

# **Mestrado em Engenharia Eletrónica e de Computadores**

## **Gestão de Projetos de Engenharia**

**Base Station in Graciosa**

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1. Introduction.....	3
2. Island and Base Station's Location .....	4
2.1. Location Selection Criteria.....	4
2.2. Island's Characterization .....	4
2.3. Description of the Base Station Location .....	5
3. Project Planning .....	5
3.1. Project Scope .....	5
3.2. Objectives.....	6
3.3. Stakeholders.....	6
3.4. Project Manager .....	6
3.5. Quality Control.....	7
3.6. Risk Assessment.....	7
3.7. Contingency Plan .....	8
3.8. Breakdown Structure.....	8
3.9. Communication Plan .....	8
3.10. Responsibility Assignment Matrix .....	9
3.11. Gant Chart .....	9
3.12. Resource Allocation .....	10
3.13. Pert Diagram.....	10
3.14. Cost Analysis.....	10
4. Final Regards .....	11
Annex.....	12 to 26

## 1. INTRODUCTION

This project was carried out in the context of a group evaluation in the Engineering Project Management, in the Master's degree in Electrotechnical and Computer Engineering at the Technical Superior Institute, guided by Professor Tania Ramos, Luís Correia and Rui Abrantes.

Currently, the use of mobile devices (mobile phones, laptops, tablets) have become quite present both in voice communication and Internet access for sending and receiving data. In this context operators need to provide conditions for good quality of service and experience on the part of the customer, not only in densely populated regions, but also in regions with fewer inhabitants. To achieve this goal, base stations need to be implemented in remote regions, such as islands with population density below 100 pop. /km<sup>2</sup> each covering approximately an area of 50 km<sup>2</sup> on flat ground.

This project consists in the installation of a telecommunications base station in Graciosa island in the Azores. With the knowledge acquired in the curricular unit the group will implement a series of practices and methodologies, wanting the success of the installation of telecommunications infrastructures and the correct functioning of them.

The project management was carried out based on the bibliography of the curricular unit namely the book *A Guide to the Project Management Body of Knowledge (PMBOK Guide)*. For good planning and organization of the installation was used the Microsoft project computer software.

## **2. Island and Base Station Location**

### **2.1 Location Selection Criteria**

As is common knowledge, in the islands access to certain resources and technologies is limited due to their geographical conditions. In view of the technological developments and the needs associated with this, the need to create new base stations arose and, due to their evades costs, with the optimized positioning of a base station. In this way, it seeks to provide and meet all needs, in the area of telecommunications that Portugal requires in the 21st century. ANACOM, Portugal's regulatory authority for postal communications and electronic communications, is focused on providing a quality service in the Azores Archipelago.

Our project team decided to build a base station on Graciosa island. This choice was made based on strategic positioning in order to provide better service and have a better signal coverage network, being sustained in the following reasons:

- ANACOM identified the need to amplify the telecommunications network in the autonomous region of the Azores in order to provide coverage to provide customers with reliable service throughout arch vogue.
- Due to the positioning of Graciosa Island, it is concluded that the installation of a base station on this island in the face of the requirements presented by our client.
- It was also considered by our team the fact that Graciosa Island has a pioneering energy system, hybrid energy system with about 65% of electricity from renewable energy sources.

### **2.2 Characterization of the island**

The island of Graciosa is a Portuguese island located in the central region of the Azores archipelago. This archipelago divided into three regions, the eastern, central and western region. The eastern region includes the island of São Miguel and the island of Santa Maria. The central region is contiguous by the Graciosa, Horta, Terceira, Pico and São Jorge islands and the western region by the Flores and Corvo islands.

Graciosa Island is situated 37km northeast of the island of São Jorge and 60km northwest of Terceira. It has an area of 60.66 Km<sup>2</sup> and because it is from the least mountainous islands it has a maximum altitude of 405 meters. It is an island with just over 4400 habitants, and most are concentrated in the village of Santa Cruz da Graciosa. Thus, this island has a population density of 70.5 habitants/km<sup>2</sup>.

## 2.3 Description of Base Station Location

After a geographical, topographic and economic analysis we identified the location with the highest potential for the base station. – Fig.1.

This site has several characteristics that support the potential of this location for the base station as the lack of an efficient telecommunications network system and a population density that checks the minimum criteria for installing a base station. In addition, this area complies with the legal conditions for installing a base station. Conditions such as the environment, health and safety.

In Fig.1 is presented the selected location is situated in the Santo Amaro, in Graciosa. The reasons why this was the right place to build our base station was because we wanted to maximizing coverage of the new telecommunications system in this Island.

After select the right location was defined an area with dimensions of 300m by 300m, including the safety zone during the work process and that the side of this square must be equal to or greater than twice the tower height. In order to have the right location were defined some criteria's as land price, accessibility to the site and an electrical grid infrastructure.

## 3. Project Planning

### • 3.1 Project Scope

This work was designed to divide the scope of the project into two different areas, one focused on the scope of the project and the other on the final product (base station).

In order to ensure a well-structured and defined project, an initial approach is required, followed by planning, execution, monitoring, control and an outcome. ANACOM's project department follows certain rules in A Guide to the Project Management Body of *Knowledge (PMBOK® Guide) - Fifth Edition*. In this way, the scope of the project follows the sequence established in PMBOK, section 3.9, page 61.

The product to be developed will be two Base Stations for ANACOM, on Graciosa Island. The construction of this infrastructure is divided into different parts. A first approach to the situation will be the choice of places where to place stations followed by the design or choice of a station already previously designed. It is necessary a careful polling to assemble a structure that ensures a reliable supply of goods and services at bearable prices to the company (as cheap as possible). It is then important to set up and install the Base Station in order to agree with the rules laid down by ANACOM, as well as in the region in question. Finally, after the resolution of the goals previously set out the station should be finished, in full function, the place cleaned and organized so that the project has had the least possible environmental impact.

- **3.2 Objectives**

The main objective of this project is to contribute to the whole country, including more isolated areas, such as Graciosa Island, to obtain the most benefit in terms of choice, price, quality and safety in mobile communications through active regulation and promoting efficient investment, facilitating infrastructure sharing and ensuring fair and dynamic competition.

The maximum protection of the rights of telecommunications users, in particular to the most vulnerable areas, by promoting a regulatory framework that prioritizes information with transparency, discourages and sanctions bad practices. Internally the completion of this project should increase the market share of our project team from 0% to 5% in the Azores region with the potential of expanding in the following 3 years to the rest of the islands. The implementation of this project should serve as an introduction and learning for an eventual insertion in the Portuguese market with the main objective of supporting a bridge between the most rural and isolated areas to the rest of the country.

- **3.3 Stakeholders**

Stakeholders (or interested parties) describe a particular group of people or companies that have an interest in the company and may or may not have made an investment. It is succinctly a group of people who legitimize the actions of an organization and play a direct or indirect role in the management and results of that same organization. Thus, a stakeholder can positively or negatively affect a company, depending on its policies and form of action, being crucial the research of the correct stakeholders in order to make the most of the company.

There are two types of stakeholders, internal and external. The interns are the intermediaries and surrounding people inside the company. The external, are a consortium outside the company committed with the project in one way or another, for example, subcontracted companies.

- **3.4 Requirements**

The list of the main Stakeholder's and their obligations are presented in Annex B. The requirements were established with conversations with the different parties involved reaching up to a legal agreement with each one of the stakeholders demanding the execution and completion of each task assigned.

The company decided to not overburden the stakeholders so that they could perform their tasks with high quality standards and in a way that wouldn't be necessary any main time schedule restructuration, with a final purpose of achieving general satisfaction between the stakeholders.

- **3.5 Project Manager**

The assignment of the project manager designates an individual capable of defining the project and developing the schedule and budget.

Defining the project means understanding and obtaining agreement on the objectives, scopes, risks, approach, etc., also includes defining and adopting a specific project management plan that will be used to manage the project in question. By applying these directives to this project, the project manager will be responsible for managing different tasks in the different working groups, always being aware of the timing and quality of each task to be designated, such as communication, cooperation between departments and ensure that the work is completed during the established time goals.

- **3.6 Quality Control**

In project management, quality control requires the project manager and the project team to ensure and inspect the quality of the work and guarantee a high standard to the final result, while ensuring it's alignment with the project scope.

The quality management plan for this project relies on the internal stakeholders and mostly on the external stakeholders, since most of the services are outsourced, so the main preoccupation is that the companies that are subcontracted must be able to be in accord with the high standards of our company. So, the subcontracted companies should comply with our quality regulation, requirements, standards and deadlines.

The beginning in establishing a good quality management plane starts with acknowledging and identifying the customers requirement, because it is crucial for the development of our company keeping the costumer satisfied instead of just working one time with that client it is much more likely that the client in question will hire our company for a future job. Also, there is a need to comply with the different stakeholders' requirements and quality intended for the project, so there are more implications besides what the costumer pretends. This implication might represent risks in the management plan such as schedule delays and cost increases.

Our company believes that the cost-benefit of working in a high standard environment it eventually pays off. Comparing the benefits against the cost increases of a good quality control plan the company ends up with less rework, higher stakeholder's satisfaction customer satisfaction, higher team moral and finally, increased profitability. There should be an equilibrium between the increased costs and the quality control in order to maximize the company profit as well as customer satisfaction.

Some quality requirements have been identified for the building of this base station such as the client demands as the requirements provided by the local population of Graciosa which could be affected by the construction and landscape impact of this to a base stations and different requirements by the stakeholders these different requirements are identified in Gantt chart. The Gantt chart isn't a static document, it's something that should be updated as eventually the project moves on, in order to meet everyone's expectation and requirements.

### • 3.7 Risk Assessment

In project planning, there should always exist a well-structured and carefully thought plan of what the risks of the project development might be. Risk assessment is the combined effort of identifying and analyzing potential events that may impact the different components of the project in a negative way like timing, stakeholder's, etc., and making a careful judgement on how tolerable are the risks and if there are worth or not to pursue with the eventuality of saving the company time and money or losing it.

The project of making a base station can incur on the following risks shown in annex C/D. The main risks identified have been summarized in different categories: financial, technical, operational, schedule, and environmental.

Based on the chapter 11.3 of the PMBOK it was effectuated a qualitative analyzes of the risks inherent to the project and it's shown on C.Annex. This analysis allows to link up the different risks with the probability of them happening and the real impact they have on the project.

### • 3.8 Contingency Plan

A contingency plan is devised for an outcome that isn't expected in the project plan. For this project our team elaborated for each risk a contingency plan with the objective of preventing and mitigating the effects of other risks associated with the project. The plan is sub devised in three categories: (1.) Prevention plan, which is supposed to maximize the project protection to any negative impacts; (2.) Mitigation plan, which is supposed to mitigate the probability of certain risks occurring in the development of the project; (3.) Transfer plan, which tries to prevent the spreading of each risk to any third-party. The Risk Matrix and the Contingency Plan are represented in the annex C/D.

### • 3.9 Work Breakdown Structure

After consulting the PMBOK, we find in Chapter 5, the Work Breakdown Structure, which is demarcated as a hierarchical breakdown of the overall scope of work designed by the project team to achieve the proposed objectives and deliverables or agreed upon projects. the project team and the client. It is sorted in descending order, that is, each descending level of the Work Breakdown Structure represents an ever-deeper definition of the project. This is a crucial step at the project level because it allows for a more structured view of what must be delivered to the customer and allows for a clearer view of the scope of the project. Consequently, it facilitates the distribution of tasks within the project team. It must be organized, complete and as short as possible to facilitate project measurement and not to be an obstacle to its realization. To elaborate the WBS was required communication with stakeholders and, as a dynamic structure, is in constant changes. Our team project provided a task plan and task distribution that will be performed phase by phase during the project. These phases are defined as chronologically:

- **Conception:** Was defined the location to the installation of base station and defined the main concepts and ideas of all entire project;
- **Procurement:** Performed all activities of outsourcing;



- **Execution:** Performed all technical activities as antenna construction;
- **Final considerations:** Performed all control, evaluation, testing tasks to the equipment and structures to verify their operation and compliance, as well as the efficiency of the implemented conditions.

The attach G defines the WBS performed to our project and attach M defines the WBS definition from PMBOK of each task.

### • 3.10 Communication Plan

The Communications Plan defines the means by which the information necessary for Project implementation is widespread among the various stakeholders. The communications plan may divide into internal and external and were created after defining the WBS to analyse how the communication should be for each task.

An external communications plan was created to define the communication sources used to contact with external entities participating in the project as ANACOM and municipalities. This communication has a more formal character and therefore the most suitable are email and phone contact. There is contact through meetings scheduled to discuss the main and crucial aspects of certain steps. Is presented in attachment F the external communications plan, indicating the entities contacted, the means used and frequency.

The internal communication plan is how the information is shared between all departments of our project team, between managers and project leader. In order to provide a flowing communications tools as internal informatics network, email, videoconference. Also, repository tools are important to provide the right information for each level of project responsibility. Meeting is also an important tool as are a method that allows to concentrate in the same environment representatives of the departments for informal information sharing and some decision making. At the Annex F is the internal communications plan, indicating the type of communication, frequency and means used by internal departments.

### • 3.11 Responsibility Assignment Matrix

The Responsibility Assignment Matrix is he schema that represents the participation by various roles in finish tasks or deliverables for the project that are defined in work breakdown structure. Is attributed a responsibility to each worker that works on that task in 4 different levels: Responsible, Accountable, Consulted, and Informed. These 4 different attribution levels of responsibility are defined in chapter 9 of PWBOK. Was defined a definition for each level by our project team.

- **Responsible** is who approve the execution of task;
- **Accountable** is who supervises the task;
- **Consulted**, is who is consulted in case of moment decisions;
- **Informed** is who should be informed about the task;

- **3.12 Gant Chart**

The Gant chart was built on the WBS of this Project. The first step was to define the limit date for the project that is presented in the project charter, among other documents, and also, in the project calendar, nonworking days (Christmas holidays, New Year's Eve, New Year's Day, Easter holidays and Carnival holidays). The software that was used for this step was MS Project (Student Version). Afterwards we did the translation of the WBS to MS Projects defining the predecessors and summaries of the activities (corresponding to the WBS elements). All the tasks were created like automatically Scheduled, without monitoring and control tasks, which were created through recurring tasks. The duration of this process would be of almost 176 days. It would have to start on 20/05/2019 and the forecast is that it would be finished before the date of 20/01/2020.

- **3.13 Resource Allocation**

It's necessary to insert the resources in MS Project, defining their income rate per hour, and after that, using the RAM as reference, we can do the allocation of resources to the activities in the Gantt. The Project team also request services from external entities like logistics, installation and assembling, and also buying components that are used by these entities. Therefore, they are fixed costs that are incurred to at a single point in time, but they aren't taxed in a time basis.

Once we have all the resources properly identified (PT rejects the hypothesis of workers working overtime) it's possible to allocate them to the respective activities; the fixed costs are respective to a specific activity and the RAM defines the allocation of workers to activities.

- **3.14 Pert Diagram**

PERT diagram, is a project management tool used to schedule, organize and coordinate tasks within a project. It provides a graphical representation of a project's timeline that allows project managers to break down each individual task in the project for analysis.

The main activity done through the PERT was to define the critical path; fortunately, MS Project is endowed with a function that highlights the critical path. It's the critical path which determines the duration of the Project, and obviously, no delay can be allowed in the activities that are included in this path.

- **3.15 Cost Analysis**

Cost analysis is the process of examining the cost of doing something in order to make comparisons and to plan for the future.

The cost analysis is concerned with determining money value of inputs (labor, raw material), called as the overall cost of production which helps in deciding the optimum level of production. And is for that why estimating costs is essential to control the need of resources. There are several cost concepts relevant to the business operations and decisions, but, in our case. the 3 main things were planning, managing and control.

To control this process the project team will adopt a technique for measure project performance and progress using an EVM approach, which provides an accurate forecasts of project cost performance issues, which is an important contribution for project management, but also provides us with a good point of view of the trade (between scope, duration and costs).

The cost variance is another indicator used by the team during the Project, and the definition would be the difference between the actual expenses incurred and the standard expenses estimated at the beginning of a period. If this indicator is negative it means that the team is over Budget. The cost analysis graph is presented in annex L.

## 4. Conclusions

The planning of this project allowed this group to learn and reflect about the complexity and details of a well-structured project. We discovered new tools, like MS Project, and the vast structure that is needed to make an idea into something concrete.

A lot of the time was spent dialoging with the stakeholder's, a usually complicated and time-consuming task which was made easier by our well-organized communication structures.

The decisions made along the way were base in two distinct sources: the PMBOK, the Critical Chain. Although the content in this source is theoretical, it can be easily relatable and applied into real life problems and facilitates a step by step method on how to actually do next in a project, making it easier and organized.

Our Company would like to highlight that this was our first project and we hope that the results speak for themselves, transferring the final work to our high standards of quality. We hope that the Graciosa locals enjoy their new service, and we also hope that the whole process was the least evasive possible.

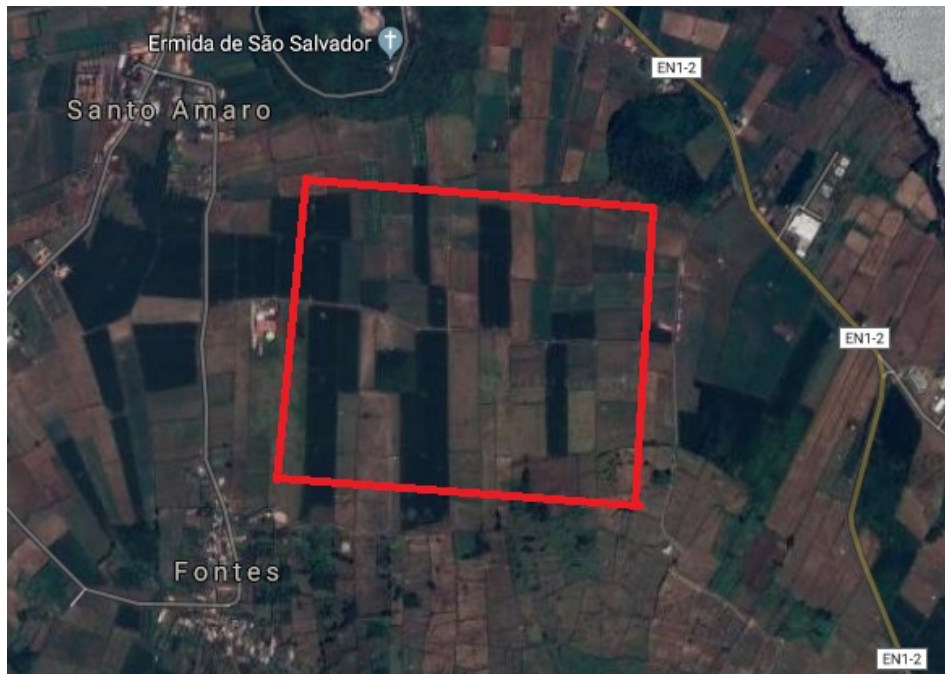
### References:

Slides of the Theoretical Classes of Management of Engineering Projects(1º Semester 2015/2016);

PMI (2013), A Guide to The Project Management Body of Knowledge (PMBOK Guide), 5th Edition.

GOLDRATT, Eliyahu (1997), Critical Chain, 1st Edition.

## A. Annex –Second Chapter



*Picture 1- Base Station Location*

## B. Annex – Third Chapter/ Requirement

	Resource Name	Number of people	Cost per person/ service
<b>Internal Departments</b>	Project leader	1	100€/hora
	Radio Department	7	80€/hora
	Regulation Department	1	80€/hora
	Management Department	3	80€/hora
	Law Department	2	80€/hora
	Buying Department	2	40€/hora
	Marketing Department	2	40€/hora
<b>Contracted External Entities</b>	Location Owner	-	5000€/service
	Constructor	-	3440€/service
	Energy Supplier	-	1200€/service
	Equipment Supplier	-	9000€/service
	Link Supplier	-	1200€/service
	ANACOM	-	-
	Town hall	-	-
	Police force	-	2720€/service
	Equipment Transportation	-	420€/service

	Resource Name	Requirements
<b>Internal Departments</b>	Project leader	Make sure the project is flowing the right way and take the necessary actions.
	Radio Department	Take care of the technology and quality of the Base Station
	Regulation Department	Make sure everything is made by the standards of ANACOM
	Management Department	Make sure the project is running smoothly and according to schedule
	Law Department	Take care of all legal actions due to the project
	Buying Department	Link up with the suppliers and take care of all purchases
	Marketing Department	Take care of all marketing issues due to the project
<b>Contracted External Entities</b>	Location Owner	Agree with the contract proposed by our team
	Constructor	Take care of the Base Station installation
	Energy Supplier	Make sure the Base Station has a durable and reliable energy source
	Equipment Supplier	Supply the equipment necessary for the Base Station
	Link Supplier	Supply other necessary components to the project
	ANACOM	Compliance with the criteria to radio communication composed by the regulations number 86/2007, 609/2011 and 256/2009, and by the rectification number 1261/2007.
	Town hall	Give permission and local guidance for the project execution
	Police force	Facilitate the access to the sites and take care of security in the site
	Equipment Transportation	Make sure the equipment is safely transported to the site

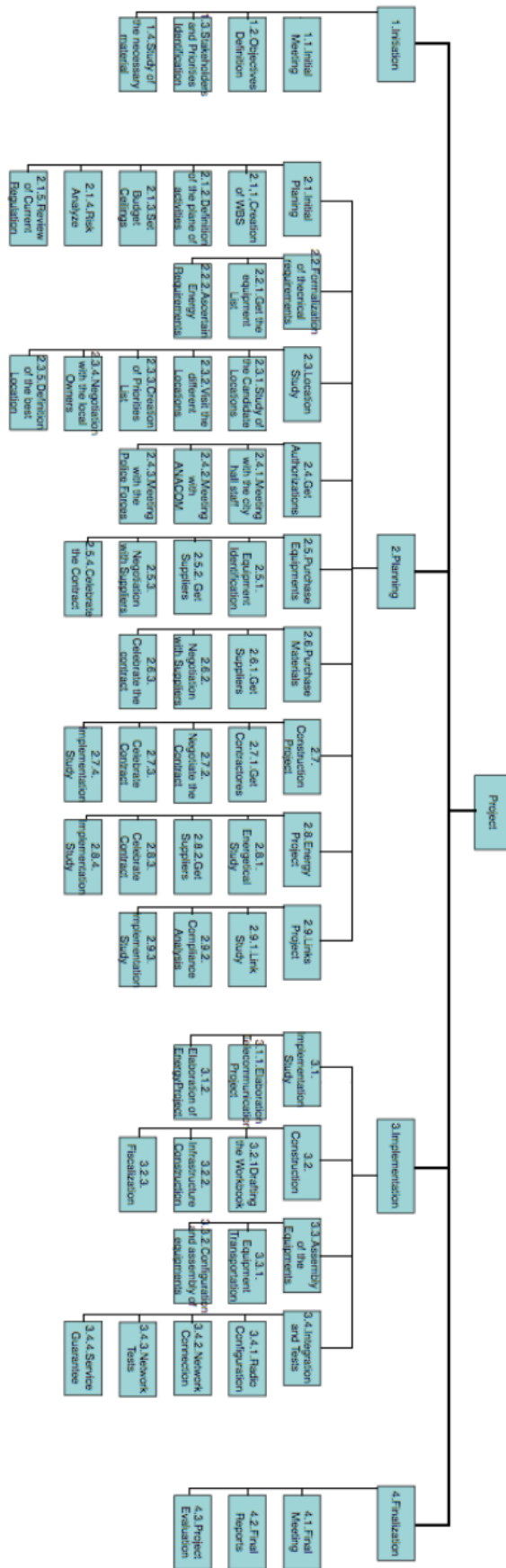
## C. Annex – Risk Matrix

	Risk Description		Qualitative Risk Analyses		
			Probability	Impact	Contingency Plan
Internal Risks	1	Lack of communication between departments and project leader	Low	Medium	Prevention Plan: Create a centralized platform where all information is gathered and that allows an easy communication between the different workers
	2	Errors committed by de engineering Department in terms of project design and technology	Low	Medium	Mitigation Plan: Once the error is detected make sure it's quickly resolved
External Risks	3	Bad weather and cold/hot temperatures	Medium	Medium	Mitigation Plan: Make sure you predict the weather and establish a schedule around it.
	4	Delays in authorization response by ANACOM	Medium	High	Mitigation Plan: Get in contact with the entities and make sure they speed up the process
	5	Delays in authorization response by the City Hall	High	High	
	6	Prohibition of the exploration site chosen in Graciosa island	Low	High	Mitigation Plan: It should exist a list of different backup sites
Internal Risks	7	Low quality equipment's delivered by the suppliers	Low	High	Prevention Plan: Make sure you test the equipment before you buy it from a trustworthy supplier
External Risks	8	Delay's in the delivery of the equipment's by the suppliers	Medium	High	Transfer Plan: Make sure in the contract that there is an indemnity clause ensuring the product delivery
	9	Delay's in dialogue with suppliers	Low	Low	Prevention Plan: Ask budgets and other information to multiple companies
	10	Delay's in work site regarding the construction of the Base Station	Low	Medium	Prevention Plan: Make financial and motivational bonus for the workers
	11	Delay's in equipment transport to Graciosa by the deliver company	Medium	Medium	Transfer Plan: Make sure in the contract that there is an indemnity clause ensuring the product delivery
	12	Base Station badly assembled by the workers	Low	High	Prevention Plan: Make regular and tight inspections throughout the project

## C. Annex - Probability Matrix

Risk Probability	Risk Impact		
	Low	Medium	High
Low	9	1,2,10	6,7,12
Medium	-	3,11	4,8
High	-	-	5

## E. Annex - WORK BREAKDOWN STRUCTURE (WBS) DO PROJETO





## F. Annex – INTERNAL AND EXTERNAL COMMUNICATION PLAN

Type of communication	Description	Frequency	Comunnication methods
Initial meeting	Meeting with all project departments to present and define its scope.	Unique	In-person
General meeting	Meeting to find out the state of the various project phases	Unique	In-person or video conferencing
Specific meeting	Meeting between certain departments to define aspects related to a specific phase of the project.	When required	In-person
Final meeting	Meeting with all project departments to close the project.	Unique	In-person

Externa Entities	Characterization	Communication method
Local proprietary	Negotiations and contract conclusion to define the venue	In-person, Email and Phone
ANACOM	Notification to the telecommunications regulatory body	Email and Phone
Tower Hall	Requirement of authorizations for the execution of the project.	In-person, Email and Phone
Shipping Company	Conclusion of the equipment transportation contract.	In-person, Email and Phone
Company Building	Conclusion of the infrastructure construction contract.	In-person, Email and Phone

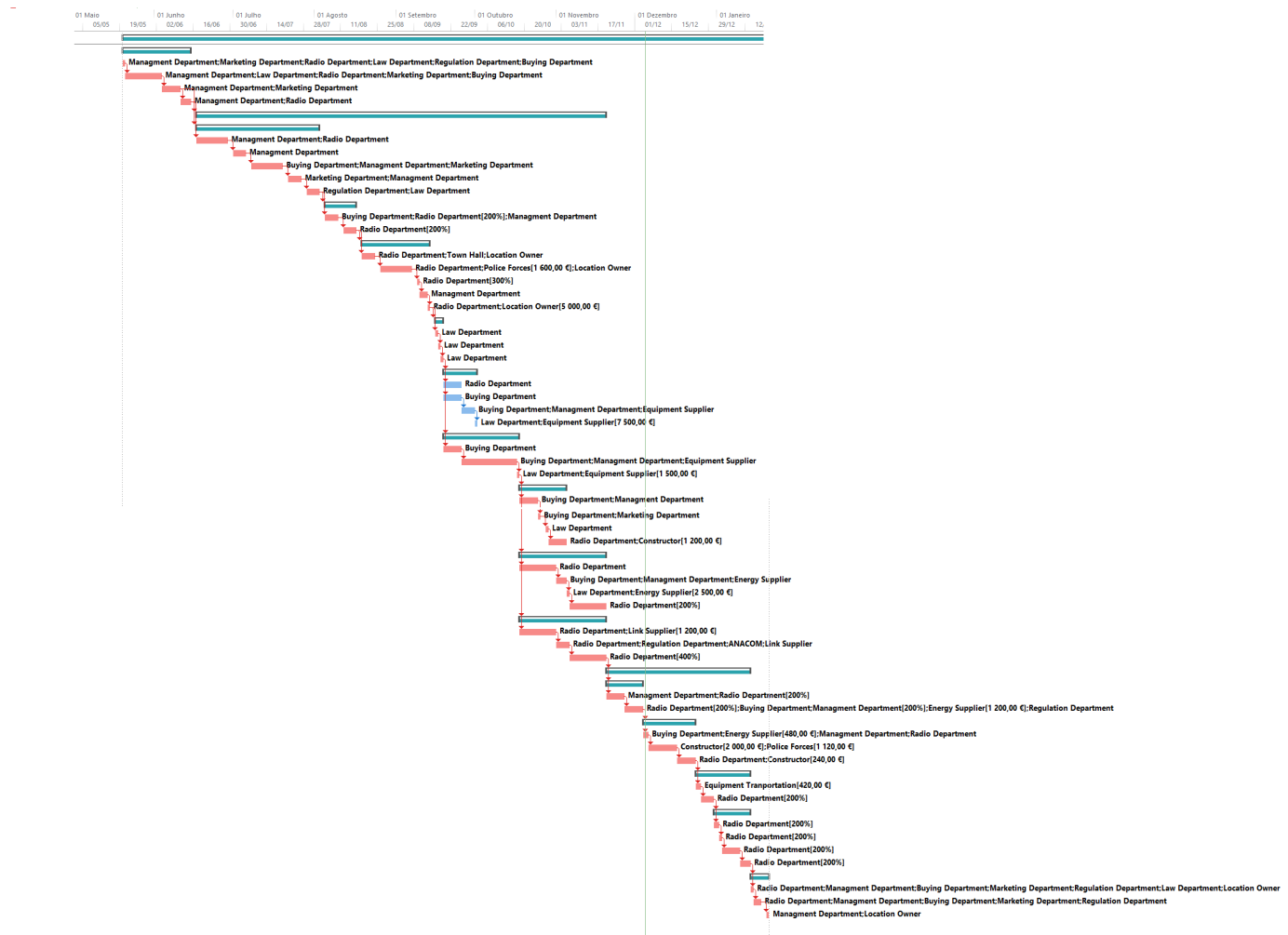
## G. Anexo - Matrix of responsibilities

	Internal Stakeholders							External Stakeholders								
								Subcontracted External Entities							External Entities Not Contracted	
Assignment	Project leader	Radio Department	Regulation Department	Management Department	Law Department	Buying Department	Marketing Department	Location Owner	Constructor	Energy Supplier	Equipment Supplier	Link Supplier	Equipment Transportation	Police force	ANACOM	Town hall
<b>1-Project Initiation</b>																
1.1- Initial Meeting	A	R	R	R												
1.2- Objective and requisition Definition	A			R		R	R									
1.3- Stakeholders identification and Priorities	A			R			R									
1.4- Study of the necessary material	A	R				R										
<b>2- Project Planning</b>																
<b>2.1.- Initial Planning</b>																
2.1.1- Objective Definitions and Creation	A	R		R												
2.1.2- Definition of the plane of activities	A	R		R												
2.1.3- Set Budget ceilings	A															
2.1.4- Risk Analyze	A															
2.1.5- Review of current Regulation	A		R	R												
<b>2.2- Formalization of technical requirements</b>																
2.2.1-Get the Material Letter and equipment list	A	R				R										
2.2.2-Ascertain Energy Requirements	A	R								C						
<b>2.3-Location Study</b>																

2.3.1-Study of the Candidate Locations	A	R						C	C							
2.3.2-Visit the different Candidates Locations	A	R		R				C	C							
2.3.3-Creation of the Priorities List	A	R		R												
2.3.4-Negotiation with the local Owners	A			R				C	C							
2.3.5-Definition of the best Location	A								C							
<b>2.4-Get Authorizations</b>																
2.4.1- Meeting with the city hall staff	A			R												C
2.4.2-Meeting with the ANACOM	A			R											I	
2.4.3-Meeting with the Police Forces	A			R										C		
<b>2.5-Purchase equipment</b>																
2.5.1-Equipment Identification	A	R				R										
2.5.2-Get Suppliers	A					R					C	C				
2.5.3-Negotiation with the suppliers	A			R		R					C	C				
2.5.4-Celebrate the Contract	A				R											
<b>2.6-Purchase Materials</b>																
2.6.1-Get Suppliers	A	R				R										
2.6.2-Negotiation with the suppliers	A	R		R		R					C	C				
2.6.3-Celebrate the Contract	A				R						C	C				
<b>2.7-Construction Project</b>																
2.7.1-Get contractors	A					R										
2.7.2-Negotiate the Contract	A			R		R										
2.7.3-Celebrate Contract	A				R											
2.7.4- Implementation Study	A															
<b>2.8-Energy Project</b>																
2.8.1-Elaborate the Energetical Study	A	R				R				C						
2.8.2-Get Suppliers	A	R		R		R				C						

2.8.3-Celebrate Contract	A				R					C						
2.8.4-Implementation Study	A	R														
2.9-Links Project																
2.9.1-Link Study	A	R														
2.9.2-Compliance Analysis	A	R		R												
2.9.3-Implementation Study	A															
3-Implementation of the Project																
3.1-Implementation Study																
3.1.1-Elaboration of the Telecommunication Project	A	R														
3.1.2-Elaboration of the Energy Project	A	R														
3.2-Construction																
3.2.1-Drafting the Workbook	A	R							C							
3.2.2-Infrastructure construction	A								C							
3.2.3-Fiscalization	A			R					C							
3.3-Assembly of the equipment																
3.3.1-Equipment Transportation	A	R											C			
3.3.2-Configuration and assembly of the equipment	A	R														
3.4-Integration and test																
3.4.1-Radio configuration	A	R														
3.4.2-Network connection	A	R														
3.4.3-Network tests	A	R														
3.4.4-Service guarantee	A	R														
4- Project Finalization																
4.1-Final Meeting	A	R	R	R	R	R	R		C	C						
4.2-Final Reports	A	R	R	R	R	R	R									
4.3-Project Evaluation	A	R	R	R	R	R	R									

## H. Annex- GANTT Diagram



## I. Annex- Initial Scheme of the project in MS

		Nome do Recurso	Tipo	Unidade do	Iniciais	Grupo	Unidade Máx.	Taxa Normal	Taxa Trab.	Custo/Utiliz.	Acumulado	Calendário base	Código	dicionar Nova Color
1		Project leader	Trabalho		Leader		100%	100,00 €/hr	0,00 €/hr	0,00 €	Rateado	Padrão		
2		Radio Department	Trabalho		Radio.E.S.		700%	80,00 €/hr	0,00 €/hr	0,00 €	Rateado	Padrão		
3		Regulation Department	Trabalho		Reg.D.		100%	80,00 €/hr	0,00 €/hr	0,00 €	Rateado	Padrão		
4		Managment Department	Trabalho		Mang. D.		300%	80,00 €/hr	0,00 €/hr	0,00 €	Rateado	Padrão		
5		Law Department	Trabalho		Law. D.		200%	80,00 €/hr	0,00 €/hr	0,00 €	Rateado	Padrão		
6		Buying Department	Trabalho		Buying.D.		200%	40,00 €/hr	0,00 €/hr	0,00 €	Rateado	Padrão		
7		Marketing Department	Trabalho		Market.S.		200%	40,00 €/hr	0,00 €/hr	0,00 €	Rateado	Padrão		
8		Location Owner	Custo		Owner						Rateado			
9		Constructor	Custo		Const.						Rateado			
10		Energy Supplier	Custo		Energy. S.						Rateado			
11		Equipment Supplier	Custo		Equip. S.						Rateado			
12		Link Supplier	Custo		Link. S.						Rateado			
13		ANACOM	Custo		ANACOM						Rateado			
14		Town Hall	Custo		Municip.						Rateado			
15		Police Forces	Custo		Polic.						Rateado			
16		Equipment Transportation	Custo		Transp.						Rateado			

## J. ANNEX - TABLE OF PRECEDECES.

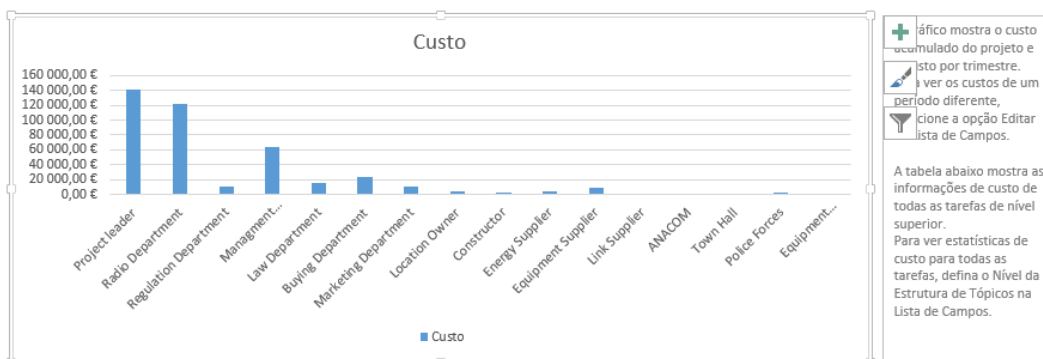
ID	Task name	Time	Precedence	Cost
<b>1</b>	<b>Project</b>	<b>176 day</b>		<b>414 760,00 €</b>
<b>2</b>	<b>Project Initiation</b>	<b>20 day</b>		<b>38 720,00 €</b>
3	Initial Meeting	1 day		3 200,00 €
4	Objective and requisition Definition	2 weeks	3	25 600,00 €
5	Stakeholders identification and Priorities	1 week	4	4 800,00 €
6	Study of the necessary material	4 day	5	5 120,00 €
<b>7</b>	<b>Project Planning</b>	<b>112 day</b>	<b>5</b>	<b>182 740,00 €</b>
<b>8</b>	<b>Initial Planning</b>	<b>35 day</b>	<b>6</b>	<b>40 000,00 €</b>
9	Objective Definitions and Creation of WBS	2 weeks	6	12 800,00 €
10	Definition of the plane of activities	1 week	9	3 200,00 €
11	Set Budget ceilings	2 weeks	10	12 800,00 €
12	Risk Analyze	1 week	11	4 800,00 €
13	Review of current Regulation	1 week	12	6 400,00 €
<b>14</b>	<b>Formalization of technical requirements</b>	<b>10 day</b>	<b>13</b>	<b>14 400,00 €</b>
15	Get the Material Letter and equipment list	1 week	13	8 000,00 €
16	Ascertain Energy Requirements	1 week	15	6 400,00 €
<b>17</b>	<b>Location Study</b>	<b>20 day</b>	<b>16</b>	<b>20 680,00 €</b>
18	Study of the Candidate Locations	1 week	16	3 200,00 €
19	Visit the different Candidates Locations	2 weeks	18	8 000,00 €
20	Creation of the Priorities List	1 day	19	1 920,00 €
21	Negotiation with the local Owners	3 day	20	1 920,00 €
22	Definition of the best Location	1 day	21	5 640,00 €
<b>23</b>	<b>Get Authorizations</b>	<b>3 day</b>	<b>22</b>	<b>1 920,00 €</b>
24	Meeting with the city hall staff	1 day	22	640,00 €
25	Meeting with the ANACOM	1 day	24	640,00 €
26	Meeting with the Police Forces	1 day	25	640,00 €
<b>27</b>	<b>Purchase equipment</b>	<b>9 day</b>	<b>26</b>	<b>15 820,00 €</b>
28	Equipment Identification	1 week	26	3 200,00 €
29	Get Suppliers	1 week	26	1 600,00 €
30	Negotiation with the suppliers	3 day	29	2 880,00 €
31	Celebrate the Contract	1 day	30	8 140,00 €
<b>32</b>	<b>Purchase Materials</b>	<b>21 day</b>	<b>26</b>	<b>18 140,00 €</b>
33	Get Suppliers	1 week	26	1 600,00 €
34	Negotiation with the suppliers	15 day	33	14 400,00 €

35	Celebrate the Contract	1 day	34	2 140,00 €
36	<b>Construction Project</b>	<b>12 day</b>	<b>35</b>	<b>10 480,00 €</b>
37	Get builders	1 week	35	4 800,00 €
38	Negotiate the Contract	1 day	37	640,00 €
39	Celebrate Contract	1 day	38	640,00 €
40	Implementation Study	1 week	39	4 400,00 €
41	<b>Energy Project</b>	<b>23 day</b>	<b>35</b>	<b>24 260,00 €</b>
42	Elaborate the Energetical Study	2 weeks	35	6 400,00 €
43	Get Suppliers	2 day	42	1 920,00 €
44	Celebrate Contract	1 day	43	3 140,00 €
45	Implementation Study	2 weeks	44	12 800,00 €
46	<b>Links Project</b>	<b>23 day</b>	<b>35</b>	<b>37 040,00 €</b>
47	Link Study	2 weeks	35	7 600,00 €
48	Compliance Analysis	3 day	47	3 840,00 €
49	Implementation Study	2 weeks	48	25 600,00 €
50	<b>Implementation of the Project</b>	<b>39 day</b>	<b>49</b>	<b>40 980,00 €</b>
51	<b>Implementation Study</b>	<b>10 day</b>	<b>49</b>	<b>16 240,00 €</b>
52	Elaboration of the Telecommunication Project	1 week	49	3 840,00 €
53	Elaboration of the Energy Project	1 week	52	12 400,00 €
54	<b>Construction</b>	<b>14 day</b>	<b>53</b>	<b>7 680,00 €</b>
55	Drafting the Workbook	2 day	53	3 680,00 €
56	Infrastructure construction	7 day	55	3 120,00 €
57	Fiscalization	1 day	56	880,00 €
58	<b>Assembly of the equipment</b>	<b>15 day</b>	<b>57</b>	<b>17 060,00 €</b>
59	Equipment Transportation	2 day	57	420,00 €
60	Configuration and assembly of the equipment	3 day	59	3 840,00 €
61	<b>Integration and test</b>	<b>10 day</b>	<b>60</b>	<b>12 800,00 €</b>
62	Radio configuration	2 day	60	2 560,00 €
63	Network connection	1 day	62	1 280,00 €
64	Network tests	5 day	63	6 400,00 €
65	Service guarantee	2 day	64	2 560,00 €
66	<b>Project Finalization</b>	<b>5 day</b>	<b>65</b>	<b>11 520,00 €</b>
67	Final Meeting	1 day	65	3 200,00 €
68	Final Reports	3 day	67	7 680,00 €
69	Project Evaluation	1 day	68	640,00 €

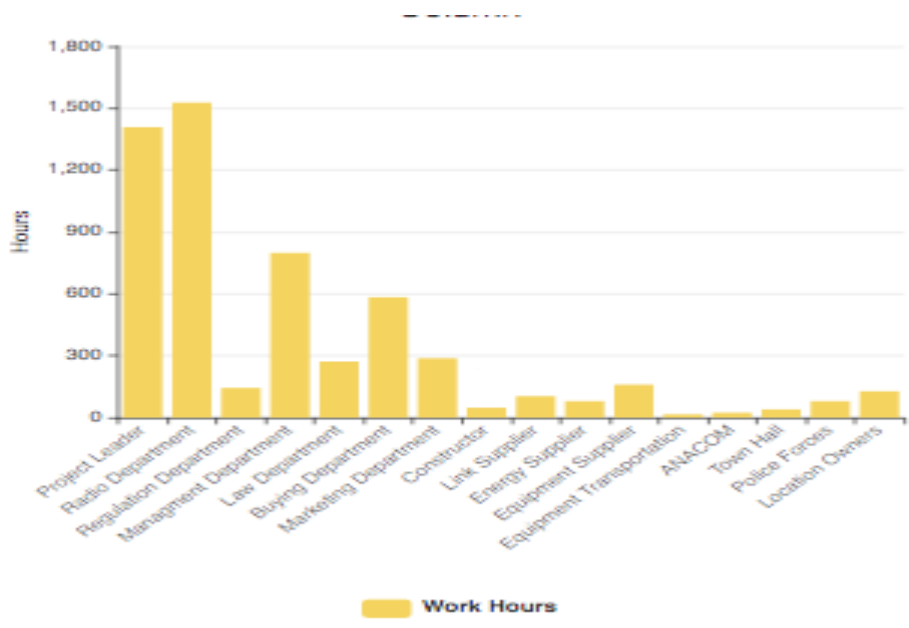
## L. ANNEX– PROJECT CASH FLOW

### FLUXO DE CAIXA

Custo real	Custo da linha de base	Custo restante	Varição de custo
0,00 €	0,00 €	414 760,00 €	414 760,00 €



Nome	Custo restante	Custo real	Custo	CR	COTE	COTA
Project	414 760,00 €	0,00 €	414 760,00 €	0,00 €	0,00 €	0,00 €





## M. ANNEX- WBS DICTIONARY

<b>Tarefa</b>	<b>Descrição</b>
<b>1. Project Initiation</b>	
<b>1.1. Inicial Meeting</b>	Internal meeting with all the departments involved in the Project for the confirmation of the objectives and goals of the Project. Was assigned a day for this because, although some aspects are already defined, this meeting have the goal of giving extra information to the people involved and the clarification of some doubts.
<b>1.2. Objectives and Requisition Definition</b>	Internal Meetings with all the departments involved for a deliberation of the requirements of the project, like the reach, capacity of base stations and access points, energy consumption and functionality. It was a two weeks task to allow the debate and focus on minute details to ensure the project is carried out in accordance with the requirements and specifications.
<b>1.3. Stakeholders and Priorities identification</b>	Internal Meetings to clearly identify stakeholders and confirm the respective inflows and for assign the priorities of the project. We decide to assign one week for this task because it is a project of considerable size as well as there is the intervention of many entities in the decision project.
<b>1.4. Study of the Necessary Material</b>	Internal Meetings for the study of the necessary material to the project. Four days were assigned for this task.
<b>2. Project Planning</b>	
<b>2.1. Initial Planning</b>	In this task, the objectives and the plane of activities are created, and the budget ceilings are set. Also, a risk Analyze is done in this task and is reviewed the current Regulation. The time for this task is 35 days so the planning is all set, and we can have some extra time if some problems occur.
<b>2.2. Formalization of technical Requirements</b>	In this task we get the Material Letter and Equipment list for the project. some Energy Requirements are also set in this task.
<b>2.3. Location Study</b>	Initially, is made a study of possible locations to implement the base station. After that, we visit the Different candidate Locations to check what is the best ones. The Priorities List is created and after a negotiation with the owner of the best locations, the Final Location is defined. 20 days were set for this task, so he has time to visit all the locations and negotiate with the owners.
<b>2.4. Get Authorizations</b>	External Meetings with the city hall staff, ANACOM and police forces for the Acquirement of the necessary authorizations for the project.
<b>2.5. Purchase Equipments</b>	After the Equipment Identification, we start the search for supplier and after we find the best one, the contract is negotiated and celebrated, and the study is implemented. 9 days were set for this task.
<b>2.6. Purchase Materials</b>	Study of the best suppliers and corresponding negotiation with them.
<b>2.7. Construction Project</b>	Search for the best Construction company for this project and corresponding negotiation with them. Celebrate the contract and Implement the Study.
<b>2.8. Energy Project</b>	This task begins with an elaboration of a Energetical Study for the Project. After that, the different Suppliers are studied, and the contract celebrated. In the end, is done the implementation Study. 23 days were set for this task so we can have some extra time if some studies take an extra time to be done.
<b>2.9. Links Project</b>	A LINK Study is made in the beginning of this task. After the Study, is done a Compliance Analysis and in the end, is done the Implementation Study. 23 days were set for this task.

<b>3. Implmentacion</b>	
<b>3.1. Implementacion Study</b>	Elaboration of the Telecommunication and Energy Project. 10 days were set for this task, so the Study is done correctly and there is no time wasting in the rest of the Project.
<b>3.2. Construction</b>	This task begins with the drafting of the Workbook. After this, the construction of the infrastructure is done. 7 days were set for the construction because is a low time-consuming work. After the construction, we set one day for the inspection of the job with all the people involved in it.
<b>3.3. Assembly of the equipment</b>	This task begins with the equipment transportation by an external company contracted for the job. After we get the equipment, the configuration and assembly of this equipment is set.
<b>3.4. Integration and tests</b>	In this final part, the radio configuration and the network connection are set. After this configuration are done, the tests for the network are made and, in the end, the guarantee of the total project is assembled.
<b>5. Project Finalization</b>	
	In the Project finalization, is set an internal meeting with all the departments involved and the final reports are made. Finally, the project end with an evaluation of the work done.