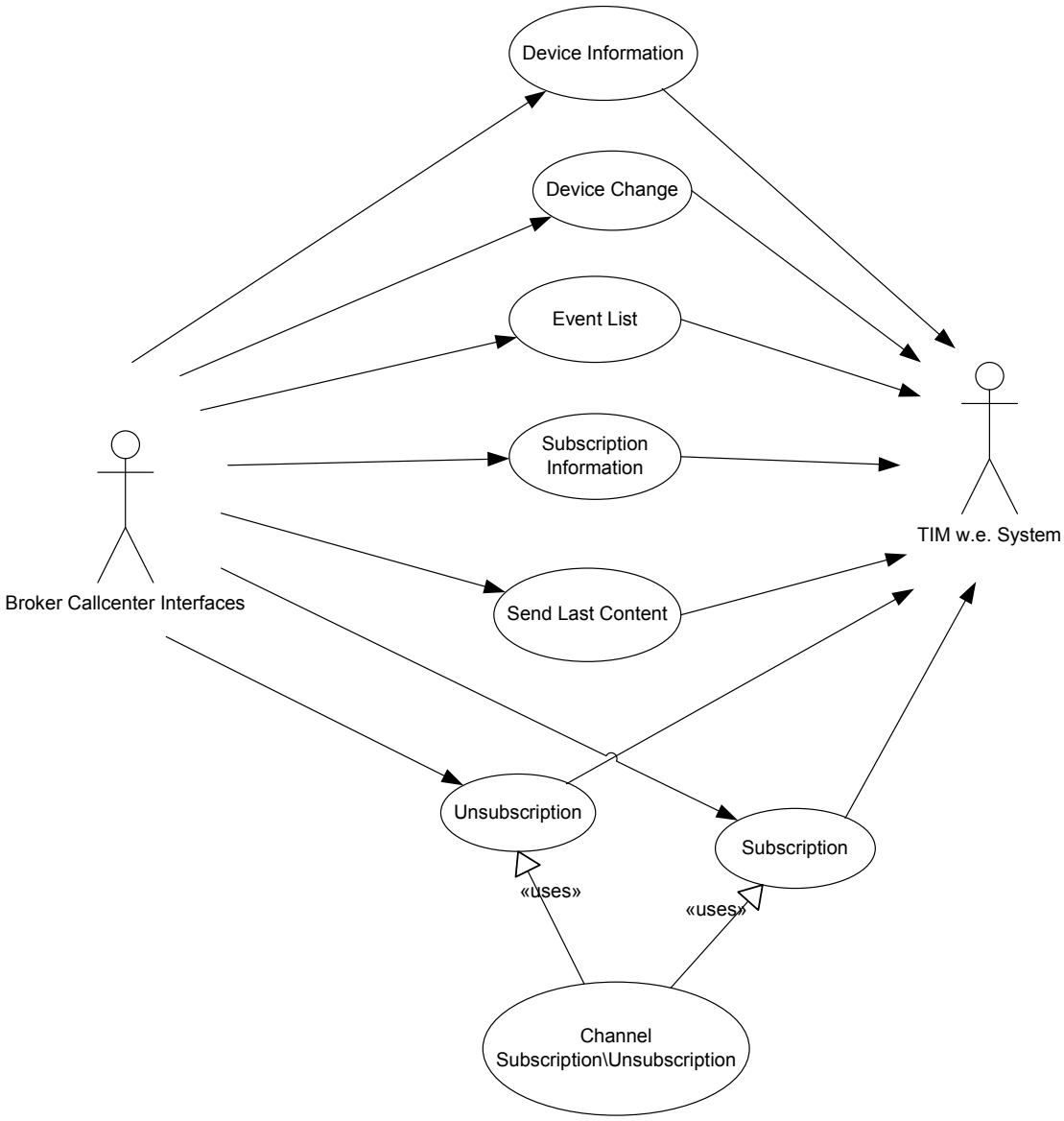


Figure 8 Broker Callcenter Interfaces Use Case Diagram

All the Callcenter Interfaces are reactive, because all the actions are initiated on the broker side.

5.2.3 - Use Cases Descriptions

5.2.3.1 - Broker Communication Interfaces Use Cases

Use Case: MO Receiving

Pre Condition

1. Request passed the Firewall.

Description

1. Receive by Http the message parameters (phone number, destination, text body, and carrier).
2. Validate the parameters.
   2.1. All ok, insert information on receive queue table.
3. Send operation result to broker.
4. Log event to history table.

Pos Condition

1. Message inserted on receive queue table.
2. Sent result to broker.

Use Case: MT Delivery

Pre Condition

1. Messages on send queue table.
2. System as a message to process.

Description

1. Read message information (msgId, source, phone number, text, service type).
2. Load Properties file.
3. Create URL to call.
   3.1. Insert Username/Password.
   3.2. Place an message id (SMS unique identifier).
   3.3. Specify Source number and Destination number.
   3.4. Specify the phone number of SMS of the message.
   3.5. Insert message body text.
   3.6. Select specific code per Service Type.
      3.6.1. Specified by club (text or content), source (sms, web, wap) and carrier.
4. Create an Http connection with the broker.
5. Call the broker interface.
6. Save the result on the message.
7. Move the message to MT Table.
8. If the call returned with an invalid error.
   8.1. Mark the message to retry if necessary or simply cancel it.
9. Close the connection
10. Log event to event table.
11. Return result to system.

Pos Condition

1. Message execution result sent to system.

Use Case: Async Notification

Pre Condition

1. Request passed the Firewall.
2. Request as valid parameters.

Description

1. Receive by Http the notification parameters (SMS unique identifier, error code).
2. Save the parameters to the notification table.
3. A notification monitor reads the pending notifications.
   3.1. Save the result error on the message on the sent queue table.
   3.2. Retry the message if existed and error and if the carrier allows, this is done moving the message back to the send queue table.
4. Resolve phone number.
5. Log notification to event table.

Pos Condition

1. Message delivery status updated.

Use Case: Credit Check

Pre Condition

1. Client requested a payed service.
2. System calls the API with valid parameters.

Description

1. Receives the target phone number, service type and the request source.
2. Load Properties file.
3. Create URL to call.
   3.1. Insert Username/Password.
   3.2. Add the target phone number.
   3.3. Specify the type of service to validate.
   3.4. Specify the request source (sms,web,wap, callcenter).
4. Create an Http connection with the broker.
5. Execute the call.
6. Close the connection.
7. Log result to event table.
8. Verify the returned Credit Check Ticket.
   8.1. If is valid return the Credit Check Ticket.
   8.2. If invalid return -1.

Pos Condition

1. Returned the Credit Check Id.

Use Case: Billing

Pre Condition

1. System as a valid Credit Check Id for the client.

Description

1. Receive the Credit Check Id and client phone number.
2. Load Properties file.
3. Create URL to call.
   3.1. Insert Username/Password.
   3.2. Add the valid Credit Check Id.
4. Create an Http connection with the broker.
5. Execute the call.
6. Close the connection.
7. Log result to event table.
8. Verify the response.
   8.1. If is valid return the success.
   8.2. Else return failed.

Pos Condition

1. Returned the result status if the billing.

Use Case: Channel Subscription/Unsubscription

Pre Condition

1. Client requested to subscribe/unsubscribe a service.
2. System calls the API with valid parameters.

Description

1. Receive the operation, channel, client phone number and request source.
2. Load Properties file.
3. Create URL to call.
   3.1. Insert Username/Password.
   3.2. Add the target phone number.
   3.3. The operation type (REG for subscription or UNREG for unsubscription).
   3.4. Specify the channel to which the action should be applied.
   3.5. Specify the request source (sms,web,wap,callcenter).
4. Create an Http connection with the broker.
5. Execute the call.
6. Close the connection.
7. Log result to event table.
8. Verify the response.
   8.1. If is valid return the success.
   8.2. Else return failed.

Pos Condition

1. Returned the result status of the call.

Use Case: Channel Content Delivery

Pre Condition

1. Executed on valid daytime.

Description

1. Check the event table for Successful Channel Content Delivery calls today.
2. Load Properties file.
3. Create several URL's to call with uncalled or unsuccessful channel content deliveries today.
   3.1. Insert Username/Password on each.
   3.2. Specify the channel to which the action should be applied.
   3.3. Add the message body text.
4. Create an Http connection with the broker.
5. Execute the calls.
6. Close the connection.
7. Save all the responses to the event tab associating the channel and its call result.

Pos Condition

1. All valid channels called and their responses saved to the database.

Use Case: Target Check (Phone number Carrier Check)

Pre Condition

1. System wants to check the validity of the phone number.

Description

1. Receive the phone number.
2. Load Properties file.
3. Create URL to call.
   3.1. Insert Username/Password.
   3.2. Add the target phone number.
4. Create an Http connection with the broker.
5. Execute the call.
6. Close the connection.
7. Verify the response.
   7.1. Translate the carrier name to the internal carrier numeration.

Pos Condition

1. Returned the internal carrier number of a specific phone number.

5.2.3.2 - Broker Callcenter Interfaces Use Cases:

Use Case: Device Information

Pre Condition

1. Message is from a valid source.
2. Callcenter requested the device information of a specific phone number.

Description

1. Receive by Http the input parameters (phone number).
2. Retrieve the customer information of the specific phone number from the Database.
3. Check client information retrieved.
   3.1. If no customer is found return an error message.
   3.2. If client found return a device manufacturer and model.
4. Return an error specifying the result of the operation.

Pos Condition

1. Returned the device information of a customer.

Use Case: Device Change

Pre Condition

1. Message is from a valid source.
2. Callcenter requested the device change for a specific phone number.

Description

1. Receive by Http the input parameters (phone number, manufacturer, model, user agent).
2. Resolve the internal id for the new device based on the information provided.
3. Update the device on the customer account
   3.1. If no client found return an error message
   3.2. If customer found return success.

Pos Condition

1. Updated the customer device on the database.
2. Return the result status of the action

Use Case: Event List

Pre Condition

1. Message is from a valid source.
2. Callcenter requested the event list for a specific phone number.

Description

1. Receive by Http the input parameters (phone number, start date, end date).
2. Resolve the customer id for the phone number sent.
3. Retrieve all customer events from the events table for the time period specified.
   3.1. If no data found send error message
   3.2. Else transform the information to the format requested by the broker and send.

Pos Condition

1. Returned the information for the requested phone number within a specified time period.

Use Case: Subscription Information

Pre Condition

1. Message is from a valid source.
2. Callcenter requested the Subscription Information for a specific phone number.

Description

1. Receive by Http the input parameters (phone number).
2. Resolve the customer id for the phone number sent.
3. Retrieve all customer subscriptions/unsubscriptions events from event table and subscription information from subscription table.
   3.1. If no data found send error message
   3.2. Otherwise compile the information to the format requested by the broker and send.

Pos Condition

1. Returned the information of all subscriptions for the requested phone number.

Use Case: Send Last Content

Pre Condition

1. Message is from a valid source.
2. Callcenter requested the resend of content for a specific phone number.

Description

1. Receive by Http the input parameters (phone number, category, service type).
2. Retrieves from the event table the last content message send for this phone number filtered by service type.
3. Validates the message.
   3.1. No message found, return error
   3.2. Else reinsert the message into the send queue table and return success.

Pos Condition

1. Resented the content to the customer.
2. Returned the status of the operation to the Callcenter.

Use Case: Subscription

Pre Condition

1. Message is from a valid source.
2. Callcenter requested to subscribe a phone number to a service.

Description

1. Receive by Http the input parameters (phone number, service type).
2. Resolve the customer id from the phone number received.
3. Create the customer if he doesn't exist
4. Subscribe the customer to the club with the corresponding service type
   4.1. If is a channel Subscription **include : Channel Subscription/Unsubscription**
5. Send customer the congratulations messages associated with the club.
6. Return the result of the operation to the Callcenter

Pos Condition

1. Customer subscribed the club and congratulations messages sent.
2. Returned the result of the operation to the Callcenter

Use Case: Unsubscription

Pre Condition

1. Message is from a valid source.
2. Callcenter requested to subscribe a phone number to a service.

Description

1. Receive by Http the input parameters (phone number, service type).
1. Resolve the customer id from the phone number received.
2. Unsubscribe the customer from the club with the corresponding service type
   2.1. If is a channel unsubscription **include : Channel Subscription/Unsubscription**
3. Send customer the cancelation messages associated with the club.
4. Return the result of the operation to the Callcenter

Pos Condition

1. Customer unsubscribed the club and cancelation messages sent.
2. Returned the result of the operation to the Callcenter

5.3 - Activity Diagrams

The activity diagrams represent all the workflow done by a class. The following diagrams represent all the use cases described above.

5.3.1 - Broker Communication Interfaces Activity Diagrams

5.3.1.1 - MO Receiving

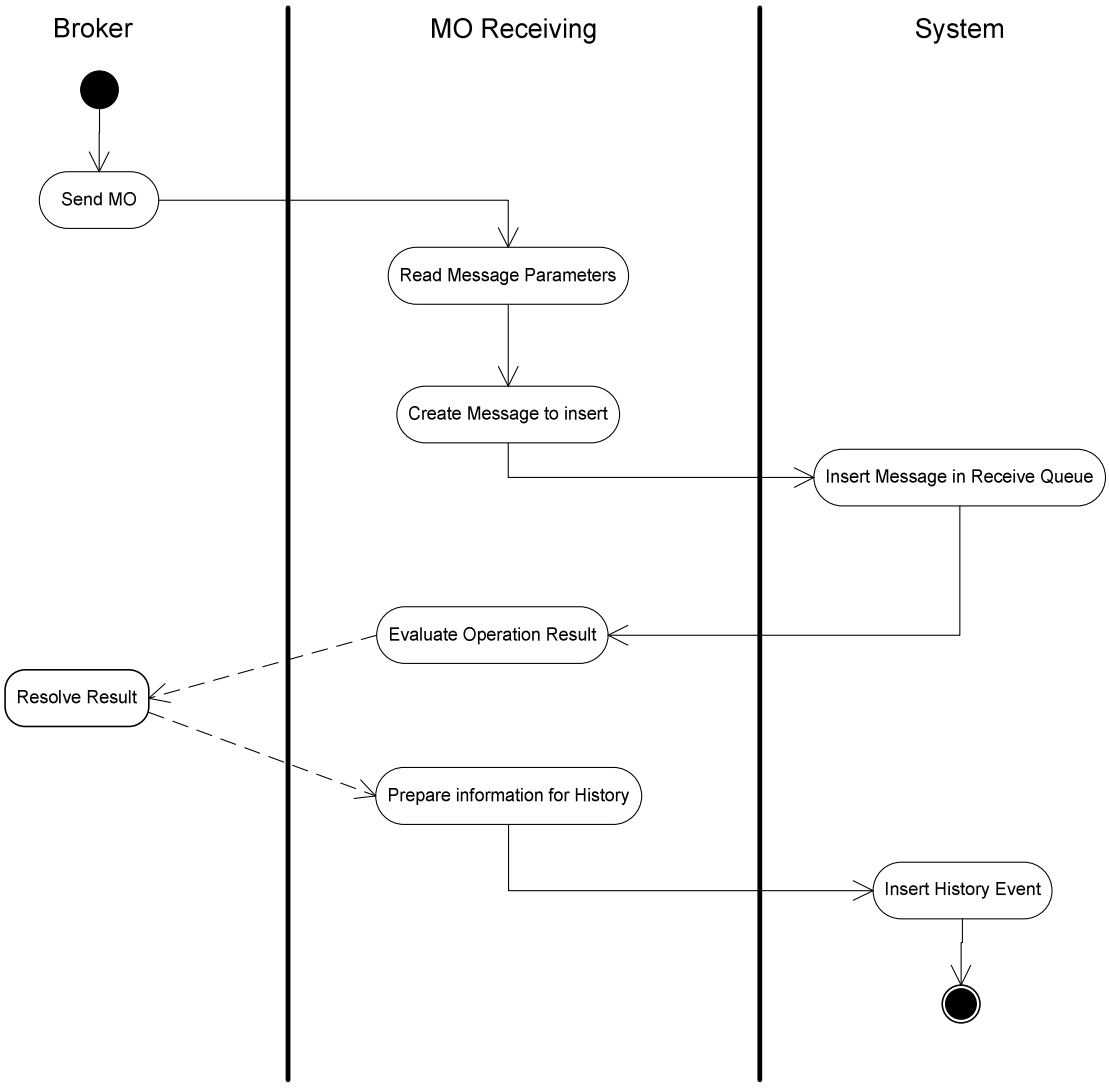


Figure 9 MO Receiving Activity Diagram

This diagram represents all the actions from the message receiving process involved between the systems. The MO Receiving listens to messages sent from the broker and processes them following the specified actions on the diagram.

5.3.1.2 - MT Delivery

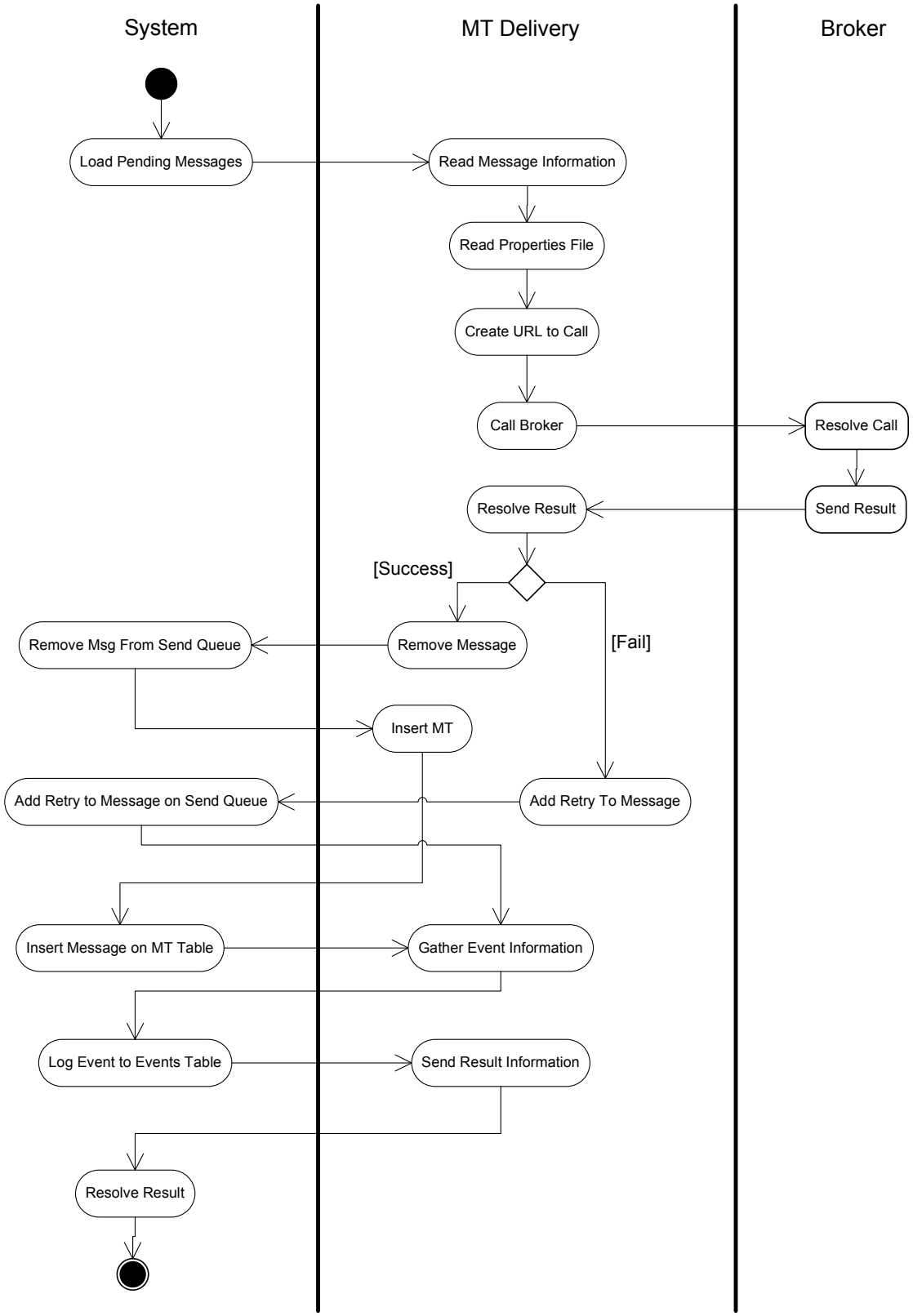


Figure 10 MT Delivery Activity Diagram

This diagram represents the actions taken to send the messages to the broker. This action is initiated by the system that injects the messages into the MT Delivery class. This class will send the message and take several actions depending on the result sent by the broker.

5.3.1.3 - Async Notification

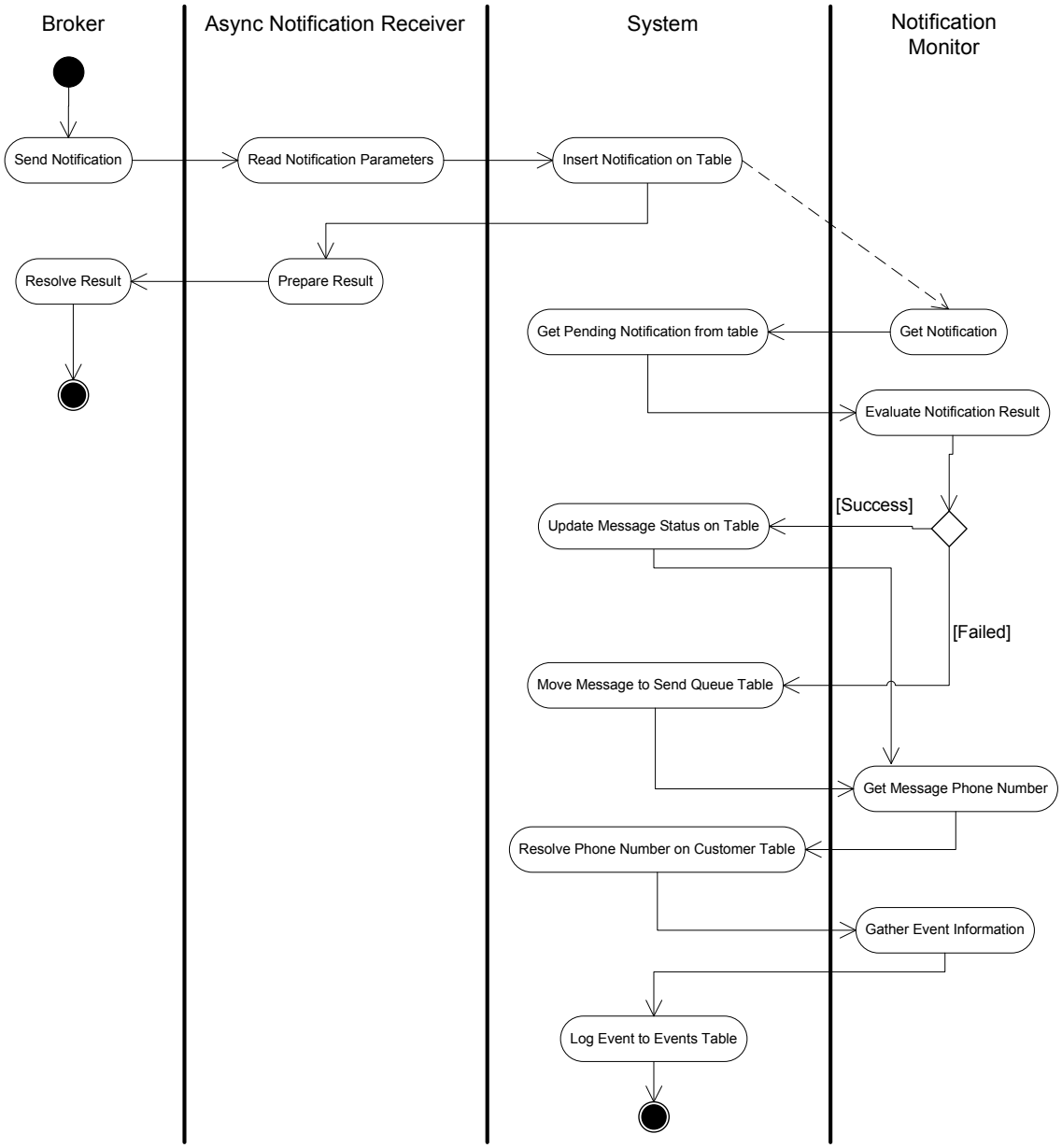


Figure 11 Async Notification Activity Diagram

On this diagram is displayed the actions taken by the notifications receiving interface and the notification monitor that updates the message status on the database.

5.3.1.4 - Credit Check

Figure 12 Credit Check Activity Diagram

This diagram represents the actions taken to get a ticket from the broker to bill a client. This process is initiated by the system and ends with the valid ticket or error ticket returned back to the system.

5.3.1.5 - Billing

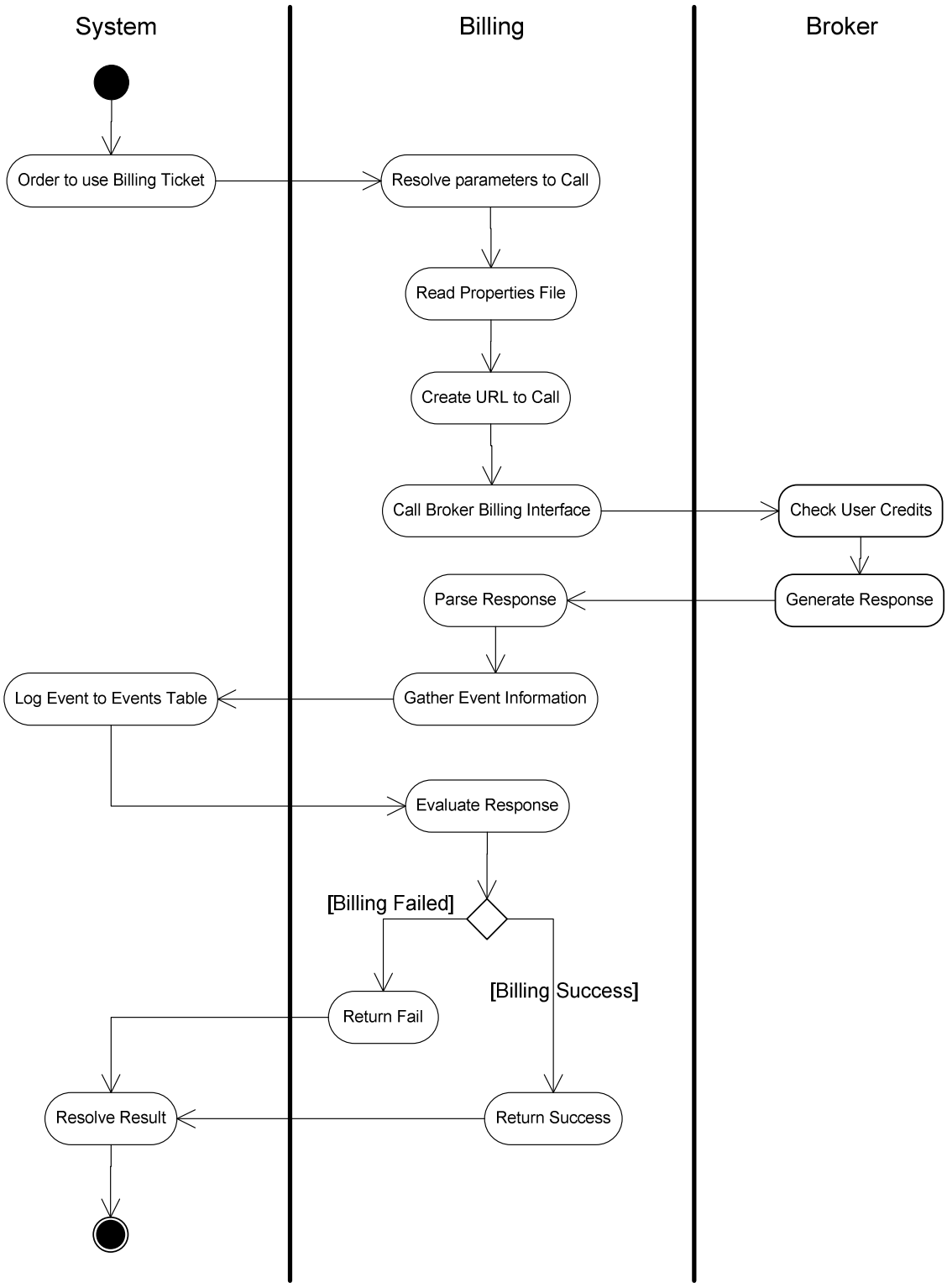


Figure 13 Billing Activity Diagram

The billing process is initiated by the system and performs a billing call to the broker. Prior to use the billing interface the user must get a valid ticket from the broker using the credit check interface.

5.3.1.6 - Channel Subscription/Unsubscription

Figure 14 Channel Subscription/Unsubscription Activity Diagram

This process represents the actions taken to subscribe or unsubscribe a user on the broker database. Only if the broker accepts the subscription or unsubscription TIM w.e. can perform the same action on its database. This is true because the broker has the master client database on their side and TIM w.e. database must be synchronized with it.

5.3.1.7 - Channel Content Delivery

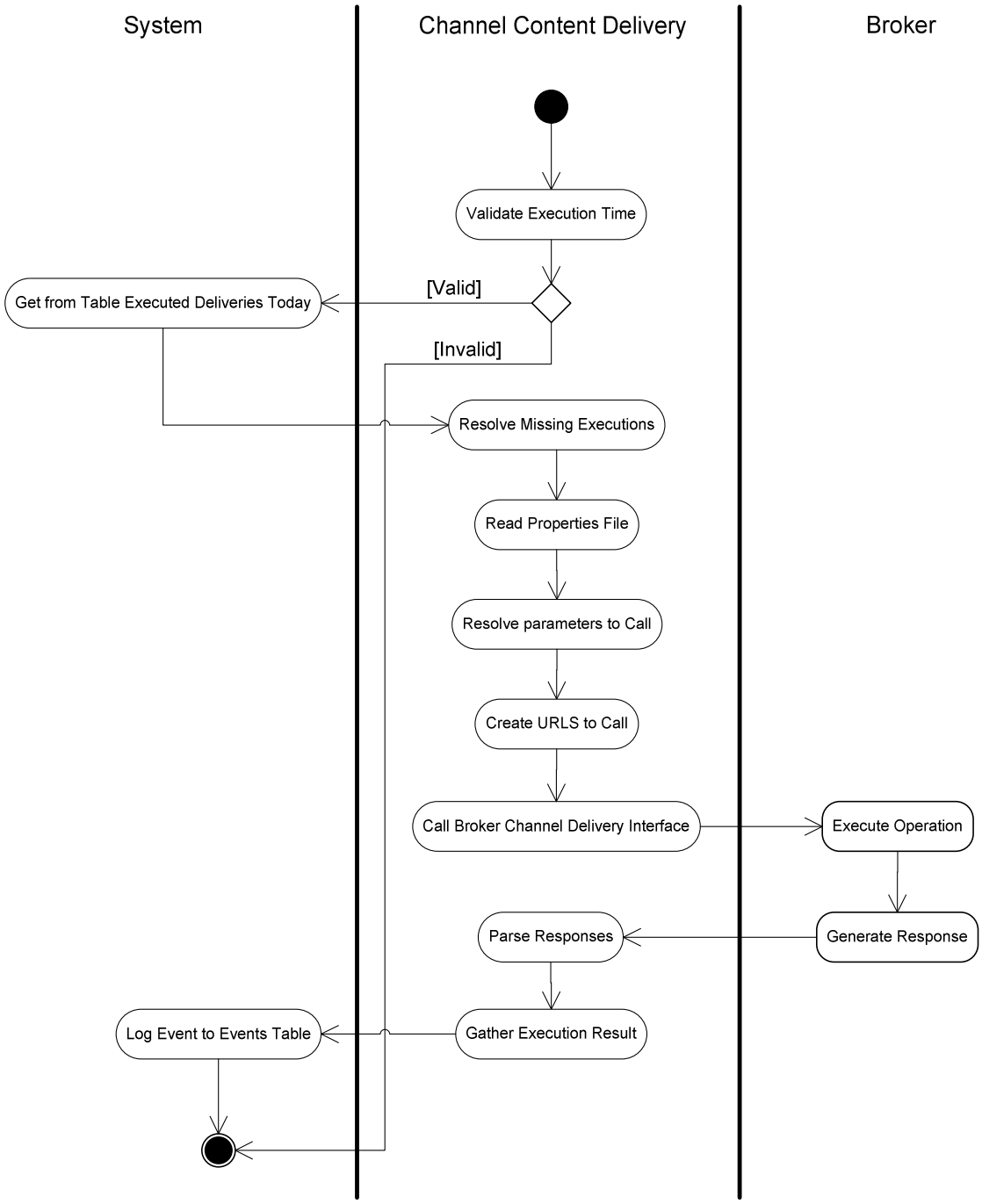


Figure 15 Channel Content Delivery Activity Diagram

This task performs a broadcast to all the users of a service with a specified message. It also controls the executions per day, per channel and per day time in order to avoid double broadcasts or broadcasts on invalid date time.

This broadcast represents only a call from TIM w.e. platform; is the broker that effectively sends the message to each of the clients.

5.3.1.8 - Target Check

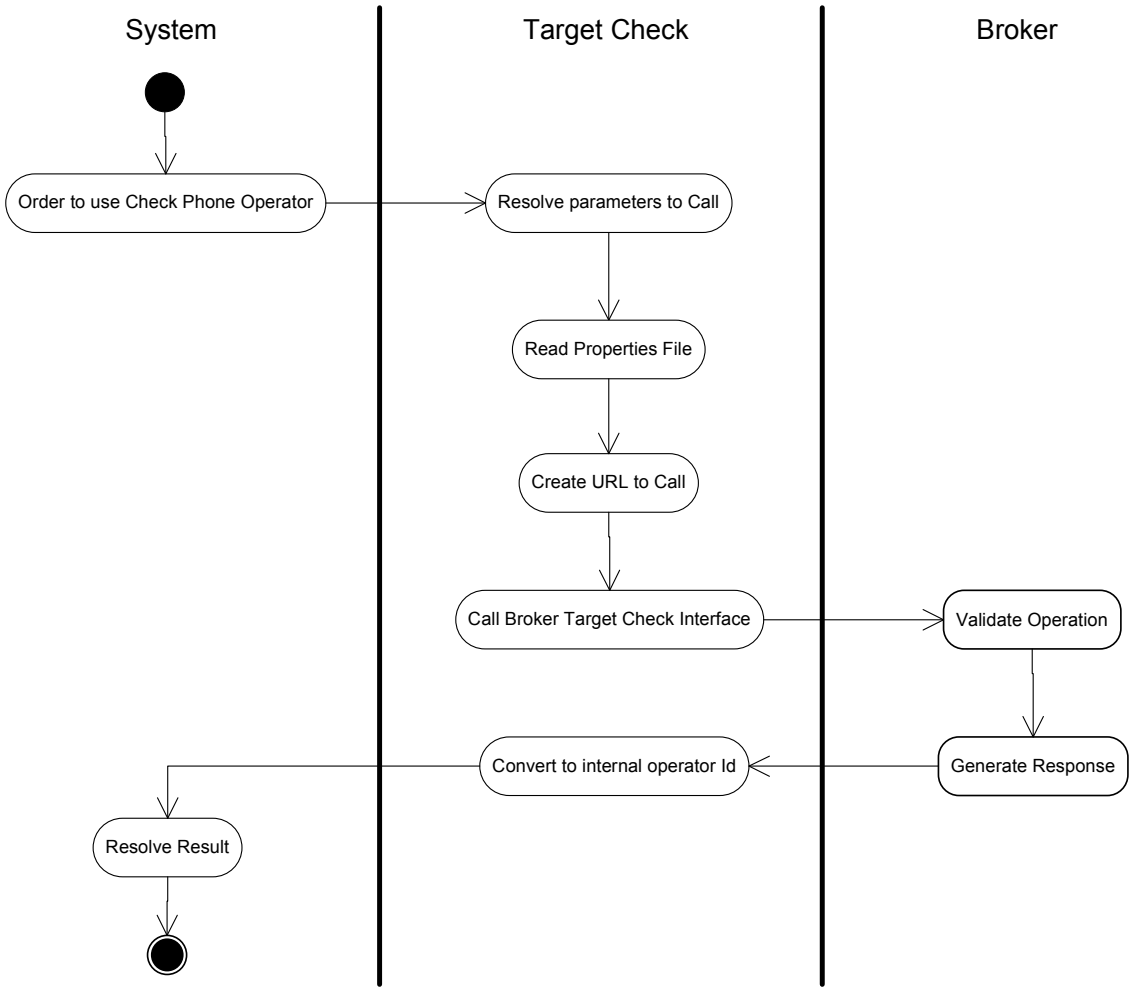


Figure 16 Target Check Activity Diagram

The Target Check task resolves the carrier having as input the phone number. The result of the call is a converted internal operator id.

5.3.2 - Broker Callcenter Interfaces Activity Diagrams

5.3.2.1 - Device Information

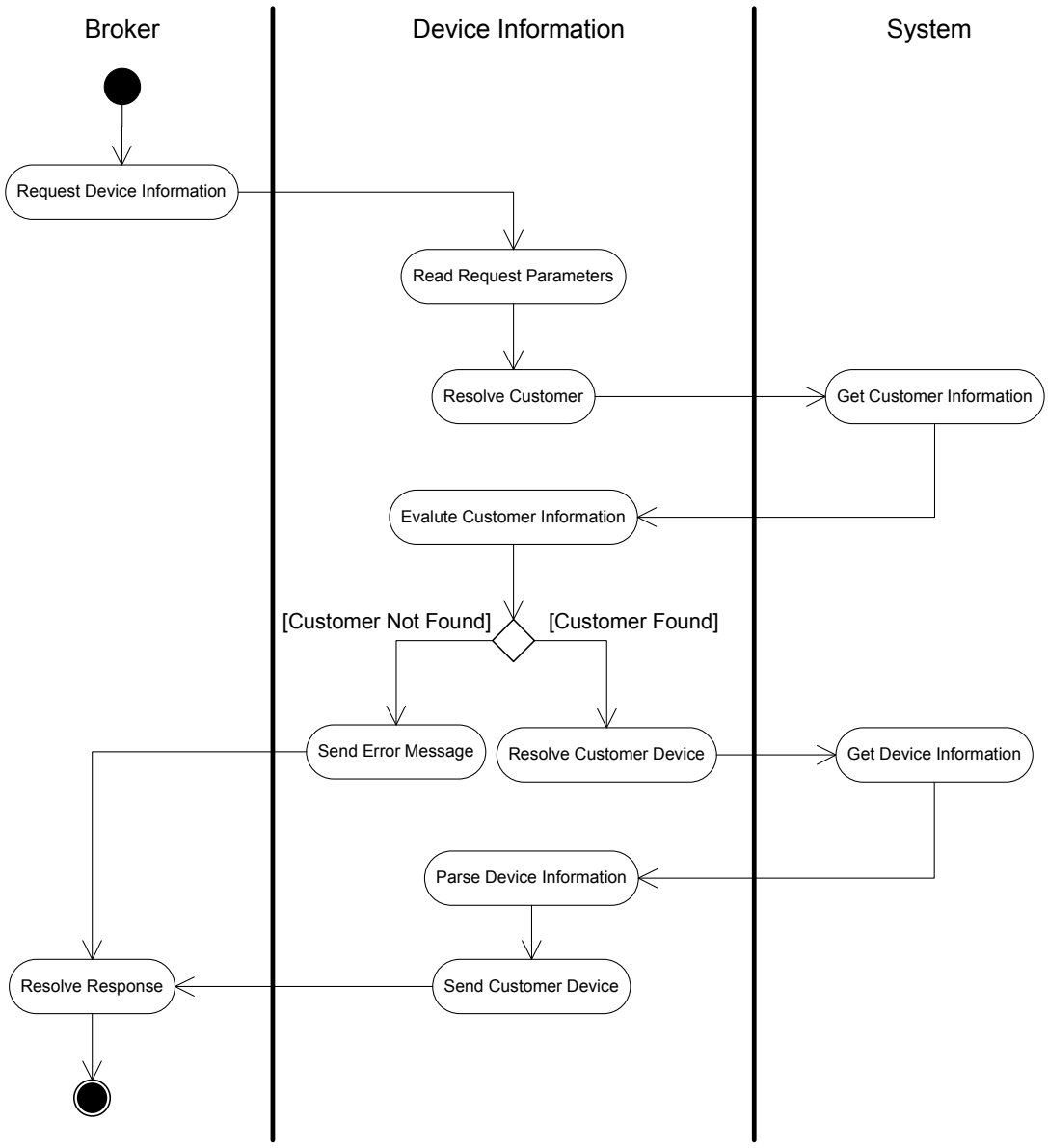


Figure 17 Device Information Activity Diagram

This diagram represents the actions taken by the Device Information interface to resolve the device from a client requested by the broker. It takes as input the client phone number and answers with the device information parsed as requested by the broker.

5.3.2.2 - Device Change

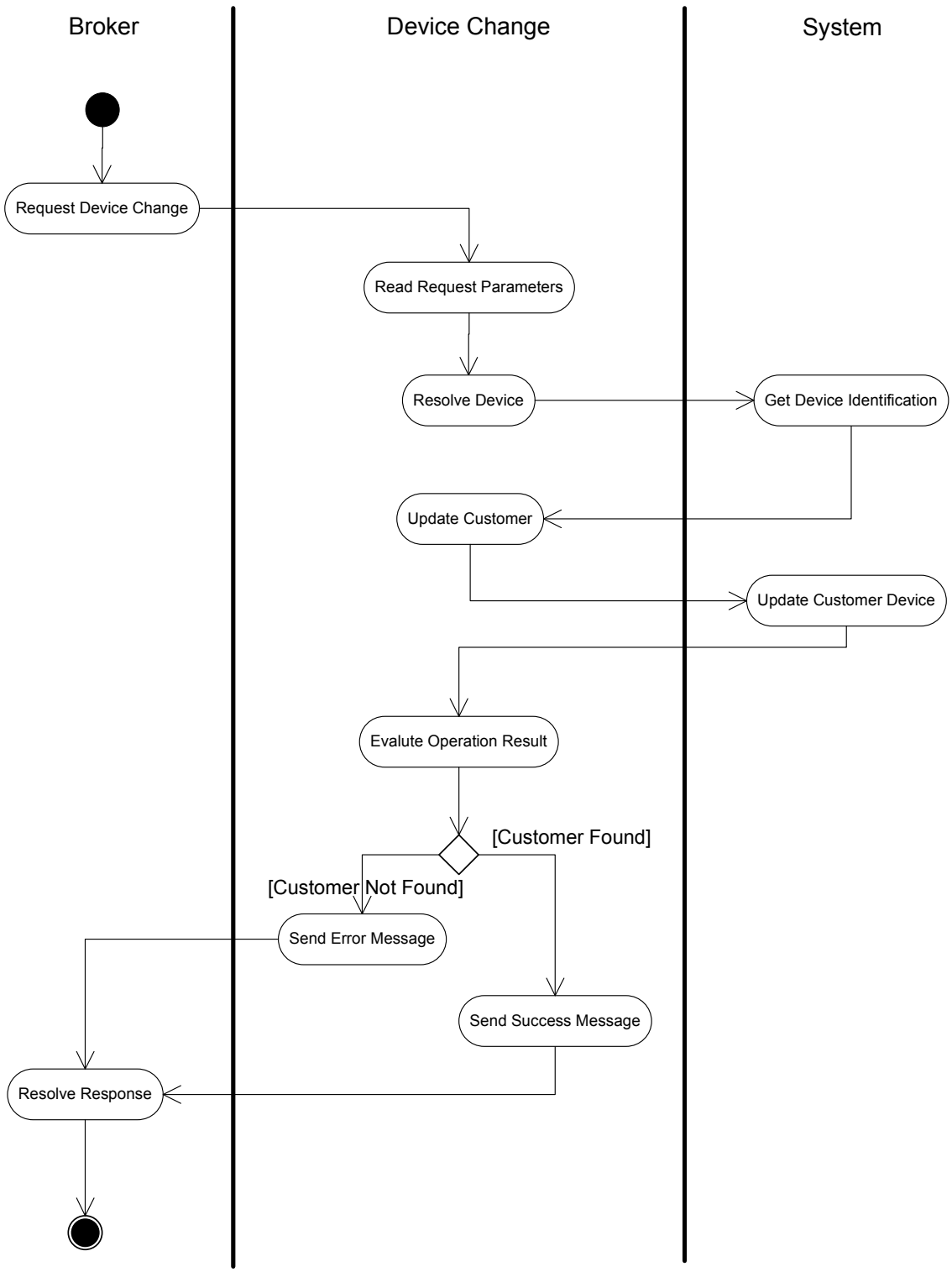


Figure 18 Device Change Activity Diagram

This interface changes the device of a customer directly on TIM w.e. database. It takes as input the client phone number and the new device information. As output it sends the result of the execution.

5.3.2.3 - Event List

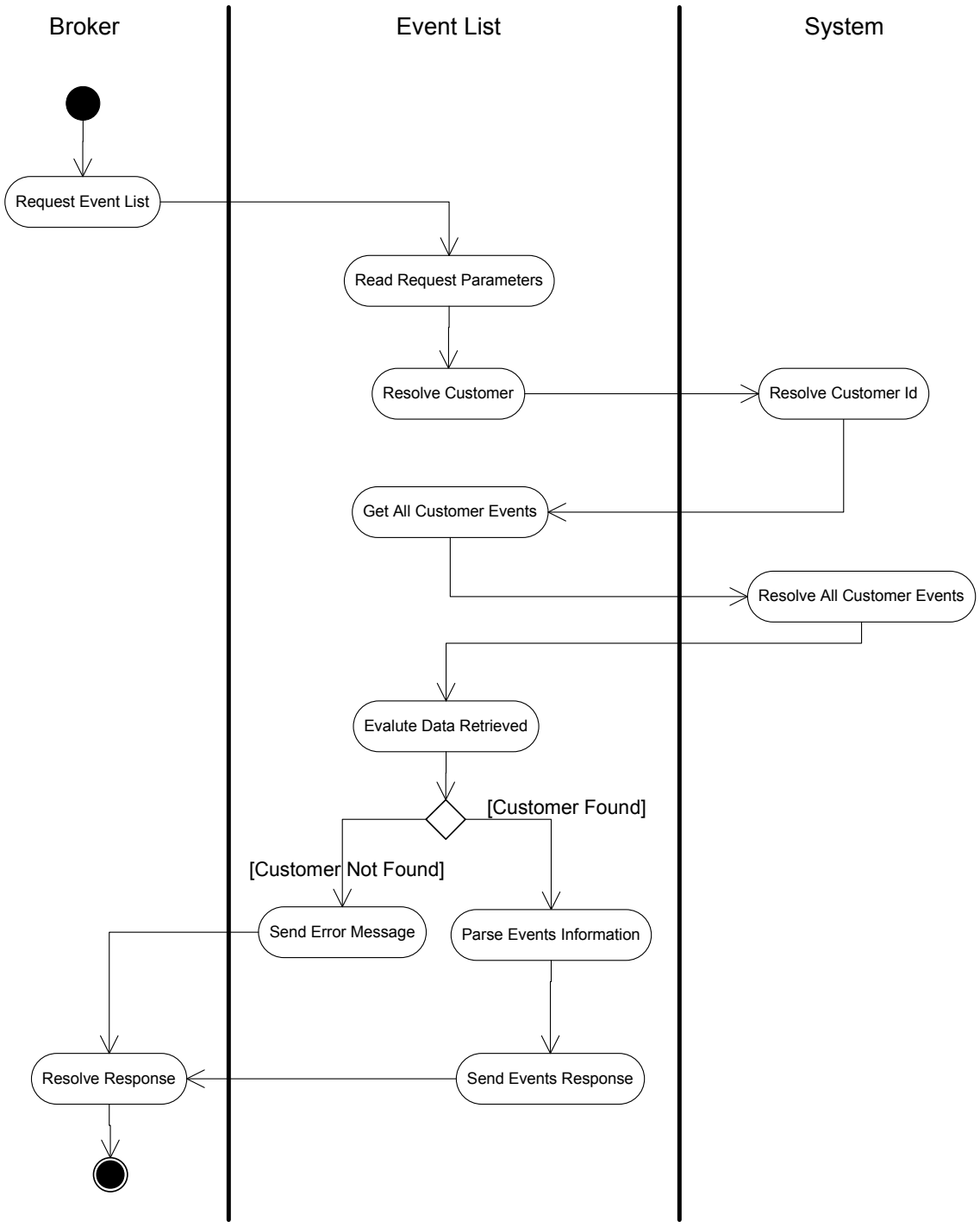


Figure 19 Event List Activity Diagram

This diagram represents the actions taken by the Event List Interface to retrieve all the events of a client from the database.

5.3.2.4 - Subscription Information

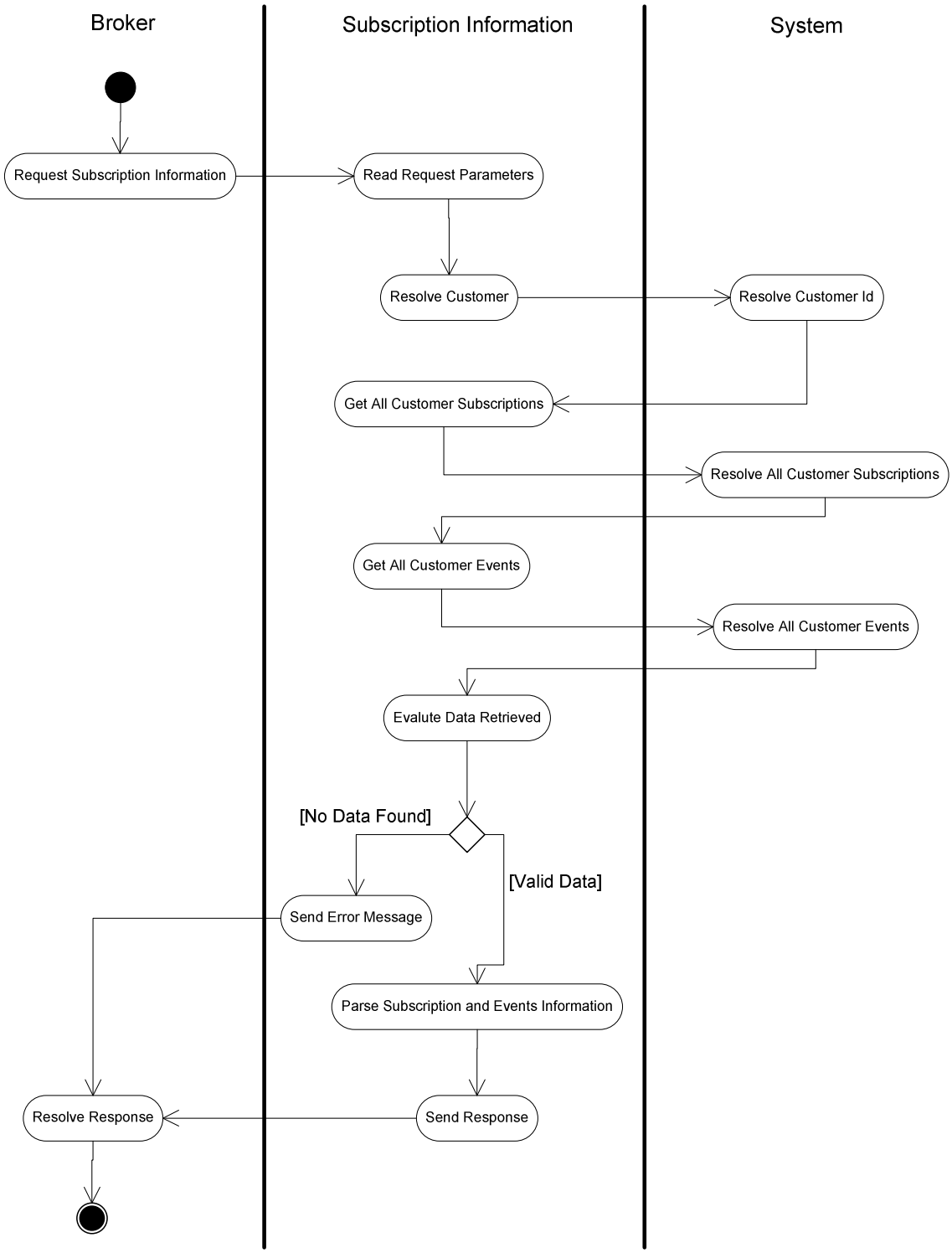


Figure 20 Subscription Information Activity Diagram

The Subscription Information task is similar to the Event List with the difference that it has a different information parsing and as more information about the subscription of the user.

5.3.2.5 - Send Last Content

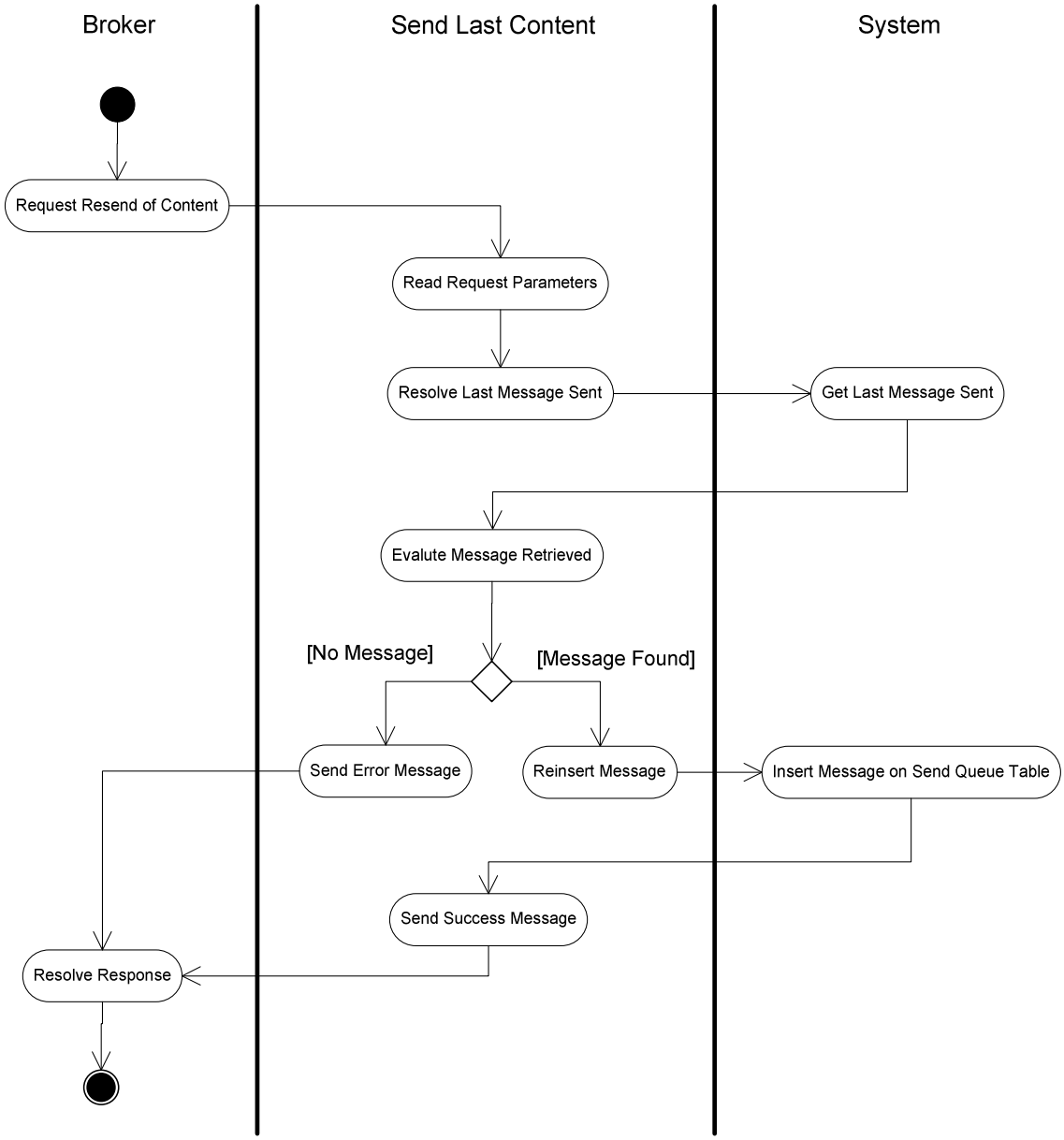


Figure 21 Send Last Content Activity Diagram

The Send Last Content interface resends a message to a user. It retrieves the specified message from the MT table and places it back on the send queue.

5.3.2.6 - Subscription

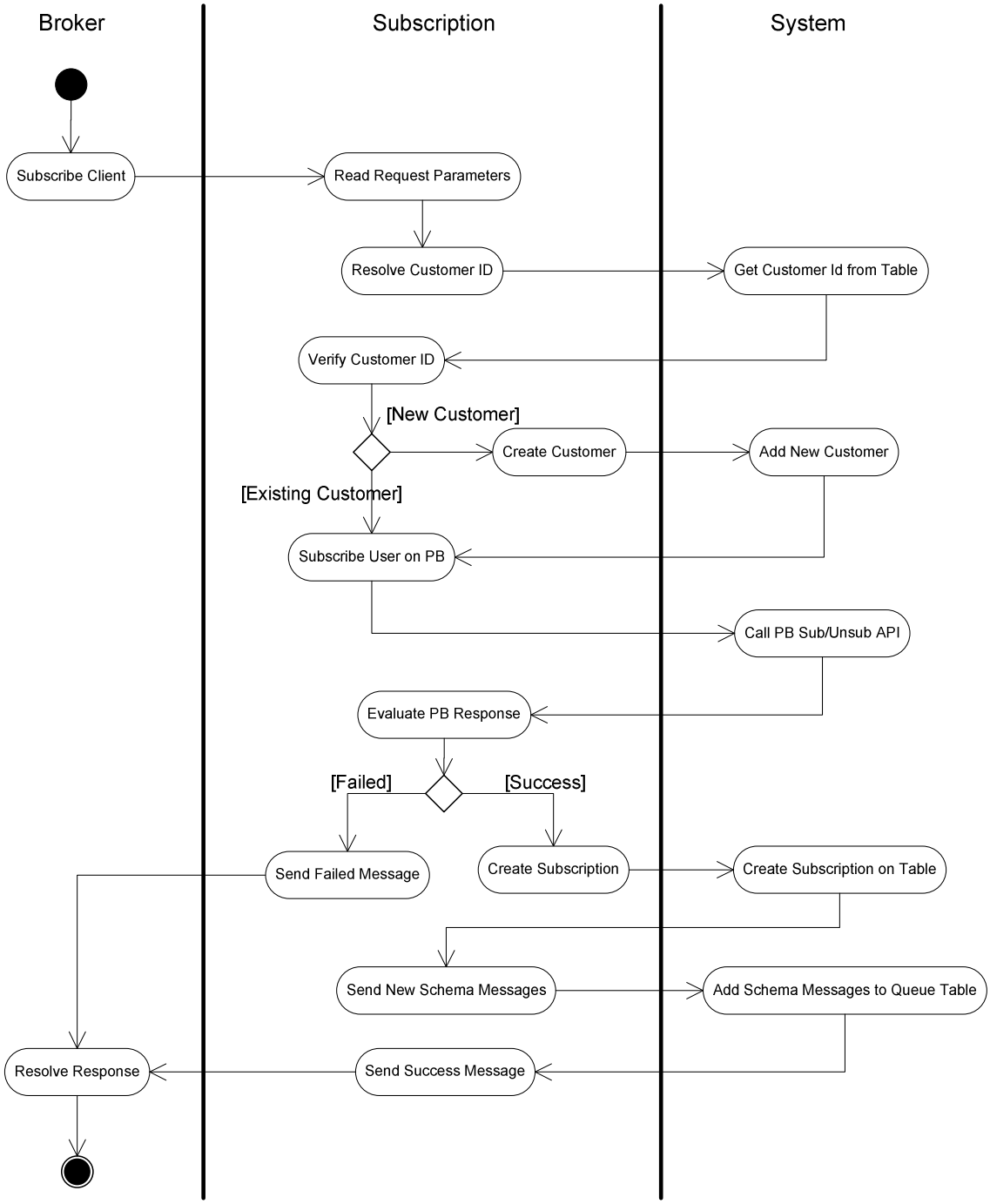


Figure 22 Subscription Activity Diagram

This interface represents the actions taken to subscribe a user on TIM w.e. database using the callcenter interface. It also sends the client the messages defined for the specified service.

The answer sent to the broker is the result of the operation.

5.3.2.7 - Unsubscription

Figure 23 Unsubscription Activity Diagram

This interface represents the actions taken to unsubscribe a user on TIM w.e. database using the callcenter interface. It also sends the client the messages defined for a cancelation.

The answer sent to the broker is the result of the operation.

5.4 - Class Diagrams

The following diagrams represent the object structure of this project. For each object is described its attributes, operations and connections to other objects.

Note: The gray objects represent existing objects used by the current project but are out of its domain. They are displayed to better understand their connections with the current project objects.

5.4.1 - Broker Communication Class Diagram

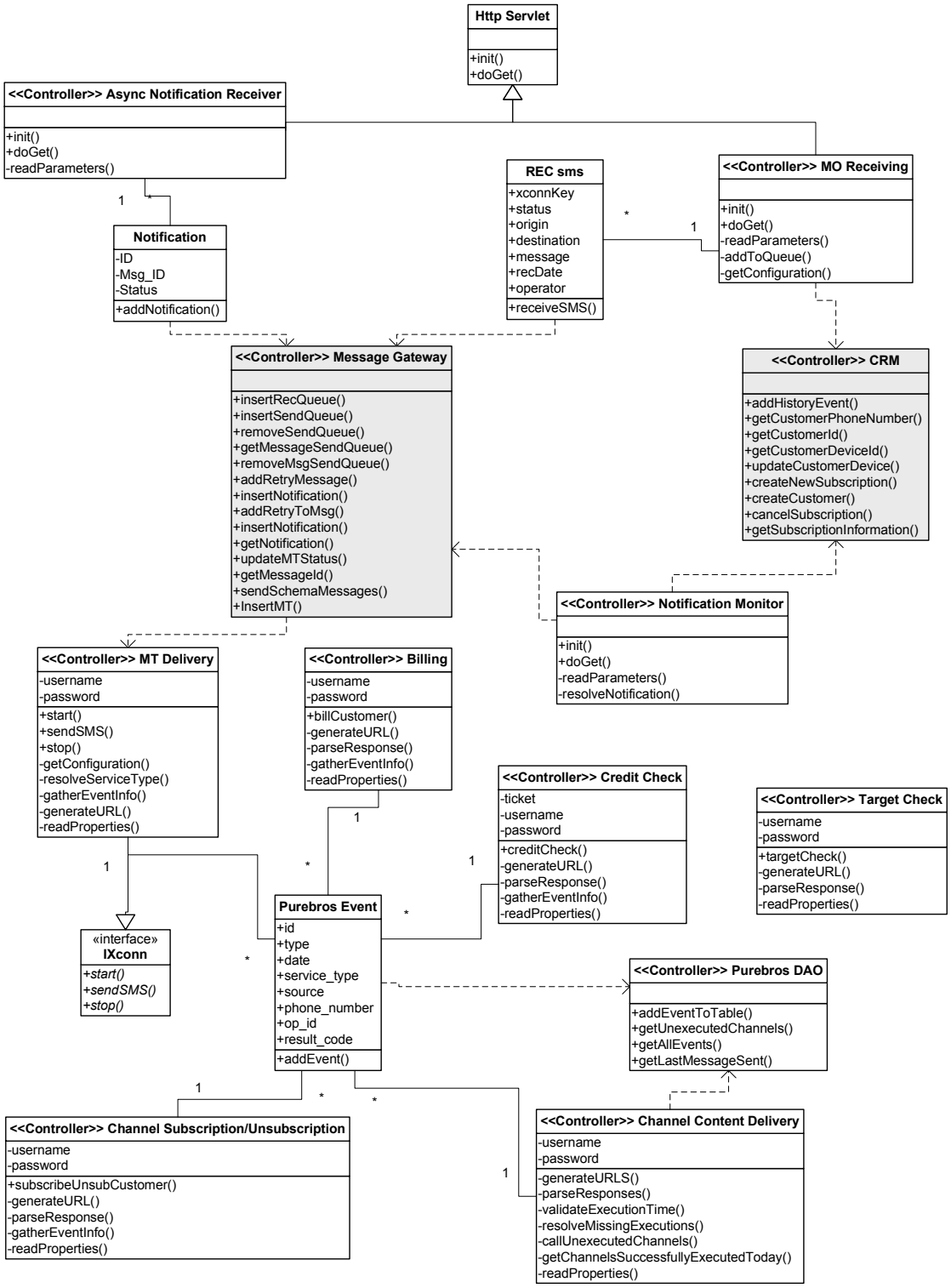


Figure 24 Broker Communication Class Diagram

This class diagram represents the object structure of the broker communication interfaces.

5.4.2 - Broker Callcenter Class Diagram

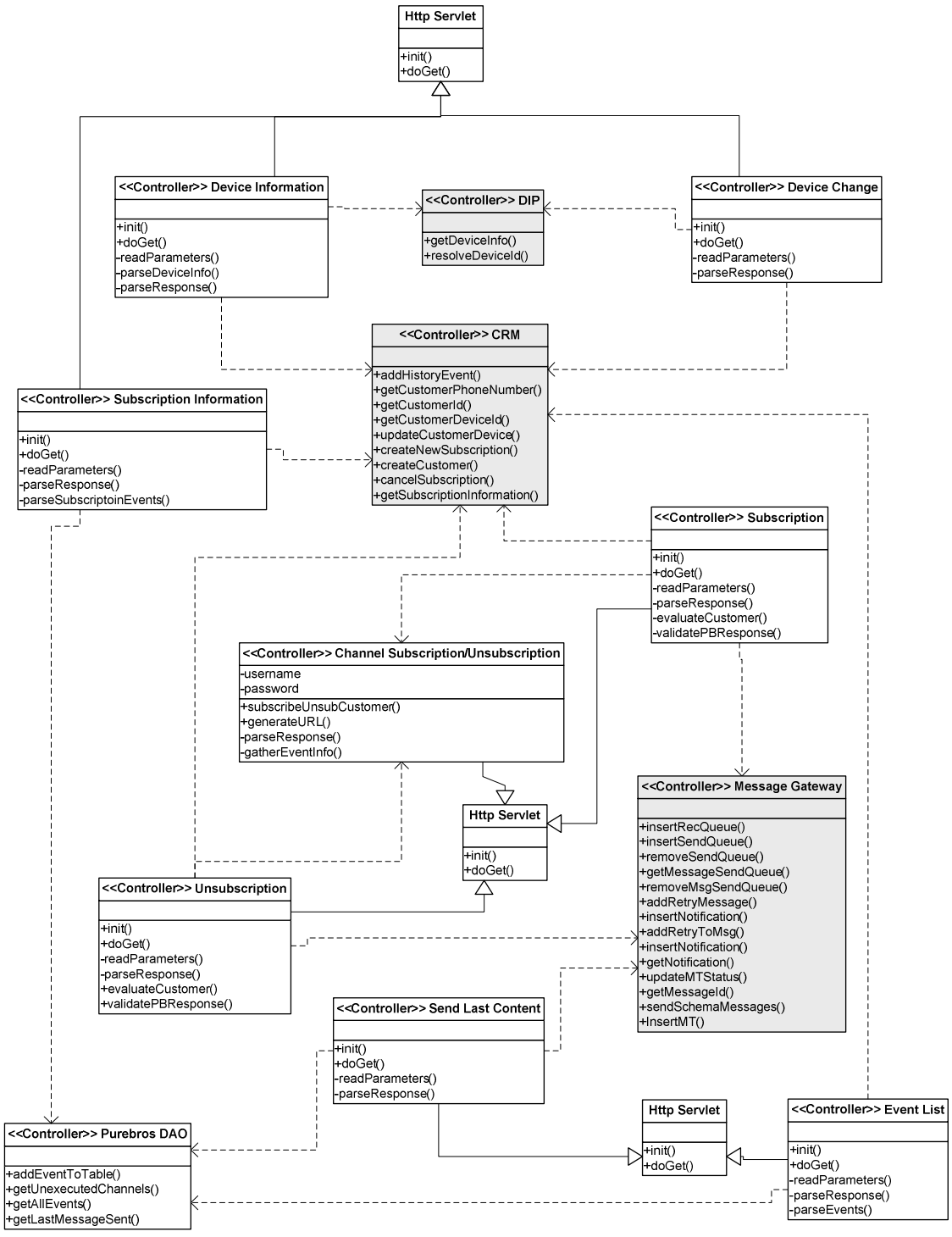


Figure 25 Broker Callcenter Class Diagram

This class diagram represents the object structure of the callcenter communication interfaces.

5.5 - Sequence Diagrams

The Sequence diagrams have the objective of controlling the complexity of the system. They represent all the interactions between the different objects of the system.

The following diagrams are the result of all the previous analysis.

5.5.1 - Broker Communication Sequence Diagrams

5.5.1.1 - MO Receiving

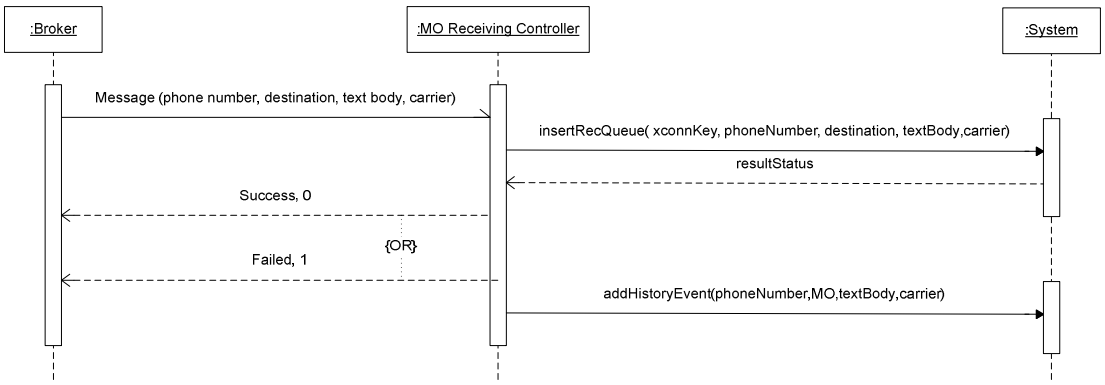


Figure 26 Mo Receiving Sequence Diagram

This diagram represents the interactions for the MO Receiving Controller process. This process is responsible for receiving the messages from the broker and inserting them into the database. On this diagram is also possible to understand what information is exchanged between all the objects.

5.5.1.2 - MT Delivery

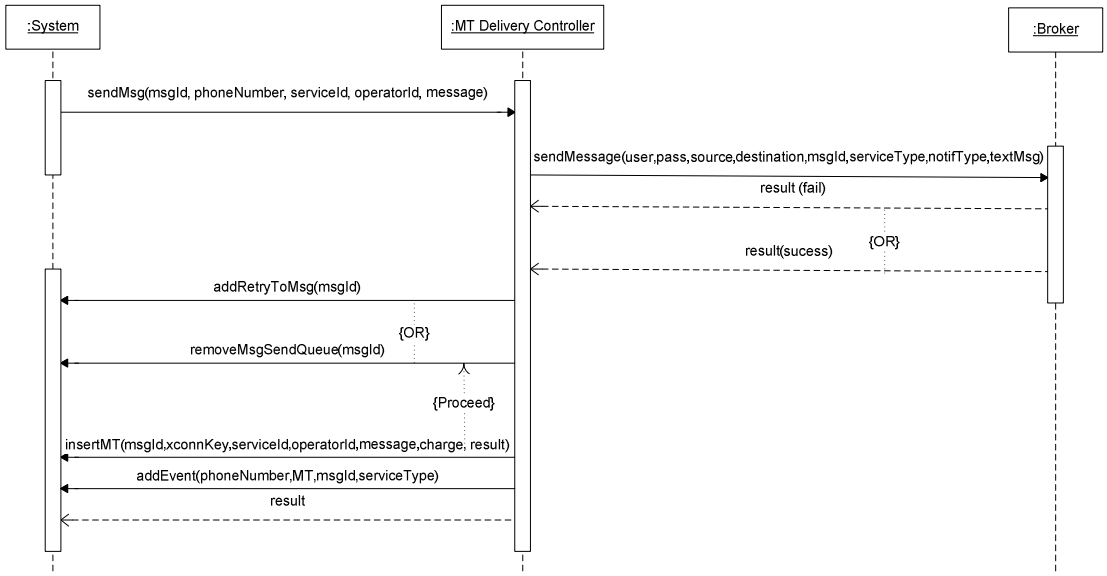


Figure 27 MT Delivery Sequence Diagram

This diagram represents the interactions for the MT Delivery Controller process. This process is responsible for receiving messages from the system and sending them to the broker. It also has the responsibility to decide what to do with the message that is stored in the send queue, either resends it or moves it to the MT table. Most of the actions on the database are done using system APIs.

5.5.1.3 -Async Notification

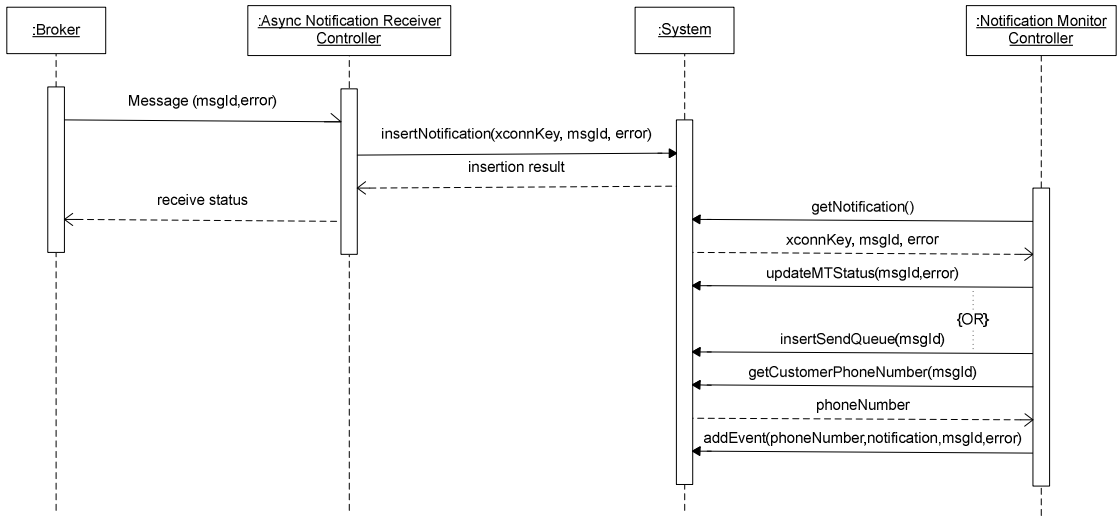


Figure 28 Async Notification Sequence Diagram

This diagram represents the interactions for the Async Notification process. On this process are involved two objects developed on this project, the first one is responsible for receiving the notifications from the broker and the second one to update the messages status based on the notification and decide what to do with the message.

5.5.1.4 -Credit Check

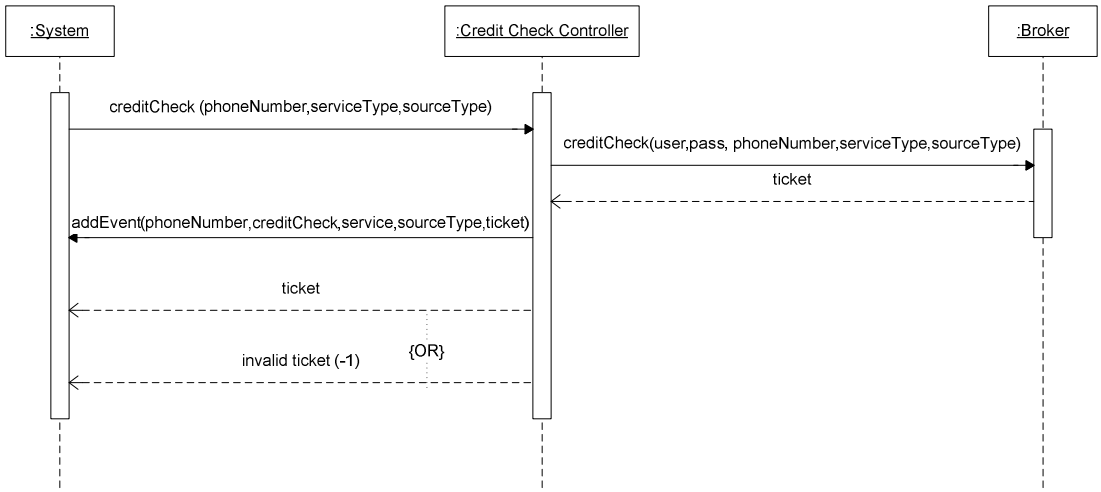


Figure 29 Credit Check Sequence Diagram

This diagram represents the interactions for the Credit Check process. This process is initiated by the system and allows it to contact the broker using the credit check controller to grab a ticket to bill a client.

5.5.1.5 -Billing

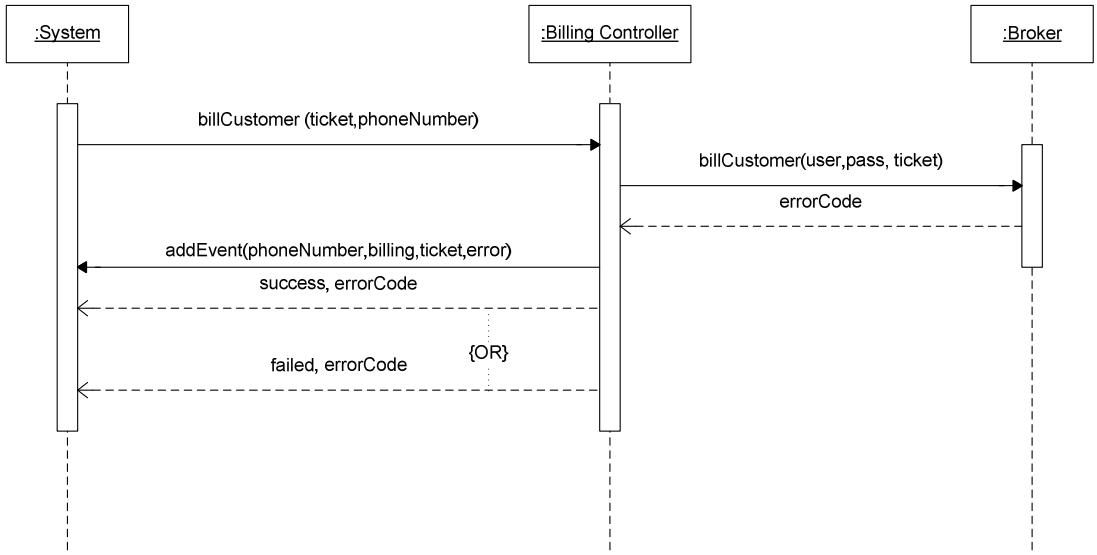


Figure 30 Billing Sequence Diagram

This diagram represents the interactions for the Billing process. This process is used by the system when it has a ticket to bill a client. This interfaces then uses the ticket to call the broker and receives a confirmation that is parsed back to the system.

5.5.1.6 -Channel Subscription/Unsubscription

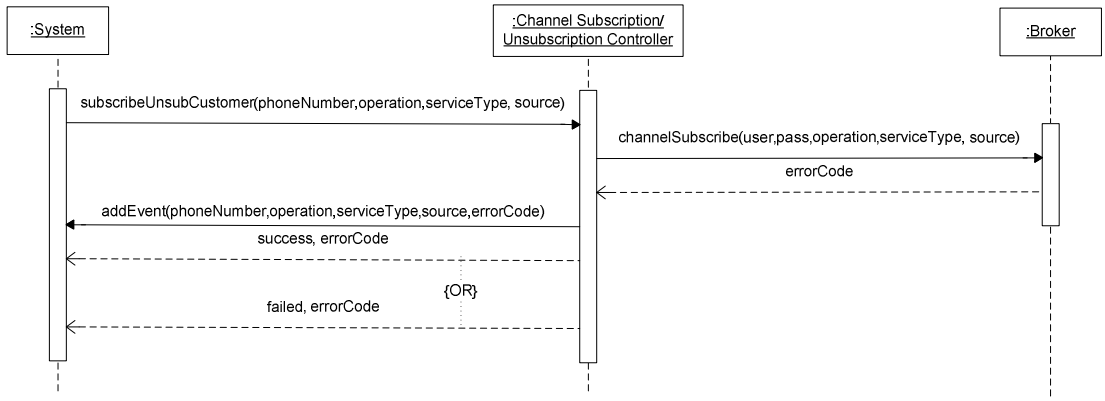


Figure 31 Channel Subscription/Unsubscription Sequence Diagram

This diagram represents the interactions for the Channel Subscription/Unsubscription process. This process is also initiated by the system and is used to register or unregister a client from the broker database.

5.5.1.7 -Channel Content Delivery

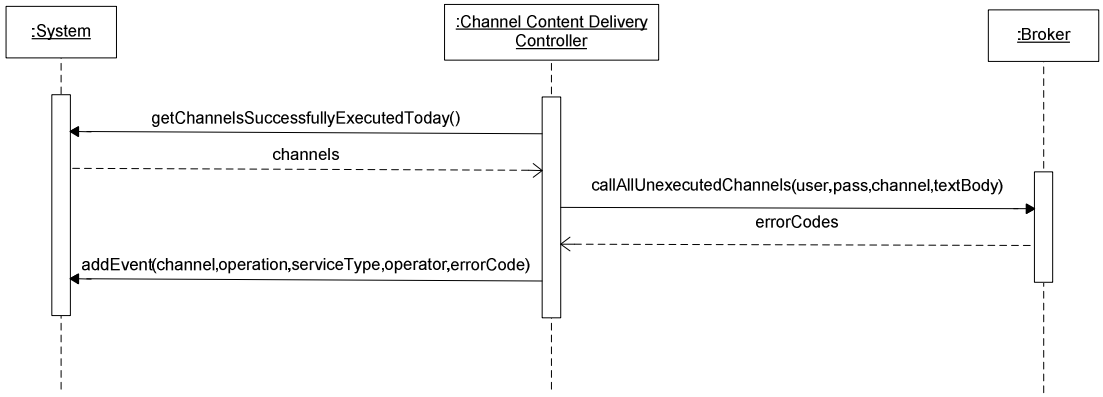


Figure 32 Channel Content Delivery Sequence Diagram

This diagram represents the interactions for the Channel Content Delivery process. This process is initiated at a specific time and tries to execute all the unexecuted channels for that day. At the end it registers the result of the channels so it never calls the same channel more than one time per day.

5.5.1.8 -Target Check

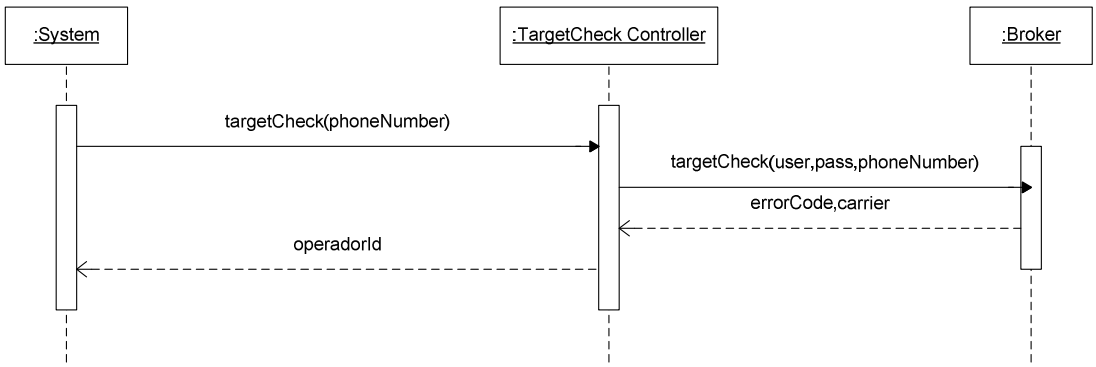


Figure 33 Target Check Sequence Diagram

This diagram represents the interactions for the Target Check process. This process is initiated by the system and shows all the interactions need to resolve the internal operator identification for a specific phone number.

5.5.2 - Broker Callcenter Sequence Diagrams

5.5.2.1 -Device Information

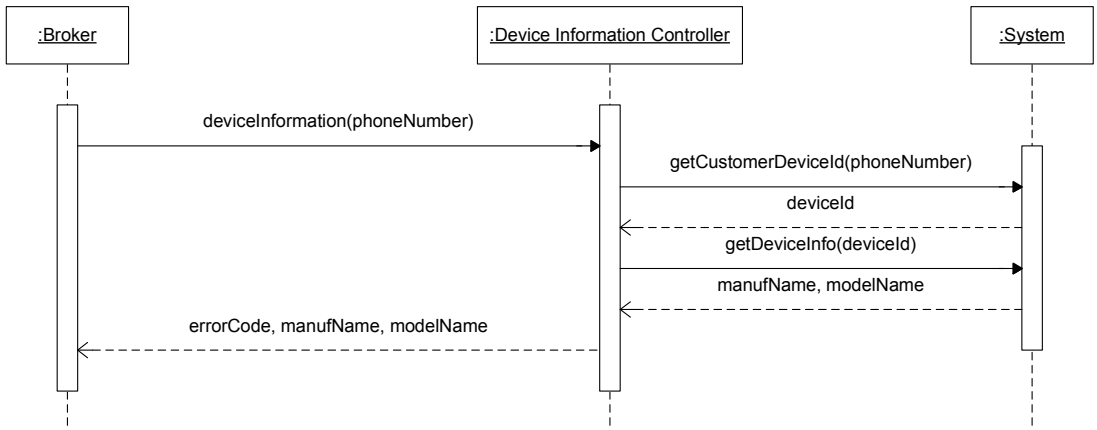


Figure 34 Device Information Sequence Diagram

This diagram represents the interactions for the Device Information process. This process is initiated by the broker and resolves the device information for a particular phone number on TIM w.e. database.

5.5.2.2 -Device Change

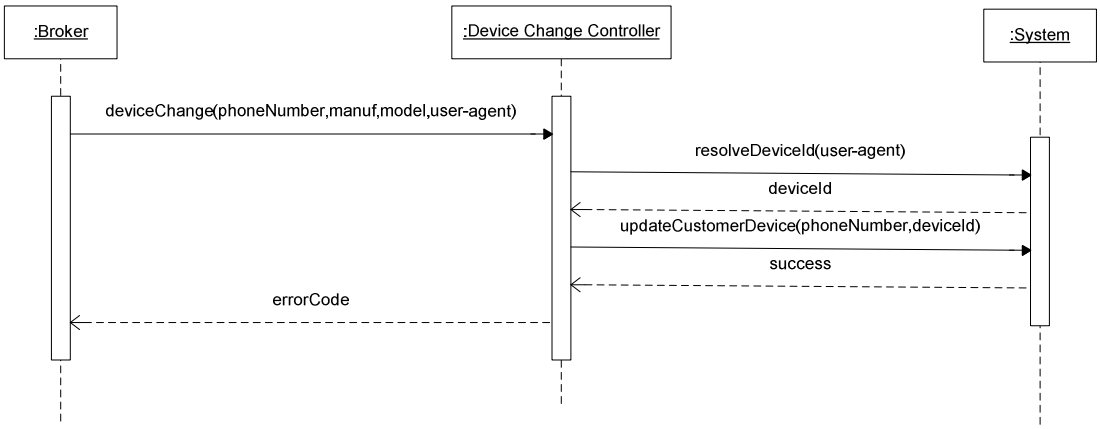


Figure 35 Device Change Sequence Diagram

This diagram represents the interactions for the Device Change process. This process changes the device on TIM w.e. database for a particular phone number. On this process the Controller

needs to resolve the internal device id on the database in order to update the device information.

5.5.2.3 -Event List

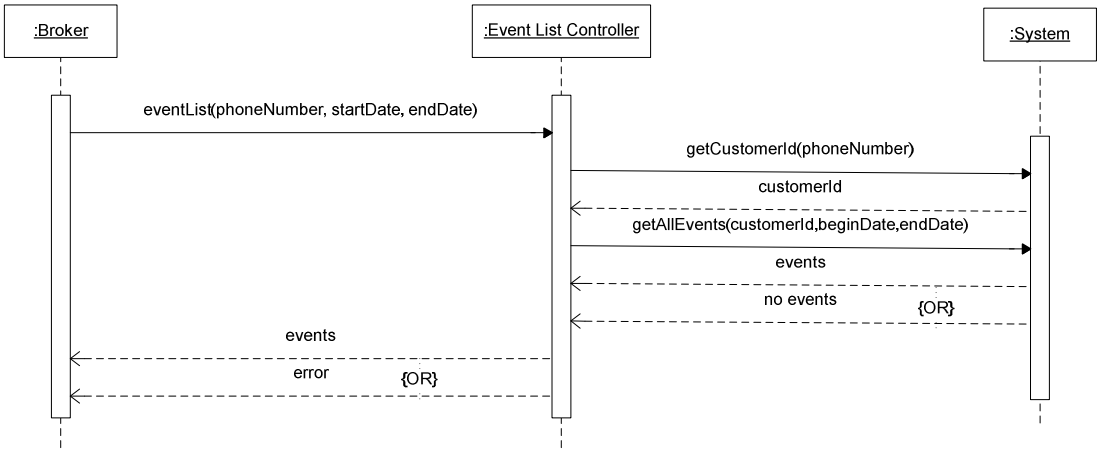


Figure 36 Event List Sequence Diagram

This diagram represents the interactions for the Event List process. On this process the controller resolves all customer events on a time frame and returns them to the broker.

5.5.2.4 - Subscription Information

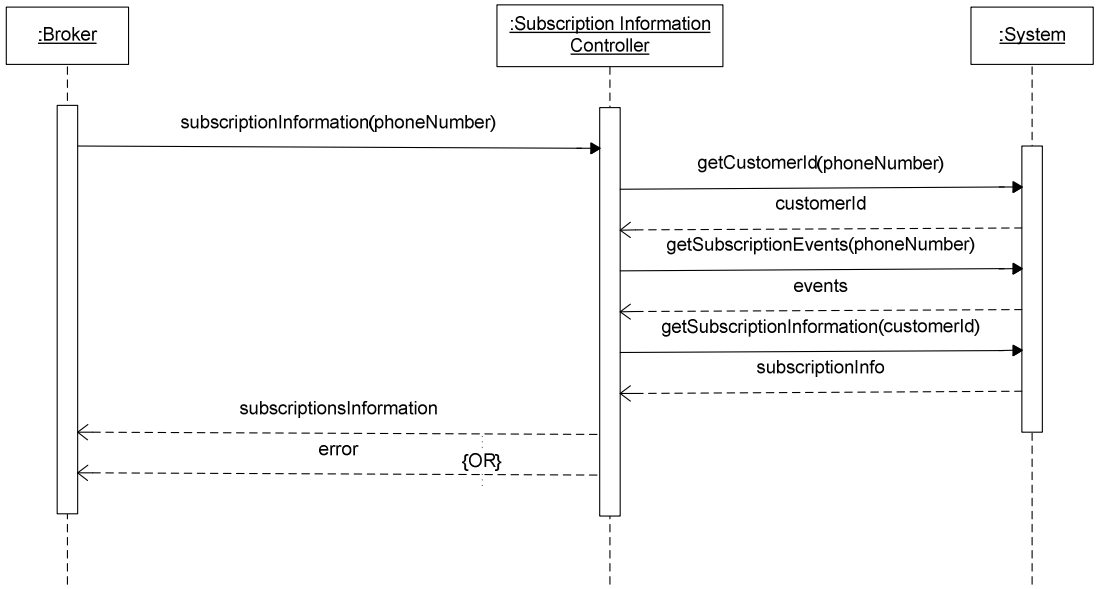


Figure 37 Subscription Information Sequence Diagram

This diagram represents the interactions for the Subscription Information process. This process is similar to the Event List with the difference that it also retrieves subscription information from the database. All this information is converted to the broker format requisites and sent.

5.5.2.5 - Send Last Content

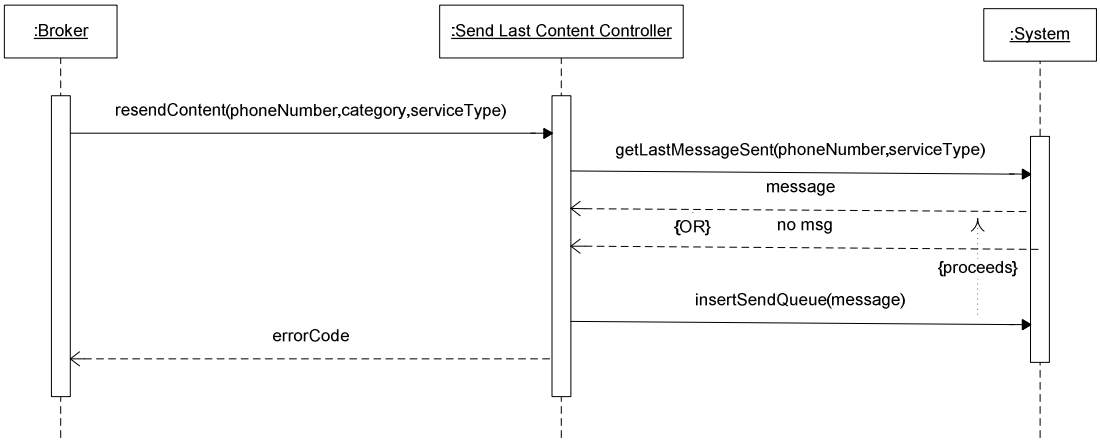


Figure 38 Send Last Content Sequence Diagram

This diagram represents the interactions for the Send Last Content process. On this process the broker requests that the last content sent to a particular phone number is resent. The controller must retrieve the message from the events table and reinserted it the send queue.

5.5.2.6 -Subscription

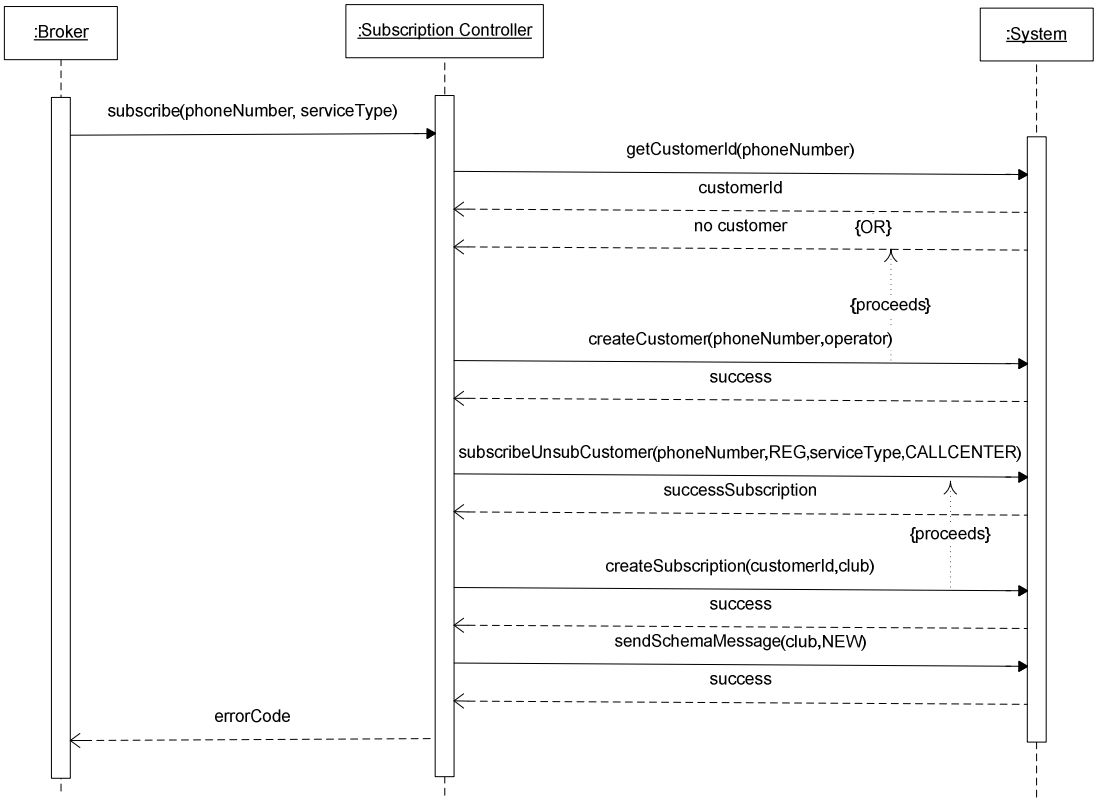


Figure 39 Subscription Sequence Diagram

This diagram represents the interactions for the Subscription process. This complex process initiated by the broker subscribes a client on a TIM w.e. service. To subscribe a client the controller needs to register the client information then it must subscribe on the broker side first, then on TIM w.e. database and last if all succeeded it must insert on the send queue the congratulation messages for the client.

5.5.2.7 - Unsubscription

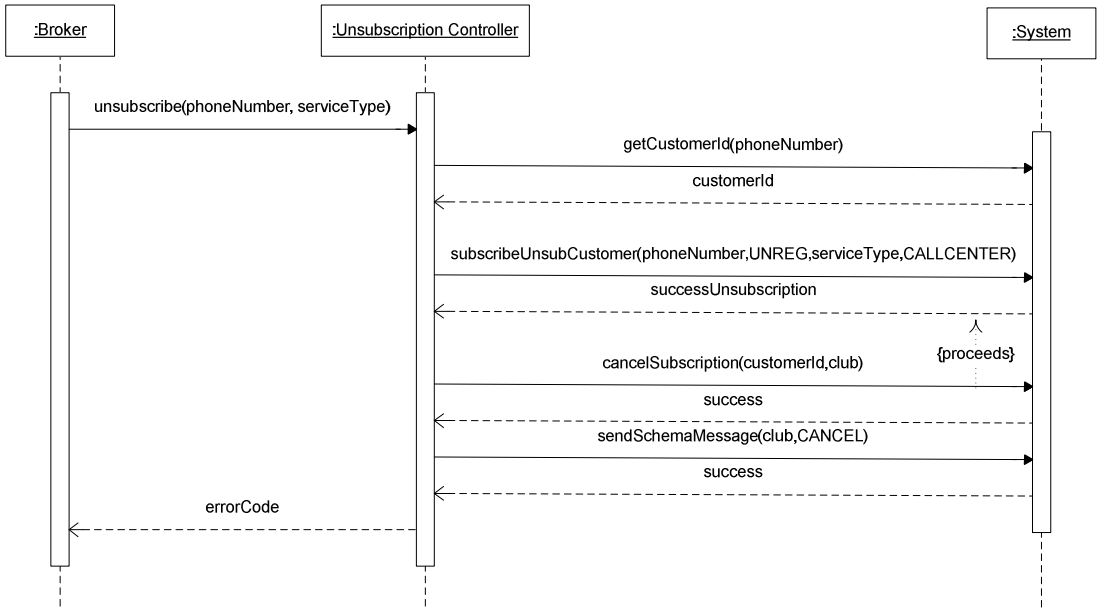


Figure 40 Unsubscription Sequence Diagram

This diagram represents the interactions for the Unsubscription process. This process is similar to the Subscription, the controller must unsubscribe the user from the broker side and them from the database, after all succeeded it inserts the cancelation messages on the send queue.

5.6 - Human Resources

On this project is allocated the Brazil Project Manager, one Tester, one System and operations architect and 2 developers.

Project Manager: Is responsible for arrangements between all the interested parts (IT, Marketing and Broker).He is also responsible for taking decisions on the implementation of the project, supervision, scheduling and allocation of the resources.

Tester: Is responsible for all the tests on development and production and as to ensure the product quality**.**

System and operations architect: Makes the deployments to production environment.

Developers: Are responsible for designing and coding the project and future features and maintenance.

Except the developers the remaining resources were not assigned to this project in full time and even the developers were assigned to other tasks temporarily when it was necessary.

5.7 - Technologies and Tools

On this project was used several technologies and tools that are open source and are standardized meaning that they offer several guaranties to its users such as retro compatibility on future releases.

Java: In this project was used Sun java 1.5 EE which is an open source and standardized programming language. The main characteristics of Java are: is an object oriented language, is platform independent, has automatic memory management and runs inside a virtual machine (JVM[22]). The Sun SDK[23] bundles several APIs that were used in this project being the most used the java Servlets API (Perry, 2003).

Oracle 10g: Is a proprietary database engine that is very scalable and provides state of the art performance. This database engine is used on this project for some DML using the SQL Developer tool from Oracle (Abramson & Abbey, 2004).

Apache Tomcat: Is an Application Server that provides a Servlet Container service. Tomcat offers high performance when compared to its competitors and is free. On this project is used Tomcat 5.5. (Chopra, Bakore, Eaves, Galbraith, Li, & Wiggers, 2004)

Maven 2: Is a free software that eases java project management and building. This tool makes use of a POM [24] which is basically an XML [25]file that can be edited manually. It is used on this project to assist the compilation and build of the project (Massol & O'Brien, 2005).

SVN: SubVersioN is a free version control system that is used to control file changes. It is used to maintain current and historical versions of files. On this project it is used to maintain all current and historical source code changes and to enable simultaneous development on the same project by different developers.

[22] *JVM*: Java Virtual Machine
[23] *SDK*: Software Development Kit
[24] *POM*: Project Object Model
[25] *XML*: eXtensible Markup Language

5.8 - Database Tables

The image below shows the main tables used by the several modules of the system. None of these tables was created for this project in particular. But it is interesting to give an image of the structure.

These tables exist on the production and reporting environment with a few differences mainly at indexes level, because they have different objectives.

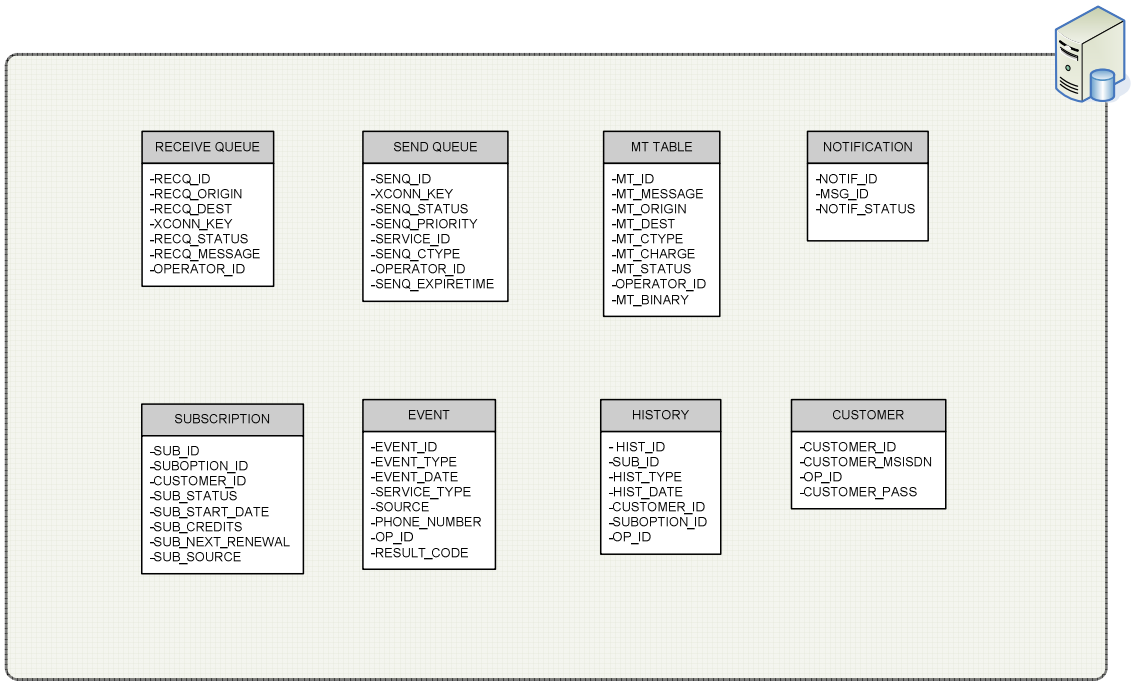


Figure 41. Main Database Used Tables

A description of the tables:

Receive Queue: Is where the messages that arrive to the platform are placed for later resolution by the service that is responsible for them.

Send Queue: Here is where the output messages are placed, and will be read and sent by the service that is responsible for sending them.

MT Table: Is where all the messages that have been sent are stored.

Notification: The notifications that come from the broker are stored on this table for later resolution.

Subscription: Here is stored all the subscription information of all customers.

Customer: Is where is stored the customers information.

Event: Here are stored all events that are needed by a specific service, as the case of the Callcenter, that needs more information that is not available or easily accessible on other tables.

History: Here is stored all the common events that occurs on the platform. This table is platform specific because it only maintains information generated by common interfaces.

5.9 - Modules

Here are shown all the modules that are present and used on this project. The grey modules are existing modules that are used by the developed modules of this project but are out of this project domain. The light blue are the modules developed on this project. After the next image is a short description of all these modules.

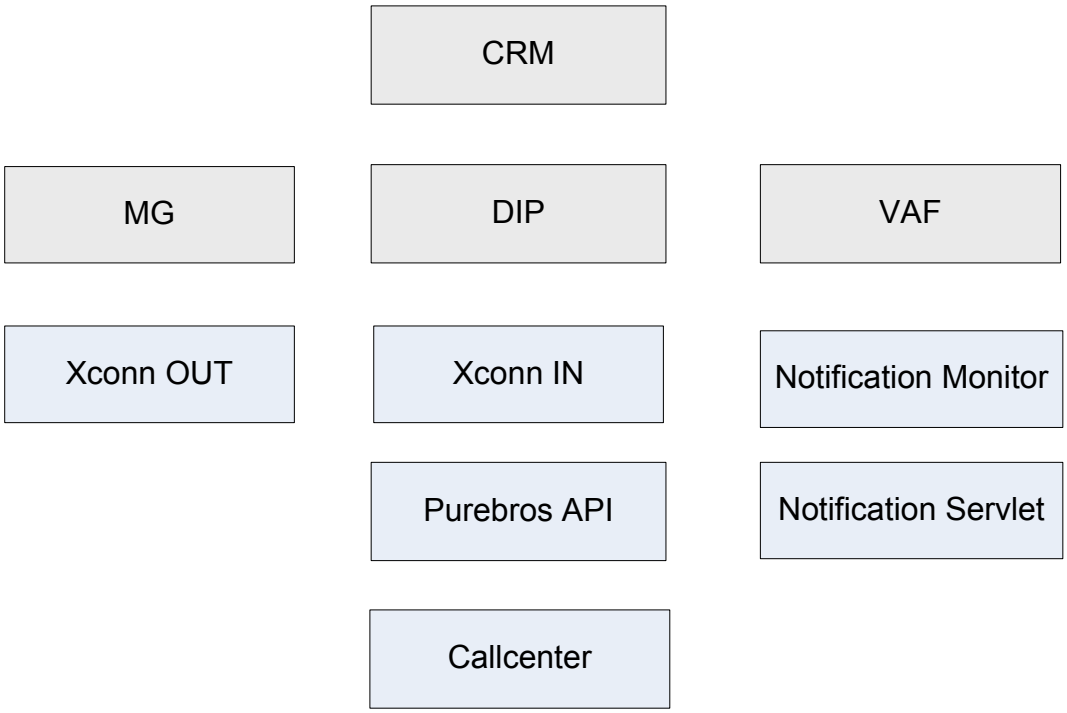


Figure 42. Project Modules

CRM: This module is composed by an API that allows subscriptions and customer operations. It encapsulates the database access for this type of operations.

MG (Message Gateway): This module is composed by an API that allows message operations and also encapsulates all the database access. It is also composed by a monitor that reads the messages from the send table and calls the class that resolves them.

DIP: This module is composed by an API that allows device resolution and information operations. It encapsulates the database access for this type of information.

VAF: This module is not used in this project but is the main user of all the components of this project. This is the module that is responsible for message resolution and is responsible for reading the incoming messages from the receive queue and generate the output messages to the send queue.

Xconn OUT: This module is known on this project by MT Delivery interface and is responsible for sending the messages to the broker, using the communication format agreed.

Xconn IN: This module is know on this project by MO Receiving interface and is responsible for receiving the messages from the broker and converting them to the platform internal format.

Notification Servlet: This module receives the message notifications from the broker and stores them on a table.

Notification Monitor: The monitor reads the pending notifications and updates the messages information.

Purebros API: The Purebros API is composed by several interfaces that implement useful functionalities to the broker. These functionalities can be used by any application on the system.

Callcenter: Is a composition of all the Callcenter interfaces that are available to the broker.

5.10 - Deployment and Architecture

Since the beginning of this project the deployment environment was already decided. The image below represents all TIM w.e. internal structure and the possible broker/carriers communication architecture. This image also displays the deployment diagram of the components used on this project.

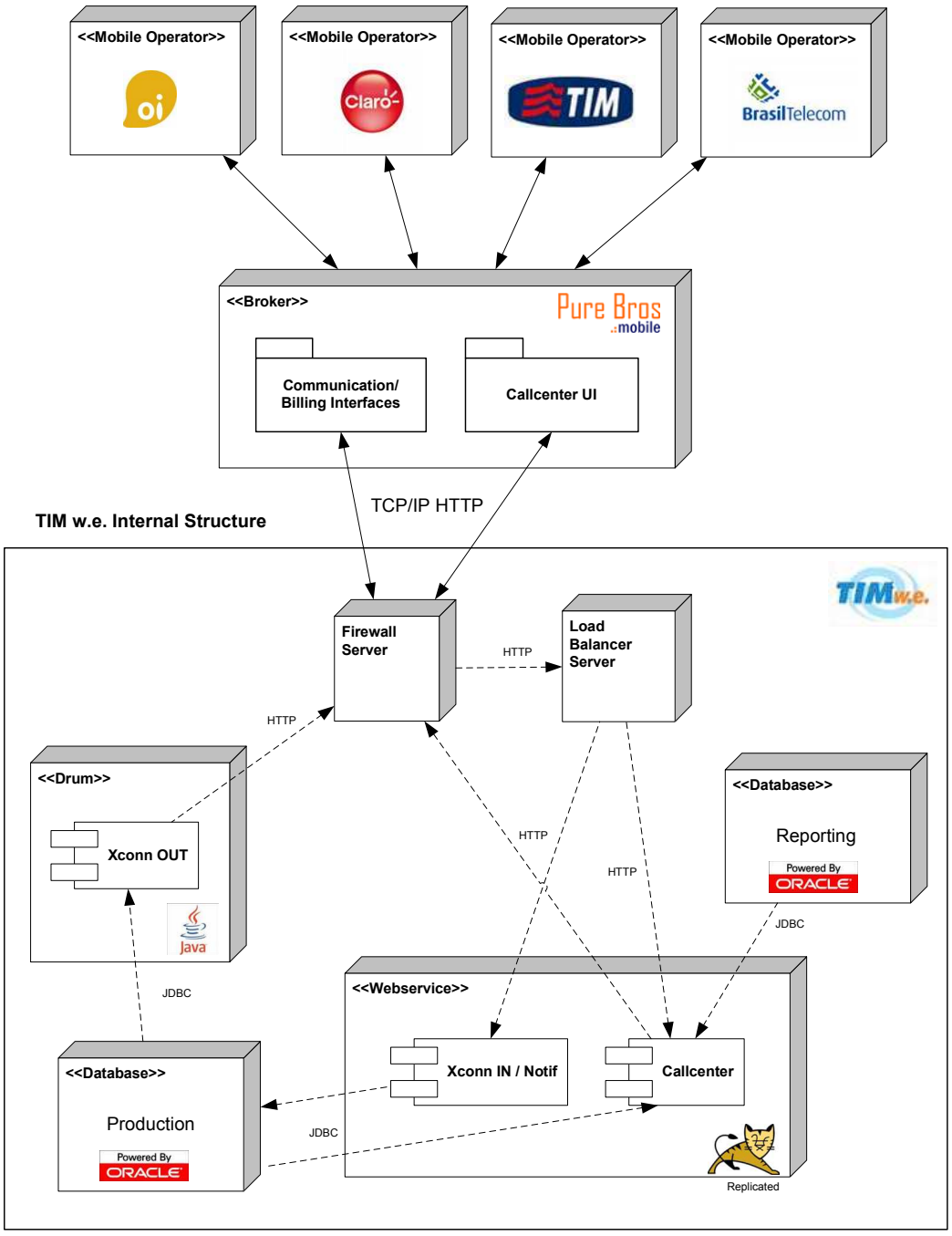


Figure 43. Deployment and Architecture Diagram

5.10.1 - Broker and Mobile Carriers

The broker is interconnected with several mobile carriers. The main object of a broker is to potentiate and simplify the integration of its clients, which using a single connection can hit all the mobile carriers clients. This eases the integration time and enables its clients to expand to new markets faster.

5.10.2 - TIM w.e. Internal Structure

The internal structure of TIM w.e. is composed by many components next is a short description of them that will help understand the big picture of the platform and its main components:

Firewall: Is the frontline of the entire platform and has the responsibility of only enabling trusted entities to access the internal services. It also controls and monitors all traffic exchanges.

Load Balancer: Since TIM w.e. has several replicated services the load balancer has the objective of distributing the requests by these services based on their load capacity.

Drum: Is a Java Application that is used as a container to other java classes that run inside it. The drum decides and controls all the launch and execution of those classes and provides error control mechanisms.

Tomcat Application Server (WebService): Tomcat is a free Application Server distributed by Apache that is able to execute java servlets. This Application Server is responsible for containing all the servlets developed on this project. The Applications Servers are also replicated on several servers to give redundancy to the system.

Production Database: This Oracle database contains all the production information that is used by all the system. Its schema is designed to give maximum performance on the most used transactions.

Report Database: This database contains all the information gathered by the Production Database. It also contains more refined data that was extracted from the raw data on Production. Its schema was design to be a data warehouse, so it delivers better performance for reporting tasks. An important fact is that the reporting database is not synchronized on real time with the production database, it as a small delay that corresponds to the time taken to the data migration from one to another.

5.11 - Tests

The objective of the software tests developed by the QA tester is to detect possible errors on the application and to ensure the application respects the context in which it is intended to operate.

These tests are done when a new functionality is implemented. This is possible because all the functionalities are independent and because the team as a member for this specific task.

The tests where executed tests on two distinct environments, development and production.

5.11.1 - Development

The development tests are the first tests done by the QA tester. The developer deploys the application to a development server and requests the tests.

These tests are done on the internal platform with simulated requests to the system. The objective is to stimulate the system and find possible integration errors, bugs or bad implementations. These tests are done until no problem is found.

The tester applies black and white tests to all the application.

5.11.1.1 - Black Box Tests

These tests aim to test the functionality of the application according to its requirements. The tester inputs data and sees the output from the test object. He then validates if the output is the expected output. The tester applies equivalence partitioning tests and boundary values analysis.

5.11.1.2 - White Box Tests

These tests aim to test the internal data structure, code and algorithms. On this tests the tester tests the functional points of the application and ensures that all the possible lines of code are executed at least one time and have the expected output. These tests are complemented with the black box tests.

5.11.2 - Production

The production tests are done after the application passes the QA tests. The developer then requests deploy of the application to production environment.

These tests are done live with the broker, with real requests from the broker and on production database. This is the final validation step before the system is accepted as fully compliant with the broker requisites. The tests applied on this phase are of broker responsibility.

5.12 - Maintenance and Improvements

After the implementation minor alterations were done at the Callcenter, mostly alterations to the response format sent to the broker. Other alterations were done on the service mappings but these were easily done at properties files, no coding needed.

There were also a few performance issues on the platform, the module that manages the messages was not being able to dispatch all the messages and the messages started to form a big queue. The cause of this problem was the enormous number of messages that Brazil service started generating. The problem was solved increasing the number of threads to send the messages and with hardware updates on the servers.

6 - Conclusions

All the development of this project as run as planned and the implementation followed the predicted timeframe.

This project is now fully operational and being used by TIM w.e. to serve more than one million clients. The communication interfaces sends more than one million messages per day and receives more than fifty thousand from all the four mobile carriers they are connecting.

The Callcenter is being used on Brazil by the broker and mobile carriers to resolve problems reported by its clients.

Since the project had a software quality tester, it greatly helped the entire project outcome because he assured all the requisites were fully compliant with the broker and with the project specifications.

Even knowing that the entire project has run as planned there are some aspects that could have been improved. Because this project is locked to an existing platform it limited the design options because there was already a predefined design and implementation model to follow. This platform has also some bad aspects and was not thought to support all the possible services that it is now offering, this means that some implementations must grow outside the platform in order to provide all the requirements, which was the case of the Callcenter.

There was a design decision that was taken that on my opinion was wrong. It was decided to follow the existing logic; this is separating the broker connection logic from the platform logic. On my opinion the common logics should have been integrated on one module that offered all the integrated broker and platform logic since most operations need several actions on the broker and on the platform. The objective was to encapsulate these regular operations and use them in the several products instead of create one logic for each product when it was not needed.

There were some performance issues also that were promptly solved, initially adding more threads to the pool of the messages and later with hardware updates to the servers. This problem could have been minimized if the monitor that calls the MT deliver interface to send the messages calls it with several messages instead only one at the time. Again this is a limitation of the platform that could be changed to enable better performances.

During this project the human resources allocated were also divided on demand between other developments such as Webspots, new SMS flows and Wapsites.

6.1 - Future work

All the interfaces that were implemented were the required for the service to be fully complaint by the broker and mobile carriers requirements.

But not all the possible interfaces that the broker provides were implemented, there still exists more communication and callcenter interfaces to implement. If fully necessary or if they come to be useful there will be future works on this project.

A very feasible future work would be the creation of a package that integrates the common operations that need actions from the broker and from the platform with the objective of standardization of all the common operations.

It is also expected that TIM w.e. platform evolves to new technologies and this will influence all the way this project is implemented. There are already plans to create all the modules using EJB[26] technology.

The new developments will also change the database structure, but this will have small impact on this project because all the database access is encapsulated by other modules.

6.2 - Personal Experience

The work developed during the last nine months on this project in particular and on the several products of TIM w.e. have teach me new technologies, tools and works methods that I ignored. Being on TIM w.e. have also proven to be a constant challenge since it is a very young company that is growing fast and has lots of new challenges and opportunities for learning new products and technologies.

Right now I have moved from the Brazil operation development team to a new Business Intelligence team, I am now learning data warehouse concepts and Microsoft Business Intelligence tools.

The environment in TIM w.e. is fantastic and my colleagues were always very helpful. The company is composed mostly by young people to have an idea the company average age is around 26 years.

[26] *EJB*: Enterprise Java Beans

Extensive Abstract in Portuguese

Introdução

Depois do *boom* da internet estamos actualmente a assistir a um novo *boom* no mercado dos serviços móveis. A empresa onde se desenrola este projecto a TIM w.e. é uma empresa portuguesa que trabalha no mercado do entretenimento para telemóveis.

A TIM w.e. nasceu em 2002 e inicialmente dedicava-se á criação e venda de conteúdos de telemóveis para operadores nacionais. Hoje em dia a TIM w.e. já opera em mais de 56 países, têm 19 escritórios no estrangeiro e mais de 260 empregados.

Actualmente a TIM w.e. encontra-se ligada a mais de dois terços dos operadores mundiais e está a vender os seus produtos em quase todo o mundo, isto tudo para uma empresa que têm apenas seis anos de existência.

O projecto efectuado durante os últimos meses corresponde á criação da ligação com um broker de telecomunicações no Brasil. Esta ligação será composta pelas interfaces de comunicação básicas e as interfaces de comunicação para o Callcenter.

As interfaces de comunicação fornecem serviços de gestão de utilizadores e troca de mensagens com o broker. As interfaces do Callcenter fornecem informações sobre os eventos dos utilizadores na plataforma da TIM w.e. e também permitem aos operadores do Callcenter aplicar operações sobre os utilizadores.

Este projecto têm elevada importância pois permitiu á TIM w.e. passar a fornecer os seus serviços a quatro grandes operadores moveis no Brasil (TIM, Claro, Brasil Telecom e OI).

Departamento de Informática

Devido ao número já significativo de empregados e às diferentes áreas técnicas que trabalham na TIM w.e. esta encontra-se dividida por departamentos. Existem quatro grandes departamentos, *Back Office* que está responsável pela resolução de problemas reportados pelos clientes. PROD onde se produzem alguns tipos de conteúdos para venda e imagens e vídeos para campanhas publicitárias. O departamento de Marketing está responsável pela tomada de decisão sobre as campanhas e contacto com novos parceiros de negócio. E finalmente o departamento de informática que é responsável por toda a plataforma informática da empresa desde criação das ligações com operadores e brokers, á criação de novos produtos *web, wap e sms*, analise de problemas, gestão da rede, monitorização e outros.

O departamento de informática encontra-se divido em vários grupos e cada uma deles pode estar associado a um projecto, pais ou parte do mundo. Este projecto em particular desenrola-se no grupo de *operation developers* associados á zona do Brasil, esta equipa é composta por um gestor de projecto, um *tester*, um arquitecto de sistemas e quatro programadores.

Trabalho Inicial

A área de *operation development* é referente às equipas trabalham especificamente para os países e para os seus produtos. Um *operation developer* trabalha com diversos produtos, entre os mais importantes estão os *webspots*, criação de novos países, serviços e clubes na plataforma, wap sites, e ligações a operadores e brokers.

O conhecimento dos diversos produtos utilizados permite entender como este funcionam sobre a plataforma da TIM w.e. isto é bastante útil em desenvolvimentos futuros pois permite tomar as melhores opções de implementação, como foi o caso deste estágio em que a sua parte inicial foi aplicada á aprendizagem e desenvolvimento nos vários produtos.

Objectivo do Projecto e Metodologias

O objectivo deste projecto foi criar varias interfaces de comunicação que permitiram á plataforma da TIM w.e. comunicar com o broker e através deste atingir os clientes de quatro operadores móveis no Brasil.

O projecto está dividido em dois objectivos: a criação das interfaces de troca de mensagens com o broker e as interfaces de comunicação para o Callcenter. As interfaces de troca de mensagens são constituídas por serviços de recepção e envio de mensagens, cobrança e outros. Estas interfaces servem de elo de comunicação e compatibilização entre a plataforma do broker e a TIM w.e.. O Callcenter será composto por varias interfaces que permitem ao broker visualizar vários tipos de eventos dos seus clientes e efectuar operações sobre estes.

Este projecto foi desenvolvido seguindo o modelo em cascata. Com uma pequena nuance que todo a analise e desenho das interfaces de troca de mensagens e do Callcenter são feitas na mesma fase e a implementação, testes e manutenção estão separadas entre elas, como se pode concluir no **anexo 2**.

O Projecto

Como trabalho de projecto foi descrito todos os requisitos dos intervenientes, alguns pressupostos assumidos inicialmente, todo o estudo de engenharia de software desde casos de uso, diagramas de actividade, de classes, de sequência e de arquitectura do sistema. Ainda foram descritos os vários módulos envolvidos neste projecto, as tecnologias utilizadas, esquemas da base de dados e os tipos de testes levados a cabo pela equipa de testes.

Ao todo são oito interfaces no contexto de troca de mensagens e sete para o Callcenter. As oito interfaces de troca de mensagens são: *MO Receiving* (recepção de mensagens), *MT Delivery* (envio de mensagens), *Async Notification* (recepção e tratamento de notificações), *Credit Check* (verificação do credito de cliente), *Billing* (cobrança de cliente), *Channel Subscription/Unsubscription* (registar ou cancelar cliente no broker), *Channel Content Delivery* (efectuar *broadcast* de uma mensagem para um canal ou serviço) e o *Target Check* (validar operador do cliente). As sete interfaces do Callcenter são: *Device Information* (obter dispositivo do cliente), *Device Change* (alterar dispositivo do cliente), *Event List* (obter todos os eventos do cliente), *Subscription Information* (obter todos os eventos de subscrição do cliente), *Send Last Content* (reenviar conteúdo ao cliente), *Subscription* (registar cliente num serviço) e Unsubscription (cancelar cliente de um serviço).

Na análise de requisitos do sistema existiram vários factores que foram levados em conta, o primeiro foi os requisitos do broker, que exige que um certo número de interfaces e serviços sejam implementados e fornecidos pela TIM w.e., para que seja possível iniciar a actividade comercial por estas interfaces. O segundo requisito têm a ver principalmente com as interfaces de troca de mensagens com o broker, estas interfaces foram implementadas seguindo o modelo de integração de novas ligações na plataforma já existente, de modo a que todos os serviços que funcionam nesta continuam a ser compatíveis e possam utilizar as novas interfaces. O facto de existir um modelo de integração levou a que tenha sido decidido á priori como as interfaces iriam ser implementadas pois isto influencia directamente todo o desenho do sistema.

Todo o desenho do sistema está descrito pormenorizadamente no relatório em inglês do projecto, desde os diagramas de caso de uso, descrição de casos de uso, diagramas de actividade, classes e sequência.

Neste projecto estiveram envolvidos cinco elementos da equipa de *operation development* do Brasil. A equipa deste projecto foi constituída por um gestor de projecto, um *tester*, um arquitecto de sistemas e dois programadores, exceptuando os programadores os restantes recursos não estão alocados a este projecto a tempo inteiro, e os programadores sempre que foi necessário efectuar outros desenvolvimento foram alocados temporariamente a outras tarefas.

Neste projecto foi utilizado varias tecnologias e ferramentas. Como linguagem de codificação foi utilizado java e em especial *servlets* java. Foi ainda utilizado algum Oracle SQL para acessos

à base de dados. Como ferramentas foi utilizado o *Apache Tomcat* como servidor aplicacional, *maven 2* para a gestão do projecto e SVN para controlo de versões dos ficheiros.

A fase de testes de desenvolvimento e integração foi efectuada pelo *tester* da equipa. Nesta fase o *tester* tem maior influência nos testes de desenvolvimento onde são aplicados testes de caixa negra e de caixa branca. Após a aplicação passar estes testes com sucesso e garantindo todos os requisitos é colocada em produção aqui será o broker que irá validar o correcto funcionamento das interfaces.

Após a implementação do sistema existiram apenas pequenas correcções pontuais que eram espectáveis.

Conclusões

Todo o desenvolvimento correu como esperado e dentro dos prazos estabelecidos. Actualmente o serviço fornece mais de um milhão de clientes, recebe mais de cinquenta mil mensagens por dia e envia mais de um milhão.

Devido ao facto do projecto ter alocado recursos em áreas bastante especificas e com objectivos definidos permitiu no geral melhorar todo o processo de desenvolvimento. O *tester* conseguiu assegurar que quando o broker efectuava os testes em produção a maioria das interfaces era aprovada na primeira tentativa.

Apesar de tudo ter corrido como esperado seria possível melhorar o sistema actual pois actualmente este tipo de integrações estão muito limitada á plataforma em que assenta e esta nem sempre se adapta da melhor maneira as necessidades de cada broker ou operador. Uma das soluções poderá passar por num futuro próximo adaptar toda a plataforma e os vários módulos á tecnologia EJB, isto iria permitir que cada módulo tivesse mais liberdade em relação á plataforma.

Este projecto e o trabalho nos vários produtos da TIM w.e. ensinaram-me novas tecnologias, ferramentas e métodos de trabalho que serão bastante úteis para a minha carreira. Estar numa empresa que está em constante crescimento oferece bastantes desafios e oportunidades para aprender e estar á frente no desenvolvimento de novos produtos e serviços.

Bibliography

Abramson, I., & Abbey, M. (2004). *Oracle Database 10g: A Beginner's Guide.* Osborne ORACLE Press Series.

Chopra, V., Bakore, A., Eaves, J., Galbraith, B., Li, S., & Wiggers, C. (2004). *Professional Apache Tomcat 5.* Wrox.

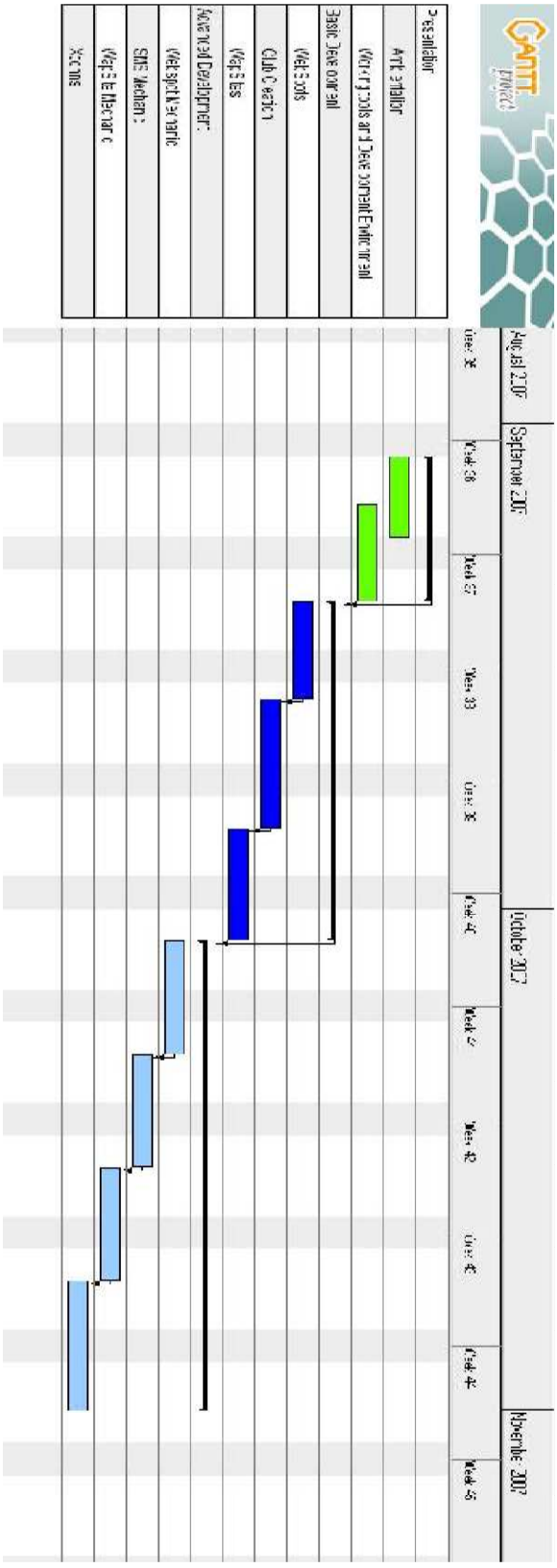
Massol, V., & O'Brien, T. (2005). *Maven: A Developer's Notebook.* O'Reilly.

Nunes, M., & O'Neill, H. (2004). *Fundamental de UML 4ª Edição.* FCA.

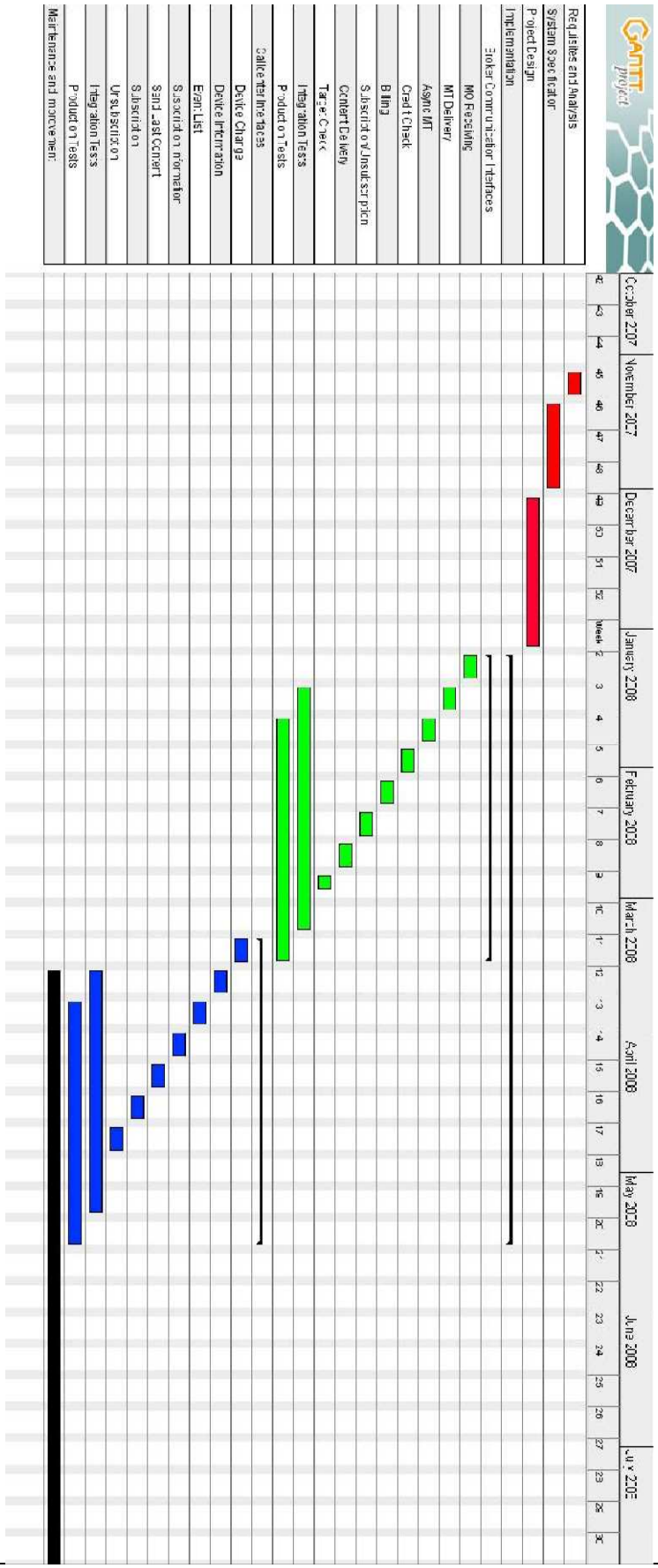
Perry, B. (2003). *Java Servlet & JSP Cookbook.* O'Reilly.

Robinson, M., & Finkelstein, E. (2004). *Jakarta Struts for Dummies.* For Dummies.

Annex 1



Annex 2


GANTT project
Requisites and Analysis
System Specification
Project Design
Implementation
Broker Communication Interfaces
MO Receiving
MT Delivery
Async MT
Credit Check
Billing
Subscription/Unsubscription
Content Delivery
Target Check
Integration Tests
Production Tests
Callcenter Interfaces
Device Charge
Device Information
Event List
Subscription Information
Send_sat Connect
Subscription
Subscription
Unsubscription
Integration Tests
Production Tests
Maintenance and improvement
October 2007
November 2007
December 2007
January 2008
February 2008
March 2008
April 2008
May 2008
June 2008
July 2008
Week